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MISCELLANEOUS REPORT
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THREE CASE STUDIES OF ORGANIZED RESPONSES TO CHEMICAL DISASTERS

Jane Gray

with the
assistance of
Nan Baer
Lori Minutilli
Philip Roblee
Henry Rossetti
Linda Sydnor

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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 19 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, 293 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 creek-bed.

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 ECC functions as an emergency dispatch center for the county's volunteer fire departments and community police departments. Under specified circumstances, the ECC 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 EOC 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.

CHAPTER III

THE FIRE IN MINUTILLI

Nature of the Event

At or just before 9:22 a.m., on a summer day, an explosion occurred in the "hot room" of a large chemical plant in the metropolitan area of the city of Minutilli. Equipment malfunction had resulted in overheating. The city fire department was called within a few minutes because a fire developed. While the fire never spread beyond the small building in which it started, a second and eventually a third alarm had to be sounded by 9:43 a.m.

Apart from continuing explosions, the greater danger stemmed from the fact that the plant manufactured and stored herbicides and pesticides, notably EPN, and methyl parathion which is a class B poison and highly toxic when inhaled, ingested or absorbed by the skin. The chemical company is on a five acre site located in the southwestern corner of the city's metropolitan area, dozens of miles from downtown and about a mile and a half east of a major river. However, the area surrounding the company grounds is very flat, and is used for residential as well as industrial purposes. The plant area is also subject to fairly high winds which usually blow northeast towards Minutilli.

About 30 employees were in the plant when an 8,000 gallon tank of methyl parathion initially exploded. One of the employees was badly burned at this time, although others were also knocked down, three of whom had to be eventually hospitalized. The explosion and fire also generally caused the release of some of the above mentioned dangerous substances into the air. A toxic cloud formed, which drifted to the southwest towards the river. Firefighters dodged exploding 55-gallon drums of chemicals which sometimes flew 500 feet into the air or sideways, and battled heat and poisonous fumes for more than two hours before the fire was brought under control. As the firefighters worked, the first of several evacuation calls were issued, as a major disaster was feared.

Evacuation eventually involved approximately 3,000 residents in a five square-mile area. Because the fumes were drifting towards the river, the Coast Guard closed the river to all traffic from the city to a point about 60 miles away in a neighboring state. General air traffic was also restricted from five miles around the site by air traffic controllers. This was at the request of the police department, both for purposes of safety and to discourage the convergence of sightseers in flying vehicles. It was later estimated that the mushrooming cloud reached a height of 3,100 feet and spread across a 30 mile area to the southwest.

There were no reported evacuations outside the city. However, internal organizational alerts were issued by law enforcement officials in four counties outside of the metropolitan area of Minutilli. Concern about the drift of the toxic cloud extended even to a nearby state. This led to the posting of state highway patrol officers and sheriff's deputies along the state line to monitor

for toxic fumes. None was ever detected.

Some of the evacuees had to be treated for illnesses. In fact, by late Thursday night, at least 230 persons had been given treatment for symptoms believed to be related to the fumes generated by the explosions at the plant. The civilian evacuees were primarily treated in hospital emergency rooms after complaining of inhaling toxic fumes, burning sensations in their eyes, vertigo, severe sweating, chest pains, severe nausea, and other similar symptoms. No deaths occurred among the civilian evacuees and there did not appear to be any permanent damage inflicted, although eight victims stayed overnight at hospitals.

The firefighters were not so fortunate. While most who had problems suffered from heat exhaustion while fighting the fire, one fire officer died as a result of a heart attack, and another broke his leg as a consequence of being hit by a falling drum. A few firefighters also exhibited the same symptoms of exposure to toxic fumes as had the civilian evacuees. Ten of them had to be hospitalized at least overnight, although again, there did not appear to be any permanent damage.

Actually casualties could have been more severe if the winds had been blowing in their usual direction. That day the winds were blowing southeast to north at 5-10 miles per hour before changing to northeast at 9 miles per hour. A weak high-pressure system had moved into the mid-south early in the morning of the explosion and reversed the area's normal wind direction so that fumes were carried southwest towards the river instead of into the heart of the city.

Most of the evacuated residents and workers were allowed to return to the evacuated neighborhoods by late afternnon. By that time, city officials had begun to worry about water pollution. They were told that water from the fire hoses might carry dangerous chemicals into nearby streams. If that happened, there was the possibility that contaminated water which ran into the neighboring creeks and lakes, could kill much of the life in them. In addition, there was also the potential hazard created by the fact that the firefighters had dumped some sulphuric acid manufactured at the chemical plant, into the nearby river to prevent further explosions.

Dikes were hastily built to direct the runoff water into a newly constructed drainage ditch. The city's public work department also poured soda ash into the creek in an attempt to neutralize impurities in the water. These actions were seemingly not totally effective, for later testing led to the finding that traces of the toxic insecticide, methyl parathion, one of the chemicals stored at the plant, had run into a nearby creek and then into a lake. Arriving late in the day, members of an EPA Emergency Response Team quickly prepared a filter system of potash to strain out impurities in the partly contained, but contaminated water. However, apparently there were not enough impurities in relation to the water volume, so that notable ecological damage was not later observed. Furthermore, in no case, was the drinking supply of any community catastrophically threatened since none used water from the creek, lake or river even under normal circumstances.

Direct property damage to the chemical plant was estimated to be in the three and a half million dollar range. In addition, nearly a half million pounds of chemicals were destroyed. Production losses because of an indefinite plant shutdown also ran high, and 80 employees were laid off. In addition, there were indirect economic costs. A major refinery and a major shopping center had been closed down and evacuated for about half a day. A department store in the center did not reopen until the next day because an executive with the keys to the store failed to return after the evacuation period ended. That next day also, businesses in the shopping center and nearby reported receiving calls from customers wondering if it would be safe to come and shop in the stores. Apparently no one made any effort to assure the general public that the neighborhoods near the chemical plant were safe after the first few hours of the disaster.

In the days after the fire, environmental and health officers scoured the southwestern part of the metropolitan area for other signs of pesticide contamination. None was found. However, nearby residents complained of damage that had been done to gardens, a neighborhood citizen's group voted to ask the plant not to rebuild at its old site, and a class action law suit for losses from the incident was instituted against the chemical company five days after the fire. The citizens' group was apparently partially successful, for at this time, the decision has been made to rebuild the facility elsewhere.

COMMUNITY CHARACTERISTICS

The city of Minutilli is surrounded by a major metropolitan area of approximately a million and a half people, considerably less than half of which live in the city itself. The county of Rossatti, in which the metropolitan area is located, covers about 750 square miles and is mostly built up residential and industrial neighborhoods. The city is also an important river port which handles millions of tons of cargo yearly.

The area is served by seven railroads and six airlines and is the hub of four interstate highways. The river port is the headquarters of half a dozen barge companies. Much of the river and railroad transport operations are in densely populated neighborhoods, many within a few blocks of the central business district.

The population is distributed about 1,000 persons per square mile. Nonwhites constituted about a third of the residents in the metropolitan area. People over the age of 65 constitute less than 10 percent of those in Rossatti county. At the time of our study, unemployment in the labor force numbered about six percent, slightly higher than the national average.

Traditionally, the area is Democratic in its political orientation. However, Republicans have done much better in recent times. The city of Minutilli has a mayor-council form of government, with Rossatti county having a mayor-court council form. Besides Minutilli, there are six other incorporated cities or towns in the county.

The total work force numbers over 300,000, with most of the employment being in nonagricultural pursuits. However, the single largest employer in

the area manufactures farm machinery, the second, automotive products. Over 30 percent of those in the manufacturing sector, are employed in the food and kindred products area. The value added by manufacturing to shipment of goods is around a billion and a half dollars a year. Retail sales in Rossatti county have recently been close to four billion dollars a year, with per capita income in the metropolitan area being around $6,000 annually.

The economy of the area is rather diversified. Minutilli is an agribusiness center involving processors, packers, shippers, distributors and merchants. There are many military installations in the region from all three branches of the armed services, as well as defense department depots. The health sector is represented by many facilities and installations. The labor force is almost equally divided between manufacturing, service industries, and retail trade.

Chemical concerns, with more than 100 plants in the metropolitan area and around $400 million in sales annually, employ almost 10 percent of the labor force. Most of the chemical manufacturing facilities, including three major installations operated by international companies, are located in relatively populated neighborhoods. Most plants, including the one in which the fire occurred, tend to be centered in complexes or clusters of similar industrial activities. One plant, manufacturing exceptionally hazardous materials, is not in a complex, and is in an isolated location within the metropolitan area but outside of the city limits.

Disaster Preparedness

There is very extensive disaster preparedness in Minutilli. This partly reflects the fact that the area is vulnerable to a wide range of disaster agents, ranging from tornadoes and earthquakes to technological accidents and breakdowns. However, there have been few actual disasters in recent years. Thus, while truck and railroad accidents have annually averaged more than 200 in recent years, there have been almost no casualties resulting from such incidents. Nonetheless, the area would rank relatively high by most criteria of disaster preparedness. There is also notably strong leadership in a few key emergency related sectors, and this has existed for a number of years.

Community awareness of possible chemical threats had particularly increased in the last few years. The Waverly, Tennessee disaster, which several years earlier attracted nation-wide interest because of the mass media coverage, had provided impetus in Minutilli for preparations for chemical disasters. The mayor and other city officials led public efforts to improve preparedness for chemical hazards. Such efforts were strongly reinforced a year later when a local hospital had to be evacuated because of a threat of an explosion from an overturned LPG tank car. In just the six months prior to the chemical plant explosion described earlier, there had been over 30 hazardous materials incidents in the city involving fires or other threats of varying magnitude.

The civil defense office has developed a comprehensive master plan for mass emergencies including besides natural disasters, incidents associated with technological accidents, civil disturbances and nuclear warfare. The

plan consists of a matrix-type division of responsibilities specifying primary and secondary responses, plus a call-up list of organizational contacts. Under the section describing the necessities of the plan, reference is made to toxic chemical disasters both in plants and various transportation modes. Apart from the formal linkages indicated in the plan, there are important informal ties between key emergency organizations as we describe later under the "Resources" section of this case study.

An annex of the plan specifically deals with evacuation and its coordination. A standby evacuation committee has representatives from the:

1. city fire services
2. county civil defense/emergency management office
3. local chapter of the American National Red Cross
4. city police department
5. county sheriff's department
6. city and surrounding area transit authority

The committee has established which organizations are responsible for what functions, how activities are to proceed, and how the overall effort is to be integrated.

While the community disaster planning is impressive and certainly better than found in the typical American metropolitan area, it is far from perfect. For example, none of the very many transportation companies in the area are involved in the community disaster planning. The standby Emergency Operating Center is located in a city government building which is astride an earthquake fault. While the police department claims to have a subplan for dealing with hazardous chemicals, no one, including the author, could locate a copy of the plan when a DRC field team asked to see it.

Resources

As might be expected, there are many emergency relevant organizations in and around the metropolitan area of Minutilli. These include not only city agencies and county groups, but also elements of state and federal units such as the military components in the numerous bases and facilities in the area. In addition, there are the relevant resources of a variety of organizations in the private sector, in particular the chemical companies located in the region.

