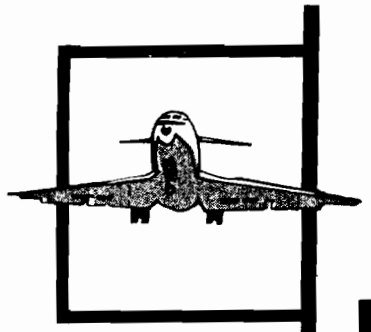

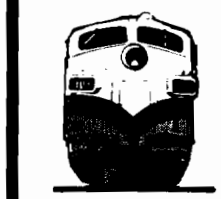

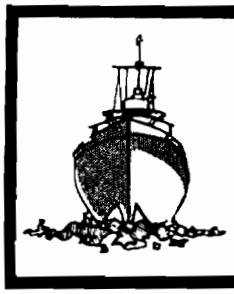

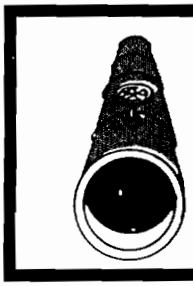

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SPECIAL INVESTIGATION REPORT

PHOSPHORUS TRICHLORIDE RELEASE IN BOSTON AND MAINE YARD 8 DURING SWITCHING OPERATIONS SOMERVILLE, MASSACHUSETTS APRIL 3, 1980

NTSB-HZM-81-1

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract

Observations of emergency response activities following an April 3, 1980, rail yard accident in Somerville, Massachusetts, prompted the Safety Board to conduct this special investigation of the technical support provided to the local community during the attempted control and removal of spilled hazardous material.

The Safety Board investigated the actions taken following release of phosphorus trichloride by local safety officials, the carrier, the Boston and Maine Corporation, and the shipper, the Monsanto Industrial Chemical Company, to determine why the actions were taken and what effects these actions had on the eventual outcome of the emergency. These actions were then analyzed to determine the effectiveness of current spill-control procedures in reducing losses following release of hazardous materials.

The analysis disclosed that technical advice to local officials and emergency action guidelines need to be improved. Difficulties observed at Somerville indicate that some of the advice and emergency guides provided to emergency response personnel by DOT, carriers, and shippers continues to be inadequate, inconsistent, and confusing. The current guides and procedure for providing advice should be reviewed where necessary, and steps taken to assure that lessons learned from handling actual emergencies be adopted for future use.

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Collision, switching, hazardous materials, railroad tank car, phosphorus trichloride, emergency response, transport, mitigation, spill recovery.	This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed-in item 2)*

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PREFACE

The Safety Board has adopted this report because it believes that it is extremely important that the "safety lessons" learned during the handling of this emergency should be made available to fire and rescue personnel who might be faced with a similar incident. Also, it believes the report highlights the importance of analyzing risks and formulating appropriate safety strategies before accidents happen. One of the tragic realities of the evolution of transportation safety is that all too often the problems have not been identified or solutions implemented until after a tragedy has occurred. There are certainly a variety of "system's safety" or "risk analysis" techniques available which could be more effectively applied by the various entities involved in the transportation of hazardous materials.

The Safety Board, however, does not mean to infer that all of the deficiencies at Somerville are "typical" and thus represent "pressing safety concerns" of national importance. This report is substantially based on one incident and the scope of the investigation did not include an overall evaluation of the adequacy of existing guides. Likewise, the investigation did not examine the adequacy of the training received by the personnel involved at Somerville, which undoubtedly affected their "interpretation" of the emergency guides available on scene.

In addition, the report, by virtue of its direction, does not sufficiently highlight the value of the recently released Department of Transportation "Emergency Response Guidebook." The guidebook is a significant improvement over earlier guides, and the U. S. Department of Transportation is commended for its development.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

SPECIAL INVESTIGATION REPORT

Adopted: February 26, 1981

PHOSPHORUS TRICHLORIDE RELEASE IN BOSTON AND MAINE YARD 8 DURING SWITCHING OPERATIONS SOMERVILLE, MASSACHUSETTS APRIL 3, 1980

INTRODUCTION

The National Transportation Safety Board has investigated several accidents 1/ in which local safety officials, carriers, and shippers, because of inadequate guides or technical advice, have been forced to use trial and error to try to control the effects of hazardous material releases in rail tank car derailments. For example, following a derailment in Pensacola, Florida, on November 9, 1977, the Pensacola fire chief had to improvise a method for back flushing a damaged tank car of ammonia in order to reduce the amount of ammonia which could have escaped into the community. Following a train derailment at Youngstown, Florida, in February 1978, after discovering that a chlorine tank car could not be patched, safety officials had to devise a special disposal procedure using an open-air pit to neutralize the product. Following an April 8, 1979, derailment near Crestview, Florida, an onsite disposal plan was improvised to neutralize chlorine at the site using an open pit. Following a train derailment near Molino, Florida, in November 1979, safety officials used explosives to control risks from burning LPG tank cars. Following a derailment near Inwood, Indiana, on November 8, 1979, ethyl acrylate was released and contaminated ground water. As a result, an extensive ground water cleanup and purification project had to be implemented.

The continuing concern about the effectiveness of the guides and technical advice in other accidents prompted the Safety Board to investigate the actions

1/ Railroad Accident Report--"Louisville and Nashville Railroad Company Freight Train Derailment and Puncture of Anhydrous Ammonia Tank Cars, Pensacola, Florida, November 9, 1977" (NTSB-RAR-78-4); Railroad Accident Report--"Derailment of Atlanta and Saint Andrews Bay Railway Company Freight Train, Youngstown, Florida, February 26, 1978" (NTSB-RAR-78-7); Railroad Accident Report--"Louisville and Nashville Railroad Company Freight Train Derailment and Puncture of Hazardous Materials Tank Cars, Crestview, Florida, April 8, 1979" (NTSB-RAR-79-11); Hazardous Materials Accident Spill Maps--"Hazardous Material Release from Railroad Tank Cars, near Molino, Florida, November 10, 1979" (NSTB-HZM MAP-80-6); Hazardous Materials Accident Spill Maps--"Hazardous Material Releases from Railroad Tank Cars, near Inwood, Indiana, November 8, 1979" (NTSB-HZM MAP-80-2).

taken following a release of phosphorus trichloride on April 3, 1980, in Somerville, Massachusetts. The Board investigated actions taken by local safety officials, the carrier, the Boston and Maine Corporation, and the shipper, the Monsanto Industrial Company, to determine why the actions were taken and what effects these actions had on the eventual outcome of the emergency.2/ These actions were then analyzed to determine the effectiveness of these spill-control procedures in reducing losses following release of hazardous materials.

The analysis of the difficulties observed at Somerville indicates that some of the advice and guidelines provided to emergency response personnel by DOT, carriers, and shippers continues to be inadequate, inconsistent, and confusing. Therefore, the Safety Board concludes that technical advice to local emergency response officials and emergency action guidelines and other advice available to local officials should be reviewed to validate that they are adequate and consistent. The Safety Board further concludes that the guidelines and other advice should be reviewed regularly on the basis of results obtained in actual emergencies, and the information validated or revised as necessary to insure that the prescribed emergency response is appropriate.

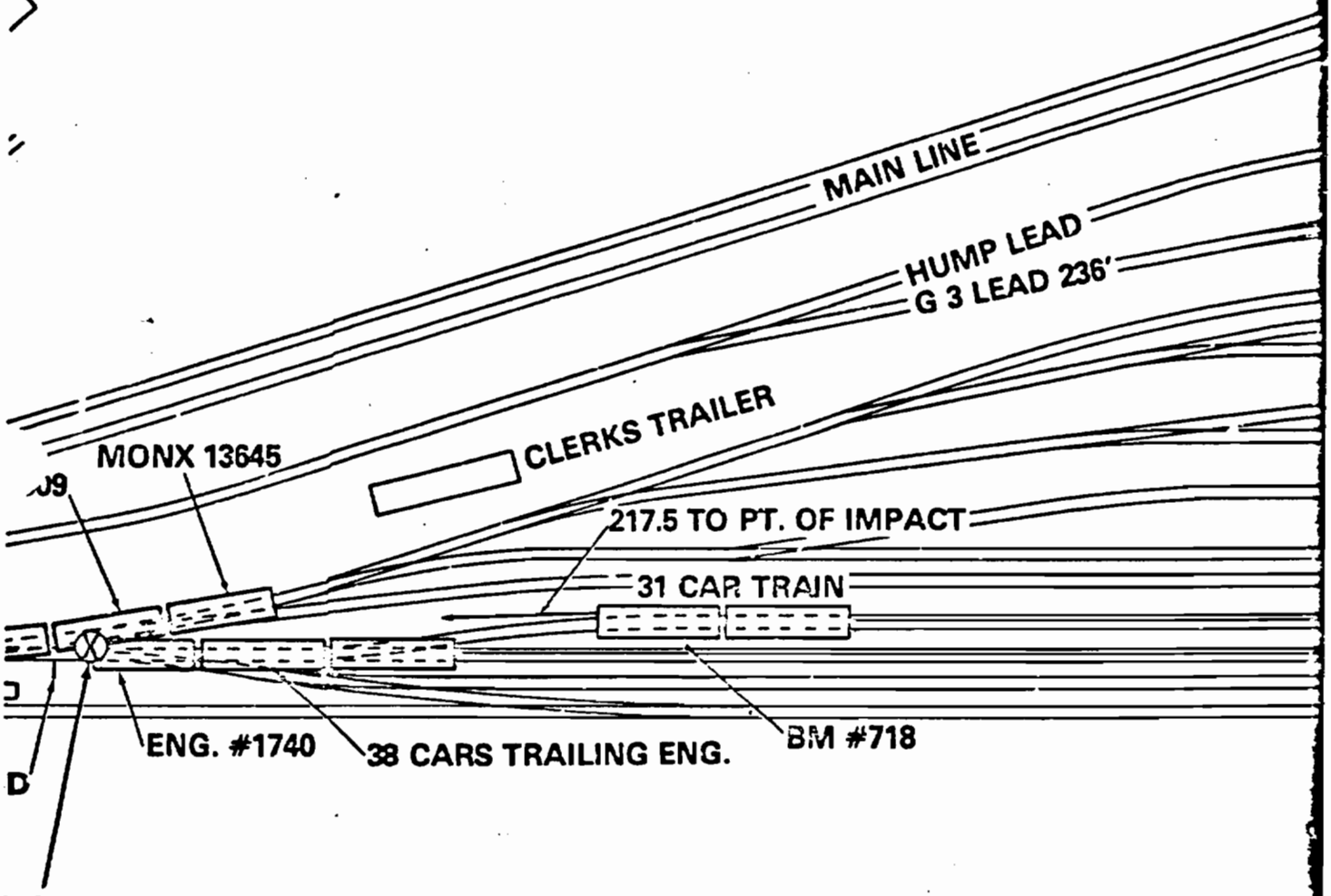
INVESTIGATION

The Spill

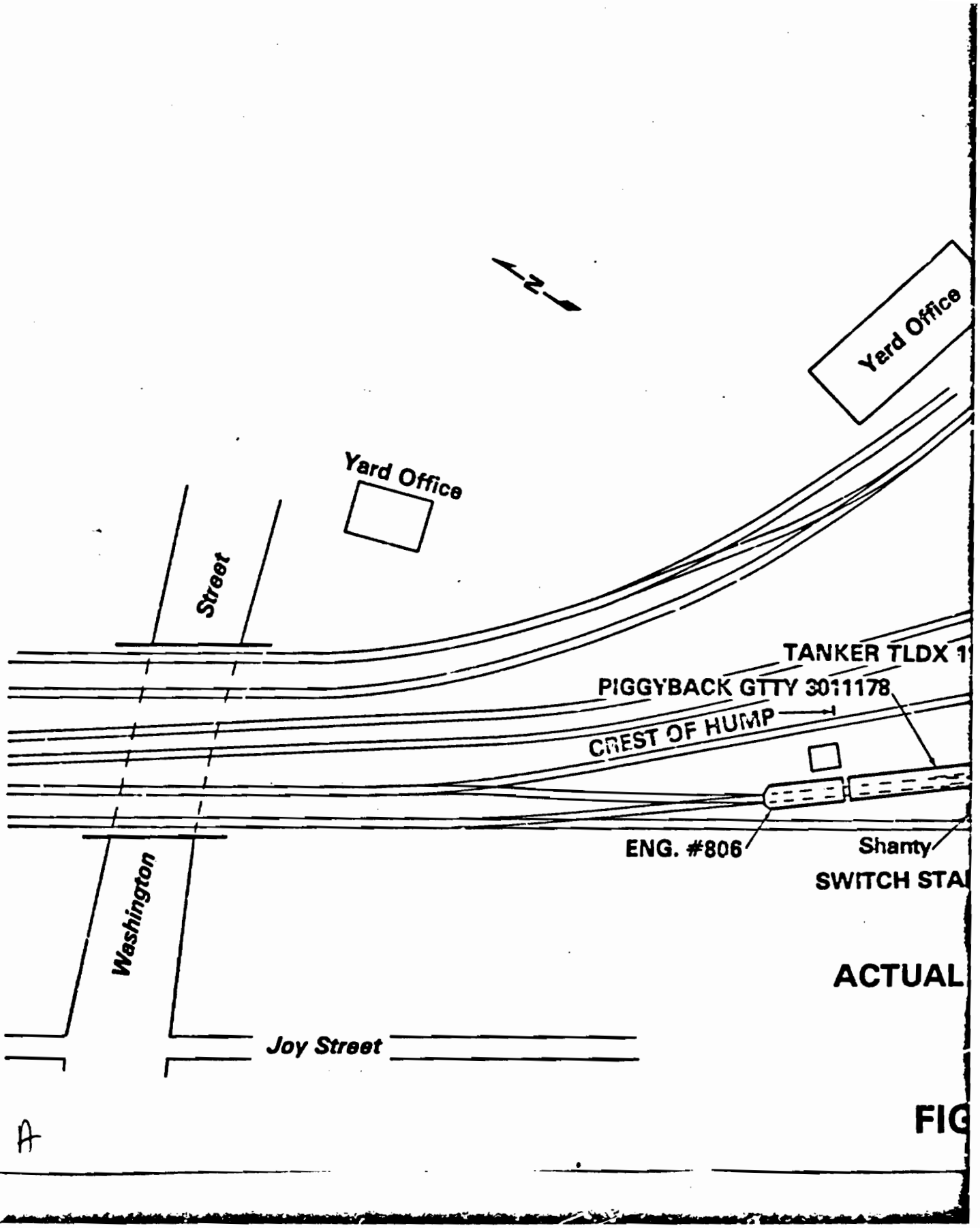
About 9 a.m., e.s.t., April 3, 1980, a Boston and Maine Corporation (BM) Boston switcher (1740) consisting of a locomotive and 38 cars collided, while moving at a speed of 4 mph, with a standing draft of cars in Somerville Yard 8 at Somerville, Massachusetts. (See figures 1 and 2.) The locomotive struck and punctured tank car TLDX 113009, the second car of the standing draft; the tank car contained about 13,000 gallons of phosphorus trichloride (PCl_3), a hazardous material classified by DOT as a corrosive liquid. The product spilled onto the moist ground and created a cloud, which ultimately necessitated an evacuation of a 1 1/2 square mile area containing 23,000 people. During the first 48 hours of the emergency, 418 persons were treated at the Somerville hospital. Damage to train equipment amounted to $8,100 and cleanup costs were reported to be $130,253.

