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FIRST RESPONDERS AND THEIR INITIAL BEHAVIOR IN HAZARDOUS CHEMICAL TRANSPORTATION ACCIDENTS

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There seems to be general agreement that accidents, disasters, and catastrophes involving dangerous chemicals have been increasing in recent years (1). The Bhopal, India incident was simply a very public manifestation of what many observers have known has been a growing trend. 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, we at the Disaster Research Center (DRC) in 1977 launched a four year study of sociobehavioral responses to acute chemical emergencies, this being the first systematic and large scale effort of its kind by social scientists.

We examined organizational and community preparedness for 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 which had 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 2, 3, 4, 5, 6–7, 8, 9, –10). This article primarily presents a general overview of what we found in this work regarding an important matter, how first responders initially tend to perceive and react to 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 our research developed 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 work that we cite above. (A general report on the study is given in 11).

Since that initial research which was concluded in 1981, we have done additional field studies on chemical disasters. In particular, we looked at a chemical tank explosion incident in Taft, Louisiana in 1982 (see 12), and a major catastrophe outside of the United States, namely the liquified petroleum gas explosion in November, 1984 in the Mexico City, Mexico metropolitan area. Also, for other purposes, we recently systematically examined a series of official reports on chemical emergencies, such as the incident in Somerville, Massachusetts where in 1980 a cloud resulting from a spill of phosphorus trichloride, as a consequence of a train accident, injured 418 people and forced the evacuation of a one and a half square mile area containing 23,000 inhabitants. Also, we had recent occasion to undertake a comparative analysis of transportation accidents involving phosgene gas versus those involving dangerous nuclear wastes (13). These later field studies and analyses were used to extend and to test some of the observations and conclusions drawn from our initial large scale research. Thus, while this article is primarily a summary presentation of some of our first systematic research, it does take into account our later work.

In the beginning of this article, we note some of the differences between responses to fixed sites compared to in-transit types of acute chemical emergencies. The overall response pattern to such emergencies is then
discussed in detail. The article generally concludes with a depiction of some of the impact and situational contingencies which may affect the behavior of first responders. A brief post-script raises the question about possible cross-societal differences in response patterns to hazardous chemical transportation accidents.

 Fixed Sites Versus In-transit Situations

In our research we found that there were some major differences in the patterns of response to hazardous chemical incidents at fixed sites when compared to those resulting from in-transit accidents. Fixed sites generally refer to episodes within chemical plants or on their property. In-transit 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 in American society, 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, in-transit situations will sooner or later, and it is usually sooner, evoke the appearance of community emergency agencies, such as the local police and fire units. In-plant emergencies usually tend to generate responses rather specific to the particular chemical hazard involved. Transportation accidents, on the other hand, often initially trigger general accident response measures rather than specific chemical disaster responses. Also, in-plant chemical emergencies 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 in the United States 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 discovered some attempts to keep secret hazardous incidents in railroad yards, for instance, but most efforts were not successful.

However, the major differences between fixed sites and in-transit 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 accident planning with disaster 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 multi-level 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. The 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 in the United States.

The Response Pattern

The importance of the initial response in a chemical emergency is widely recognized. One major American 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 hazardous chemical is involved. However, a far more problematical situation usually exists in the early states of an in-transit 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 perceptions 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 (14). Another unpublished 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 (14).

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. Also, we 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 (15).

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. Also, in some such instances, 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 in the United States, compared with in-transit situations, there seldom is a problem of identifying the chemical
threat although we did encounter one case where it took company officials hours after an explosion before they realized they had a poison gas episode potentially present in the situation. 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 that 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 officially 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 (16) that faced with responding or not responding to uncertain threat, the latter course of action is most likely to be followed.

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 (17).

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 field work, 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 judgements 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 staffed 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 defini-
tions are not always correct. In fact, there is often a delay in defining a transportation accident as having the potential for a chemical disaster. In part, this is because there can be all kinds of contingencies present in a potential disaster situation. We turn now to a discussion of such possible contingencies.