However, the key resources for disaster planning and response in the Minutilli area exist primarily in a few organizations. These include the local fire and police departments, the county civil defense, many of the hospitals and some of the major chemical companies in the area. They have substantial resources by way of planning, information, expertise and equipment for responding to a wide range of potential disasters in the Minutilli metropolitan area. In principle, extra community resources are also potentially available, but it would have to be a major disaster or catastrophe for such resources to be needed because the local organization could not meet emergency demands.

The city fire department has historically played a leading role in disaster planning. It numbers more than 1,500 personnel, has over 150 pieces of equipment, and receives more money per capita than does the local police department. The fire department by planning and tradition is designated as the primary responding agency to incidents involving hazardous materials. It has instituted a hazardous materials section which is currently receiving extensive training and has purchased hazardous materials equipment. All operational fire personnel have been given some instruction as to the handling of hazardous materials. In addition, the fire department was, at the time of the fire incident at the chemical plant, developing a specific hazardous materials disaster plan. This fire department also was one of the few in the country that, at the time of the fire incident, had established a special hazardous materials unit.

The police department in Minutilli actually is slightly smaller in size than the fire department, although average salaries are somewhat higher. In recent years it has been wracked by internal conflicts and disagreements, and does not seem to be as positively viewed by other public officials as is the fire department. The police department also has given its field personnel some training in the identification and handling of hazardous chemicals, although the training is nowhere as extensive as that given by the fire department to its own personnel. In the main, however, the police see their functions in acute chemical emergencies as not being too different than what they would do in any kind of major disaster.

Both by planning and understanding, there is a division of labor projected for the local police and fire departments in many disasters, and especially chemical emergencies. Thus, the agreed-upon strategy is that the fire department will deal directly with the incident and the police department will provide security and conduct evacuations. The county civil defense office is to handle all coordination with state agencies.

This recently developed cooperation between the police department and the fire department concerning the responses to hazardous materials has had the effect of breeching a 25 year old feud encompassing the local police and fire departments. Much of the newfound cooperative spirit seems traceable to the actions of the individuals responsible for the hazardous materials training in both the police and fire departments. There were reports of resistance to cooperation from higher authorities in both departments when disaster planning initially was jointly attempted. But whatever the history, and whatever formal written plans currently call for, there are close informal ties between key operational members of the fire and police departments.

Over several dozen hospitals in the region have unusually highly developed disaster plans, and frequent exercises of them. However, they are not well dispersed geographically, with many clustered in one section of the city, although there are satellite facilities in many locations. Because Minutilli is located relatively close to another state, the hospitals draw patients from across the state line, and both their everyday emergency operations and disaster plans take into account the crossing of this jurisdictional boundary. There is, in addition, a great deal of inter-hospital interaction especially with respect to disaster planning. The high degree of interaction is noteworthy, considering that until recently there was no federal support for the EMS system.

There are close links between the hospital sector and the county civil defense office. In part this is because the communication center at the civil defense office provides the back-up system for the dispatching of hospital ambulances in the region. Prior to the fire incident, the civil defense office and the hospitals had been in the process of developing plans to conduct drills with hospitals on how to handle hazardous chemical episodes, which had not been particularly attended to prior to that time.

A number of the chemical plants in the metropolitan area have intensive emergency and disaster plans for their individual facilities. However, there is no formal plan linking the chemical sector, and there is no mutual aid group or planning, as is often found in localities with many chemical plants. Nonetheless, there is considerable contact and interaction between a number of the major chemical companies and the Minutilli fire department. For example, the companies routinely send experts to help the fire department with chemically related incidents. There have been instances of the lending of specialized emergency equipment between and among the chemical companies and the fire department.

Other city and county emergency relevant organizations tend to be more low keyed in their orientation to disaster and chemical incidents planning than those just discussed. Thus, the Minutilli public works department is allocated a debris clearance function at times of disasters. This is known by key officials in the organization but is otherwise not a very salient matter. The county sheriff's office has some general plans and understanding of its role in a community emergency, but is not especially linked for this purpose to other emergency relevant agencies.

Organized Response to the Disaster

At 9:22 a.m., the city fire department received a call from an unknown observer stating that there was a large cloud of smoke around the area of the chemical plant. At 9:23 a.m., records indicate the chemical company called and informed the fire department that an explosion had occurred. The city fire department immediately sent a company to the scene of the fire. The senior fire officer who arrived on the scene then radioed back to headquarters that the other companies should stay out of the area until it could be determined exactly what dangerous chemicals might be present. However, the fire was such that at the same time, he called in a second alarm. It was not until a little after the second alarm was activated at 9:37 a.m. that the fire department, with the help of the chemical company president, identified one of the main chemicals involved--methyl parathion. By the time the third alarm was called in at 9:43 a.m., the fire department had already dispatched two hazardous materials units to the scene, and all firefighters had been instructed to don protective gear.

When the local fire chief arrived and assessed the situation, he decided to contact by radio the Rossatti county civil defense office, and requested that they send some of their personnel to the scene to set up evacuation procedures. A command post was then set up in a hazardous materials vehicle, parked upwind from the building in which the major fire raged. At the time when the fire companies responding to the third alarm were arriving on the

scene, a lieutenant in one of the hazardous materials unit of the department noted an additional potential problem. It appeared some of the runoff water being sprayed on the fire might be sweeping some hazardous chemicals into a nearby creek. Because of this, the city public works department was contacted for earthmoving equipment and dirt to build dikes to catch the runoff water in a drainage ditch. But it was some time before the work could be done, and all the runoff water was never fully channeled into the drainage ditch. The last of the fire was put out by about 11:40 a.m. In all, the city fire department eventually had 28 pieces of equipment from 17 stations on the scene.

Units from the city police department arrived at the chemical plant only after the third fire alarm had been sounded. Apparently they learned of the fire situation from hearing communications on the Minutilli fire department radio channels. When the police got to the plant they also consciously and deliberately set up their own command post apart from the one that had been established by the fire department.

The Rossatti county civil defense director arrived on the scene at approximately 10:30 a.m., summoned by his own office which had been monitoring the radio communications of the local emergency organizations. After meeting at the fire department's command post with representatives from both the fire and police departments, he decided to evacuate civilians from nearby areas. A public announcement of an evacuation was made at 11:00 a.m., more than an hour and a half after the initial explosion at the chemical plant.

The major organizations involved in the evacuation effort were the civil defense agency, the city police department, the sheriff's office, and the city mass transit authority (which was asked to participate by the local police). The local chapter of the American Red Cross was apparently only contacted by telephone. A general decision was made to evacuate nearby neighborhoods. Several different evacuation calls were consecutively issued, encompassing an even larger area. Eventually a five square mile area was evacuated, and it was later estimated that about 3,000 residents left. The evacuation was kept in effect until the late afternoon. At that time, evacuees were allowed to return to all but a two block neighborhood right around the chemical plant. At 9:00 p.m. finally, all evacuated residents were allowed to return to their homes, although most had returned much earlier.

The majority of evacuees, as is usually the case in mass emergencies and disasters, went to friends and relatives. Only about 300 persons moved into a Red Cross shelter set up at a nearby high school. These people left this shelter in the middle of the afternoon, when some public officials said it was safe to return to the affected area. The public shelter was not well organized since until about 1:45 p.m., the only organizational representative at the shelter was a Red Cross volunteer. Other agency officials arrived later, but at the time most got to the building almost all the evacuees were already starting to leave. Mass transit buses that were supposed to take people home never materialized, so most evacuees had difficulty getting quick transportation.

The organization involved in the evacuation effort originally tried to warn people by use of speakers on police helicopters and squad cars. This did not prove to be a totally effective way of reaching people. Some residents

near the chemical company had their windows closed and air conditioners running. So they never heard the warnings broadcast over the public address systems of the three helicopters being used in the effort. Most of these people learned of the possible danger from neighbors who came to their houses and told them of the fire and the explosion. Some also reported the presence of a cloud of "black smoke" coming from the plant site.

The warnings issued by the police cars were more successful in alerting people to a crisis situation. However, the warning messages were not clear on what to do. Thus, some residents left using their own cars. Others in the neighborhood collected on streetcorners, because some of the warning messages from the police indicated city buses would come into the area to evaucate people. Still other persons, including some elderly persons, attempted to walk out of the neighborhood. Little information was ever provided by anyone as to the best direction in which to flee. But as is usual in disaster evacuations, a significant number, even among those who heard the police warnings, refused to leave the area. Most of those who evacuated seemed to have left at a relatively slow pace, and except in isolated cases, there appears to have been little sense of urgency on the part of evacuees.

Part of the difficulty in the evacuation effort was that the involved emergency organizations were themselves not too clear initially about the situation. The fire, police and civil defense organizations had different and sometimes contradictory information about the incident and its development. Thus, at one point, one agency understood evacuation should be to the east whereas another organization thought the evacuees would be safer to the west of the burning chemical plant. After considerable discussion, consensus was reached on this point, but as indicated earlier, was not very well communicated to the possibly endangered population.

In retrospect, the civil defense office responsible for coordinating the evacuation thought it had gone well, and did not think much of anything would be done differently in a future similar situation. However, it was noted that afterwards some neighborhood residents complained they never received any official notice or warning of the danger, and others said that promised bus transportation, both for leaving from and returning to their homes, never materialized. In turn, civil defense officials reported observing neighborhood residents ignoring the evacuation calls and remaining in their homes.

In addition to helping and trying to coordinate the evacuation, the local civil defense office, using the Emergency Operations Center under its control, monitored all radio communications to and from the plant site so as to keep informed about the general situation. The office also answered requests for information from press representatives as well as private citizens, and attempted to keep a record of all happenings (later, the detailed time sheets that had been filled out during the emergency were accidentally thrown away when the office was cleaned up several days after the disaster). The civil defense communications officer also called CHEMTREC, duplicated a similar call for information by the hazardous materials unit of the Minutilli fire department. CHEMTREC put both organizational callers in contact with the Pesticide Safety Team network.

The police department, apart from assisting in the evacuation, primarily provided security at the plant site. Their operational command post did not seem to be as fully cognizant about the situation as was the fire department, but little effort beyond the use of couriers was made to establish better on-the-scene communication between the two. The relative absence of massive congence on the plant, and the relatively low number of evacuees, allowed the police to maintain their normal traffic control patterns. There were apparently no reports of looting in the evacuated neighborhoods, mostly consisting of a working class nature.

The area hospitals did not receive any special notification of the plant incident. Six of the hospitals started receiving patients in their emergency rooms at approximately 10:30 a.m., a good hour after the initial explosion. The influx of patients was such that none of the hospitals ever activated their disaster plans, although several went to an emergency stand-by alert. Some of the local institutions did contact the state university poison control center for information on how to handle the toxic symptoms exhibited by their patients. A rather delayed triage effort near the plant site did not handle many casualties. These patients were transported by fire department ambulances, which on an everyday basis, provide this component of the EMS system in the city of Minutilli as well as Rossatti county.