The community of Somerville is a highly populated industrial and residential area covering 6 square miles with over 80,000 residents. Somerville is located directly north of Boston and is bounded by Boston, Cambridge, Arlington, Medford, Everett, and Chelsea. The BM yard 8 lies in the southeast quadrant of Somerville with industrial property immediately adjacent to the yard. (See appendix H.) Residential property and high rise buildings are within several blocks of the yard. The terrain is relatively level with a descending grade toward the Washington Street underpass at Joy Street north of the spill site.

2/ The accident was investigated by the Safety Board and a Brief of Accident will be issued. The complete accident report and evidence is maintained in public docket No. DCA-80-FR-030.



URE 1.--ACCIDENT SCENE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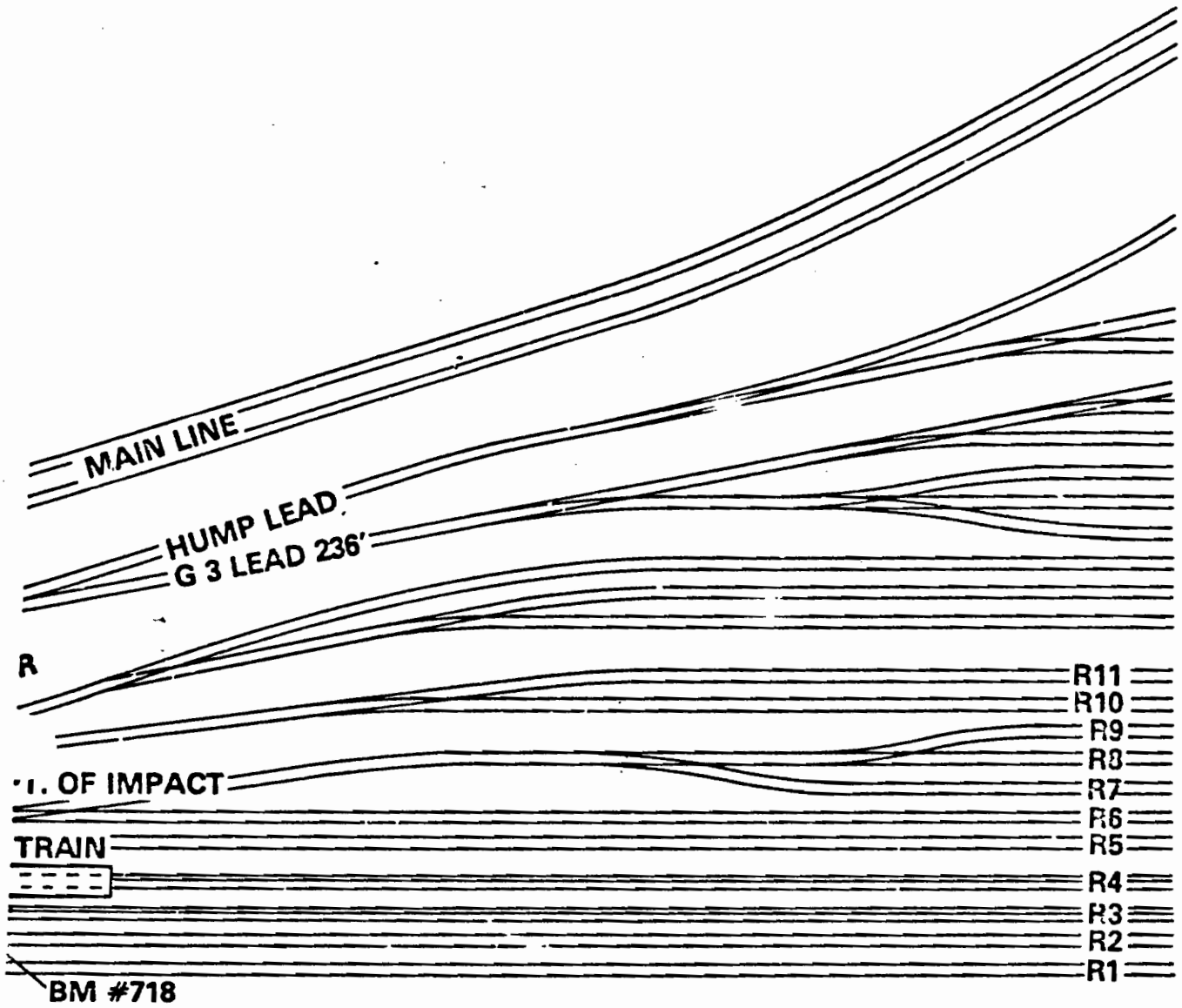
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R11
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R4
R3
R2
R1
T. OF IMPACT
TRAIN
BM #718

Figure 2.--Aerial view of scene.

TLDX 113009 is a DOT 111A 100W tank car and, on April 3, contained 173,800 pounds (about 13,000 gallons) of phosphorus trichloride. The car was placed in transit on March 26, 1980, at Sauget, Illinois, by Monsanto Chemical Company for transportation to Monsanto Industrial Chemical at Everett, Massachusetts. The car bore placards indicating that the lading was corrosive, and the shipping name "phosphorus trichloride" was stenciled on the car.

Phosphorus trichloride is a clear, colorless or slightly yellowish, highly volatile liquid. The chemical is used in the manufacture of phosphites, gasoline additives, plastics, and dyestuffs and is used as a chlorinating agent for water purification. Phosphorus trichloride vapors have a pungent odor and are extremely irritating to the eyes, skin, and mucous membrane. Skin contact with the liquid may produce burns, especially when moisture from perspiration is present. Phosphorus trichloride is heavier than water, and its vapor density is almost five times that of air. It is corrosive to most metals except nickel and lead.

This was the first phosphorus trichloride spill in transportation reported to the Department of Transportation.

When the BM locomotive sideswiped the right side of tank car TLDX 113009, the locomotive's handrailing struck the midsection of the tank car 10 feet forward of the dome access ladder. As the locomotive advanced, the right corner of the locomotive bed struck the dome access ladder and then struck the sidewall of the tank car about 1 foot above the tank car drip lip for excess product runoff. As the locomotive moved farther forward, the right corner of the locomotive bed continued to scrape and dent the side wall of the tank. As a result, the tank car tilted several degrees eastward and the side wall of the tank car was breached. The crease extended diagonally 10 foot along the tank side until reaching a jagged tear 15 1/4 inches long, which tapered from 1 to 4 inches wide. When the locomotive came to rest, the locomotive bed intruded into the tank car through the tear. Neither the tank car nor the locomotive derailed. (See figures 3 and 4.)

The traincrew reported hearing a scraping noise during the collision, followed by a hissing sound as the chemical poured from the hole in the tank car onto the ground. The initial rate of discharge was more than 100 gallons/minute, and immediately upon contact with the moisture in the air, a white fog was generated. This white fog contained both hydrochloric and phosphorus acid vapors. The white fog, or cloud, advanced immediately several hundred feet downwind in a southeasterly direction.

The engineer, the front brakeman, and the rear brakeman immediately scrambled from the locomotive and headed north. Additionally, an estimated 60 BM yard employees fled from the yard. One BM worker caught in the cloud reported that the acid fumes had stung his nostrils and he felt a burning sensation in his lungs. He also said that he had difficulty breathing.

The liquid phosphorus trichloride quickly flooded the ground adjacent to the track, and it followed the ground contours and flowed west under the locomotive to the locomotive's left side. Next, the spilled material flowed south 30 to 50 feet along an adjacent track before flowing down a 10-foot embankment into a recessed fill area, adjacent to the tracks and bounded by Joy Street. The liquid phosphorus trichloride flowed through this recessed area and fanned out to about a 20-foot

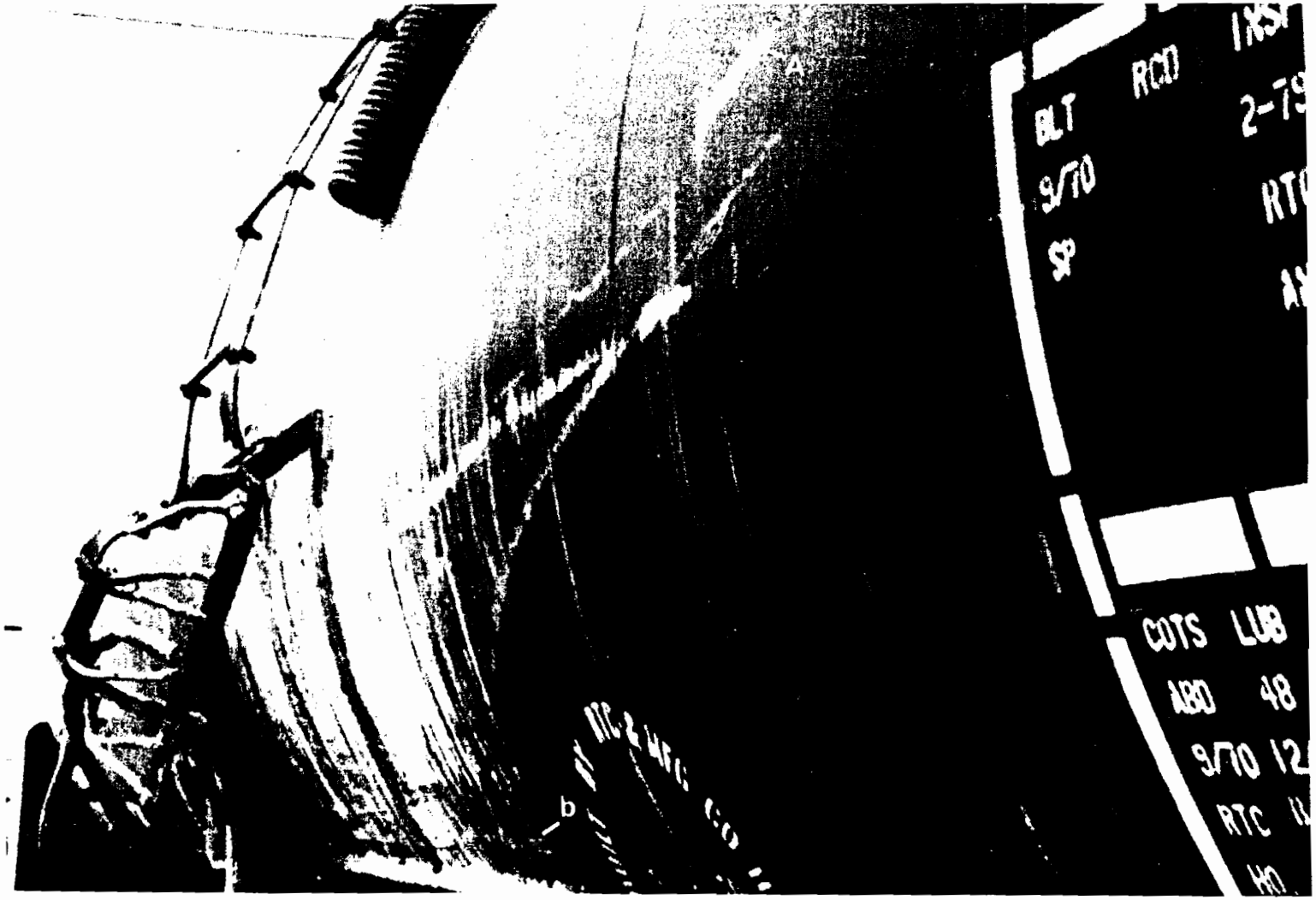


Figure 3.--Right side of TLDX 11300 showing initial point of contact of (a) locomotive railing and (b) locomotive bed.

