University of Delaware
Disaster Research Center

PRELIMINARY PAPER
#88

THE BEHAVIOR OF FIRST RESPONDERS AND THEIR INITIAL DEFINITIONS OF ACUTE CHEMICAL EMERGENCIES*

Jane Gray
and
E.L. Quarantelli

October 1983

*The data in this article were partly obtained through National Science Foundation Grant Number PFR 7714445 to the Disaster Research Center. However, any opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of the National Science Foundation.

There seems to be general agreement that accidents and disasters involving dangerous chemicals have been increasing in modern societies in recent years (Fawcett, 1981). Considerable research of a technical nature has been undertaken on the problem. However, very little attention has been paid to the behavioral, that is, the human and group aspects of the matter. To begin to close this gap in knowledge, the Disaster Research Center (DRC) in 1977, under a three year grant from the U.S. National Science Foundation, launched a three year study of sociobehavioral responses to acute chemical emergencies.

We examined organizational and community preparedness for and response to sudden dangers involving hazardous chemicals. Forty-five field studies were conducted. In the first phase of our study, we obtained systematic and comparative data on preparedness for acute chemical emergencies in 19 American communities with varying degrees of risk from dangerous chemicals. In the second phase of the research, we studied 26 responses to major accidents or disasters resulting from toxic releases, explosions, spills, fires, or other acute chemical emergencies.

The on-site data in both phases of the study, obtained primarily through intensive interviewing of key personnel and collection of documents, were subjected to a variety of quantitative and qualitative analyses, the specifics of which have already been reported in publications elsewhere (see Quarantelli and Tierney, 1979; Tierney, 1980; Gray, 1981; Gray and Quarantelli, 1981; Quarantelli, 1981; Quarantelli and Tierney, 1981; Tierney, 1982; Quarantelli, forthcoming). This article presents a general overview of what we found regarding an important matter, how first responders act and initially tend to perceive the acute chemical emergencies with which they are faced. While rooted in our empirical data, this article is intended as a summary of the general picture we found about a crucial response pattern rather than a concrete detailing of very specific findings. Anyone interested in specifics about the methodology, theory, or the different substantive foci of the study, should look at the other publications from our study that we cite above. (For a general report on the total study, see Quarantelli, forthcoming.)

In the beginning of this article, we note some of the differences between responses to fixed sites compared to intransit types of acute chemical emergencies. In the rest of the article we depict the initial perceptions in the response patterns in suddent accidents where hazardous chemical substances were present.

Fixed Sites Versus Intransit Situations

In our research we discovered that there were some major differences in the patterns of response to hazardous chemical incidents at fixed sites when compared to those resulting from intransit accidents. Fixed sites generally refers to episodes within chemical plants or on their property. Intransit has reference to incidents associated with transportation accidents such as those involving trucks, trains, barges, or aircrafts carrying hazardous chemicals which occur on publically accessible lands. We noted that which organizations participate in the response and what they do, as well as

the difficulties that emerge, differ somewhat in the two kinds of situations. While there are many elements in common between the two situations, there are enough differences in the response to make them worthwhile noting.

In particular, in-plant emergencies are likely to involve only company related groups, such as the plant fire squad rather than the fire department of the local community. In contrast, intransit situations will sooner or later, and it is usually sooner, evoke the appearance of community emergency agencies such as police and fire units. In-plant emergencies usually tend to generate responses rather specific to the chemical hazard. Transportation accidents on the other hand, often initially trigger general accident response measures rather than specific chemical disaster responses. In-plant chemical emergencies also tend to lead to actions to contain if not to prevent the chemical emergency from developing. In contrast, many of the initial activities in transportation accidents are devoted to measures to protect the larger community.