While the fire in the plant was out by noon the day of the explosion, smaller fires broke out the following two days. This necessitated further runs by the fire department. At the end of that time, several fire officials returned to the fire scene to assist in the decontamination of hoses and other appliances which might have been contaminated during the course of the fire fighting. Several fire fighters also put on special suits so they could enter the ruins of the building where the fire originated to recover the thermostat that controlled the heating unit.

During this time also, the fire department was asked to check on the temporary dam which the public works department had constructed to contain the contaminated water in a drainage ditch. It was decided that the dam was deteriorating and needed to be reinforced and its height raised. The public works department was again contacted, and performed the necessary tasks to the temporary dam.

The federal EPA was brought into the situation to deal with the possible water contamination problem. In fact, in less than two hours after the initial explosion, a local unit of the Coast Guard, following the National Contingency Plan for hazardous spills and at the urging of the local civil defense office, notified the EPA of the situation. An emergency response team was sent from a nearby state to do the chemical containment and clean up. A regional EPA coordinating officer arrived on the scene about 5 p.m. the day of the explosion. The city public works department had already made its initial effort to build dikes and to channel the runoff water into a drainage ditch. The EPA team eventually took over, and nearly a week later helped pump the contained contaminated (although somewhat treated) water into the river.

Overall, the explosions, fire and toxic releases and spills at the chemical plant were a major and serious emergency for those directly involved. However, the incident presented more of a potential threat rather than actual

disaster for the city of Minutilli. While most of the emergency organizations in Minutilli and some of those from Rossatti county participated in the emergency response, community life as a whole was not interrupted for long or in a serious way. For most people in the metropolitan area, the incident at the plant was primarily a local news story; only for several thousand people around the plant was there a direct impact or actual threat to life and well being. A more community-wide disaster had been possible, but did not materialize, which was fortunate since the organized response to the incident showed some weaknesses as well as strengths in the community disaster stance.

Evaluation of Response

In the previously discussed case study of Baer, it was observed that there was a generally poor response to the explosion. In the fire case reported in this chapter in Minutilli, both positive and negative aspects of the response can be noted. Overall, the organized effort was far better than that described for Baer, but not as good as will be detailed in the next chapter which describes the major dangerous chemical incident at Mississauga, Canada.

Extra community agencies who participated in or evaluated the organized response at Minutilli, found much to praise. Similarly, the post-disaster self critiques made by the community emergency organizations noted a number of positive aspects about what had happened. Likewise, it is possible to arrive at some favorable evaluations when the organized response is measured against the pre-impact planning for mass emergencies.

From a technological viewpoint, the community as a whole had more expertise and resources available for chemical disasters than is typically the case. There was no shortage either of appropriate knowledge or material and immaterial things necessary for the kind of incident which occurred. The fire department seemed particularly professional in its approach to the plant explosions and fires. The firefighters who initially arrived on the scene were careful, and quickly obtained information about the nature and properties of the dangerous chemicals which might be involved. Protective clothing was worn as it should have been in such a situation. Fire department members were well trained in setting up equipment, and in the use of unmanned nozzles which permitted the penetration of a volatile fire situation without unnecessarily risking personnel.

From an organizational perspective, some, although not all, appropriate communication and coordination was achieved. The civil defense office performed its mandated function of monitoring all emergency relevant communications. It did notify several key officials and organizations fairly quickly after the incident started. The Emergency Operation Center did partially operate as a general information center and a referral point. Prior liaisons between the local fire department and the chemical company enabled the two organizations to quickly exchange information when the first fire units arrived at the plant site. Officials from the company were able to keep the firefighters fairly well informed of the nature, properties and locations of dangerous chemicals in the installation. Chemical company and fire department officials kept in communication from the start of the incident through to the small fires occurring in the post-disaster period, and essentially took a

cooperative approach to the whole situation.

Some of the previously planned division of labor was carried out. The fire department, with its expertise (including its hazardous material units) was in complete charge of operations on the scene. The police department, as prior disaster planning had specified, led the effort to warn residents in the neighborhoods about the danger, and also issued the calls for an evacuation. The federal EPA regional team was the coordinative agency in charge of the neutralization and the clean-up of the resultant water contamination.

Up until the incident, the community disaster planning for a toxic chemical incident had not been seriously tested. The explosions and poisonous fumes from the chemical company presented a potentially dangerous situation for the community as a whole, and an actual disaster for those most directly involved. On the whole, emergency organization officials believed that they did well. As one official said:

> We have a plan for disaster preparedness and this is what we used to great effect. We had the potential for having a lot of people killed, but the firemen knew what to do and what had to be done. They did a superhuman effort at getting things under control.

Similar positive statements were made in post-impact mass media evaluations of the incident.

On the other hand, there were some serious technological and organizational problems in the organized response, not all of which were explicitly recognized by the responding groups. Not all parts of the disaster planning worked equally well, and in some cases, even when the plan was followed, unforeseen difficulties emerged. One very important aspect of what occurred, the evacuation effort, was seriously flawed from the initial warnings to the returning of the evacuees to their homes.

In the technological realm, at least several questions could be raised, although none are as important as some major organizational weaknesses. None proved to be serious in the particular incident involved, but the potential for problems in future similar emergencies is obvious.

There was a possibility that foam rather than water could have been used in extinguishing the initial blaze. This could have restricted the extent of the toxic plume. Even the specialists in the fire department's hazardous materials unit were unclear after the incident, as to which substance was preferable although it was acknowledged that the cost of the foam might be prohibitive.

The fire department personnel themselves felt that they may have concentrated too much of their effort on extinguishing the fire. This led them to ignore the eventual run-off problem. They indicated that they should have recognized the problem sooner and avoided much of the contamination through earlier construction of a dike.

No thought had apparently been given to the communication batteries that would certainly run dry if they were in continuous use. Minor lapses in

communication occurred because of this lack of planning. It was thought the problem might be solved in the future by maintaining additional batteries and charges at the operational command post.

There seemed to be some question, although not by the agency itself of how well the EPA Regional Team handled the whole post-disaster contamination issue. It was not certain, according to some local experts, that an adequate analysis had been made of the contaminated water contained by temporary dikes in the drainage ditch. The decision to let the water into the river appeared doubtful to some.

More important were several organizational problems. In particular, there were serious difficulties with the evacuation process and with some aspects of interorganizational communication with the public.

As already noted, while people were evacuated, there were problems at all stages of the process. There was confusion and delay in deciding when and how far to evacuate. Warning messages failed to reach all potential evacuees, and when it was heard, the information provided was sometimes incomplete or inaccurate. The public shelter was not prepared to receive evacuees. No clear system of notifying evacuees when to return was developed, and residents obtained inconsistent information on the matter from a variety of sources. Those in the public shelter had to find their own way back to their homes. Behind the scenes, key organizational officials never had a good overall grasp of the evacuation effort.

Some organizations communicated well with one another, but many did not. The separate command posts established by the fire and the police departments, according to the disaster plan, to avoid communication related convergence, created other communication problems. The use of couriers between the posts to coordinate fire fighting operations with those relating to site security and evacuation, did not work too well. The police department clearly lagged in its knowledge of disaster related happenings. Close pre-disaster informal links between some fire and police personnel helped to link the two organizations, but could not completely compensate for the consequences stemming from the establishment of two command posts. The area hospitals were never really linked to the other emergency organizations. Extra-community groups were sometimes independently and unnecessarily contacted by several different local groups.

The lack of interorganizational communication extended over from the emergency to the post-impact period. This resulted in unnecessary duplication, for example, in the testing of water quality. This task was performed by the EPA, the public health department and the local department of public works. While the EPA was sending samples for analysis to its laboratories, the state D.P.H. maintained a mobile lab at the site, and unknown to both organizations, the Minutilli public works department had comprehensive laboratory equipment and qualified analysts in its own organization who could have done the analyses.

Apart from these two major problems, there were other, more minor difficulties. Information dissemination to the press was provided by many different organizational personnel at the scene, resulting in the public receiving

confusing and inconsistent information. The civil defense agency tried to deal with this problem but could respond only to press calls to its Emergency Operations Center. No pass system was ever established. While there was no great convergence on the disaster site, law enforcement agencies enforced site security so tightly, that key officials from other emergency organizations were unnecessarily detained at roadblocks. Not all organizations which on an everyday basis have little or no emergency functions or responsibilities can quickly adapt when a disaster happens, even when they are made a part of the community disaster plan. In the Minutilli incident, the city's public works department was quickly able to provide the personnel and equipment to build temporary dikes; the mass transit company proved unable to speedily deliver the buses and drivers needed for a relatively small-scale evacuation effort.

Concluding Remarks

The technological difficulties noted should be seen in a larger context. Those aspects alluded to partly reflect the professionalism and standards of excellence pursued in a particular community. Both professionalism and standards are high in Minutilli, certainly as compared with the orientation of many other communities to chemical emergencies and disasters. The problems of contaminated water run-off, radio communications disruptions and questions relating to the use of foam in firefighting are ubiquitous in such situations although the recognition of errors in response is variable. In Minutilli, they were recognized because they were seen as falling below acceptable professional standards.

There was far less recognition of the organizational problems in the response. There was little indication that the evacuation process in disasters was going to undergo a major reexamination. Neither did it appear intensive efforts would be made to attempt to improve the planning for interorganizational communication and coordination in future disasters. In part, this may stem from the relatively weak position of the civil defense organization in Rossatti county, both in terms of legitimacy and power. While the local civil defense office seems to be more positively evaluated in the area than is the typical civil defense agency in most American communities, this is only in relative rather than absolute terms. It does not appear that advantage will be taken of the opportunity provided by the incident, to point out the weaknesses of disaster planning and response in the area, and how the event showed what serious problems could arise in a more catastrophic future situation.

There were positive aspects of the organized response, as noted earlier. Unfortunately, it appears the key and relevant emergency officials and organizations in Minutilli will only stress those in their longer run post-disaster public stance. It is valid and important to point out where disaster planning is good and when it works. In fact, the positive aspects can be used to lead into an examination and analysis of the less positive features in the situation. If this is not done in Minutilli, and it does not appear to have been done as of the writing of this report, the future may bring a catastrophe where the negative aspects might overwhelm the positive ones, unlike in the just discussed case where there were elements of both.

CHAPTER IV

THE MISSISSAUGA, CANADA, TRAIN DERAILMENT

As indicated earlier, we make no attempt to mask or provide pseudonyms for the persons, places, and organizations described in this case study. Such details have already been publically published by others elsewhere (see [illegible] especially Scanlon and Padgham, 1980 and Whyte, 1980). But as is often true when multiple accounts of a disaster are available, differences in "facts" as well as interpretations have to be reconciled. In general, we have taken as the more valid account that which was most consistent with what was found by our own DRC field researchers.