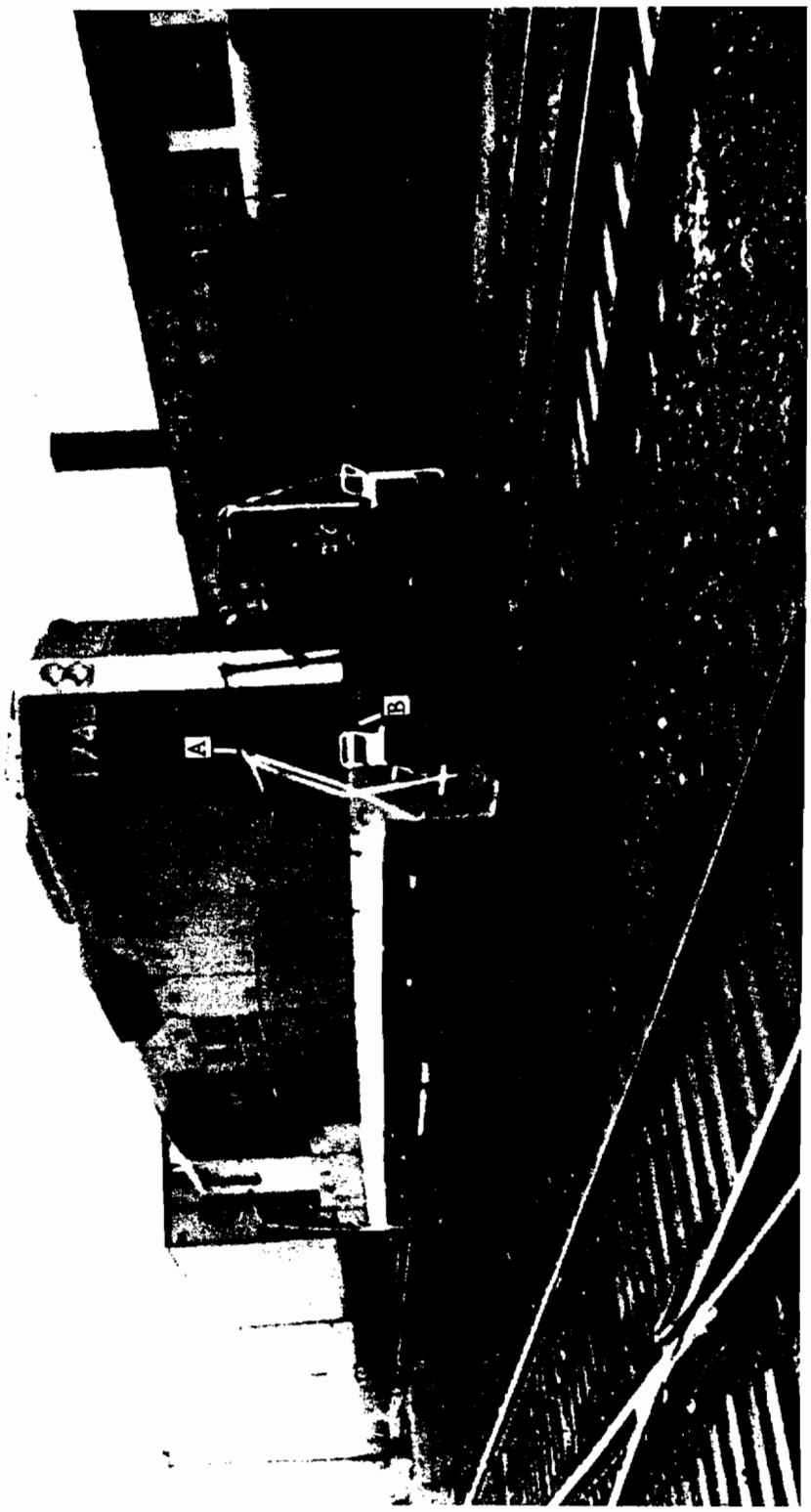


Figure 4.--Right side of locomotive
(a) hand railing and (b) locomotive bed.

wide stream as it flowed toward Joy Street, covering an approximate 800-square-foot area.

During this time, the wind fanned the vapors as they rose several hundred feet above the ground; the wind was from the north-northwest at 6 knots. These vapors traveled southwest principally through the industrial area adjacent to the rail yard. Nearby office workers, including occupants of high rise building located 1/2 mile downwind of the path of the cloud, immediately fled the buildings.

At the time of the accident, the skies were clear with no restrictions to visibility. Cloud dispersion conditions were fair to good and vertical mixing 3/ was good to about 8,000 feet. Appendix A lists the various agencies which responded, and appendix B lists the chronology of major attempts to control and recover the phosphorus trichloride spill.

Events Leading to the First Water Attack

The BM trainmaster, who was in the Mystic Junction office several hundred feet east of the locomotive, saw a billowing white cloud engulf the yard office and the yardmaster's office. The trainmaster was not aware of the collision, but assumed that a tank car seam had split. At 9:10 a.m., within 10 minutes after the accident, the trainmaster notified the Somerville fire department dispatcher of a tank car leak in Yard 8. Following the call, the trainmaster obtained the number of the tank car by using a telescope and returned to the vapor engulfed yard office with the waybill clerk to retrieve the waybill for the car, which contained a description of the tank car's contents.

At 9:13 a.m. the deputy fire chief responded to the call with two trucks. The deputy chief met the trainmaster at the yard office, and the trainmaster provided the deputy chief with the waybill and the Bureau of Explosives (BOE) Guide for phosphorus trichloride. (See appendix C.) The guide, among other things, advised firefighters to wear self-contained breathing apparatus, boots, protective gloves, and safety glasses, and if contact with the material was anticipated, to wear full protective clothing; also to keep material out of water sources and sewers, to build dikes to contain flow as necessary, to use water spray to knock down vapors, but to not use water on the material itself, and to neutralize spilled material with crushed limestone, soda ash, or lime. The guide made no distinction between large or small spills. The deputy chief also carried the Department of Transportation Emergency Action Guide for Hazardous Materials Emergencies to the scene. (See appendix D). This 1978 edition of the DOT guide, among other things, advised the use of flooding amounts of water on the entire spill for large spills and absorption of the material with dry sand or soda ash for small spills. This guide also advised that if possible to wear self-containing breathing apparatus and full protective clothing.

The deputy chief contacted the fire dispatcher to verify the BOE protective measures and later obtained additional information contained in the National Fire Protection Association (NFPA) Guide No. 49. (See appendix E). This guide indicates that spilled amounts of material can be cleaned up by absorbing it in very

3/ Maximum extent of vertical travel or rise of pollutants above the ground.

dry sand or by using flooding amounts of water applied very quickly to the entire spill.

At this time, the trainmaster informed the deputy chief of the location of the tank car, the product hazard classification, name, and quantity, and the Manufacturing Chemists Association's Chemical Transportation Emergency Center's (CHEMTREC) phone number.

Following the guides, the deputy chief then ordered all firefighters to wear self-contained breathing apparatus; he then attempted to inspect the perimeter of the spill. As the deputy chief approached the embankment on the west side of the locomotive, he saw the liquid flowing from the rail bed toward Joy Street and a thick white mist drifting southerly through the rail yard.

From 9:15 a.m. to 9:20 a.m., the Somerville fire dispatcher notified local agencies--the Mayor's office, State civil defense and environmental departments, city police, and the Somerville hospital. These agencies in turn dispatched units to the scene. A BM employee contacted the Monsanto Industrial Chemical (Monsanto) Company at Everett, Massachusetts. Upon receipt of notification, Monsanto dispatched a team from Everett, consisting of a corrosive liquid production supervisor and a technician, with equipment to attempt to patch a small tank car leak. Upon receipt of notification at the Somerville police communication center, the police chief alerted surrounding jurisdictions, using the BAPERN communication system, 4/ that Somerville fire units were on the scene of a major chemical spill requiring mutual-aid assistance. Following his arrival at 9:15 a.m., the Somerville fire chief maintained operational control on scene during the spill-control and recovery operations.

Shortly afterwards the following Federal agencies were notified: the U. S. Coast Guard, the Environmental Protection Agency, and the Federal Railroad Administration.

Medical support was organized under a predisaster alert plan so that within minutes of receiving notification, the medical emergency service system in greater Boston was in operation. Designated representatives at local hospitals were notified at 9:20 a.m. of a potential major problem involving toxic fumes, with possible complications and of the potential for a large numbers of victims.

At 9:20 a.m., the deputy fire chief established a command post at Washington and Joy Streets. The deputy chief saw the chemical flowing from the recessed area adjacent to the yard, down a driveway ramp to Joy Street, and along the Joy Street curb toward Washington Street. The product flowed about 100 feet along Joy Street until it entered a storm drain catch basin. The deputy fire chief was aware that the emergency guides cautioned to prevent contamination of water sources, such as sewers, and immediately attempted to divert the liquid runoff from the Joy Street storm drains with hose streams.

4/ Boston Area Police Emergency Response Network allows police of all jurisdictions to use the same frequency to pass and coordinate information between responding cruisers when rendering mutual-aid assistance.

Firefighters laid hoses from the nearest hydrant on Joy Street and attempted to push the free flowing phosphorus trichloride back with firehoses. However, when the water hit the chemical runoff, the phosphorus trichloride began to froth, boil up, and release a billowy, white cloud that moved south along Joy Street toward Cambridge. Because of the cloud intensification, the fire department widened the evacuation area to extend beyond Joy Street (a 1- by 3-block area). At this time, large white clouds were drifting between Joy Street and the yard tracks in a southeasterly direction toward Cambridge. The deputy fire chief alerted the Cambridge fire department of the direction of travel of the white cloud. The Cambridge fire department dispatcher in turn contacted CHEMTREC for "Chem Card" information on protective measures. CHEMTREC advised to keep people upwind and for firefighters to wear protective equipment. Occupants near the yard were told to evacuate by police units who went from street to street using bull horns and the cruisers' public address systems.

BM Officials contacted Coastal Services, a hazardous materials waste recovery subcontractor, for cleanup. Because Coastal Services personnel could not arrive before 2 p.m., Coastal Services contacted Jet Liner Services Inc., a local hazardous material recovery subcontractor, and arranged for three trucking firms in the area to begin product recovery operations.

Events Leading to the Second Water Attack

Around 9:40 a.m., the deputy fire chief ordered his men to begin shoveling dirt to build dikes and ditches to contain the flow of spilled product. During shoveling operations, several firefighters had to withdraw to clear vapors from their masks. Later, the vapor cloud engulfed several of these firefighters at a rest station when the wind abruptly shifted. Somerville doctors treated several of them for toxic chemical exposure. Additionally, two firefighters received leg and back chemical burns while shoveling the liquid runoff. Two of these firefighters were later admited to the Somerville hospital; one firefighter for treatment of chemical burns, and the other firefighter for smoke inhalation.

At 10:00 a.m., the deputy chief requested the BM trainmaster to provide earth-moving equipment to dig a pit about the size of the tank car. However, vapor generation was still a problem. Three bulldozers dug a pit 30 feet long, 30 feet wide, and 10 feet deep. The bulldozer operators wore self-contained breathing apparatus during this operation. At the completion of the operation at 10:30 a.m., most of the escaping residue quickly drained into the pit, and the spread of product was minimized. Later doctors at the Somerville hospital examined and released the bulldozer operators.

The State fire marshal arrived on scene at 10 a.m. and recommended that the Somerville fire chief establish a supervisory command post and a 3,000-foot radius evacuation, that he acquire the names of designated representatives of all parties involved, that he establish a chain of command, and that protective equipment be worn within the evacuation area. The fire chief concurred and implemented the fire marshal's recommendations.

When the Monsanto response team arrived at 10 a.m., they donned chemical protection suits. These suits provide complete isolation from the environment and consisted of hood, self-contained breathing apparatus inside the suit, and integral boots and gloves. They immediately attempted to put a temporary patch on the tank car breach; however, they found that the breach was too large to patch.

By 10:30 a.m., the flow of the phosphorus trichloride from the breached tank car had diminished to an estimated 10 to 15 gallons per minute, and by 11:15 a.m. the liquid stopped flowing from the tank car. The fire chief believed that the pit would successfully contain the product remaining. However, the chief was concerned about the vapor clouds escaping from the pit. (See figure 5.)

Around 11:30 a.m. the fire chief attempted to wash down the spill area on Joy Street with fog hoses in order to break up the spread of fumes over the ground. The chief found that these operations again intensified the vapor cloud, and he terminated the water operation.

Inspite of the two unsuccessful attempts by the fire department to use water to control the liquid spill and vapor cloud, the Monsanto team reportedly suggested washing the spill area with water. The Environmental Protection Agency (EPA) team arrived after 11 a.m. and consulted with the fire chief and Monsanto advisors. The EPA team objected to Monsanto's advice to flood the area. The EPA objection was based on information contained in the OHM-TAD technical support system.5/(See appendix F.) As a result, the area was not washed down.

Next the fire chief focused on the recovery of the product from the pit. At 11:45 a.m., the first cargo tank arrived. However, the EPA advisor objected to loading spilled product into a truck containing residual oil because of chemical incompatibility; so the recovery operation was delayed until 12:45 p.m. in order to clean out residual oil in the cargo tank, and to wait for the vacuum equipment en route from New Jersey. Rather than wait any longer, BM contracted Pollution Control Unlimited, Inc., another local hazardous material recovery subcontractor, to vacuum the product from the pit.

At 11:57 a.m., an apparent sea breeze caused the wind to shift southeast at 6 to 12 knots. Skies remained clear and ventilation and vertical mixing were good.

Between 1:45 p.m. and 4:30 p.m., vacuum tank trucks removed about 5,500 gallons from the pit, leaving 2 inches of residue.

Events Leading to the Third Water Attack

The fire chief met with more than 30 local, State, and Federal safety representatives at the command post at 2, 4, and 6 p.m. to discuss the status of the recovery operations and to plan the next actions to be taken. During the 2 p.m.

5/ Oil and Hazardous Material—Technical Assistance Data System is an automated information retrieval file designed to facilitate rapid retrieval of information on 1,000 petroleum products and hazardous material substances. The system is designed to provide the onscene coordinator with data on the degree of hazard involved, countermeasures, and personnel protection.

Figure 5.--Aerial view of scene during recovery operation.

meeting, representatives of the EPA advised the firefighters to spread a curtain of water downwind of the pit in order to leech out the escaping hydrochloric acid vapors from the air. EPA provided the fire chief with a sketch showing where to locate the water cannons. Because the firefighters had seen earlier the accelerated vapor production caused by water spraying, the fire department strongly opposed the procedure but reluctantly complied with the Federal recommendation. During this operation, the wind shifted and as a result, the spray directly hit the pit, where it mixed with the phosphorus trichloride and created additional massive clouds of vapor. The streams of water were terminated immediately, but the clouds quickly spread throughout the area, and at 3:30 p.m., an evacuation of Somerville Central Hills was required.