The differences in the two kinds of situations stem from a variety of factors. For one, chemical plant incidents almost always occur on private property. In contrast, transportation accidents even though they may involve a private carrier, in the great majority of cases happen in what normally is viewed as a public setting. This in turn is related to the fact that plant incidents often do not have much social visibility. Unless they are of major magnitude, only the immediately present workers and officials in the plant may even know that there had been a chemical mishap. Although incidents beyond a certain level of impact are supposed to be reported to the public authorities, this does not always occur. In contrast, most (although not all) transportation accidents are much more socially visible and usually cannot be kept from the knowledge of the larger community. In our study we did discover some attempts to keep secret hazardous incidents in railroad yards, for instance but most such efforts were not successful.

However, the major differences between fixed sites and intransit situations probably stem from other factors. For one, there is generally good emergency preparedness within chemical companies. In fact, the larger the company (and especially if the plant is part of a nationwide or international corporation) the more the preparedness planning for chemical mishaps is likely to be detailed and extensive. It is true that there is a tendency to equate <u>accident</u> planning with <u>disaster</u> preparedness; but even if it is the former, it does mean the probable collective mobilization of certain relevant resources for the latter. In addition, not only is there likely to be less preparedness planning for transportation accidents, but there are simply more problems which must be coped with in transportation-related events. As examples, there are often complicated jurisdictional questions and multilevel organizational issues when trains, tank trucks, ships, or planes carrying dangerous chemicals are involved in a transportation accident. For instance, any incident in American society which may lead to the pollution of any body of water could lead to the activation of the national contingency plan for such events and the active participation of the U.S. Coast Guard, regardless of local and state plans and the activities of community and state agencies.

Taken as a whole, with everything else being equal, responses to chemically threatening incidents are better in fixed facilities than in transportation accidents. Often in chemical plants minor mishaps are so well handled that they never develop a potential for becoming a disaster. Also when the level of risk is considered, our study found that motor vehicle incidents are generally handled less efficiently and effectively than those occurring on railroads. In part, this results from the fact that there is relatively little systematic chemical disaster preparedness planning for accidents on roads or highways; railroads as a whole have undertaken far more elaborate planning for chemical emergencies.

On the other hand, it does appear from our work that the potential for catastrophic chemical disasters as compared to average-type incidents appears to be relatively greatest in fixed installations. Next most vulnerable would be railroads. Least likely to result in catastrophes are motor vehicle incidents. Our study did not obtain enough information to form any impression about the potential for chemical catastrophes as a result of barge-ship and airplane accidents. There are any number of factors which can affect the magnitude of the possible danger in any given incident. In very general terms, it does seem that situations having the greatest risk potential for a chemical catastrophe or major disaster are those in which the better preparedness and response is likely to be found. That is, the better state of affairs exist generally in plants producing the most dangerous and greatest volume of hazardous chemicals. Thus, it is in such situations that the quickest and most efficient initial responses to chemical mishap are likely to occur.

The Response Pattern

The importantce of the initial response in a chemical emergency is widely recognized. One major chemical manufacturer, in fact, produced a safety training film and entitled it "Those Vital First Minutes" to emphasize the crucial nature and the necessity of proper and quick actions during the period immediately following a chemical mishap or an accident involving chemical substances. It is often the actions in the first few minutes, just before a release or just following a spill, that determine whether there will be a minor even non-chemical mishap or whether instead there will be the threat of or actual impact of a chemical disaster.

In incidents inside chemical plants, there is usually no danger of not understanding that a chemical is involved. However, a far more problematical situation usually exists in the early states of an intransit mishap. We observe in our study that in transportation accidents, first responders seldom initially perceive a dangerous chemical threat unless there are obvious sensory cues such as a strong pungent odor or eye and skin irritations. This is true even when first responders are from emergency organizations such as fire or police departments. Instead, motor vehicle or train accidents are initially seen as transportation accidents or wrecks. The general tendency of first responders is to define the situation as what it "obviously" is, namely a transportation incident. In doing this, responders are doing what has long been observed in the disaster literature, that is, there is a strong tendency to define all cues in terms of the normal or the expected. If it

appears to be a transportation accident, it will be perceived and defined as a transportation accident.