Nature of the Event

On Saturday, November 10, 1979, at approximately 11:52 P.M., Canadian Pacific Railway (CPR) train #54 derailed in Mississauga at the Mavis Road crossing. Mississauga is a city lying along the north shore of Lake Ontario just west of Toronto, Canada. En route to Toronto from London, Ontario, the train pulled by three locomotives consisted of 106 freight cars, thirty-nine of which were carrying dangerous chemicals--butane, propane, styrene, propylene caustic soda, and toluene. There was also one tank car containing ninety tons of chlorine.

The accident was attributed to an overheated journal box on the 33rd car, a tanker carrying the highly flammable solvent, toluene. Eyewitness reports indicate that as the train entered Mississauga the wheel assembly of the tanker was glowing red. Due to a lack of proper lubrication, the friction bearing within the journal box had seized up. This, in turn, caused the wheels to seize up, generating a great deal of heat. The heat resulted in the loss of a set of wheels at the Burnhamthorpe Road crossing. Approximately a mile and a half down the track, the tank car derailed at the Mavis Road crossing, causing the next twenty-three cars or so to also derail. Two of the derailed cars carried insulation; all the rest were loaded with dangerous chemicals. The fire which ensued at the time of the derailment ignited the toluene, resulting in a massive and noisy explosion that could be seen and heard for miles around.

About fifteen minutes after the derailment and initial explosion, there was another explosion which sent a propane tank car flying nearly half a mile through the air. Ten minutes later, another one of the eleven propane cars exploded. About this time, the train crew managed to move the uninvolved, anterior part of the train three or four miles down the track out of danger. However, it was also determined that the chlorine tanker was one of the derailed cars, and that chlorine was leaking from it, though some gas was initially sucked up by the thermal column created by the fire.

The Mavis Road area is a mixed, light industrial/residential area. Geographically, it is the approximate center of Mississauga, though not a typical downtown business district. Two chemical plants; a Bell Telephone of Canada

switching facility; a nursery greenhouse; a large truck repair garage; and a garage that houses city maintenance vehicles are all located within the general area of the derailment.

The response to the incident lasted from approximately 11:53 P.M., Saturday, November 10 to the afternoon of Friday, November 16. Despite the actual derailment, the massive explosions, and the emission of toxic gases, there was not a single fatality. Only a few injuries (numbered at less than a dozen) did occur as a direct consequence of the incident. Less than a dozen fire and police officers, or other emergency responders were treated for fume inhalation, with only one being hospitalized.

However, the incident led to a massive evacuation. Approximately 217,000 residents, three hospitals and several nursing homes were evacuated. As such, there was the displacement of seventy five percent of the population and disruption of the entire city and much of the surrounding area for the better part of a week. It can even be said that the whole of the Province of Ontario was affected by the Mississauga incident, as much social disruption resulted in the region surrounding the community due to the necessary absorption of the thousands of evacuees.

The large-scale evacuation resulted in enormous costs. The absorption of evacuees by surrounding communities required time, effort and financing for the supply of food and shelter. Additionally, all business establishments, schools, hospitals, nursing homes, etc. in Mississauga were closed from Sunday, November 11 through Saturday, November 17, resulting in a loss of income to individuals and a loss of productivity to employers.

There were also indirect consequences of the incident. There was, for example, the loss of family pets and the damage done to homes by pets in the absence of their owners. At a more immaterial level, there was the psychological cost of having routines abruptly interrupted although serious mental health effects can not be seriously attributed to the incident, some evacuees and others affected probably had their sense of security shaken.

Physical damages caused directly by the derailment, fires, and toxic releases are minimal compared to the general social disruption. The greatest physical damage was done to the railroad track, roadbed, and twenty-four or so railroad cars. Other significant physical losses include: the melting of a greenhouse roof; the total loss of a roof and fire damage to the parking garage for city vehicles; several burned city vehicles; and slight damage to a few houses due to heat generated from the fires.

The environmental or ecological impact of the incident appears to have been almost nonexistent. The clouds of gases released into the area were probably blown south over Lake Ontario where they dissipated safely. The railroad roadbed was contaminated by substances such as caustic soda and hydrochloric acid, but the soil was later replaced with new soil.

Community Characteristics

The city of Mississauga is the home for some 285,000 residents. The population is thinly scattered over an area of approximately 111 square miles of relatively flat terrain. It is an ethnically mixed and diverse population with many recent immigrants. The residents mainly fall into the middle and upper-middle income ranges, and are on the average, relatively young (only 16 percent of the population is over 45 years of age).

Although Mississauga is a city in the legal sense, it lacks any definable central core which is usually characteristic of a city. This lack of a recognizable city center can probably be attributed to the way the city came into being. In 1968, the Township of Toronto became the "Town" of Mississauga. Six years later, on January 1, 1974, the "City" of Mississauga was formed through the incorporation of the Town of Mississauga, with the three small surrounding communities of Port Credit, and Streetsville and part of the town of Oakville. As a result of this reorganization of several distinct entities into a single city, Mississauga has no identifiable nucleus. Part of an urban corridor along the northern shore of Lake Ontario, it is bordered on the north, east and west by urban communities with respective populations of about 150,000: 2,200,000; and 540,000.

Mississauga contains the largest shopping center in Canada, Square One, as well as private homes among the most expensive in the country. Its highways are the busiest in the nation, in part because nearly 50,000 residents commute to work mainly in Toronto, and another 30,000 people daily come into the community to work. The residents depend heavily on their own motor cars with mass rapid transit carrying less than twenty percent of the population at rush hour.

The city has its own school system, hospital, public works and fire departments. The waterfront is patrolled by a marine division of the police who have a departmental boat. Mississauga has a mayor--city council type of governmental structure. The mayor is elected by the voters at large, but each of the nine councillors is elected from a particular ward.

Governmentally, the city of Mississauga is part of the Peel Region. On the same day the city was created, the county containing, was regionalized. Peel Region is composed of the three municipalities of Mississauga, and two adjacent communities. At the time of regionalization, the Peel Region occupied 484 square miles and had an approximate population of 330,000. A more recent (1979) population estimate for the Region is 437,000 with a population density of 693 persons per square mile.

The Peel Region is largely urban with a strong industrial base. Several oil refineries, numerous chemical factories, an airplane plant, and an international airport can be found within the Region. There are limited port facilities, but extensive railway lines run throughout the area.

The regional government consists of a Regional Chairman and a Regional Council. The Chairman and five of the Councillors are elected with the three remaining Councillors being appointees from the elected members of the city councils involved. The regional government is responsible for property

assessment, arterial roads, health and welfare services, regional financial planning, emergency measures, conservation efforts, water supply and treatment, garbage disposal, and police duties. Other services, including firefighting and engineering services, are provided by the municipalities.

Disaster Preparedness

Various agencies and organizations within the Peel Region have their own disaster plans--plans which range from the very specific and detailed to the very general. Overall, disaster preparedness in the form of formal written plans is comprehensive but general in nature for the region. One plan, the Peel Police Disaster Plan, is particularly noteworthy. The Peel Regional Police force provides the police services for Mississauga. Not only is this the plan that was put to the most use during the incident in question, but this police force is the core of disaster planning for the region. The Peel Police Disaster plan was formulated in 1974 by police planners in conjunction with other emergency relevant organizations: the city management and department heads, the ambulance services and the region's hospital administrators.

The plan calls for a specific notification procedure; the establishment of an on-site command post (Temporary Headquarters); and a designated senior officer as on-scene commander. Also, great emphasis is put on communications and mass media relations. The plan provides for the maintenance of contact between personnel operating at the scene and the Temporary Headquarters, and personnel at the communications bureau of police headquarters. The plan also addresses media relations, making explicit provisions for the accommodation of media personnel. The plan calls for the establishment of a press information center and a senior officer as mass media relations officer. The plan also contains provisions for crowd control and evacuation, and specifies the duties of various officers who might respond to a major emergency. Hazardous materials are addressed in an appendix to the plan entitled "dangerous gases."

It is required that officers know the present plan before they can pass examinations for more advanced positions in the force. The plan is regularly updated and revised. In fact, the plan has been further revised since the occurrence of the Mississauga incident.

The plan has been tested both in actuality and simulations. In June, 1978, the Peel police responded to a plane crash at the Toronto International Airport. Two people died and one hundred passengers and five crew members were injured as a result of the crash. This disaster led to the implementation of the Peel plan for major emergencies and gave the police experience in setting up an outer and inner perimeter, using their mobile control trailer, and in dealing with mass media personnel. On October 2, 1978, an arsonist started a fire at a large fuel oil storage area in Mississauga. Again, the police responded. The plan's provisions for evacuation were put to the test as approximately 1500 persons were evacuated. It also gave the police some familiarity with the structure and functioning of other emergency organizations in the area.

The plan has also been tested by way of simulation. One simulation involved a cooperative effort with the Royal Canadian Mounted Police, the

Ontario Provincial Police, the Metro Police of Toronto and Metro Ambulance at the Toronto International Airport. The other simulation involved a hostage incident, which included a relocation action.

Three major points can serve to summarize the state of disaster preparedness in the Mississauga area. First, the Peel Police Disaster Plan is general but comprehensive. The "paper" plan is in existence, but more importantly, relevant personnel are knowledgeable of it. This knowledge extends beyond the police department to other emergency relevant organizations who seem to be well aware of the plan. In addition, emergency relevant organizations seem to be quite aware of what other organizations are supposed to do in times of disaster.

Secondly, disaster preparedness is greatly enhanced by the existence of interorganizational linkages. The linkages are partially the result of the interaction that took place between organizations during previous disaster experiences and simulations. This prior contact has helped the Peel police to establish ties with other emergency relevant organizations, social bonds which will facilitate coordination during disaster. Moreover, these prior experiences revealed to emergency planners the need to develop expertise in decision-making abilities in order to improvise solutions to problems encountered which are not covered in planning manuals.

Lastly, preparedness is greatly enhanced by the generally positive attitude towards planning by emergency relevant officials. In general, community officials show a great desire to maintain a high level of preparedness for emergency situations. The community's proximity to the Toronto International Airport has been noted as a most visible objective threat to the area and has served as a primary impetus to the development of community-wide disaster planning.

Resources

There are extensive disaster-relevant resources available to the Mississauga area. There are not only municipal resources, but various extra-community ones. Our description will primarily touch on the police resources since they are central to the disaster planning in the area, and were the most crucial in the train derailment event.

On January 1, 1974 when Peel County became Peel Region, the Peel Regional Police Force also came into existence. Five separate police forces--those from Brampton, Chingacougy, Mississauga, Port Credit and Streetsville--were combined to form the Peel Regional Police. Before the amalgamation, the policing of rural areas not within the jurisdiction of the five separate police forces was provided by Ontario Provincial Police (OPP) at no cost to the municipalities. However, Peel Regional Police now have jurisdiction throughout the region. They report to a locally appointed police commission and, ultimately, are responsible to the Provincial Solicitor General's office.

The combining of the strengths of the separate forces was the result of a decision by the province that certain government duties would best be handled in larger regions. Indeed, the amalgamation resulted in the consolidation of separate resources for more effective use. Prior to regionalization, the

separate police forces ranged in size from 232 men at Mississauga to 10 men at Streetsville. As a result of the consolidation, there are three detachments of police, one located in each of Mississauga, Brampton, and Streetsville, and there is approximately one officer per every 800 residents, or about 6,000 officers. These sworn police officers are assisted by about 125 civilian workers.