Events Leading to the Sand Fill and Washdown

At 5 p.m., an atmospheric inversion developed because of radiation cooling and sharply reduced vertical mixing. The wind diminished slightly to southeast-to-south at 9 knots and remained there until 1 a.m., April 4. As a result, the fire chief maintained the evacuation perimeter north of the site.

During the 6 p.m. meeting of officials and experts, State, Federal, and industry advisors suggested to the fire chief three differing approaches for disposal of the 2-inch residue in the pit. One recommended backfilling the pit with sand, another advised drowning and diluting the remaining product with water, and another advised neutralizing the pit with limestone or soda ash. The advisors could not agree which was the best plan to follow. Faced with these disagreements and the continuing chemical cloud, the Mayor of Somerville designated a technical advisory committee with representatives from the shipper (Monsanto), the carrier (BM), and the State of Massachusetts and instructed them to reach unanimous agreement on how to dispose of the remaining chemical in the pit. About 7 p.m., almost 10 hours after the spill, the committee of advisors selected backfilling with sand and the gradual addition of water as the best method, because the other two alternatives contained more uncertainties.

By 7 p.m., backfilling operations had begun, with 10 to 15 trucks relaying 60 truckloads of sand to the pit. Small amounts of water were applied from 7:30 p.m. to 12 p.m. Three firehose cannons doused the entire area during the remainder of the night. At 1:30 a.m., April 4, safety officials allowed residents to return to their homes. An estimated 13,000 persons had been evacuated to safe distances in Somerville and an additional 10,000 had been evacuated in East Cambridge. At daybreak, firefighters again washed down residues remaining on the ground. Following this, BM spread 4 tons of soda ash around the area to neutralize any product remaining on the ground.

The Somerville hospital reported that, during a 3-month period following the emergency, the hospital received 817 patient visits with complaints relating to the spill; 9 of these patients were admitted on the first day of the accident. 13 patients complained of abnormal pulmonary functioning and 2 patients received chemical burns. The remainder of the patients were treated for symptoms of temporary toxic hepatitis. For several months following the release, Somerville doctors monitored the enzyme count of a control group of 99 residents and response personnel for symptoms of temporary toxic hepatitis. After 3 months, the

enzyme count of these patients returned to normal and hospital doctors concluded that no apparent persistent symptoms of chemical exposure remained. However, after 6 months, two of the firefighters involved in the ditch-digging operation were still undergoing treatment for abnormal pulmonary function.

ANALYSIS

Analysis of the technical advice provided to local officials at Somerville indicates that problems cited previously by the Board with both existing emergency guides and onscene technical advice have not been adequately resolved. At Somerville, the actions based on the guides and technical advice increased the number of persons exposed to the hazardous material release and increased the amount of time the community was disrupted by at least 5 hours.

Emergency Response Guides Need Improvement

The guides available at Somerville provided conflicting information to the firefighters responding to the scene. The 1978 edition of the DOT guide listed as "potential hazards" fire, explosion, and health hazards, and warned against pollution problems. The BOE guide contained similar warnings. The DOT guide did not tell firefighters the magnitude of the chemical cloud that would be generated if a large spill was flooded with water, as it suggested. In contrast, although the BOE guide did not distinguish between a "small" spill and a "large" spill, it advised against the use of water on the material itself. The NFPA guide warned of a violent reaction on contact with water, but suggested that flooding amounts of water be applied to the entire spill. This contradictory and ambiguous advice created uncertainties which onscene firefighters had to resolve quickly, because spilled material was flowing toward nearby sewers. Faced with these uncertainties, the firefighters resorted to the tools available, water and shovels, to try to control the spill. Use of hose streams to keep flammable liquid spills out of sewers is a common practice in the fire service. Thus, in the absence of other advice during the first 30 minutes, the firefighters' first water attack was a logical action, based on the information available to them at that time.

The massive cloud which followed the firefighters' first water attack increased the number of persons exposed to the hazard, and provided the firefighters unexpected information about the behavior of the hazardous material they were trying to control. None of the guides warned them of the massive cloud the water would create. This new information, collected through "trial and error," strongly influenced subsequent actions.

The inadequate guides also led to another problem at Somerville. When firefighters later tried to control the spill with hand shovels, they were forced to work within the fuming spill. The guides advised use of "self-contained breathing apparatus and full protective clothing," which to firefighters meant their standard air masks and firefighting uniforms. Their firefighting uniforms, known as turnout gear, did not protect them from injury from the chemical. Their turnout gear included a helmet, coats, pants, rubber boots, and gloves customarily worn by firefighters. Their turnout gear was not designed for protection from corrosive fumes. Since none of the guides in use at the time made any distinction, the firemen were not aware that special clothing was needed for handling phosphorus trichloride.

DOT is currently distributing a newly revised Emergency Response Guidebook (see appendix G), which includes improvements, such as information on handling most regulated hazardous materials and the use of numerical identifiers to facilitate identification of commodities involved in emergencies. The revised guide contains improved introductory material and evacuation guidance; for example, the revised guide defines full protective clothing as including helmet, self-contained breathing apparatus, coats, pants, rubber boots and gloves customarily worn by firefighters. Special protective clothing is described as vinyl or rubber acid suits that would be required for the handling of some very corrosive or poisonous materials. Special protective clothing is advised for phosphorus trichloride in DOT's 1980 guidebook. This guidance should reduce injuries of the kind experienced at Somerville during the initial trenching or ditch digging operations and pit excavation.

The newly revised DOT guidebook contains revised response guidance for phosphorus trichloride releases. However, the guide does not warn about the chemical cloud formation experienced at Somerville and is still ambiguous on the use of water. The new guidebook warns of violent reaction with water under potential fire or explosion hazards and that runoff to sewers may create fire or explosion hazard, but advises fighting large fires by flooding with water. It warns that runoff or water used for dilution may cause pollution, but advises flushing small spill areas with water and advises, for large spills, dike for later disposal and dilute with large amounts of water. It also advises not to get water inside container, and to use water spray to reduce vapor but do not put water on leak area. The official responsible for the content of the guidebook reviewed the Somerville accident before the revised guide was published and concluded that the advice, developed for the revised guidebook, was valid and that no changes were warranted. The Safety Board does not agree with this conclusion and knows of no formal evaluation made by the official in arriving at his conclusion. The Safety Board believes that the lessons learned concerning the use of water at Somerville should be incorporated into the guidebook.6/

Following its investigation of an accident near Pursley, West Virginia, in 1975, the Safety Board expressed its concern about problems with disseminating the lessons learned during the handling of hazardous materials emergencies and recommended that the Secretary of Transportation:

> Redesign its hazardous materials incident data reporting system so it will generate information about what emergency actions were taken, why they were taken, and what influence they had on the outcome of the emergency, for use in training firefighters and law-enforcement personnel to handle hazardous material transportation emergencies. (Class II, Priority Action) (I-76-9)
>
> Develop a procedure to report such information regularly to Federal and State agencies with responsibilities for

6/ Informal discussions with an MTB official indicate that changes to the 1980 guidebook are now being contemplated.

developing emergency training programs for law-enforcement and firefighting personnel. (Class II, Priority Action) (I-76-10)

Develop a procedure to use the emergency response information on dealing with emergencies to review periodically the validity of advice which DOT provides to other agencies with regard to hazardous materials transportation emergencies. Periodically review the operational experience in meeting hazardous materials emergencies to assure that the practices recommeded are appropriate. (Class II, Priority Action) (I-76-11)

The DOT, in its responses to these three recommendations, questioned its authority to require collection of the needed data, concluded that a formal review process was not required, and asserted that new information is incorporated into its Materials Transportation Bureau (MTB) activities as it becomes available. MTB later contracted with Operational Research Incorporated (ORI) to examine 26 selected incidents to get data needed to evaluate the adequacy of emergency response advice. This study is expected to be completed during 1981. In the meantime, the status of these recommendations is "open, unacceptable action."

The Somerville experience again points out the need for a method of incorporating lessons learned into the system that provides technical advice to emergency response personnel in hazardous materials emergencies. The Safety Board, is hopeful that, based on the results of the ORI study and the handling of the Somerville accident, the recommended actions will be taken without further delay.

Because of their employer's responsibility for the consequences of the accident, railroad personnel had to join the efforts to stabilize the emergency. As a result, BM employees also were exposed to chemical injury from the spilled phosphorus trichloride during the initial spill and during the excavation of the pit. The Safety Boad has previously addressed the health risks to equipment operators from exposure to released hazardous materials. After investigating a derailment at Crestview, Florida, on April 18, 1979, in which 10 workers were treated for chemical fume inhalation, the Safety Board recommended that the Federal Railroad Administration:

Analyze risks to wreck-clearing personnel during wreck-clearing operations involving hazardous materials exposures, and establish appropriate safety requirements based on its findings. (Class II, Priority Action) (I-79-13)

The FRA is analyzing these risks and has awarded a contract to Edwards Air Force Base to study wreck-clearing procedures. The Somerville experience again reinforces the need for safety requirements or guides on the risk of exposure of railroad employees when conducting spilled product recovery operations. The Safety Board considers the recommendation "open, acceptable action," and looks forward to the results of the study.

Technical Advice Needs Improvement

Experience gained by the onscene firefighters during the first and second water attacks influenced their subsequent reluctance to implement the technical advice they had received. The firefighters objected to the shipper's onscene technical advisor's advice to wash down the spill area and flood the liquid in the pit with water because of their earlier experience with hose streams on Joy Street. The shipper's advisor's interpretation of the term "flooding amount" used in the guides would have produced over 70,000 gallons of contaminated run-off--more than the pit could hold--and would have enlarged the acid cloud. The firefighters estimated that a larger acid cloud could have doubled the evacuation area and escalated the emergency to a disaster requiring implementation of the State's Emergency Disaster Plan. Although the Monsanto team had experience in plugging leaks, it was not able to provide reliable advice on controlling or eliminating the spill problem.

The NFPA also concluded, as a result of its study of the Somerville emergency, that "neither the NFPA nor the DOT hazardous chemicals information indicates what a 'flooding amount of water' is.... However, treating 7,000 gallons of product with flooding amounts of water (70,000 gallons) in an efficient manner would be nearly impossible."7/ Consequently, while the flooding with water would dilute the liquid in the pit and eventually cut down on the amount of vapor generated, flooding would initially accelerate evaporation and exacerbate the acid cloud in the community.

The experience gained from the second water attack raised similar concerns among firefighters when the EPA proposed a similar attack to control the acid cloud at the 2 p.m. coordination meeting. The concerns proved well founded given the results of the 3 p.m. spray attack.

After more than 7 hours at the scene, technical advisors on whom local officials depended for guidance had not reached agreement about how to handle the emergency. As a result the mayor intervened. While the precise areas of disagreement were not established, the fact that the final action chosen by the "technical advisory committee" was different from the shipper's advice is significant. Rather than duplicate CHEMTREC's unique capabilities with respect to dangerous characteristics of chemicals, DOT relies on CHEMTREC to provide additional emergency response advice or shipper assistance to supplement the advice in DOT's Guidebook. The Guidebook instructs users to contact CHEMTREC for such additional assistance. The CHEMTREC operation is based on advice developed primarily by shippers. The Somerville experience suggests that DOT should not assume that this advice is always completely adequate, and that shipper's advice may require reexamination for its technical adequacy.

The disagreement among advisors on the scene and inconsistencies and ambiguities in hazardous materials emergency guides give rise to an even more pressing safety concern. So long as knowledgeable technical advisors cannot agree on a recommeded course of action, either in guidance or while they are at the site,

7/ "NFPA Fire Command: You Just Couldn't Take A Breath," (Volume 49, Number 10, October, 1980, p 18-21).

the Safety Board does not believe that local firefighters will be provided with reliable, consistent advice for handling such emergencies. Unless technical advice, including that contained in written guides, is consistent, local officials will be forced to continue to depend on trial-and-error procedures such as those employed at Somerville. Trial and error clearly increases the risks to emergency response personnel and the surrounding community.

The local officials' experiences at Somerville, including the mayor's intervention, have convinced the Safety Board that action to resolve differing technical opinions about emergency responses is essential. The diversity of persons and interests involved can be seen in the variety of organizational and agency representatives present and giving advice at Somerville. Their ineffectiveness can be seen in the effects of their advice on the course of events that occurred. The lessons of Somerville should not have to be learned again elsewhere.

The differences stem from differing technical views, which must be reconciled by adequate coordinated technical review of proposed actions that could be taken during hazardous materials emergencies and analysis of their total effects on the response personnel and the community. Their resolution must take into account the uncertainties involved with each alternative. If these differences remain unresolved, they will surface again and again during future accidents. The Safety Board knows of no reason why these differences cannot be resolved before hand through analysis, rather than on the scene trial and error. Since shipments of hazardous materials will continue and additional spills can be expected, resolution of technical differences should not be delayed. DOT is charged by the Hazardous Materials Transportation Act to provide emergency response advice to local officials in hazardous materials transportation emergencies. It should take the initiative to get these technical differences resolved. Once the guidance is analyzed and the best handling method established, consistent guidance should be incorporated into emergency response guides. Until DOT assures the adequacy and consistency of the technical guidance provided for emergencies, the Safety Board believes that consistent, adequate hazardous material emergency response guides will not become available.

CONCLUSIONS

1. The handling of the hazardous material emergency at Somerville indicates inadequacies in the technical guidance and onscene advice available to the local officials during the emergency.

2. The guidance and technical advice provided at Somerville impeded the local officials' efforts to control the spill and increased the spill's adverse effects on the community.

3. Local officials were forced to use a "trial-and-error" procedure during the emergency because available emergency response guides and on scene technical advice were inadequate, inconsistent, and confusing.

4. Until the technical inconsistencies in some of the emergency response guides and in technical advice are identified and eliminated, local officials will encounter unnecessary problems during future emergencies.

5. The advice on the use of water in the BOE guide proved to be more practical than that contained in both the DOT and NFPA guides.

