

WORKING PAPER #82
PLANNING FOR TRANSPORTATION ACCIDENTS
INVOLVING HAZARDOUS MATERIALS*

E. L. Quarantelli

Disaster Research Center
University of Delaware

1989

*An oral version of this paper was presented at a Workshop on Hazardous Materials Transportation Incidents in Washington, DC on May 10, 1989.

My perspective on this is one who has looked at about three dozen community preparedness situations and about three-four dozen community response studies to acute chemical emergencies and disasters as part of a larger study base of over 505 field studies of mass emergencies and disasters of all kinds.

An advantage of this is that we can have a broader perspective on a fuller range of acute chemical emergencies and disasters than the typical planner and/or responder who at best will have only a few experiences, and also we can observe what, if any, are the special or unique aspects of these situations when compared with the full range of mass emergencies and disasters.

A. What is the nature of the problem?

We are talking of something that is not new, but that has come to the fore in the last decade or so, and unfortunately that will get worse in several ways.

The past.

If we look at the past we can see that some of the worst disasters ever to hit the North American continent have involved transportation accidents of hazardous materials.

E.g. Halifax explosion in 1917 in Canada; two ships collided setting off a munitions explosion which destroyed a two sq mile area and killed nearly 2,000 people.

In Texas City in 1947 a freighter carrying 1,400 tons of ammonium nitrate fertilizer exploded after a fire broke out, followed by another ship explosion the next day, which killed 576 people and injured over 2,000.

In 1979 over 215,000 persons had to be evacuated in a suburb of Toronto, Canada as a result of a train derailment threatening the release of chlorine gas.

So we have had major incidents in the past.

The present.

Until the last decade or so, there were a number of communities in the United States that had very low probabilities for having any kind of natural disaster impacts. However, with the development of a technologically based society, any community now that is near a railroad track, an interstate or major highway, or barge/river traffic, is at risk, even if there are no chemical or nuclear plants in the vicinity.

It is clear that much of American society has come to be at risk from accidents involving hazardous materials but the exact magnitude of the problem is not that clear since while there are all sorts of statistics around, none of the figures being very solid. Nevertheless, the overall and general picture is clear, even though all the specifics are not.

E.g. In 1984 the National Transportation Safety Board estimated that about 250,000 shipments of hazardous materials are made ever day. The draft of the

primer being prepared for this workshop uses a figure of 500,000. In either case, it's a lot of hazardous shipments.

The Congressional Office of Technology Assessment estimates that over 1.5 billion tons of hazardous materials are transported annually in the United States. Another estimate is that between 1980-1985 there were 420 million pounds of chemical spills. While obviously that means that the overwhelming majority of what is shipped gets to its destination without any trouble whatsoever, there is still a lot of hazardous material that never gets to its original destination.

Even if we take just one specific dangerous item, it can be impressive insofar as potential risk is concerned. For instance, 15.7 billion gallons of liquid propane are shipped every year, 90 % of which are carried in about 25,000 tanker trucks.

Between 1971 and 1980, more than 111,000 hazardous material accidents were reported by the US Transportation Research Board.

But it is not just the materials themselves that can be a problem--the ways they are shipped or transported can in themselves create problems or magnify the risks.

For example, a special unit of state troopers in New Jersey in 1987 found after stopping 2,000 trucks carrying hazardous materials, about 720 had to be placed out of service because the trucks were unsafe to drive. In New York State in 1988 a survey found safety violations in 60% of 40,000 trucks examined.

The future.

Will get worst in the two ways the situation can get worst.

There is continuing increasing production of dangerous materials and therefore increasing transportation of them (Superfund Title III will probably reduce both somewhat, since it makes sense for plants to have less dangerous substances around, but not enough to make a substantial difference). We have gone from 6.5 million chemicals in 1984 from 4.5 million in 1980 (to be sure the great majority are not hazardous in any way).