The creation of the Peel Regional Police Force did not just consolidate police personnel; it also brought together officers with varied experience in disaster operations. For example, the police in Mississauga had responded to a major fire resulting from a gas leak. In this incident, fifty-four vehicles were destroyed as well as twelve homes. Nineteen other homes were damaged, and people were burned and one person was killed. This emergency necessitated the evacuation of residents in the vicinity of the fire. Many of the same officers who were involved in this earlier disaster in 1969 were also involved in the train derailment incident, and the experience they brought with them was invaluable.

In addition to its experienced human resources, the regional police force is also very advanced in regards to specialized equipment. The force's disaster operations are facilitated by cars with public address systems; disaster kits equipped for major emergencies; portable radios for every officer on duty, and among other equipment, a 36 foot self-contained Mobile Command Trailer. The force also has about 175 vehicles of different kinds.

Other notable changes that have occurred since regionalization include the adoption of the detailed emergency plan described earlier; an overall increase in emergency training for officers; and a general increase in professionalizatio alization, with all officers attending the provincial police college. The increased emergency training may be partially due to the demise of the Emergency Measures Office (EMO) at the provincial level (roughly equivalent to state civil defense in the United States). There is no longer an EMO budget or any EMO equipment, and as such most of the duties of the defunct organization have been taken up by other organizations such as the Peel Regional Police Force. The increased level of professionalism is also probably due, in part, to the efforts of the current police chief. He places great value on educated and articulate officers, and is thus very selective and encourages his officers to advance their studies. By 1979, over half of the police force had acquired diplomas or university degrees either before or after being hired with much of the costs being borne by the department. The The police chief himself has had university training in psychology and administration. As might be expected, within two years after regionalization police expenditures had nearly tripled. The increase in expenditures is due not only to the increase in emergency measures training of officers and the increase in emergency measures training of officers and the increase in overall professionalism, but also to the inclusion of rural areas within the police jurisdiction which were previously patrolled by the Ontario Provincial Police (OPP).

Even though Peel Regional Police is the force mainly responsible for the policing of Mississauga, other police forces are at the city's disposal. During emergencies, the Royal Canadian Mounted Police (RCMP) and OPP readily render assistance. RCMP is the federal force, and OPP is the provincial. There are also two other police forces to which Mississauga has access. Mississauga lies between the police jurisdictinns of Metro Toronto and Halton Regional, and thus Peel Regional Police has regular interactions with those two factors

The regionalization of the Peel area also led to consolidation of fire departments. Currently, there are separate departments in Mississauga, and two other communities within the region. There is a regional fire coordinator, but these three municipalities are chiefly responsible for their own fire protection. However, old mutual aid agreements are still in existence and have been strengthened. There is an Emergency Fire Services Plan which provides for one department backing up another department at times of great emergency. The Mississauga fire department at the time of the train derailment had nine fire stations and a total staff of 288 fire fighters.

In addition to police and fire forces, there were other disaster relevant resources available to Mississauga. Many of these were primarily extra-community. Examples would be the Metropolitan Toronto and the provincial ambulance services and the many hospitals in that section of Canada. Within the community there were the emergency relevant resources of the local Red Cross and the Mississauga Transit Authority. In fact, one estimate is that over one hundred organiaations and agencies were involved in the organized response to the train derailment, although not that many had been involved in prior disaster planning.

Organized Response to the Disaster

Canadian Pacific Railway (CPR) train #54 was derailed in Mississauga at the Marvis Road Crossing at about 11:53 p.m., on Saturday, November 10, 1979. Peel Regional Police patrol officers on duty in the area and firefighters at the Mississauga Fire Department headquarters noticed the flames lighting the sky from the fire which ensued. They immediately proceeeded to investigate. At 11:54 p.m., a Peel police radio car reported a large explosion and fire at the Marvis Road Crossing, to the communications room at the police headquarters. The police officers quickly on the scene within a minute or two, attempted to impose some roadblocks around the site. Closing off the few cross roads provec easy, but spectators immediately flocked to the scene and either ignored the partial police perimeter or came in across open fields. The nine fire stations in Mississauga were notified by the district fire chief, and the first units arrived at the site at around 11:56 p.m. Within half an hour, 110 firefighters were on the scene along with eight pumpers, three ladder trucks and two rescue vehicles. Several deluge gun nozzles were positioned approximately fifty feet from the blazing wreckage.

At 12:09 a.m., or shortly after midnight on Sunday, November 11, a propane tank car exploded causing considerable blast damage and hurling debris nearly half a mile in a southeasternly direction. Approximately ten minutes later, a third BLEVE ("Boiling Liquid Evaporating Vapor Explosion") occurred as a second propane tanker exploded. The explosions did lessen the crowd control problem of the police, as almost all of the gathering spectators who had converged on the disaster site, left.

The CPR dispatcher's offices in London and Agincourt were notified through the train's radio system at the time of the derailemtn, and the CPR emergency plan was immediately activated. This involved the notification of CPR's technical experts and the start of the movement of technicians to the accident site. Also included in CPR procedures for chemical emergencies is the

notification of local hospitals, police and fire departments, the Environmental Protection Services of Environment Canada, Transportation Emergency Assistance Plan (TEAP), and the Canadian representative of the Bureau of Explosives of the Association of American Railways.

Once sufficient personnel from the Peel Regional Police Force and the Mississauga Fire Department had arrived at the site, a more systematic security system was established to restrict entry of traffic to the site, and the train manifest was obtained from the caboose. Because the manifest was difficult to discern, the fire chief requested another copy from the CPR dispatcher in Toronto. At this time, a Peel police duty-inspector called police headquarters and asked the radio-room sergeant to officially implement the police disaster plan. This involved notifying the appropriate emergency relevant agencies and technical experts. By 12:08 a.m., Metropolitan Toronto Police and OPP had offered assistance to the Peel Regional Plice Force. At 12:12 a.m., a request was made for the Mobile Command Trailer (MCT), and at 12:19 a.m., the police chief was notified and asked to come to the site.

While it was fairly clear that the train had been carrying dangerous chemicals, it was not certain which chemicals were in the derailed cars. As it eventually was discovered, there were twenty four derailed cars, twenty two of them tank cars, and two boxcars which carried insulation. Eleven of the tank cars contained propane, four caustic soda, three styrene, three toluene, and one chlorine--all dangerous chemicals. The tank car carrying the ninety tons of chlorine was severely damaged and leaking. But the police were initially told that the chlorine tank car was <u>not</u> one of the derailed cars. However, when the police on the basis of a visual car-by-car check could not find it in the remainder of the train, they correctly deduced that it had to be among the wrecked and derailed tank cars. After a while, a crew member from the train was able to manually close the brake-hose on the 32nd car, enabling the train engineer to move the front portion of the train to a safe distance away from the fire.

By 12:35 a.m., two local ambulance services had dispatched eight ambulances and three emergency support units to the site. Approximately five minutes later, the Red Cross, Salvation Army, and a locally based relief agency offered their assistance. By 1:00 a.m., officials from the two ambulance services had established their mobile command post approximately a quarter of a mile south of the site in order to coordinate ambulance services. The Peel Regional Police Force established their command post in the same area. At approximately 1:10 a.m., the police chief and deputy chief arrived on the scene and assumed authority for overall coordination.

By 1:00 a.m., the Mississauga Fire Department had established two command posts and positioned three masterlines pumping water from hydrants on both sides of the train. The strategy adopted by the firefighters was to cool the cars (not to extinguish the flames) and allow a "controlled burning" of the escaping gases so as to avoid possible explosions. Electricity lines had been damaged by fragments from an exploding tank car, thus cutting current to the area. The Mississauga Municipal Service's fuel supply therefore could no longer be utilized as there was no electricity to activate the fuel pumps. Fire departments from the neighboring communities of Brampton and Etobicoke maintained the disrupted supply until the electricity lines in Mississauga

were re-established. Brampton and Etobicoke also augmented the Mississauga Fire Department's resources with additional equipment and manpower.

At 1:34 a.m., the mayor of Mississauga was briefed by the Peel police via telephone. At approximately 1:47 a.m., the Peel police chief ordered an initial evacuation of an area of at least a 2,500 feet radius around the derailed cars. The decision was based less on expertise advice than on the fact there had been explosions, and others could obviously follow. There was also the great uncertainty about a chlorine tank car with its deadly cargo of gas, which might or might not be in the wreckage of the derailed cars. In order to notify the approximately 3,500 residents within the neighborhood to be evacuated, police officers using quickly prepared maps of the different blocks, knocked on doors and used loudspeakers. In this evacuation, almost all residents appeared to have left the designated area.

Between 4:15 a.m., and 7:29 a.m., the polcie chief gave a series of evacuation orders, partly on the basis of observations on the scene, and partly as the result of information obtained from meteorologists and environmental experts on wind and other weather conditions. These orders called for the evacuation of about 12,000 residents mostly living immediately south and west of the derailment site, in areas of approximately one and a half square miles. The Peel Police Force requested the assistance of the Metro Toronto Police Department to help carry out these evacuation orders. The Peel Police Force Communication Center identified and secured evacuation shelters and requested assistance from the local Red Cross chapter and Salvation Army branch in staffing the shelters. A covered shopping mall located approximately a mile and half northeast of the site was selected as the initial reception center.

These evacuations were systematically carried out. Police officers carefully went through assigned blocks, stopped at every door, and marked with chalk every house in which residents had been told to leave. The personal calls were reinforced by messages over public address systems on police cars moving up and down affected streets. While the vast majority of evacuees left using their own transportation, some public transit buses were utilized to take others to the initial reception center. As this reception center became crowded, additional reception centers were opened and "stand-by" chapters of the Red Cross were activated so that a chapter was available to man each opened center. However, only a small proportion of evacuees ever used the reception centers. The great majority of residents who left went to relatives or friends. A great number, one survey suggests eighty four percent, left as household units--at least the household members were together when the evacuation started.

Special police patrols were mobilized to secure and protect evacuated neighborhoods from possible resultant criminal activity. Police roadblocks were established at the newly created boundaries of the evacuated zones in order to prevent residents from returning to the hazardous area.

At 2:15 a.m., the Provincial Ambulance Coordinating Center dispatched a general request for all available ambulances in the area to come to the affected location. Within six hours, 139 ambulances and 300 ambulance workers had arrived in the area. Some came from as far as Niagara Falls and Kingston (77 and 165 miles, respectively). Twenty-seven other emergency and public

transportation vehicles were also supplied by neighboring communities. Upon request from the Peel police, the ambulance workers assisted in notifying residents in the designated evacuation areas and transporting incapacitated persons.