6. Inconsistencies and ambiguities in hazardous materials emergency guides and other prepared technical material should be resolved systematically by DOT before emergencies, rather than during emergencies.

7. The newly revised DOT emergency response guidebook contains many improvements, but it does not incorporate the lessons learned during the Somerville accident. DOT needs to develop a formal procedure to evaluate guidance in the DOT guide and in other guides in general use.

8. Hazardous materials capable of causing major disruptions of a community, if released, should not be moved in transportation unless the persons causing their transportation have adequately analyzed the probable course of potential accidental spills and resultant control problems, and are prepared to provide expert technical advice to local officials that will result in timely, effective, and efficient control of spills.

9. A procedure for timely dissemination of safety lessons learned during the handling of hazardous materials transportation emergencies is needed, but does not exist and is not being developed.

RECOMMENDATIONS

As a result of this special investigation, the National Transportation Safety Board recommends that the Department of Transportation:

> Investigate the adequacy and consistency of hazardous materials emergency guides and other advice available to local officials for use in controlling hazardous materials releases during transportation, and take necessary steps to assure that they provide sufficient and consistent guidance and advice to help local officials control hazardous materials spills quickly and effectively. (Class II, Priority Action) (I-81-1)

> Revise the advice provided in the 1980 DOT Emergency Response Guidebook concerning phosphorus trichloride to clarify the ambiguous language on the use of water in handling large spills. (Class II, Priority Action) (I-81-2)

In addition, the Safety Board reiterates its earlier recommendations to the Department of Transportation:

> Redesign its hazardous materials incident data reporting system so it will generate information about what emergency actions were taken, why they were taken, and what influence they had on the outcome of the emergency, for use in training firefighters and law-enforcement personnel to handle hazardous material transportation emergencies. (Class II, Priority Action) (I-76-9)

Develop a procedure to report such information regularly to Federal and State agencies with responsibilities for developing emergency training programs for law-enforcement and firefighting personnel. (Class II, Priority Action) (I-76-10)

Develop a procedure to use the emergency response information on dealing with emergencies to review periodically the validity of advice which DOT provides to other agencies with regard to hazardous materials transportation emergencies. Periodically review the operational experience in meeting hazardous materials emergencies to assure that the practices recommeded are appropriate. (Class II, Priority Action) (I-76-11)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

ELWOOD T. DRIVER, Vice Chairman, did not participate.

February 26, 1981

APPENDIXES

APPENDIX A

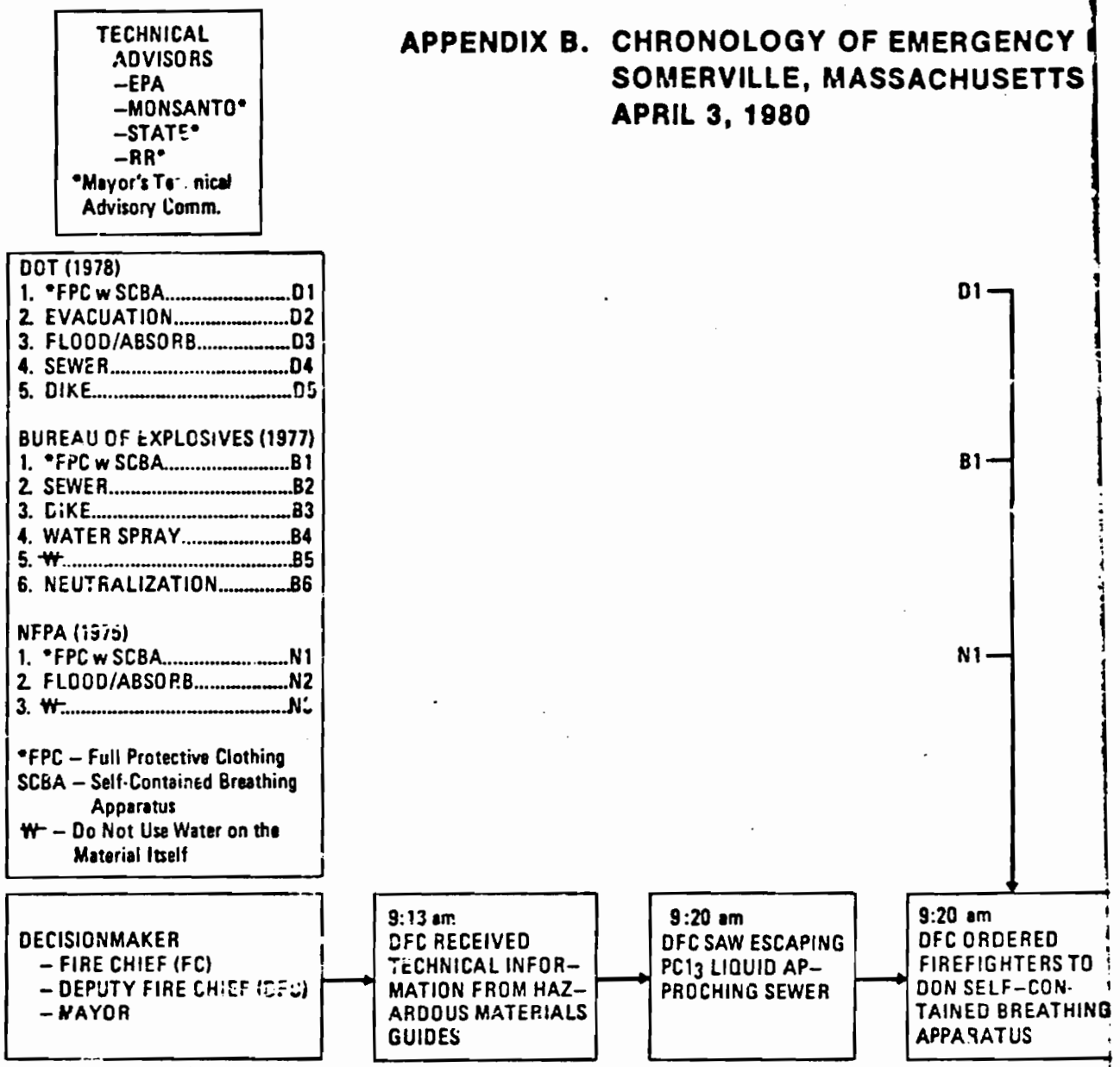
LIST OF ORGANIZATIONS AND ADVISORS INVOLVED IN HAZARDOUS MATERIALS EMERGENCY, SOMERVILLE, MASSACHUSETTS* APRIL 3-4, 1980

Organization/Advisor	Represented by	Notified a.m. 4/3	Arrived On Scene
Boston and Marine Corp	Superintendent Trainmaster Yardmaster Safety Officer Environmental Officer 60 Yard #8 employees	9:00	9:00
Somerville Fire Dept.	Chief Deputy Chief 104 firefighters	9:10	9:13
Somerville Police Dept.	Chief 26 cruisers	9:10	HQRS.
Mayor's Office	Mayor Brune	9:12	9:15
Somerville Dept of Public Health	Director	9:12	9:25
Somerville Civil Defense Director	Director	9:13	HQRS.
Greater Boston Emergency Service Center	Somerville Hospital	9:13	
Monsanto Industrial Chemical Co. Everett, MA	Corrosive Liquid Production Supervisor and Technician	9:15	10:00
E. St. Louis, MO	Tehnical Advisor	9:35	

*This is not intended as a complete list of all the responding agencies involved in the emergency.

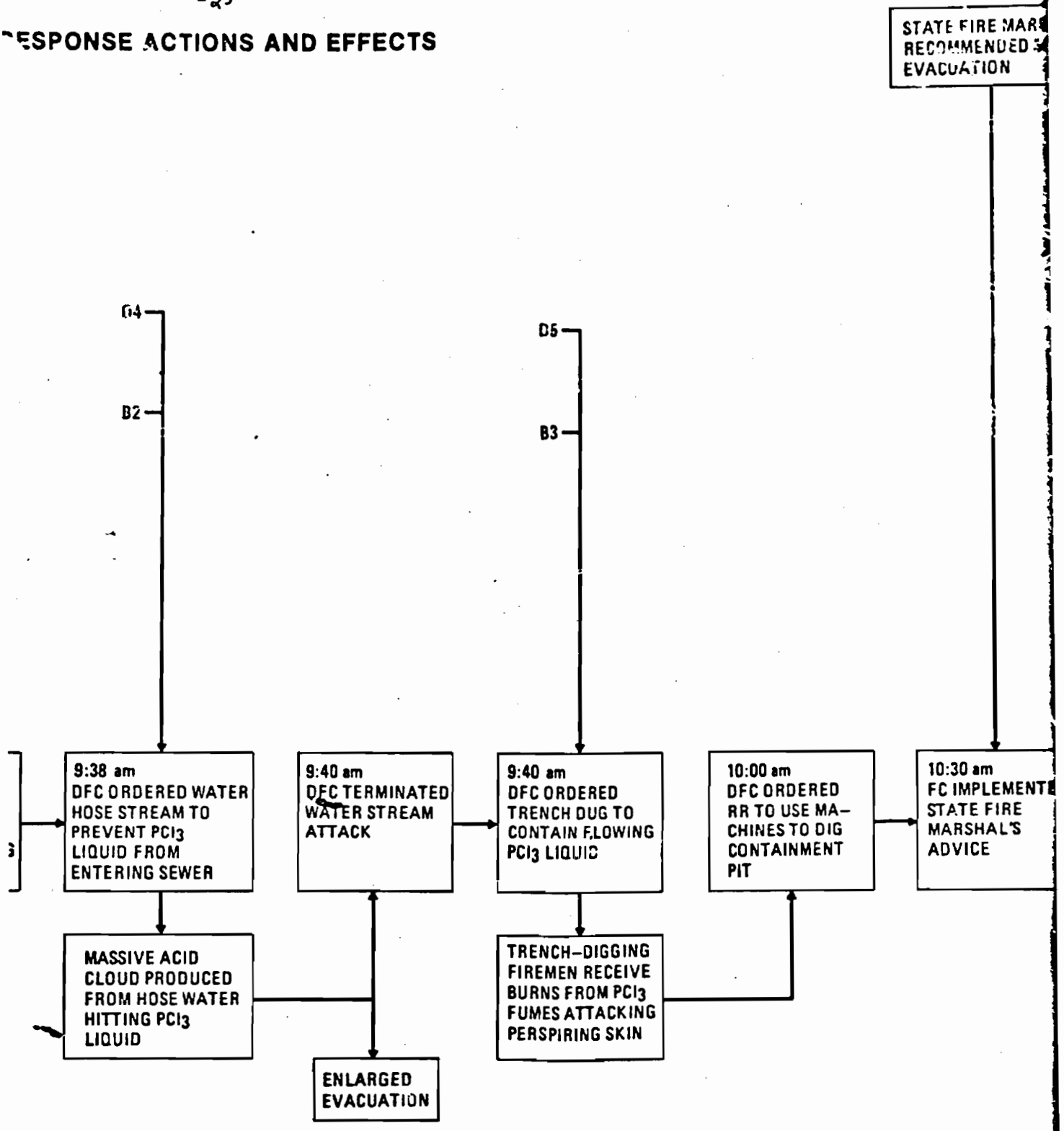
Organization/Advisor	Represented by	Notified a.m. 4/3	Arrived On Scene
State Civil Defense	Director and Emergency Planner	9:20	10:30
State Department of Public Safety	Commissioner, Fire Marshal Inspector, Chem. consultant	9:20	10:00
State Department of Environmental Quality Engineering	Area response teams for water, air, and hazardous materials	9:20	9:25
State Police	Helicopter and patrol units	9:20	9:30
CHEMTREC	Duty Operator Washington, D.C.	9:35	
U.S. Coast Guard, Boston	EPA response team - Boston	9:20 +	11:00
Federal Railroad Administration	HM Inspector Boston, Field Office	9:30	1:00
NOAA - U.S. Weather Service	Logan Airport Boston, MA	9:30	
Coastal Services	Recovery Team	9:35	12:30
Jetliner Services Inc.	Supervisor	1:00	1:00 +
Pollution Control Unlimited	Operator		11:00 +
Ray Brothers and Sufford Trucking	Cargo tank truck operators	9:35	11:45