Impact and Situational Contingencies

Impact and situational contingencies can greatly influence the way and the degree to which any community will respond to a particular chemical emergency. For exposition purposes, we divide these contingencies into two categories: impact (or agent variable) and situational variables. While the response and its effectiveness in a chemical emergency will be affected by differences in the agent's impact characteristics, as well as by variations within the social aspects of the particular situation, we are not arguing for idiosyncratic factors. Quite the contrary, we want to note that even the individualistic features of a chemical emergency can be generalized. In fact, even a general recognition that contingencies will always be present should force emergency personnel to consider such problematical aspects in disaster preparedness planning.

Impact Contingencies

Impact contingencies include those characteristics of the chemical agent which can affect the organized response. Different agents impose different risk threats. While risk assessment essentially involves a perceptual component, there are risk dimensions which are inherent to the agent. For example, some chemicals are toxic, while most are not; a few chemicals can explode, others can not. Certain chemicals only become dangerous when they combine with other chemicals; certain other chemicals remain inert, and so on.
Thus, the specific characteristics of the chemical agent on agents involved in a major accident will influence the risk threat posed for a particular environment. Given the variety of characteristics which might be involved, myriad risk possibilities could be present. However, many of these variations can be reduced to one of two kinds of possible consequences: the destruction or damaging potential of the chemical(s), and the controllability of the chemical(s). Both of these characteristics will have implications for the manner in which emergency responders can and will attempt to neutralize the threat. The situation is complicated, of course, in that responders to the emergency may not correctly perceive either the destructive-damaging potential or the controllability of the chemical threat. But in such instances, the risk consequences will still remain, even if they are incorrectly perceived.

The destructive-damaging potential of any chemical agent is the amount of damage and destruction it can cause people and the ecological environment. Certain agents have a greater potential for such damaging results than others. In general, the high-risk chemicals are those which are extremely volatile or which exhibit unstable molecular structure. Chemicals which have a high-risk potential are exemplified by the inherent dangers of compressed gases or the hazards posed by such gases as butadiene and vinyl chloride, which are both highly reactive and have a tendency to polymerize. Of course, the typical first responder (whether police or fire) to a chemical accident, unless it occurs within the confines of a chemical plant, usually has little idea of the destructive potential of the chemical.

Instead, what we want to stress here is that responders to a chemical emergency can be faced with widely differing dangers, depending on which chemical(s) happens to be involved. Thus, in one emergency the responders
might find themselves faced with a relatively low-risk situation. In another emergency, the risk may be extremely high. One result is that multiple exposures to chemical risks may not provide much of a learning experience. Unlike many natural disaster situations, experience in one situation does not transfer very well to the next incident. This great variation in possible destructive-damaging potential is an inherent agent contingency in a threatening chemical situation.

Of course, there can be actual impact, often with substantial variation in the destructive or damaging consequences. DRC studied some actual chemical emergencies where populations dozens of miles away from the actual disaster site were endangered. Yet we examined other chemical disasters where the actual destructive impact was confined merely to the truck or railroad tank cars involved. Depending upon which of these two situations have to be faced, responders have to deal with different types of disasters. A very localized disaster presents some different operational and response problems than does a very diffuse disaster. There can be tremendous difference in threat or impact depending partly on inherently differing qualities of different substances.

In both of the situations just noted, we are saying that different contingencies may be presented to responders which are primarily dependent on the inherent properties of whatever chemicals are involved. This is in addition to the fact that responders may incorrectly perceive the chemical danger or even not perceive any threat at all. Perceptual differences aside, however, different dangerous chemicals will provide different threat or actual impact contingencies to which responders have to react.

As an additional example, we may illustrate how the magnitude of a
disaster can complicate the response pattern. In a large disaster, whose magnitude partially depends on inherent properties of the chemical(s), a number of representatives and agencies from different jurisdictional levels will respond to the event. We found that incidents of larger magnitude tend to be "top heavy" in terms of the involvement of state and federal organizations. This usually complicates jurisdictional problems, since there are often discrepancies in regard to responsibilities among different governmental sectors. That is, they do not correspond and they are not equivalent. In other words, we have found that if a disaster is large enough to necessitate a response from state, regional, and/or federal levels of government, these representatives will attempt to exercise the authority and control in the situation, in opposition to local community officials. Thus, the contingency of the destructive-damaging potential of any chemical agent may influence the coordination of interorganizational response.