When the involvement of the chlorine tanker in the derailment was confirmed by CPR crewmen and communicated to TEAP experts, the latter notified CHLOREP experts from the Chlorine Institute in the area. At this time, five tankers were burning some distance from the chlorine tank car. The wind was blowing in a northwesternly direction towards a residential area located about 530 feet from the site. At 2:15 a.m., a representative from the Ministry of the Environment arrived at the police command post. Approximately five minutes later, CHLOREP teams arrived with equipment provided by Canadian Industries Ltd. (CIL) in Quelph and Markham. The CHLOREP teams were replaced by a chemical response team from Dow Chemical Company (DOW) in Sarnia at approximately 7:00 a.m. DOW had also been notified by TEAP. The chemical response experts from DOW, TEAP, and CPR decided that it was not feasible to attempt to repair the ruptured chlorine tanker until the propane fires had burned themselves out. Therefore, they remained at the police command post to discuss strategies for eventually sealing the tanker and to make arrangements for obtaining the necessary equipment. At 3:40 a.m., TEAP contacted CANUTEC, the Emergency Response Information Center of Transport Canada, for technical assistance as well as for help in locating equipment. Shortly after 3:30 a.m., Peel police contacted the Atmospheric Environment Services (AES) of Environment Canada to arrange for continuous meteorological reports.

At 4:30 a.m., the wind direction changed, making it necessary for Peel police to move the location of their mobile command post. The on-site fire headquarters, the Peel Police Mobile Command Trailer (MCT) and the ambulance were also re-located. The site of re-location was on the north side of the tracks, about one-half mile from the derailment site next to the Bell Canada Center. At about 6:30 a.m., when the OPP command headquarters trailer was activated, it joined the other mobile units at the Bell Canada Center. The multiple command post at this location subsequently expanded into the Bell Telephone Communications building itself, resulting in a considerable increase in communications hardware resources.

Shortly before 5:00 a.m., officials from the Ontario Ministry of the Environment started contacting other provincial officials, including the Solicitor-General. At the same time, Peel police notified the chairman of the Peel Regional Council, regional councillors, municipal councillors, and the Mississauga city engineers. At approximately 6:00 a.m., OPP contacted the office of Emergency Planning Canada in Toronto in an effort to locate technical personnel with expertise in handling PCB. It was thought at that time that a PCB tank car was involved in the accident. It was later learned that the computer print-out of the manifest information was misinterpreted by police officers at the site, and that PCB was not present in the shipment.

At 7:30 a.m., the first four members (the chairman of Peel Regional Council, the mayor of Mississauga, the Peel police chief, and the Mississauga fire chief) of the Emergency Operations Control Group (EOCG) met to discuss evacuation and neutralization strategies. At this time, a decision was made to extend the evacuated area, and subsequently the administrator of Mississauga

General Hospital was advised to prepare to evacuate the hospital.

By 7:30 a.m., the Metro Toronto's Mobile Command Unit was stationed next to the nearby Peel division police station, and Metro police officers began implementing their emergency planning guide. The guide provides for the integration of police, fire, engineering, medical and welfare disaster plans. Metro Police support throughout the next six days involved an average of 277 policemen per day, thirty five to forty patrol cars and twenty one mobile sound vehicles.

Shortly after 8:30 a.m., the Peel police chief, in consultation with other members of EOCG, issued still another evacuation order. This time, the evacuation was to include Mississauga General Hospital and two nursing homes located in the city. A Peel police mobile command unit was dispatched to the ambulance service command post to coordinate and communicate with the numerous ambulances involved in the hospital evacuation. There were 450 patients in the Hospital and 539 patients in the nursing homes. A total of 262 ambulatory patients were first discharged, and the remaining patients were transferred to Toronto General Hospital and to other medical facilities and nursing homes. The evacuation operation was initiated at 10:00 a.m., and was coordinated by the Peel regional police officer in charge of patient evacuation, and regional ambulance coordinator, and officials from the Institutional Division of the Ministry of Health. The ambulance service communications system was utilized to contact host hospitals, and the Ambulance Services Disaster Plan was implemented. Hospital disaster plans were implemented as well, and the Ontario Medical Association arranged for specialists and medical volunteers to be on stand-by. At 11:10 a.m., an additional 29,000 people were asked to leave an area of about three square miles.

At 3:40 a.m., EOCG members and hospital officials also decided to evacuate the 280 patients in Queensway General Hospital. This decision was made due to noticeable chlorine fumes in the area. A total of eight eight of the patients were discharged, and by 6:15 p.m., the others had been transferred to surrounding hospitals via ambulances and public transit buses. Shortly thereafter, 322 patients from three additional nursing homes in the area were evacuated.

The Solicitor-General, the chief law officer for the province, arrived at the site at about 9:30 a.m., and was briefed by the other members of EOCG on the status of the situation. At 9:40 a.m., members of EOCG decided to extend the evacuation area an additional block further to the east. At 1:10 p.m., the evacuation area was further increased to the south approximately two miles, to the shores of Lake Ontario.

The first mobile air analysis unit of MOE (a vehicle equipped with mass spectometry and other sampling and analysis devices) arrived at Command Post No. 1 at 10:00 a.m., and was immediately sent out to test for hydrocarbons, nitrogen oxides, and sulpher dioxide in the atmosphere. Within an hour, two additional mobile air units arrived and began to analyze the atmospheric content for chlorine.

Three computers provided by DOW were programmed to constantly correlate data on weather, meteorological changes, topography, population densities and

other variables in an effort to predict resultant damages from a range of chlorine release scenarios. This information was continuously communicated to members of EOCG to assist them in evacuation planning and decision-making. AES supplied EOCG with low level wind and air stability forecasts at two to three hour intervals.

At 12:30 a.m., the initial reception center was ordered to evacuate. Subsequent evacuation calls occurred at 3:40, 5:00, 5:10, 6:45, and 8:16 p.m., resulting in a total of thirteen different evacuation orders. Large areas and many people were involved in these evacuations. Thus, the calls around five o'clock involved nearly nine square miles and close to 60,000 residents. The door-to-door personal calls of police officers, as well as the messages from the public address systems of police cars, were during the day being reinforced by the very extensive news coverage on both radio and television, both of which clearly portrayed a potentially very dangerous situation for the residents of Mississauga. Nonetheless, as is done in almost all major disasters, some individuals and families refused to leave, and remained in their homes. In fact, the more time went on and the greater the disasters from the derailment site, the more reluctant and unwilling residents were to evacuate their homes.

More than 600 volunteer workers provided by the federal, provincial, and local relief agencies and private citizens, as well, assisted in the registration, feeding and sheltering of evacuees. Additionally, numerous citizens in response to radio requests opened their homes to evacuees and their pets. Food was provided by neighboring commercial establishments as well as the general public and was collected and distributed to the shelters by volunteer agencies. The Canadian Armed Forces, at the request of community and social service agencies, provided 1,499 sleeping bags, 823 air mattresses, 10,358 blankets, and thrity six thermal-food containers for use in evacuation centers. Health and Welfare Canada assisted in the coordination of emergency health and welfare requirements and remained on stand-by. Drug depots were also established to dispense free prescription drugs to evacuees in the centers. Due to concern on the part of the evacuees for pets left behind, Peel police officers and volunteers from the Ontario Humane Society arranged for the feeding of pets in the evacuated area.

At 7:00 p.m., officials of the nearby community Oakville decided to evacuate their hospital and nursing home holding a total of 468 patients. Within nineteen hours, a total of three large hospitals and six nursing homes, containing nearly 2,000 patients, had been evacuated without serious problems or complications.

At 7:00 p.m., a number of RCMP officers reported to Peel regional police which had overall police responsibility for the area. The evacuation area was patrolled by 609 uniformed Peel police officers (approximately 200 per shift), reinforced by ninety five Metro Toronto, sixty five OPP and fifty two RCMP officers per shift. The total number of police officers on duty at any given time was about 500. Police duties throughout the event included cordoning off the area, notifying residents, controlling traffic, establishing and manning roadblocks, patrolling the area with cruisers and helicopters, assisting in the evacuation of hospitals and maintaining order at the evacuation centers. The police also processed some 50,000 telephone inquiries and

assisted volunteers in caring for pets left behind during the evacuation. One estimate was that around 7,000 pets had been left in evacuated residences, mostly cats but dogs and birds as well.

Radio and television coverage was given from the time of the accident with twenty four hour coverage during the following days. Many stations implemented contingency plans for increased coverage including increased staffing. Toronto's CBC station suspended regualr programming 11:00 a.m., on November 11 and for more than twelve hours carried special news reports as well as messages from resident in the area who had become separated from their families.

By the end of the day, approximately 217,000 residents had been evacuated without accidents or casualties. The evacuated area covered approximately sixty square miles. The fire departments had consolidated hose lines, and the equipment used in controlling the fire had been reduced to six pieces since the fire although not the chlorine threat had been substantially reduced.

Congruent with expert advise, the decision to allow the propane fires to burn themselves out, rather than attempt to extinguish the flames, was maintained. By 10:00 a.m., on Monday, November 12, there were still three propane tankers burning, but the flames were under control and the tankers were located some distance from the chlorine tanker. A steel patch was prepared to cover the two square feet hole in the ruptured chlorine tank car. The patch was to be applied to the hole in such a manner as to keep the chlorine under pressure while being transferred to other tank cars. Throughout the day, CPR's rescue team worked to remove the remaining train cars which had not been derailed, and clear as much debris as possible without disrupting the chlorine and propane tankers.

Due to extreme heat and stress, the chlorine tanker had become deformed, making the steel patch unsuitable for sealing the hole. Therefore, throughout the remainder of the day, members of EOCG met with representatives of the MOE, police and fire departments, and a number of chemical experts and technicians to consider alternate approaches for sealing the hole in the chlorine tanker.

Emergency responders ran into different kinds of complication apart from technical problems. One example was the erroneous report at 12:00 (noon) by the Canadian Broadcasting Corporation network that the evacuation of Etobicoke residents had been initiated. While this did not result in any serious problems, it did increase the number of phone calls to emergency relevant organizations, thereby complicating already strained lines of interorganizational communication, and adding to the typical post disaster convergence pattern. Another example of non-technical difficulties involved the utilization of man power for security reasons. This was the result of reported break and entry occurrences in the evacuated area, which had only an extremely limited basis in fact. As still another example, fire department personnel coming in to report to duty had trouble clearing police lines. The problem of adequate identification for people with legitimate reasons to pass police roadblocks proved a problem for the duration of the emergency.

The propane flames had burned out by 2:30 a.m. on Tuesday, November 13, and the fire equipment at the site had been reduced to four pieces. Further unsuccessful attempts were made to seal the chlorine tanker. But by now

specialists examining the car thought but were not certain that much of the chlorine had disappeared during the course of the fire.

At 11:00 a.m., the Metro Toronto Ambulance Services and municipal buses began returning 154 patients to Queensway Hospital, and the Halton-Mississauga Ambulance Service began returning patients to Oakville. At 3:10 p.m., after a meeting of the EOCG, the Solicitor-General announced the beginning of re-entry of evacuees to peripheral areas. By late evening around 145,000 evacuees had returned home, and the number of evacuation centers had been reduced to six.

On Wednesday morning, November 14, a nineteen square mile area of Mississauga remained restricted and the three main hospitals which had been evacuated remained closed. In the early morning, high winds slowed the operation to seal the chlorine leak. Operations were temporarily suspended while alternative strategies were again discussed. Citizens residing southwest of the site were warned of a possible secondary evacuation as there were reports of moderately high levels of chlorine in the air.