APPENDIX B. CHRONOLOGY OF EMERGENCY
SOMERVILLE, MASSACHUSETTS
APRIL 3, 1980



A

RESPONSE ACTIONS AND EFFECTS



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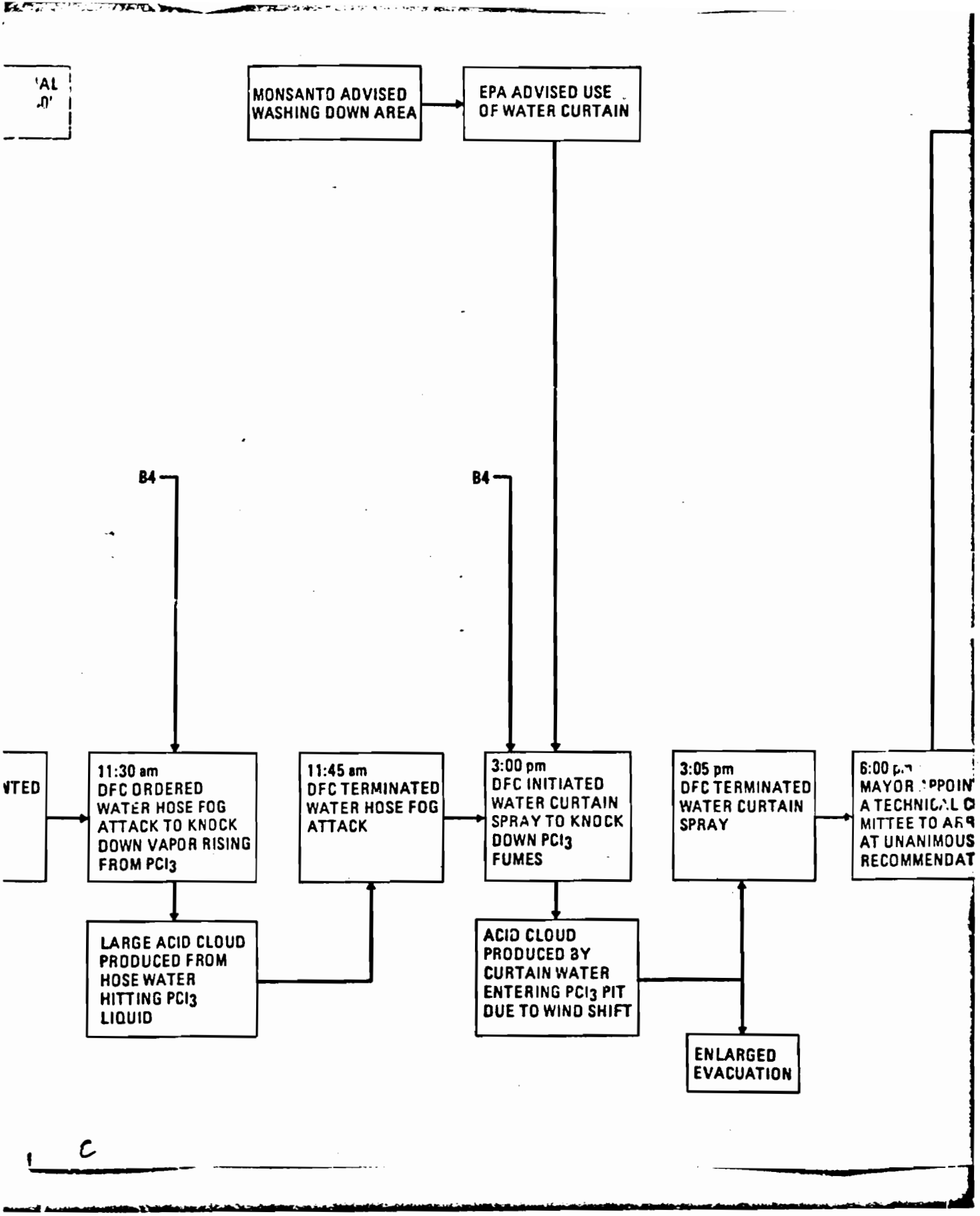
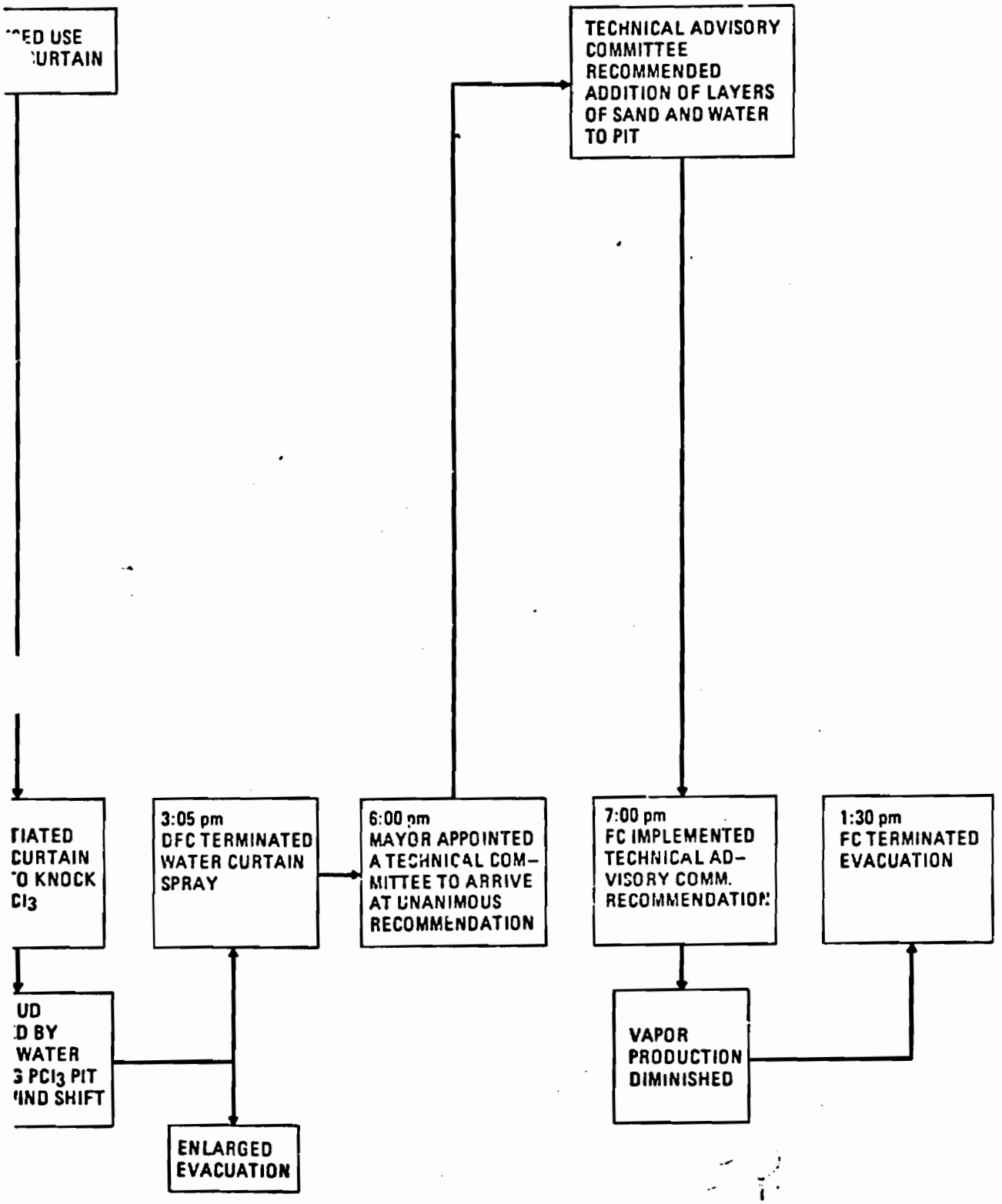

'AL
'D'
MONSANTO ADVISED WASHING DOWN AREA
EPA ADVISED USE OF WATER CURTAIN
B4
B4
NTED
11:30 am DFC ORDERED WATER HOSE FOG ATTACK TO KNOCK DOWN VAPOR RISING FROM PCl_3
11:45 am DFC TERMINATED WATER HOSE FOG ATTACK
3:00 pm DFC INITIATED WATER CURTAIN SPRAY TO KNOCK DOWN PCl_3 FUMES
3:05 pm DFC TERMINATED WATER CURTAIN SPRAY
6:00 p.m
MAYOR APPOIN
A TECHNICAL C
MITTEE TO AR
AT UNANIMOUS
RECOMMENDAT
LARGE ACID CLOUD PRODUCED FROM HOSE WATER HITTING PCl_3 LIQUID
ACID CLOUD PRODUCED BY CURTAIN WATER ENTERING PCl_3 PIT DUE TO WIND SHIFT
ENLARGED EVACUATION

1 C


ED USE
URTAIN
TECHNICAL ADVISORY COMMITTEE RECOMMENDED ADDITION OF LAYERS OF SAND AND WATER TO PIT
TIATED
CURTAIN
O KNOCK
Cl3
3:05 pm
DFC TERMINATED WATER CURTAIN SPRAY
6:00 pm
MAYOR APPOINTED A TECHNICAL COMMITTEE TO ARRIVE AT UNANIMOUS RECOMMENDATION
7:00 pm
FC IMPLEMENTED TECHNICAL ADVISORY COMM. RECOMMENDATION
1:30 pm
FC TERMINATED EVACUATION
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D BY
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ENLARGED EVACUATION

APPENDIX C

BUREAU OF EXPLOSIVES GUIDELINES*

RECOMMENDED PRACTICE FOR HANDLING INCIDENTS INVOLVING HAZARDOUS MATERIALS*

PHOSPHORUS TRICHLORIDE 4932359
CORROSIVE MATERIAL, ACIDIC

Phosphorus trichloride is a colorless fuming liquid with a pungent odor. It is decomposed by water to hydrochloric and phosphorus acids with evolution of heat. It is corrosive to metals and tissue.

If material involved in fire
- Use dry chemical, carbon dioxide, or dry sand
- Do not use water on material itself
- If large quantities of combustibles are involved, use water in flooding quantities as spray and fog
- Use water spray to absorb vapors
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible

If material not involved in fire
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Use water spray to knock-down vapors
- Do not use water on material itself
- Neutralize spilled material with crushed limestone, soda ash, or lime

Personnel protection
- Avoid breathing vapors
- Keep upwind
- Wear self-contained breathing apparatus
- Avoid bodily contact with the material
- Wear boots, protective gloves, and safety glasses
- Do not handle broken packages without protective equipment
- Wash away any material which may have contacted the body with copious amounts of water or soap and water
- If contact with the material anticipated, wear full protective clothing

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APPENDIX D

1978 DOT EMERGENCY GUIDELINES

Phosphorus Trichloride

(Corrosive, Poisonous)

Potential Hazards

Fire:—Cannot catch fire.

Explosion:—Contact with water may form flammable and poisonous gas and cause explosions.

Health:—Liquid causes burns to skin and eyes.
—Vapors extremely irritating.
—*Vapors may be fatal if inhaled.*
—Runoff may pollute water supply.

Immediate Action

—Get helper and notify local authorities.
—If possible, wear self-contained breathing apparatus and full protective clothing.
—Keep upwind and estimate *Immediate Danger Area.*
—Evacuate according to *Evacuation Table.*

Immediate Follow-up Action

Fire:—Move containers from fire area if without risk.
—Cool containers with water from *maximum distance* until well after fire is out.
—Do not get water inside containers.

Spill or Leak:—**Large Spill:** Use flooding amounts of water on the entire spill.
—**Small Spill:** Absorb with dry sand or soda ash.
—Do not touch spilled liquid.
—Stop leak if without risk.
—Do not get water inside containers.

First Aid:—Remove victim to fresh air. Call for emergency medical care. *Effects of contact or inhalation may be delayed.*
—If victim is not breathing, give artificial respiration. If breathing is difficult, give oxygen.
—If victim contacted material, immediately flush skin or eyes with water for *at least 15 minutes.*
—Remove contaminated clothes.
—Keep victim warm and quiet.

For Assistance Call Chemtrec toll free (800) 424-9300

In the District of Columbia, the Virgin Islands, Guam, Samoa, Puerto Rico and Alaska, call (202) 483-7616.

Additional Follow-up Action

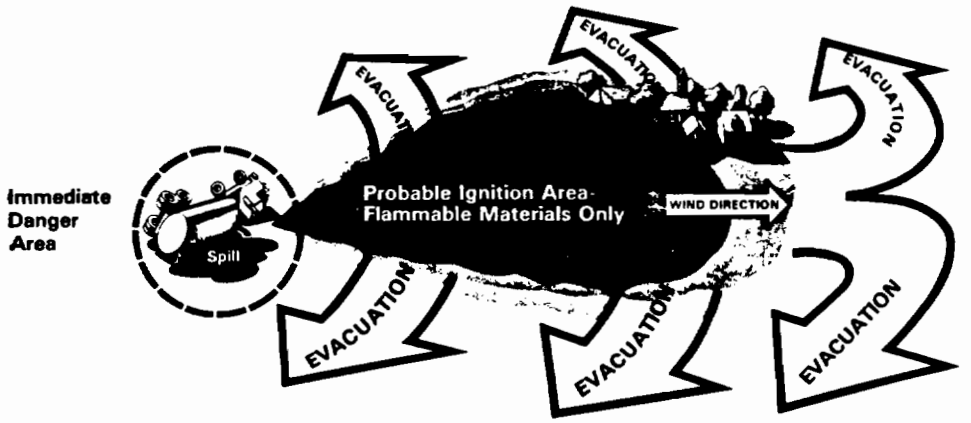
—For more detailed assistance in controlling the hazard, call Chemtrec (Chemical Transportation Emergency Center) toll free (800) 424-9300. You will be asked for the following information:

- Your location and phone number.
- Location of the accident.
- Name of product and shipper, if known.
- The color and number on any labels on the carrier or cargo.
- Weather conditions.
- Type of environment (populated, rural, business, etc.)
- Availability of water supply.

—Adjust evacuation area according to wind changes and observed effect on population.

Water Pollution Control

—Prevent runoff from fire control or dilution water from entering streams or drinking water supply. Dike for later disposal. Notify Coast Guard or Environmental Protection Agency of the situation through Chemtrec or your local authorities.



Evacuation Table — Based on Prevailing Wind of 6-12 mph.

Approximate Size of Spill	Distance to Evacuate From Immediate Danger Area	For Maximum Safety, Downwind Evacuation Area Should Be
200 square feet	70 yards (84 paces)	1,584 feet long, 1,056 feet wide
400 square feet	100 yards (120 paces)	1/2 mile long, 1/3 mile wide
600 square feet	125 yards (150 paces)	2/3 mile long, 1/2 mile wide
800 square feet	150 yards (180 paces)	3/4 mile long, 1/2 mile wide
In the event of an explosion, the minimum safe distance from flying fragments is 2,000 feet in all directions.		

APPENDIX E

NATIONAL FIRE PROTECTION ASSOCIATION GUIDELINES*

PHOSPHOROUS TRICHLORIDE PCl_3

DESCRIPTION: A clear fuming liquid with a pungent odor similar to that of hydrochloric acid.

FIRE AND EXPLOSION HAZARDS: Nonflammable, but will react violently when brought into contact with water; and this reaction may produce flashes of fire. With water, or even moisture, it is broken down into hydrochloric and phosphorous acids which attack most common metals, except nickel and lead, leading to the formation of flammable hydrogen.

LIFE HAZARD: Vapors are extremely irritating. Moist tissue, including eyes and lungs, can be acid-burned by contact due to the formation of hydrochloric and phosphorous acids.

PERSONAL PROTECTION: Wear full protective clothing.