The perception of the initial situation is compounded by the fact that organizational and community disaster plans rarely discuss the combination of a transportation accident and a hazardous chemical incident. In fact, a DRC content analysis of plans determined that separation of the two kinds of events was almost universal. One consequence of this we noted, was that there is an initial tendency for responding groups in transportation accidents to use their standard operating procedures (SOPs) for routine accidents; they seldom initially activate the disaster much less the chemically relevant plans of their organizations.

In principle, first responders should be aware of the various placards and symbols that by law in the United States are mandated to be carried on tanks and other containers of hazardous materials. Unfortunately, various studies have determined that the legal requirements are not always followed. Thus, one systematic study of trucks in Virginia found that 41 percent of the trucks stopped for inspection were in violation of placarding requirements for hazardous materials (Schmidt and Price, 1977). Another report from a railroad states that its own study showed that required placards were in place on rail cars only 77 percent of the time. Our more impressionistic observations support the view that placarding requirements are often widely ignored.

However, even when placards and symbols are still in place and readable after an accident, there is no automatic recognition of them. In our research we found that first responders do not always note the signs identifying hazardous materials, and even if aware of them, do not at all times fully understand their meaning. This excludes situations when placards and symbols had either been destroyed or were made illegible as a result of the transportation accident. Also seldom do first responders have easily accessible manuals or booklets which would translate the symbols for them or indicate what they should immediately do given what a placard might identify as the dangerous chemical substance involved.

Sometimes first responders in transportation incidents do initiate searches for invoices or other relevant papers. However, even if a search is initiated, it is sometimes difficult to find the invoices or shipping bills for what is being transported. If found, the papers are not always understandable to people without an appropriate technical background. Personnel from law enforcement agencies, usually the first responders to transportation accidents, seldom have the knowledge to read technical papers correctly. Of course, relevant papers are not always available; one survey found that 23 percent of trucks carrying hazardous materials failed to carry required shipping papers (Schmidt and Price, 1977).

Also, personnel from the transporting carrier are sometimes killed, injured, or disappear from the accident scene thus precluding questioning by first responders. Of course, such personnel themselves do not always know exactly what they had been carrying. There have been cases where first responders have been unintentionally misinformed by truck or train personnel about the dangerous cargoes they supposedly were carrying. We also observed in our study that personnel from the carriers were sometimes reluctant

(if not actually uncooperative) in providing relevant information to first responders. Thus, for all these reasons, first responders are frequently uncertain about the specific nature of the chemical threat even after they suspect the incident is more than a routine accident.

Some of the DRC observations on these matters have also been reported by others, especially operational personnel. In a United States National Transportation Safety Board hearing, witnesses from the fire service areas:

> Indicated that reliance on technical manuals, placards, computer printouts, and waybills did not fulfill their informational needs. They stated that all too often placards located on hazardous materials tank cars were destroyed, the knowledge of the train crew was limited as to the exact placement of tank cars and the materials carried; and in immediate emergency conditions, there was not adequate time to search for waybills and cross-reference materials with an emergency manual to determine general emergency actions (National Transportation Safety Board, 1978:11).

Because of all these matters, we found that first responders, even if they believe more than a routine accident is involved, are often uncertain as to the specific nature of the chemical threat with which they must cope. In fact, it was rare in the chemical emergencies resulting from a transportation accident, for first responders to learn quickly what they had to face. In some such instances also, and not uncommon where multiple dangerous chemicals were involved, responders sometimes never learned what the hazards were until long after the incident was over.

In situations in chemical plants compared with intransit situations, there seldom is a problem of identifying the chemical threat. However, there are other kinds of problems that stem from the typical behavior of first responders in plant accidents. We observed more than once that company personnel often failed to promptly report fixed installation accidents involving chemicals to outside authorities. There was this failure to communicate even when the threat spilled over or continued to develop outside of the plant grounds. Our study observed that community emergency officials often fortuitously learned about the possible danger to their localities. Not infrequently, the outside community agencies were delayed in finding out about a chemical threat until there were obvious sensory cues, such as a toxic cloud.