In 1985 we had 12,900 tons of spent nuclear fuel to ship. By the year 2000 we will have over 47,900 metric tons to ship somewhere; in addition, there are hundreds of shipments of military generated radioactive material. This contrasts with a total of a total of 1,904 separate shipments of 54,000 pounds in 1979.

Also some of the means of transporting hazardous materials have gotten larger. For instance, from 1960 to 1980 not only has the number of tankers doubled, but their shipping tonnage has increased sevenfold. So, increasingly, there is something bigger to spill, explode or burn on waterways. Also not only are there more trucks than ever before, but they are increasing larger. (Accidents involving truck rose 23.4% from 1983 to 1985 from 31,628 to 39,030). A 1981 NTSB report stated that there were at least 413,000 tank trucks which regularly transport hazardous materials in bulk. In fact, DOT has estimated that

somewhere between 5-15 % of all trucks on the road at any time carry hazardous materials.

It is also estimated that there are about 170,000 tank cars, about 10 % of all freight cars. The hazardous materials most often transported by rail such as liquified petroleum gas (LPG), chlorine, anhydrous ammonia and vinyl chloride are carried in tank cars with capacities of up to 42,000 gallons. One report back in 1978 said that about 35% of all manifest train cargoes contain hazardous materials. One railroad alone reportedly moved over 100,000 carloads of hazardous substances in just one year, 1974.

The context also in which accidents can occur will present more opportunities for mass emergencies and disasters. There are simply more people, more inhabited areas, more localities to impact out there. Even if there were no increase in dangerous substances, there is a continual increase of more that can be affected--in many communities the question can be simply asked--given what you know of your community a decade ago and now, isn't there more now by way of new housing developments, new roads that could be affected by an accident?

Given all this, it is not surprising that some scenarios for an LPG explosion in or near a major port area in Southern California have projected a possible 70,000 dead and 325 million dollars of property damage.

B. What are the problems in preparedness planning?

The way to get a good response is to prepare ahead of time. Unfortunately, there are at least four kinds of problems in preparing well for hazardous materials transportation accidents.

It is not that preparations can not be made; it is that unlike in the case of other kinds of threats, the planning is simply more difficult and complicated.

1. In the case of hazardous materials we are really talking of multiple kinds of risks and threats. When we talk of chemicals we are talking of substances that can be liquid, gas or solid; we are talking of material that can explode, burn, asphyxiate, poison, corrode and otherwise damage and destroy property, lives or the environment. Put another way, there are multiple ways in which human and other organisms, plant life and fauna, and physical and material objects can be destroyed, damaged or otherwise directly negatively affected by a dangerous chemical. In short, a chemical emergency or disaster can be many happenings unlike an earthquake or a volcanic eruption. So preparations and managements of hazardous incidents will vary rather drastically depending on the chemical involved.

2. In the case of hazardous materials transportation incidents we are talking of something that may occur almost anywhere. It is not true that the problem can arise at any place; roads and railroad tracks are at certain points. But unlike the estimates that can be made, e.g., about where a hurricane tidal surge will come in, or what buildings are likely to be affected by an earthquake, it is in a real sense impossible to develop real specific models of risk. In principle you could compute traffic load, accident rates, hazardous cargos and arrive at a risk probability, but it is not a very practical thing to do (This

does not deny that in particular communities, you can in a less statistical way, undertake very educated guesses where you are likely to have hazardous transportation problems).

Furthermore, the risk is not only likely to pop up almost anywhere, but again, unlike in the instance of many natural disaster type agents, the point of impact and the point of later consequences may be rather distant. For example, in the Crestview, Florida incident, the chlorine gas cloud drifted 28 miles from where the train accident occurred; it moved towards the Alabama/Florida state line.

3. Also for a variety of reasons, transportation accidents are more likely to occur in either localities that are less well prepared than others (e.g., in rural or semi-rural areas that because of budget and other circumstances are less likely to have good emergency preparedness and response capabilities for any kind of emergency and disaster), or in localities that are often in very complicated jurisdictions (the extreme would be harbors and airports, but this also applies to railroad yards or interstate highways that are often both formally and informally the responsibilities of more than one local emergency agency---e.g. city police, county police, the sheriff's department, the state police, private security forces, etc.).