In addition to actual or potential destructiveness, there is also the factor of the uncontrollability of chemical agents. Here, too, there is considerable variation. There may not be a correspondence between the inherent uncontrollability of a chemical agent and the responder's perception of this uncontrollability.

Our study determined that most community officials are likely to assume a high degree of uncontrollability of most chemical agents. While the same perception exists for most natural disaster agents, there is sometimes the expressed feeling that this should not be the case for chemical substances. In actuality, any chemical's controllability is only partly dependent on the properties of the chemical agents themselves. Also, controllability depends upon the amount or volume of the chemicals, and also the capability
of the community to respond appropriately in the typical critical time period immediately following the onset of an accident with the potential for a disaster.

The chemical properties include flash points, toxicity, vapor density, synergistic possibilities, etc., and all can be further affected by meteorological conditions such as precipitation, wind velocity, and other similar factors. Usually, everything else being equal, the greater the volume, the greater the uncontrollability. Finally, controllability is partly dependent on the community's capability to perform certain initial response tasks.

While both destructiveness and uncontrollability are inherent to the properties of the chemical, they are not, insofar as response is concerned, independent of the perceptual factors. Our study suggests that there is misunderstanding with respect to both matters. In general, both community officials and the public tend to overestimate the destructive and damaging potentials of dangerous chemicals. As in the instance of projections of risks at nuclear plants the picture that is often conjured up for chemical emergencies exceeds the inherent possibilities of most chemical substances. To be sure, as previously indicated, chemicals can present major risks and result in major consequences, but they are seldom major threats across-the-board. Most chemicals cannot be inherently dangerous, but our study showed the common view is often the reverse: the perception that chemicals are involved in an accident often leads to a perception of danger.

We think one reason for a general misunderstanding of the potential effects of chemical agents is that except within the chemical industry, few people have any experiential point of reference with which to view
chemicals and certain risks associated with technological accidents. Chemical agents may be ubiquitous in American society, but they are relatively random in their hazardous manifestations. That is, the risks posed by dangerous chemicals are not restricted to certain localities or regions of the country; they are nonspecific in this respect. In contrast, most natural disaster agents such as earthquakes, hurricanes, or tornadoes are specific to certain localities; in contrast, the impact of hazardous chemicals is not confined and specific to certain localities. Therefore, it is unlikely that any given population group will have had much if any direct experience with dangerous chemicals. Consequently, the image of the risk presented by chemical agents is vague and tends to be exaggerated.

In general, impact contingencies add to the possible variation and complexity of the response in chemical emergencies. In some actual chemical disasters, the situation is further compounded for responders by the multiplicity and variety of hazardous aspects which may be involved. In some acute chemical emergencies, there are often multiple elements of a disaster occurring either concurrently or sequentially. For instance, in the derailment of a train carrying dangerous chemicals, there may be multiple hazards and problems. The derailment is, in itself, a problem which must be solved. There may be resultant fires and explosions from the derailment. In turn, these may cause a chemical spill or toxic cloud which may not otherwise have occurred just from the derailment. Each of these events creates differing demands. In one sense, a single situation may involve multiple disaster potentials which generate different demands to which the affected community must respond. The incident may generate different emergency-related tasks incompatible with each other. Thus, the water needed to douse the fire, for example, might actually trigger some dangerous chemical reaction.
which otherwise would not have occurred. In fact, the example just given represents an extreme, but not unknown, manifestation of the complexities which can be generated by impact contingencies for responding organizations.

It is very easy to think of impact contingencies in very individualistic or idiosyncratic terms. However, we have tried to indicate that there are some general aspects even to contingencies, including the simple fact that there will be impact-related contingencies in any chemical emergency. This realization should encourage general planning for a response which takes contingencies into account.