FIRE FIGHTING PHASES: Carbon dioxide and dry chemical are effective in fighting fires involving phosphorous trichloride. Spilled amounts of the material can be cleaned up by absorbing it in very dry sand or by using flooding amounts of water applied very quickly to the entire spill. Do not use small amounts of water on partial areas of a spill, or flashes of fire may result.

USUAL SHIPPING CONTAINERS: Bottles, carboys, drums, tank cars.

STORAGE: Protect against physical damage. Small containers and drums should be stored in cool, dry locations. Larger tanks should be located away from congested areas. All storage containers should be corrosion-resistant. Suitable materials include glass, ceramics, enamel linings, nickel or lead. The hazards of breakage should be considered when using the more fragile materials.

REMARKS: See Chemical Safety Data Sheet, SD-27 (Manufacturing Chemists' Association, Inc.).

APPENDIX F

EXCERPTS FROM EPA TECHNICAL ADVISORY DATA

NIH-EPA CIS (Version 3.10)*

OHM/TADS (Version 4.13/3.0)

File 1: Entry 1

(1) TECHNICAL ASSISTANCE DATA SYSTEM: 72T16858

(2) CAS REGISTRY NO: 7719122

(4) MATERIAL: $$$ PHOSPHORUS TRICHLORIDE $$$

(5) SYNONYMS: PHOSPHOROUS CHLORIDE;

(7) CHEMICAL FORMULA: PCL3

(8) SPECIES IN MIXTURE: 100% PURE

(9) COMMON USES: IRRIDESCENT METALLICS PHOSPHOROUS CPDS

(10) RAIL TRANSPORT (%): 57.7

(11) BARGE TRANSPORT (%): 005.

12) TRUCK TRANSPORT (%): 36.7

(13) PIPE TRANSPORT (%): 000.

(14) CONTAINERS: BOTTLES, CARBOYS, DRUMS, TANK CARS.

(15) GENERAL STORAGE PROCEDURES: KEEP IN TIGHTLY CLOSED CONTAINERS & HANDLE WITH CAUTION. PROTECT AGAINST PHYSICAL DAMAGE. SMALL CONTAINERS & DRUMS SHOULD BE STORED IN COOL, DRY LOCATIONS. LARGER TANKS SHOULD BE LOCATED AWAY FROM CONGESTED AREAS. CORROSION RESISTANT CONTAINERS.

(16) GENERAL HANDLING PROCEDURES: EXTREMELY HAZARDOUS REACTION PRODUCTS RESULTING FROM CONTACT WITH WATER, MAKE IT IMPERATIVE TO AVOID SUCH CONTACT.

(108) PERSONAL SAFETY PRECAUTIONS: USE EYE PROTECTION AND INDUSTRIAL GAS MASK WITH FULL FACE COVER AND APPROVED CANISTER. RUBBER OUTERWEAR IS ESSENTIAL WHEREVER HCL MAY BE CONCENTRATED.

(109) ACUTE HAZARD LEVEL: STRONG IRRITANT. HIGHLY TOXIC WHEN INHALED OR INGESTED. PRODUCES HCL & H3P04 WHEN CONTACTED WITH WATER. THESE ACIDS ON LOWER PH TO HAZARDOUS LEVELS FOR ALL WATER USE.

(110) CHRONIC HAZARD LEVEL: CHRONIC POISONING FROM INHALATION CAN OCCUR FROM REPEATED EXPOSURE. THIS OCCURS AS PULMONARY IRRITATION AND NONFIBRATIC LUNG DISORDERS.

(111) DEGREE OF HAZARD TO PUBLIC HEALTH: STRONG IRRITANT. HIGHLY TOXIC WHEN INGESTED OR INHALED. EMITS TOXIC VAPORS WHEN CONTACTED WITH WATER OR HEATED TO DECOMPOSITION.

(112) AIR POLUTION: HIGH

(113) ACTION LEVELS: NOTIFY AIR AUTHORITY. RESTRICT ACCESS TO AFFECTED WATERS.

(114) IN SITU AMELIORATION: NEUTRALIZE WITH LIME OR NA2C03.

(115) BEACH AND SHORE RESTORATION: WASH WITH MILD CAUSTIC.

(116) AVAILABILITY OF COUNTERMEASURE MATERIALS: LIME-CEMENT PLANTS NA2C03-GROCERY DISTRIBUTORS, BAKERIES

(117) DISPOSAL METHODS: PHOSPHOROUS TRICHLORIDE CAN BE SYPHONED INTO A RUNNING STREAM AND NEUTRALIZED. HOWEVER, THE DANGER OF FORMING EXPLOSIVE OR TOXIC FUMES DICTATES THE WORK BE ACCOMPLISHED IN AN ISOLATED AREA WITH ALL PERSONNEL ADEQUATELY PROTECTED.

(118) DISPOSAL NOTIFICATION: LOCAL FIRE AUTHORITY.

(119) INDUSTRIAL FOULING POTENTIAL: TOLERANCES FOR CL: PULP & PAPER-75 PPM, TEXTILE & BREWING 100 PPM, CARBONATED DRINKS-250 PPM, FOOD PROCESSING-1000 PPM CORROSIVE TO EQUIPMENT.

(120) EFFECTS ON WATER TREATMENT PROCESS: MAY REDUCE PH AND INTERFERE WITH COAGULATION.

(121) MAJOR WATER USES THREATENED: ALL USES

(122) PROBABLE LOCATION AND STATE OF MATERIAL: WILL HAVE DECOMPOSED IN WATER TO PHOSPHORIC ACID AND HYDROCHLORIC ACID. WILL EVOLVE GAS; SHIPPED AS COLORLESS LIQUID.

(124) WATER CHEMISTRY: DECOMPOSES ON CONTACT WITH WATER FORMING HCL AND H3P04.

APPENDIX G

1980 DOT EMERGENCY RESPONSE GUIDEBOOK
GUIDE 39-PHOSPHORUS TRICHLORIDE

HEALTH HAZARDS

Poison.
Poisonous if inhaled or swallowed.
Vapor extremely irritating.
Contact may cause burns to skin and eyes.
Runoff from fire control or dilution water may cause pollution.

FIRE OR EXPLOSION

Some of these materials may burn but do not ignite readily.
May ignite combustibles (wood, paper, oil, etc.).
Violent reaction with water.
Explosive concentrations of gas may accumulate in tanks.
Runoff to sewer may create fire or explosion hazard.

EMERGENCY ACTION

Keep unnecessary people away.
Stay upwind; keep out of low areas.
Isolate hazard area and deny entry.
Wear positive pressure breathing apparatus and special protective clothing.
FOR EMERGENCY ASSISTANCE CALL CHEMTREC **(800) 424-9300.**
Also, in case of water pollution, call local authorities.

FIRE

Do not get water inside container.
Small Fires: Dry chemical or CO2.
Large Fires: Flood with water.
Move container from fire area if you can do it without risk.
Cool containers that are exposed to flames with water from the side until well after fire is out.

SPILL OR LEAK

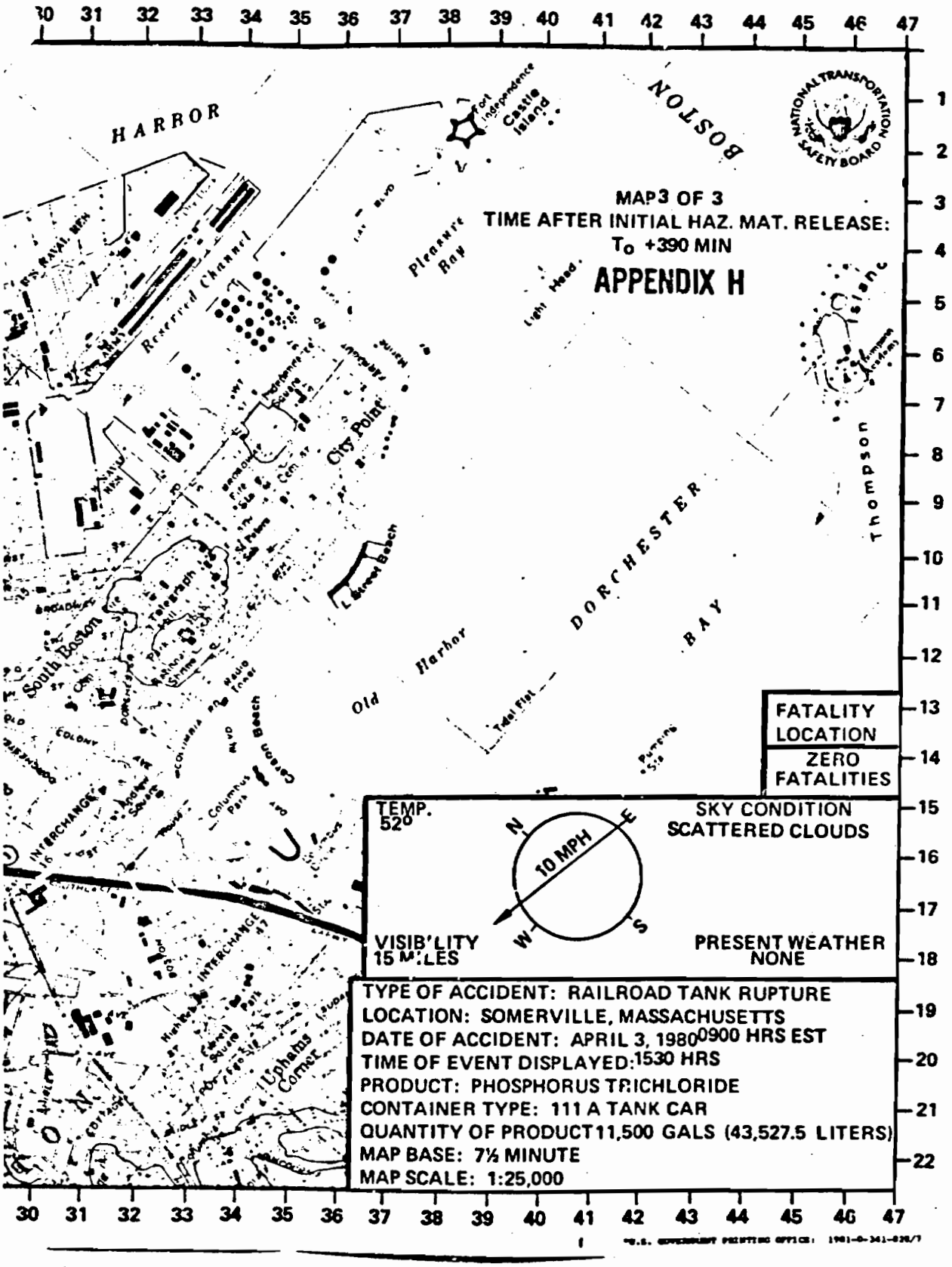
Do not get water inside container.
Do not touch spilled material.
Stop leak if you can do it without risk.
Use water spray to reduce vapors but **do not** put water on leak area.
Keep combustibles (wood, paper, oil, etc.) away from spilled material.
Small Spills: Flush area with water. (USE CAUTION)
Large Spills: Dike for later disposal and dilute with large amounts of water.

FIRST AID

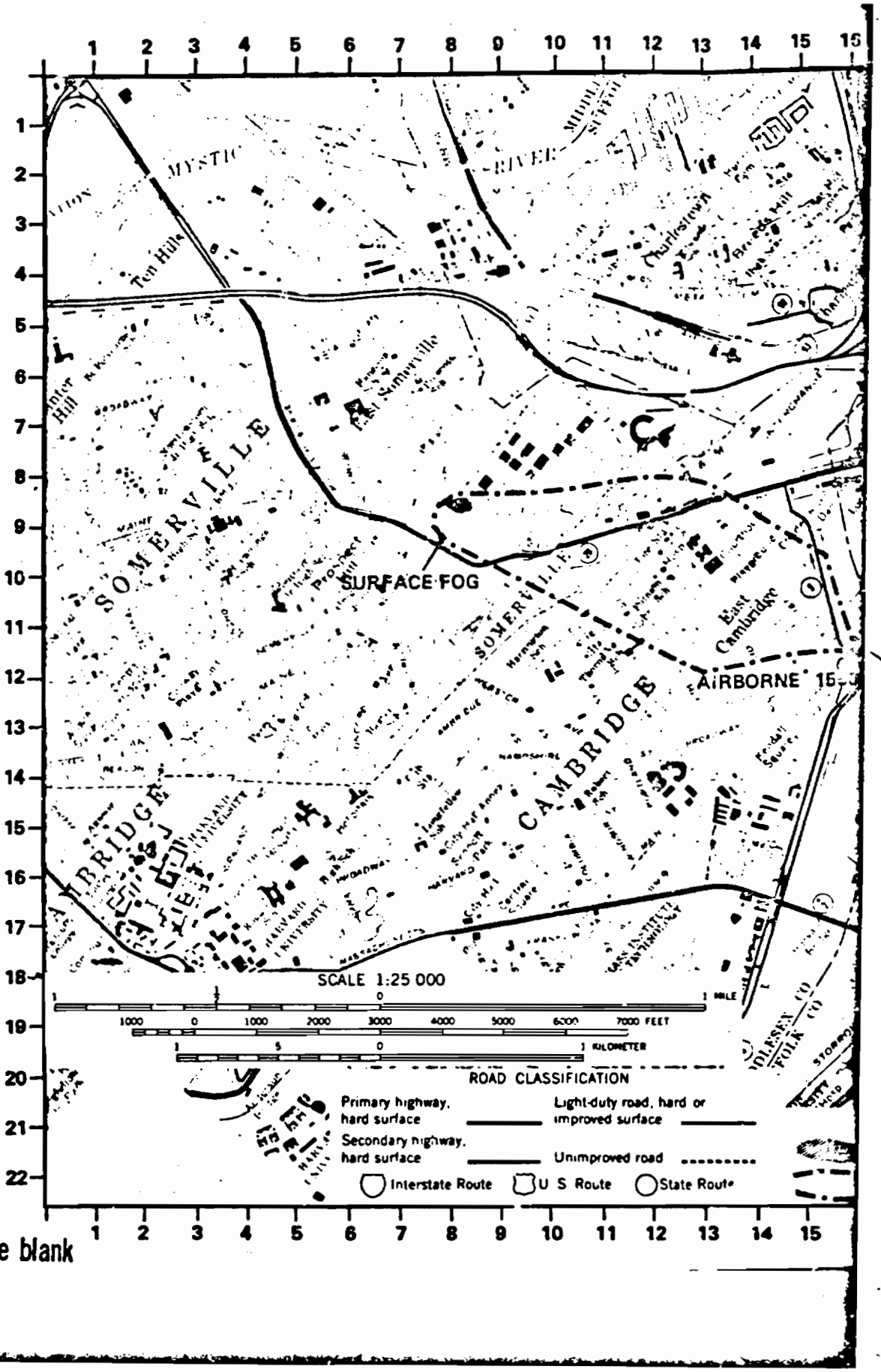
Move victim to fresh air; call emergency medical care.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
Remove and isolate contaminated clothing and shoes.
Speed in removing material from skin is of extreme importance.
Wipe material from skin immediately; then flush skin or eyes with running water for at least 15 minutes.
Keep victim quiet and maintain normal body temperature.