Given such circumstances, it is understandable that we found the responders from outside plants often remain unclear for some time about the specific nature of the chemical threat. They may recognize that the community is possibly endangered, and that some chemicals may be involved, but have no specific knowledge beyond those facts. We observed a few situations where an evacuation was initiated even though the community officials did not know from what danger people were being evacuated in the situation. Actually in the face of an unclear and uncertain threat there is likely to be a delay in doing anything, this being a reflection of the general principle stated in the disaster literature that faced with responding or not responding to uncertain threat, the latter course of action is most likely to be followed (Quarantelli, 1982).

Actually, all efforts by first responders to identify the exact nature of the chemical threat in transportation accidents are beset by a number of difficulties. As noted before, correct identification by the first or earlier responders of the chemical involved sometimes just does not occur. Incorrect identification may be diffused to many others through rumor among local officials outside a plant or near a transportation accident site. It is, as students of rumor phenomena have stated, the function of rumor behavior to provide some definition of a situation when none is otherwise readily or officially available (Shibutani, 1966).

Also, because it is known that a danger exists, does not necessarily mean that the exact nature of the danger is understood. Hazardous chemicals may have varied and multiple effects on humans and the ecology of the environment. Thus, we observed that in some chemical emergencies, even when the identification of the chemical substance was correct, an equivalent recognition of the specific dangerous nature of the threat was not always necessarily known. To identify something as a threat, does not automatically mean that there is much knowledge about the specific nature of the threat or how to handle it.

In our study we also found that first responders to transportation accidents tended to overlook two important dangerous possibilities. In almost all cases there was an initial overlooking of possible synergistic effects, for example, the volatile reaction that will occur if water is combined with calcium carbide. First responders tended to be single--rather than multiple--chemical agent oriented in the emergencies we studied. In addition, the on-site responders generally did not recognize the different and various kinds of multiple hazards which might be present due to a variety of dangerous chemicals being on the same train or truckload. Thus, if a fire was perceived or one chemical involved was identified as capable of burning, this was what we focused on but overlooking, for example, explosive, asphyxiating, or corrosive threats which might result from other chemicals involved in the transportation accident.

Especially at the local community level, there is not widespread knowledge about correct stabilization and neutralization procedures. Thus, first responders to chemical emergencies often literally do not know what to do, even if they correctly identify the dangerous chemical and know its effects. Thus, even when a chemical threat is correctly identified, fire department personnel (the most likely first responders to the danger) may not act appropriately. Their traditional routine of quickly putting water on a blaze tends to be done automatically; unfortunately in some instances this can be one of the worst things to do.

Even trained personnel may not act appropriately. In the DRC study, we had direct observations of trained company emergency response teams who acted incorrectly and endangered themselves and others. Trained teams, of course, normally do what should be done. However, it is more than possible for mistakes in judgments to be made, given the complex nature of dangerous chemicals and the various contingencies involved.

Overall, fire departments, with the exception of some in large communities and other special cases, are not well prepared to respond to most sudden chemical emergencies. They usually lack the appropriate equipment,

materials, and protective gear. Perhaps surprisingly, they often do not know where to turn for information. For instance, DRC discovered more than one fire department whose personnel had never heard of CHEMTREC, the nationwide chemical emergency reporting center. Although the situation has been rapidly changing in recent years, relatively few local personnel have had training for dealing with hazardous chemicals. Many of these weaknesses in coping with chemical emergencies stem from the fact that most of the nearly 30,000 fire departments in the United States are primarily manned by volunteers. Yet it is such volunteer groups which are very often among the first responders and usually are the lead organizations in fighting hazardous chemical threats in transportation accidents.