Situational Contingencies

Situational contingencies include those specific characteristics of the particular social context in which a chemical mishap first occurs. Thus, a chemical emergency does not just happen. It happens in a particular locality, in a place with distinctive features. Similarly, a chemical emergency occurs at a specific point in time—more accurately—at some social time in the community life. Likewise, there are particular circumstances associated with any particular chemical emergency; for example, the overturned truck carrying a dangerous chemical cargo may or may not have displayed the required warning placards. While these do not exhaust all the types of situational contingencies, we will primarily illustrate those that can be subsumed under space, time, or circumstantial variations affecting the response to a chemical emergency.

a. Variations in Space

Where a chemical threat or disaster occurs significantly affects the response. A chemical emergency, for instance, can occur on private property, a mixed public/private setting, or a public location. These possibilities have implications on a variety of factors, ranging from the degree of know-
ledge the public will have about the event, to the possible courses of action which responding organizations could take. For example, our research observed that when chemical accidents occurred inside plants or chemical company property, seldom did the larger community quickly find out about such events unless there were immediate casualties. In nearly every case, there was a delay between the time the accident on private property was turning into a potential disaster and when this happening became public knowledge. We also ran across situations where local fire departments were denied entry onto private property where a chemical emergency was occurring. On the other hand, our research looked into situations where, because the chemical emergency was in a public setting, the response was delayed and confused because no local agency believed it had exclusive responsibility and jurisdiction over the incident. Such a lack of clarity over response initiative would not occur in a private setting. Thus, the spatial--actually property responsibility--setting (which is a contingent matter) makes a difference in the response patterns to chemical emergencies.

Another spatial contingency involves the geographic and demographic setting of incidents. An obvious possibility which may make a difference is whether the incident occurs in a rural or urban setting. What might pose only minor consequences in a rural area could have catastrophic potential in an urban area with high population density and heavy concentrations of buildings. The inherent destructiveness of the chemical agent might not differ, but could vary depending on the physical setting in which the destructive agent might manifest itself. Also, the geographical location will usually affect the mobilization of resources during the initial phases of a response. In general, smaller communities with predominately volunteer fire departments and other scarce resources will not respond as well as
larger metropolitan areas with extensive and/or sophisticated resources, or quick access to them. Thus, since resource capability is indirectly related to geographic setting, the spatial locality of the chemical emergency can affect the response pattern. Put another way, response resource capability will vary according to different settings, as will the mobilization of the resources and the magnitude of the disaster in terms of population threats.

Furthermore, we frequently noted in our research that interjurisdictional and interagency problems may arise depending on the location in which the chemical emergency occurs. On an everyday basis, many jurisdictional boundaries and domains are often vague at best. Therefore, if any emergency occurs near the uncertain boundaries of two or more separate jurisdictions, ambiguities can surface as to who has major responsibility for responding to the disasters. Chemical disasters in port areas or involving bodies of water, in particular, seem to generate jurisdictional problems in the response, although the same difficulties also frequently surface outside of city boundaries. Many rural or quasi-rural areas in the United States are locales where organizational responsibility, authority, and domain are unclear and often overlapping. A chemical emergency in such a location is certain to elicit interagency confusion, if not competition or conflict. Thus, the contingency of the location of a chemical emergency can have a major impact on the response pattern.

b. Variations in Time

When a chemical threat or disaster occurs is also important in affecting the response. However, it is not chronological but social time which creates an effect. The two times are not equivalent. In every community, there is a rhythm to social life, with certain activities ebbing and increasing in particular patterns and cycles. These patterned activities vary (and
not always directly) in relation to the time of day, the day of the week, and the season. Thus, there are such community social phenomena such as the rush hour, the evening or afternoon during which major sports events are scheduled, and holiday weekends. Such social times affect where people will be concentrated and what they will be doing, as well as the state of readiness of emergency organizations and how quickly resources can be mobilized.