Municipal and provincial authorities, in conjunction with CPR officials, made arrangements to house as many evacuees as possible in hotels. Through special registration arrangements with thirteen hotels, the Red Cross managed to empty all but two reception centers. Most evacuees of course were not in the reception centers, but had been staying with friends and relatives. The nearly 73,000 evacuees who were still out of their homes on Wednesday, increasingly became restless and pressed to get back into their neighborhoods. Police were forced to establish special conciliation teams to deal with evacuees who came to the police perimeters and insisted that they must get back to their homes. CPR officials announced that they would open a claims office in Mississauga the following Monday to begin paying "reasonable out-of-pocket expenses" of evacuees. A class-action suit was being considered by a number of the evacuees for costs incurred, including lost income.

At 12:00 noon, the Solicitor-General called a special meeting of the EOCG. At this meeting, the decision was made to not allow the remaining evacuees to return home for at least one additional night due to difficulty experienced in sealing the chlorine tanker. A request was also formulated at the meeting for the on-site presence of a senior federal officer, an outside scientific advisor and additional back-up crews. This request was transmitted to Emergency Planning Canada for immediate attention.

By late evening, emergency response crews had successfully accomplished the transfer of propane from the damaged tankers to empty tank cars. Subsequently, the damaged tank cars were purged and removed from the site.

Difficulties with the chlorine tank car persisted through Thursday, November 15. Although it was possible to manually position the steel patch over the hole in the tanker, the patch failed to fit tightly enough to insure proper pressurization. The steel patch was replaced by a neoprene air bag pressed over the aperture by a timber mat and secured by metal chains. As estimated through optical observations approximately twenty tons of chlorine still remained in the tanker. As a result of the cold weather conditions during the preceeding days, a substantial layer of ice had formed on the surface of the

chlorine within the tanker. The additional surface pressure of the ice upon the chlorine posed further hazards in removing the chlorine through a suction hose. The on-site experts were of the opinion that as the chlorine was removed from the tanker, an air space would form between the layers of liquid chlorine and ice. This air space, having a lower density than the liquid chlorine would eventually fail to sustain the ice, causing it to abruptly fall upon the surface level of the liquid chlorine. In turn, this would result in an inversion of the positions of ice and the air space. This inversion would likely allow chlorine vapors to escape along with the air, thus posing a substantial threat to emergency workers as well as to those citizens residing downwind of the site. The problem was finally resolved by applying a liquid line below the ice and a vacuum line above it. Chlorine vapors were drawn from the tanker and pumped into a container of caustic soda to neutralize them. This removal of vapors helped to lighten the pressure on the neoprene patch.

At 4:10 a.m., the removal of liquid-form chlorine was commenced. At 6:30 a.m., six firemen were taken to Queensway hospital after becoming overwhelmed by chlorine vapors. By 11:50 a.m., most of the chlorine had been pumped into trucks and transported to Toronto. During the process, one firefighter was hospitalized and seven others were treated at the on-site emergency clinic for inhalation of chlorine gas. All were after examination declared to be in satisfactory condition.

A press conference was held in the early afternoon, at which time the Solicitor-General announced that the remaining evacuees could not return home that night. He stated that there was no degree of certainty that the state of emergency would end the following day, as the success of the operation depended on wind conditions. The St. John Ambulance Brigade withdrew its personnel at midnight. Using sixty one mobile units and 470 members, the organization had provided over 11,000 hours of voluntary service over a five day period. The personnel had served from ambulance attendants to kitchen help to couriers.

Most of the caustic soda and toluene had leaked onto and contaminated the soil in a large area surrounding the derailment site. The fourte-n tons of caustic soda which remained in the tank cars were drained by emergency crews during the early morning hours on Friday, November 16. While the transfer was in process, there was another delay in allowing the remaining evacuees to ret return to their homes. At 3:00 p.m., an announcement was made that most of the remaining evacuees would be allowed to return home; however, six remaining tons of chlorine in the tanker necessitated the delay in allowing reentry to those residing closest to the site. At 7:20 p.m., the Solicitor-General announced that since most of the chlorine having been safely neutralized, all remaining evacuees could return to their homes. At 7:45 p.m., all roadblocks on traffic arteries leading to and from Mississauga were removed, and the city was re-opened. Only the derailment site remained under restriction. By late evening, re-entry was completed and the remaining reception center was closed. By midnight, Metro Police, OPP and RCMP personnel began to withdraw from the community.

At 4:00 a.m., Saturday, November 17 the Metro police communications post was closed. The return of the remaining evacuated nursing home residents was initiated by 7:00 a.m. The Salvation Army after providing over 20,000 meals terminated their emergency feeding services with the serving of a noon meal,

and took away their seven mobile units. At 8:00 a.m., on Sunday, November 18, ambulance crews began transporting patients back to Mississauga Hospital; the movement was completed by 5:50 p.m. Red Cross emergency support operations were terminated during the day, and the 300 volunteers were discharged of their duties. In all, the Red Cross had registered 9,500 evacuees at the reception centers and had served about 36,000 meals to evacuees and the same number to emergency organization personnel. At 4:30 a.m. on Monday the chlorine tank car was finally empty; purging of the tanker began at 7:10 a.m. the final ambulance on stand-by at the disaster site was released from duty at 7:30 a.m. the next day. A total of twenty five southern Ontario ambulance services had provided 159 ambulances with a staff of 651 persons during the emergency.

All fire equipment was removed from the site by 10:30 a.m. Wednesday, November 21. This signalled the end of a 250 and a half hour fire call duty for the Mississauga Fire Department. Activities of the firefighters included not only the containment of fire, but also chlorine gas containment, floodlight maintenance during the nine preceding nights, application of foam and sand upon various chemical pools and spills, neutralization of the chlorine and removal of other caustic substances, and the provision of fire-related advice to other emergency responders.

The preceding pages suggest but could not detail all the organizations and agencies, public and private, local and extra-community, which were involved in the organized response to the train derailment at one crossing in Mississauga. Very many groups took part in bringing about one of the quickest and largest mass evacuations in history from a relatively spatially small endangered locality. This evacuation occurred in a major metropolitan area, with all the advantages and disadvantages that provided. Along some lines, the disaster at Mississauga stands in sharp contrast to the emergency at Baer, as described in our first case study.

Evaluation of Response

both in absolute and relative terms, the Mississauga train derailment was handled very successfully. Disaster plans were generally implemented, necessary emergency resources were mobilized, a massive number of threatened people were removed from danger, destruction and damage was kept to a minimum, and a major metropolitan area was spared from undergoing what at the start of the crisis seemed to have the potential for being one of the world's most notable catastrophes. Compared to others disasters, furthermore, the organized response seemed to be rather effective and efficient.

What accounted for this? With an accident such as the train derailment (which was followed by fires, explosions and toxic releases) it would have been impossible to have a successful response without the utilization of the skills and materials of many. Numerous local, regional, provincial and federal officials and agencies, as well as segments of the private sector, came together in the response. At one level, therefore, the availability of the necessary personnel and resources was a major contributory factor in the successful response.

But in turn, this availability and especially the integration of disparate elements, depended on still other factors. Among the most important of these

was the prior disaster planning in the area, and especially the prior thought and effort given by the Peel Region Police Force to disasters and mass emergencies. This planning and the written plan was very helpful, serving to guide the police responses. The plan was not followed exactly, but it was always supposed to be a general "guide" to behavior rather than a blueprint for fixed actions at times of community emergencies. The plan generally indicated organizational channels and interorganizational linkages which ought to be followed. This facilitated the procurement of necessary resources. Furthermore, the experimental knowledge and training of the police allowed them to improvise as changing situations warranted. Previous disaster experiences suggested ways of doing things in the emergency, and facilitated the development of coordination among the organizations involved. In many ways, the prior disaster planning in Mississauga functioned in just the appropriate ways as disaster researchers have said planning could when emergencies arise.

Situational contingencies in the disaster also helped the success of the organized responses. The timing and location of the train derailment helped. It occurred just before midnight on the first day of a long weekend. This facilitated a timely public response since most families were together in their homes at the time of the incident. Also, traffic conditions during the time were conducive to quick mobilization and movement of the involved population group. Similarly, the location of the incident contributed to the success of the operation. The accident site was at a relatively unpopulated industrial area which has sufficient access roads, fire hydrants, and a Bell Telephone Exchange 500 yards away. Lastly, the wind and weather conditions during the event were moderate and generally favorable.

However, despite the overall success of the disaster operations, a number of difficulties surfaced, with some of them prevailing almost for the duration of the organized response. There were problems in the technological area, as well as in organizational aspects. Among the former type of problems were the following.

The initial identification of the exact nature of the chemical threat was beset by a number of difficulties. First, responders had problems interpreting the train's manifest due to its general illegibility and the manner in which the information was coded on the document. Second, due to the fact that the train crew had moved the anterior portion of the train several miles ahead of the point of derailment relatively soon after the accident, responders had difficulties matching the sequence of cars as listed on the manifest with the cars involved in the derailment. Finally, the story concerning the presence of PCBs (polychlorinated byphenols) in the wreckage was circulated at the accident site as a result of a misreading of the manifest. Although this account was fairly soon discounted, it resulted in a slight delay in disaster operations. Of course, as DRC research has found, ascertaining the exact nature of the threat in an acute chemical disaster involving a transportation mode, is a frequent problem, and as such what happened at Mississauga was relatively typical.

There was also a problem generated by the uncertainty of how large an area should be evacuated. Initially, this was because of lack of knowledge about the threat. But later it was because information concerning the amount of chlorine remaining in the tanker after the initial explosions was unavailable. Consequently, responders acted upon the basis of a "worst case" scenario

and issued the various evacuation orders. The resultant large-scale evacuation prompted many individuals to question the need for such a drastic protective action, but the decisions makers, especially higher echelon officials, never had all the full technical information they would have needed to be more conservative as to what were the endangered neighborhoods and populations. In fact, as noted earlier, the police themselves decided that the chlorine tanker was one of the derailed cars, even though they were initially told the opposite.

The identification of an appropriate method for sealing the chlorine tanker proved problematic throughout the emergency time period. Due to the size and location of the rupture, as well as the deformation of the surrounding metal, various attempts to patch the tanker were unsuccessful. This obviously created difficulties for controlling and monitoring the removal of the remaining chlorine. While overall this was a technical problem, it was also a fact that so-called experts had difficulty reaching consensus on the matter; at times, inconsistent technical advice was given to the emergency responders.

In addition to these and other technological problems (such as with respirators), there were a number of organizational ones. Among the more important of the latter, were the following.