4. Increasingly so, because of the increased production, transportation and storage of hazardous chemicals, natural disaster agents such as earthquakes or floods which in the past would have simply been natural disasters can now create technological disasters. Train derailments, for example, have followed earthquakes. Among other things, this suggests that preparedness planning for chemical disasters be not totally independent of that for other kinds of disasters.

It is clear that for these and other reasons that planning and response to fixed compared to hazardous transportation incidents can be simpler and tend to be better.

At fixed sites, there are almost always only, at least initially, company related personnel who are knowledgeable about the chemicals involved. Whereas in transportation accidents, community emergency agencies with varying knowledge of threats will be involved.

Fixed site accidents generate responses specific to the particular chemical hazard involved. Transportation accidents often initially trigger general accident response measures rather than chemical disaster responses.

Emergencies in plants tend to lead to actions to contain if not to prevent the threat from developing, whereas in transportation accidents measures are mostly to protect the community.

Plant accidents are almost always on private property, whereas transportation accidents while they may involve a private carrier, usually occur in what normally is viewed as a public setting. The latter are more socially visible and difficult to hide like many plant accidents are hidden.

Accidents in plants often occur where there is at least some prior planning for handling emergencies. Transportation accidents may or may not occur where there has been much prior planning.

Accidents in plants usually involve only plant personnel; transportation accidents sometime leads to automatic involvement of various governmental agencies--any incident in the United States that may lead to the pollution of any body of water can lead to the activation of the national contingency plan for such events and the active participation of the US Coast Guard, regardless of the local and state plans and the activities of community and state agencies.

3. What are the problems in emergency responses?

First, we should note that the importance of the initial response in a chemical emergency is widely recognized. One major chemical manufacturer produced a safety training film entitled "Those Vital First Minutes" to emphasize the necessity of proper and quick actions during the period immediately following a mishap or accident that involves chemical substances. It is often the actions taken in the first few minutes, just before a release or just following a spill, that determine whether there will be a minor nonchemical mishap or the threat or actual occurrence of a chemical disaster.

We should also note that there are relatively more problems with accidents on roads and highways than on railroads; this is because many although not all railroads have undertaken far more elaborate planning for chemical threats. Also, some estimates are that 75-90% of all incidents involving release of hazardous materials occur on highways.

Now in theory there are all sorts of safeguards and measures that either ought to prevent hazards from appearing or if they appear indicate their nature.

Take the matter of placards about hazardous material.

State enforcement officials and the police have found that 25-50% of placards on hazardous material shipments are incorrect.

One systematic study of trucks in Virginia found that 41% of the trucks stopped for inspection were violating placard requirements for hazardous materials (either they had no placards or improper ones).

In an unpublished report from a railroad, its own study showed that required placards were in place on only 77% of the railcars.

However, even when placards and symbols are in place and readable after an accident, they are not automatically recognized. For one, first responders do not always note the signs that identify hazardous materials, and even if aware of them, they do not always fully understand their meaning.

Also first responders seldom have easily accessible manuals or booklets that would define the symbols or indicate how they should respond to the incident according to the type of dangerous chemical substance, identified by the placard, that is involved.

Sometimes first responders to 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 papers for the material that is being transported. Relevant papers are not always carried on the vehicle; one survey found that 23% of trucks carrying hazardous materials failed to carry required shipping papers.

Shipping papers are sometimes incomplete or inaccessible. In the New Jersey state police survey I mentioned earlier, they issued 900 summonses of which 40% were given to drivers whose documents did not give enough specific information on what they were carrying, their origin or destination (another 30% were for placarding violations).

Personnel from the transporting carrier are sometime killed, injured or disappear from the accident scene, thus precluding questioning by first responders. Of course, such personnel do not necessarily know exactly what type of goods the vehicle has been carrying. There have been cases in which first responders have been unintentionally misinformed by truck or train personnel about the dangerous cargoes that were being carried. Also, we have observed situations where personnel from the carriers were sometimes reluctant (if not actually uncooperative) to provide relevant information to first responders.