Our studies noted great response variation depending on the timing of chemical emergencies. Evacuation, for example, is much easier to carry out during light than darkness. At the Mississauga chemical incident, massive evacuation was partly delayed, as police reports point out, because of a reluctance to try to move a great number of people at night. Convergence is relatively less likely to occur during regular working hours than other times. Unless there is an immediate threat, persons at work cannot just leave work to go and look at a disaster site. Even organizations that operate on a shift basis, and most emergency groups are operative on a 24-hour basis, do not have either the same quantity or quality of personnel available around the clock. We studied some chemical emergencies where the response was slow in developing because higher-level emergency officials were not immediately available because the incident occurred outside of regular weekday working hours. In a few cases, certain material resources could not be easily located and used because the organizations owning them were closed and it proved difficult to find any personnel with relevant information and/or authority on how the resources could be obtained.

Thus, in the same manner as spatial variations, temporal variations can create different contingencies. With respect to time, the rhythms of community life (or social time) can create radically different situations
with which responders must cope. The chemical risks might be identical in two chemical emergencies, but due to timing there could actually be somewhat different situations for the responders in the two cases.

c. Variations in Circumstances

In addition to spatial and temporal contingencies, there are still other variations possible. There may simply be other circumstances affecting the situation. Many factors could be cited, but we will illustrate only two examples: the duration of the threat and the speed of onset.

In our research we observed chemical emergencies whose response activities ranged from a few hours to nearly a week. As we indicated earlier, some events which eventually become chemical emergencies may be no more initially than a transportation accident or a plant mishap. Thus, a railroad derailment may produce no chemical toxic release for several hours, days, or perhaps, not at all. However, responding organizations have to maintain site security and mobilize certain resources for the entire duration of the episode. The residual polluting effects of a dangerous chemical neutralizer can likewise extend an incident. In other cases, however, the circumstances are such that everything of an emergency nature is quickly over, and just hours after the initial indication of the emergency, there is little sign that anything has happened.

This can cause greatly differing consequences, depending on the kind of community in which it occurs. For example, we noted not surprisingly that smaller communities were more adversely affected by a prolonged emergency. Among the negative consequences noted were lost wages for volunteers in emergency organizations, substantial losses to the local economy because of closed businesses, and rapid depletion of certain kinds of resources. A chemical emergency of the same duration would not have the same consequences
in a metropolitan area. In fact, while an urban area might suffer more in absolute terms, we observed smaller communities tended to incur relatively higher losses for chemical emergencies of the same duration.

Also, we found that the speed of onset is another situational variable which may make a difference in response patterns. Depending on many factors, including properties of the chemical agents, as well as how the potentially dangerous substances are initially treated, there may be little or no advance warning of an impact. In such cases, there can be no preventive efforts and the response generally focuses on recovery efforts. However, in many transportation accidents particularly the initial accident does not always produce an immediate chemical emergency. In many such cases, the response can be primarily directed at preventing a chemical emergency from ever developing. As the examples illustrate, circumstances can create different kinds of situations, and in that way partially structure the necessary response.

In this section we have tried to stress that there are many contingencies in potential and actual chemical emergencies, some of which may actually prevent such an emergency from manifestly occurring. Some contingencies result from the property of chemical agents themselves. Other contingencies are more situational in nature, resulting from spatial, temporal, or circumstantial factors. However, while contingencies are important in affecting responses, they primarily set the stage for responding organizations. What responders do, is heavily influenced by how they initially define the situation which is discussed in the first part of this article.

Postscript

We have reported what our study uncovered regarding the behavior of first responders to acute in-transit chemical emergencies in American society.
Do these patterns of response hold elsewhere? This is very difficult to say because the few systematic social science studies of chemical disasters outside of the United States have focused on in-plant accidents. However, the research done in such societies as England, Italy, France, and Japan suggest that there may be more similarities in behavioral responses in these kinds of disasters than differences across different societies (18, 19, 20). Some observations made in Bhopal, India and what we ourselves found in the Mexico City liquified petroleum gas explosion are less definitive about cross-societal similarities. Since there have been so few studies elsewhere, and practically none on hazardous chemical transportation accidents, we shall have to await the result of future research to see if the pattern of behavior of first responders that we reported prevails outside of the United States also.

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