A major observation of the DRC study was that the initial responding activities of emergency organizations usually follow SOPs. This generally gets the organizations into action, although not necessarily doing anything of a relevant nature. As the nature of the chemical threat becomes clearer, there usually is a tendency to try to adjust to the newly recognized situation. For the vast majority of first responders, there is no prior similar experience which can be called upon. Thus, experience in prior but unusual emergencies is likely to influence that response. We did observe in our field work that some emergency organizations have relevant technical manuals available, although they are not often in the hands of the very first responders. However, there is considerable variation in the usage of such manuals and frequently, as said earlier, they are not consulted at the height of the emergency.

In the first response effort, there is much of an ad lib quality to what is done especially in transportation accidents. Trying to clarify the situation is often a prime activity. Defining what is happening and what can and should be done is much of the early response, but such definitions are not always correct. In fact, there is often a delay in defining a transportation accident as having the potential for a chemical disaster.

Postscript

We have reported what our study uncovered regarding the behavior of first responders to acute chemical emergencies in American society. Research will have to establish if the same pattern of response prevails outside of the United States. However, a few studies elsewhere such as in England, Italy, and Japan suggest that there may be more similarities in behavioral responses than differences across different societies (see, for example, Westgate, 1975; Fuller, 1977; Ikeda, 1982).

References

Fawcett, H. W.
1981 "The changing nature of acute chemical hazards: a historical perspective." Journal of Hazardous Materials 4: 313-320.

Fuller, John G.
1977 The Poison That Fell From the Sky. New York: Random House.

Gray, Jane
1981 "Three case studies of organized response to chemical disasters." Miscellaneous Report #29. Columbus, Ohio: Disaster Research Center, The Ohio State University.

Gray, Jane and E. L. Quarantelli (eds.)
1981 "Special Issue: Social aspects of acute chemical emergencies." Journal of Hazardous Materials 4: 309-394.

Ikeda, Ken'ichi
1982 "Warning of disaster and evacuation behavior in a Japanese chemical fire." Journal of Hazardous Materials 7: 51-62.

National Transportation Safety Board
1981 Safety Effectiveness Evaluation--Federal and State Enforcement Efforts in Hazardous Materials Transportation by Truck. Washington, D.C.: National Transportation Safety Board.

Quarantelli, E. L.
1981 "Sociobehavioral responses to chemical hazards: preparations for and responses to acute chemical emergencies at the local community level." Final Project Report #28. Columbus, Ohio: Disaster Research Center, The Ohio State University.

1982 "People's reactions to emergency warnings." Preliminary Paper #75. Columbus, Ohio: Disaster Research Center, The Ohio State University.

forthcoming Acute Chemical Emergencies: Preparations and Responses at the Local Community Level.

Quarantelli, E. L. and Kathleen Tierney
1979 "Social climate and preparedness for sudden chemical disasters." Pp. 457-460 in E. F. Lewis, L. D. Nelson, D. H. Scully, and J. S. Williams (eds.), Sociological Research Symposium IX. Richmond, Virginia: Department of Sociology, Virginia Commonwealth University.

1981 "A model for studying community preparedness for acute chemical disasters." Unfall-und Katastrophen-forschung, ed. by H. Graf-Baumann and Stephan Metreveli: 336-353.

Schmidt, J. W. and D. L. Price
1977 Virginia Highway Hazardous Materials Flow. Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Shibutani, Tamotsu
1966 Improvised News: A Sociological Study of Rumor. Indianapolis, Indiana: Bobbs Merrill.

Tierney, Kathleen J.
1980 A Primer for Preparedness for Acute Chemical Emergencies. Book and Monograph Series #14. Columbus, Ohio: Disaster Research Center, The Ohio State University.

1982 "Developing a community-preparedness capability for sudden emergencies involving hazardous materials." Pp. 759-787 in Howard Fawcett and William S. Wood (eds.), Safety and Accident Prevention in Chemical Operations, second edition. New York: Wiley.

Westgate, Kenneth
1975 Flixborough: The Human Response. Bradford, England: Disaster Research Unit, University of Bradford.