Community emergency responders had little confidence in the information they obtained from the chemical experts involved. Specifically, they felt -- correctly or not -- that representatives from DOW might be withholding information on the risks involved in an effort to protect corporate interests. In addition, doubts were expressed -- again whether correctly or not -- regarding the chemical expertise being offered by the Canadian Transport Commission (CTC). To rectify this situation, the Peel police requested that CTC send a higher level functionary to the disaster site. Additionally, a Peel regional policeman with a chemicstry background was placed at the site; a CHLOREP team from Canadian Industries Limited was brought back to the site; and a professor of chemistry at the University of Toronto was asked to provide advice. All of these efforts were directed at ensuring that the Emergency Operations Control Group (EOCG) was getting correct information upon which to base their decisions. Clearly, there is a problem in an emergency response if some of the key agencies are mistrustful of information being provided by other key groups involved.

The order to evacuate the Queensway Hospital precipitated a conflict between the hospital administrator and the supervisor of the ambulance service. concerning who should direct the evacuation process. The supervisor (who had managed the evacuations of two other hospitals) and the administrator both felt they should control the dispersal of patients. The administrator felt they were his patients and thus he should make provisions for their dispersal. The ambulance supervisor had direct radio communications with the other hospitals (the administrator had only land lines to one hospital at a time) and was coordinating the movement of ambulances. Thus, he felt he should control patient dispersal. Rather than have the Ministry of Health intervene, the administrator and the ambulance supervisor reached a compromise. The administrator used radio information provided by the ambulance service for making decisions regarding patient dispersal. It should be noted that with such a compromise the ambulance supervisor was able to manipulate radio information or selectively feed it to the administrator who in turn acted upon it. While

superficially, this conflict may appear to have been a personality clash or simply a difference between two individuals, it actually reflected a question of organizational territory and domain. During routine times, the responsibilities of the hospital and the ambulance services do not overlap. The disaster, however, forced a situation where the usual lines between organizational boundaries collapsed, a matter very easy to overlook even with good emergency planning.

The degree of personnel convergence and general confusion during the initial EOCG meetings was an early source of irritation in the overall response effort. In order to remedy the situation, the Solicitor-General decided to limit the number of participants in the meetings. Consequently, meetings became more formalized, productive and orderly. The meetings were chaired by the Solicitor-General, but upon his insistence there had to be a consensus for every decision. If it was a fire matter, the fire chief had to be satisfied. If it was a police matter, the Peel Regional Police Force and OPP had to be satisfied. But the Solicitor-General always required that all others agree before a decision was made. Not all officials were satisfied with this process, although none seem to have publically protested. However, other officials especially at lower levels, complained that the consensus reaching process was extremely time consuming, and noted that some decisions may have been reached more as a result of fatigue rather than compelling reasons. Thus, while the decision to restrict participation in the EOCG meeting solved the problem of crowding, it was not seen by all as a necessarily perfect solution.

There were still other organizational problems. A pass system satisfactory to all organizations was never developed. Many evacuees felt that they did not get adequate or clear enough explanations about when and how they could return to their homes, and why police perimeter boundaries were set up in certain places rather than others. Some mass media personnel, especially in retrospect, had the suspicion they had been more controlled in their coverage of the disaster, than they realized during its duration. A few of the organizations allowed their personnel to work too long, and would have had no rested reserves to call upon if the situation had escolated suddenly in a catastrophic direction. The overall disaster planning had not well taken into account the difficulties for some evacuees who thought they were leaving only for a short time, but had to stay away for days (e.g., patients on medical drugs who could not locate their preseriptions or contact their physician or pharmacist who also probably evacuated).

Despite these and other organizational problems, as well as the technological ones mentioned earlier, the Mississauga disaster was handled about as well as any major, actual disaster could have been. Measured against absolute or ideal standards, the organized response fell short. Measured against the realities of the situation, and compared with most other organized responses in disasters, a good job was done.

Concluding Remarks

Questions might be raised about the applicability of the lessons of Mississauga, Canada to other societies. There are different social structures and political arrangements in various nation states around the world. Different societies have their own cultures, the norms and values which are crucial

to their functioning. These cross-cultural differences will be reflected in the organized responses to disasters in different societies (see McLuckie, 1977).

Nonetheless, to the extent societies are similar to one another in structure and culture, it is to be expected that their disaster responses will be similar also. Thus, to the extent, for example, Canada and the United States are similar, the lessons of Mississauga are generally applicable to a similarly situated metropolitan area in the United States. This does not deny certain distinctive Canadian characteristics, they exist and they influenced the organized response to the disaster described in this chapter.

CHAPTER V

CONCLUSION

This chapter discusses a few general impressions of chemical disaster response which can be derived from the case studies and the implications they have for improvements in community response capability.

As alluded to in Chapter I of this report, certain socio-behavioral patterns are characteristic of nearly all responses to acute chemical emergencies. For example, as noted in an earlier DRC publication (Gray, 1981) interorganizational conflict is likely to prevail during the emergency time period of chemically-induced disasters. This conflict seems to be engendered in acute chemical incidents by the interaction of the public/private sectors, their differential experiences with hazardous chemicals, their differing responsibilities and mandates, and the different perceptions of crisis they bring to bear on the situation. In addition to the public/private sector cleavage, interorganizational conflicts tend to emerge among local organizations as well as between community and extracommunity groups. Typically, these disagreements concern definitions of organizational domain (i.e., interorganizational task allocation). As the number of groups responding to a chemical incident increases, organizational boundaries become more vague and tend to overlap. This weakening of domain definition compels responding agencies to address the issue of autonomy maintenance; that is, organization will attempt to function as independent entities in order to preserve their autonomy. Consequently, problems of authority and coordination tend to develop and overall response efforts become more fragmented and disjointed.

While disagreements among local organizations in the community of Baer were noted, the most severe manifestations of interorganizational conflict occurred between organizations from the public and private sectors. Disparate perceptions of the chemical hazard held by corporate officials and local responders resulted in a general mistrust and hostility between the two sectors. Similarly, in Mississauga, community officials were suspicious of the information provided by the corporate "experts" and consequently procured additional sources to advise them on the technical nature of the threat.

Conflicts over organizational domain between local responders are also evident in the case studies used in this report. The reluctance of the hospital administrator in Mississauga to relinquish his authority concerning hospital evacuation is an indication of the manner in which organizational members seek to maintain autonomy in disaster situations. Furthermore, the exclusion of several secondary responders from preparatory sessions during the incident occurring in Baer illustrates how organizations attempt to design response efforts in a manner conducive to autonomy maintenance. That is, by reducing the number of secondary responders involved in the emergency decision-making process, primary responders could protect their autonomy in the overall response.

As indicated earlier in this report, there is also a major difference in the patterns of response to hazardous chemical incidents at fixed installations when compared to those resulting from transportation-related accidents. The

types of organizations involved in the response and the tasks they undertake, as well as the difficulties that emerge, differ in the two situational settings. As the case studies suggest, a greater number and wider range of problems emerge in responses to transportation-related incidents. One typical problem encountered in transportation-related responses involves efforts to identify the exact nature of the chemical threat. First responders in transportation-related incidents are typically unfamiliar with many of the numerical codes used to identify hazardous materials as listed in invoices and other shipping papers. Similarly, information relevant to the interpretation of hazardous materials placards and symbols is not uniformly distributed among potential responders. Hence, even when such signifiers are noted, first responders frequently do not fully understand their meanings.

The Mississauga response was initially complicated by problems related to correct identification of the chemical agents involved in the incident. As noted in the study, shipping papers were misinterpreted by initial responders and this misinformation was subsequently diffused to many others through interaction among local officials near the accident site. While this discrepancy was quickly rectified upon correct identification of the chemicals involved and thus did not result in inappropriate operational actions, it nevertheless reflects the typical difficulties involved in chemical identification in transportation accidents.

Another problem related to correct identification of chemical agents is illustrated in the Baer case study. Although initial responders were successful in quickly locating and interpreting the transportation vehicle's bill of lading, the information provided by the document was erroneous. The instructions pertaining to chemical neutralization procedures were inappropriate for the specific agent being transported. This provision of misinformation not only resulted in a retardation of disaster operations, but consequently resulted in increased property damage. This suggests that correct identification of the specific nature of a chemical threat is likely to be beset by multiple difficulties. Even when documents of identification are located, problems related to the validity and interpretation of the information contained therein cannot be overlooked.

An additional impression provided by the case studies concerns the nature and degree of influence and effect that preparedness efforts have on response to acute chemical emergencies. It is possible to conclude that at whatever level preparedness planning for acute chemical hazards does exist, the emergency time response in actual incidents tends to be more coordinated and effective. Furthermore, even when previously developed plans are not fully or correctly implemented in an emergency, the pre-impact discussions, drills and contacts facilitate relevant emergent or ad hoc activities. This observation is supported by the incidents described in all three case studies.

The three communities discussed exemplify a range of preparedness efforts, from the nearly negligible to the very comprehensive. In Baer, in which preparedness for hazardous materials incidents was essentially nonexistent or, at best embryonic in nature, the overall response to the incident was delayed, fragmented and uncoordinated. On the other hand, the response to the Mississauga incident proceeded in a relatively orderly fashion, despite major impediments resulting from the magnitude of the event. While a number of

situational elements contributed to the effectiveness and efficiency of the response effort, the sophisticated system of preparedness within the community clearly had the greatest effect on the successful outcome of the disaster operations. The response in Minutilli provides an example of the extent to which informal preparedness systems can influence and affect actual responses to chemical incidents. In that situation, mutual agreements among representatives in the private and public sector facilitated the degree to which resources were mobilized in the overall response. In addition, the cooperation between the police department and the fire department with respect to hazardous materials responses was nurtured by informal, personal contacts made by individuals from each of these agencies.

These illustrations provide a positive starting point for potential responders in all communities. They suggest that regardless of the level of sophistication, preparedness efforts do make for a positive difference in organizational, interorganizational and community responses. While many of the response-related problems identified in this report are inherent in the nature of the chemical threat, the effects of these problems on the overall response can be minimized through prior planning efforts. Although the participation of relevant groups in a community-wide preparedness program cannot ensure such things as adequate resource availability or the provision of necessary expertise, the interorganizational relations facilitated by the previously established contacts among the potential responders can positively influence the outcome of any response effort.

In conclusion, the descriptive accounts of chemical disaster response provided in the preceeding case studies should be useful to responders to emergencies on a number of accounts. Inasmuch as they implicitly identify some of the socio-behavioral patterns likely to prevail during the emergency time period of chemically-induced disasters, the accounts should help those who might respond to develop a clearer understanding of the social or interactional features they can expect to encounter in any chemically-related disaster response. This knowledge concerning what is to be expected from others involved in responding to the disaster event can help potential responders reduce the potential for interorganizational conflict during the emergency time period. Furthermore, by indicating typical problems of chemical disaster response and the situations in which they are most likely to emerge, this report should encourage potential responders to consider methods whereby areas of difficulty can be circumvented in the event of an actual chemical emergency.

It is hoped that this report provides general information which local responders to chemical incidents can use in their efforts to improve their community's response capability. Although none of the incidents discussed within this publication can be considered an ideal prototype of chemical disaster response, the three different situational responses described do provide information which is generally applicable to all chemical disaster situations. In fact, a number of the problems noted are found not only in acute chemical emergencies but in many other kinds of disaster situations.

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