Incorrect identification may be diffused to many others through rumor among local officials near the site of a transportation accident.

Thus, for all these reasons, first responders are frequently uncertain about the specific nature of the chemical threat even after they suspect that the incident is more than a routine accident. It is rare in chemical emergencies that result from a transportation accident for first responders to learn quickly what they have to face. Also, in some instances, and frequently in accidents that involved multiple dangerous chemicals, responders learn about the hazards long after the incident is over.

Given such circumstances, it is understandable that the responders 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 about these impressions. In the fact of a very unclear and uncertain threat there is likely to be a delay in doing anything.

There is also a tendency to overlook two important and dangerous possibilities.

In almost all cases there is an initial overlooking of possible synergistic effects, for example, the volatile reactions that will occur if water is combined with calcium carbide. First responders tend to be oriented to the existence of a single chemical agent rather than a multiple chemical agent. In many cases there are multiple not just one hazardous chemical involved. Shipments often have different chemicals with varying threats to them. In the Crestview accident, besides chlorine there were four other hazardous materials in the derailed cars.

In addition, responders to transportation accidents generally do not recognize the different and various kinds of multiple hazards that might be present. Thus, if a fire is perceived or if one chemical is identified as capable of burning, this is focused on, but explosive, asphyxiating, or corrosive threats that might result from other chemicals involved in the transportation accident are overlooked.

It should also be noted that planning can not just stop with first responders. Let me indicate the following.

In a survey done in 1987 in New York State it was found that only 29% of hospitals had a list of facilities in their vicinity which handled chemicals and the names of the substances used; a full 68% of emergency room staff had no official contact person to call at nearby facilities which use chemicals to find out what chemicals were released; nearly 63% of emergency room staffs had no special training to treat victims of a toxic chemical accident; only 27% were specifically prepared for a chemical accident. (Incidentally, hospitals can treat an average of less than 10 critically ill patients within 30 minutes of their arrival in the emergency room).

There is frequently an adlib quality to the pattern of the first response, 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 a large part of the early response, but such definitions are not always correct. There is often a delay in defining a transportation accident as one that has the potential to be a chemical disaster. This is in part because there can be many contingencies present in a potential disaster situation.

Different types of contingencies can influence the way in which a response can be handled. These contingencies can be divided into two categories:

Impact variables (or chemical/nuclear agent variables).
Situational variables.

Impact contingencies:
Characteristics of the agent.

Situational contingencies:

a) variations in locations (private, public, mixed public/private);
geographic and demographic setting (rural/urban);
jurisdictional areas.

b) variations in time (social time).

c) variations in circumstances (duration of threat and speed of onset).

Finally we should note some problems with the Incident Command System (ICS) which is mentioned as a model to be used in the draft document being prepared by this Workshop.

1. The Incident Command System is a buzzword which seldom has all the components it is supposed to have in places where ICS is supposedly in place.

2. The recommended shift of command from officers of lower rank to those of higher often leads to loss of information and effective management.
3. The ICS involves primarily intraorganizational planning that does not provide for an interfacing or integrating of activities with relevant outside organizations; gives impression fire department is in charge.
4. The ICS does not encourage integration of activities with a variety of local organizations such as LEMAs, relief groups and volunteers.
5. Use of the ICS creates serious problems in disasters where the impacts occur in focused, limited areas because it appears to facilitate "overkill" mobilization of forces and resources.
6. The ICS does not handle very well intraorganizational problems of communication and coordination.
7. Unless they are involved in its initial development, the system does not solve the problems of coordination that arise between responding units.
8. The ICS is based upon classic command and control models of emergency management instead of coordinative and resource management models; studies suggest numerous problems with the former kinds of models.

Given all these problems, there ought to be considerable caution in accepting the Incident Command System as the model to be used for any kind of disaster situation, including transportation accidents involving hazardous materials.