APPENDIX H

SOMERVILLE, MASSACHUSETTS
SPILL MAPS


MAP 3 OF 3
TIME AFTER INITIAL HAZ. MAT. RELEASE:
To +390 MIN
APPENDIX H
HARBOR
BOSTON
Fort Independence
Castle Island
Pleasure Bay
Light Head
Reserved Channel
City Point
DORCHESTER BAY
Old Harbor
Tidal Flat
Thompson Island
South Boston
Columbia Beach
Pumping Sta
INTERCHANGE 16
INTERCHANGE 17
Uphams Corner
FATALITY LOCATION
ZERO FATALITIES
TEMP. 52°
10 MPH
N
E
S
W
SKY CONDITION SCATTERED CLOUDS
VISIB'LITY 15 MILES
PRESENT WEATHER NONE
TYPE OF ACCIDENT: RAILROAD TANK RUPTURE
LOCATION: SOMERVILLE, MASSACHUSETTS
DATE OF ACCIDENT: APRIL 3, 1980 0900 HRS EST
TIME OF EVENT DISPLAYED: 1530 HRS
PRODUCT: PHOSPHORUS TRICHLORIDE
CONTAINER TYPE: 111 A TANK CAR
QUANTITY OF PRODUCT 11,500 GALS (43,527.5 LITERS)
MAP BASE: 7½ MINUTE
MAP SCALE: 1:25,000

C



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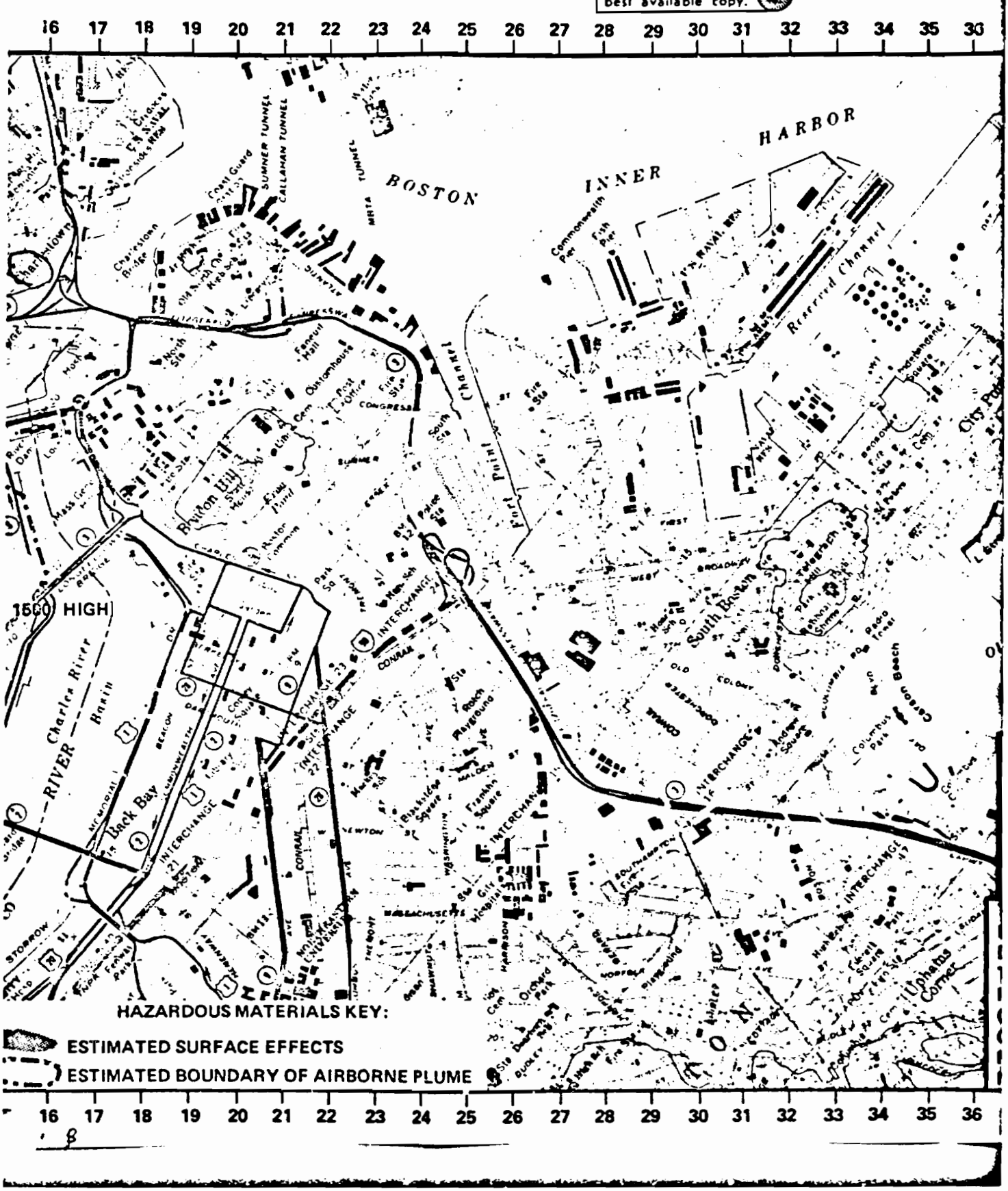
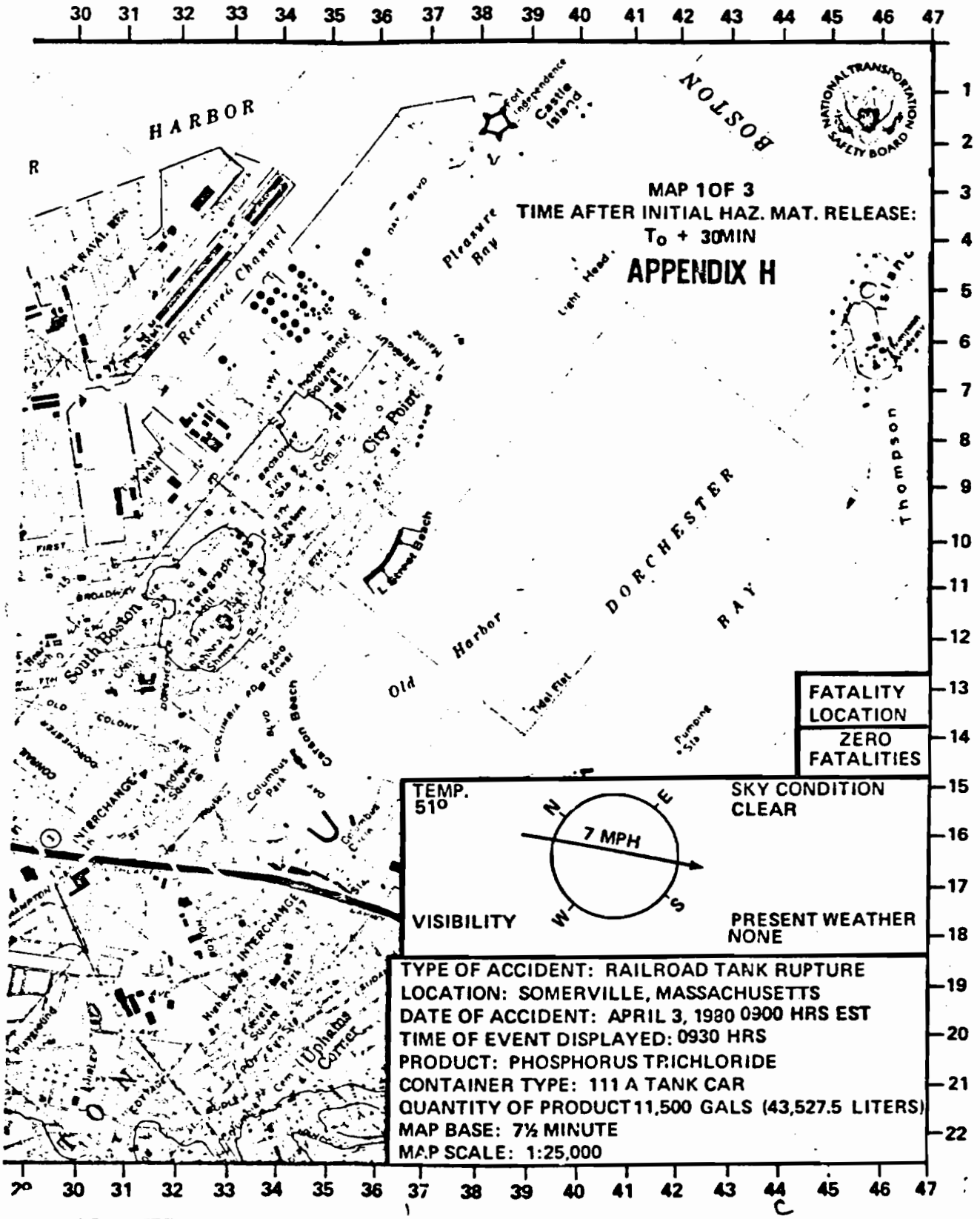
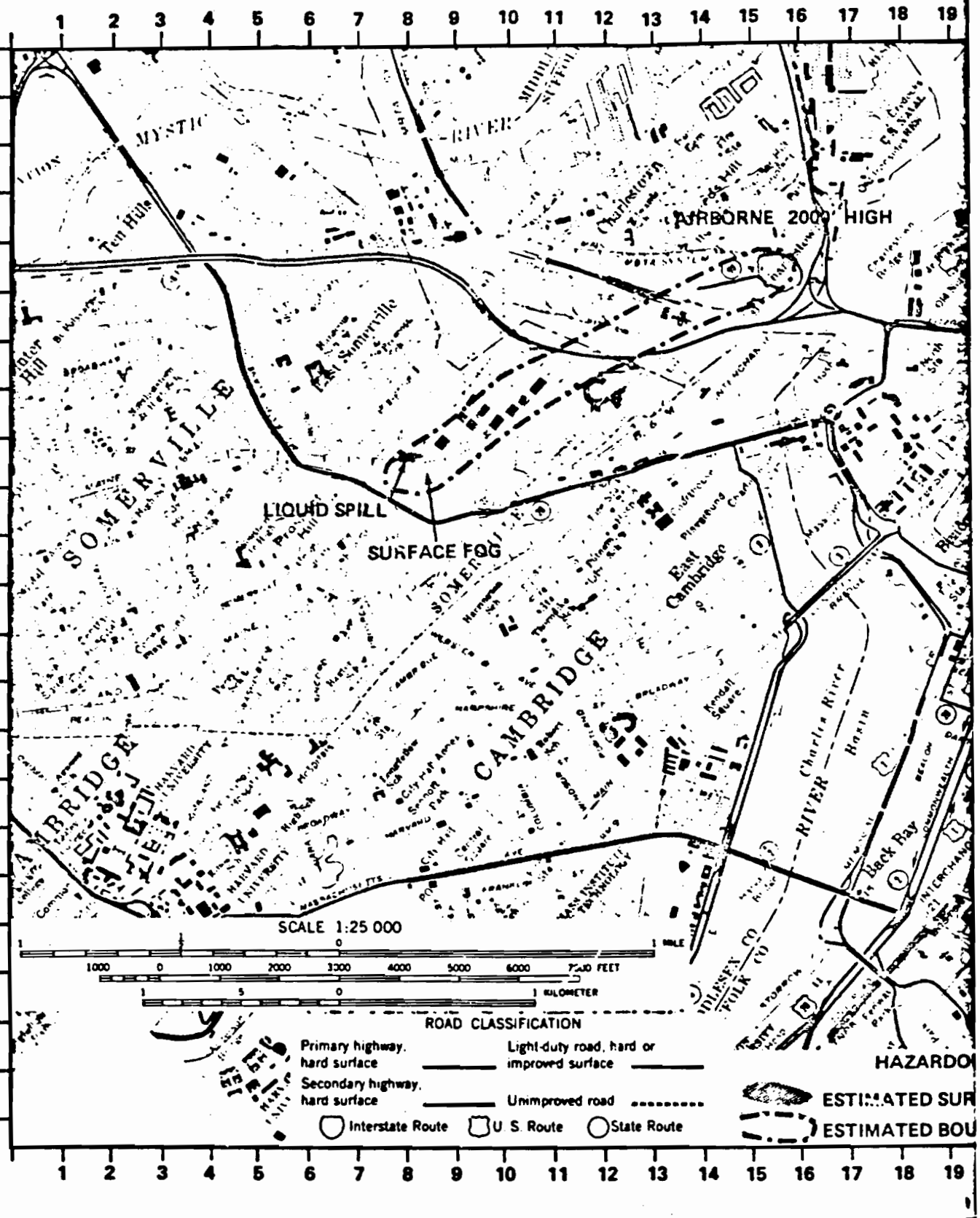


APPENDIX H

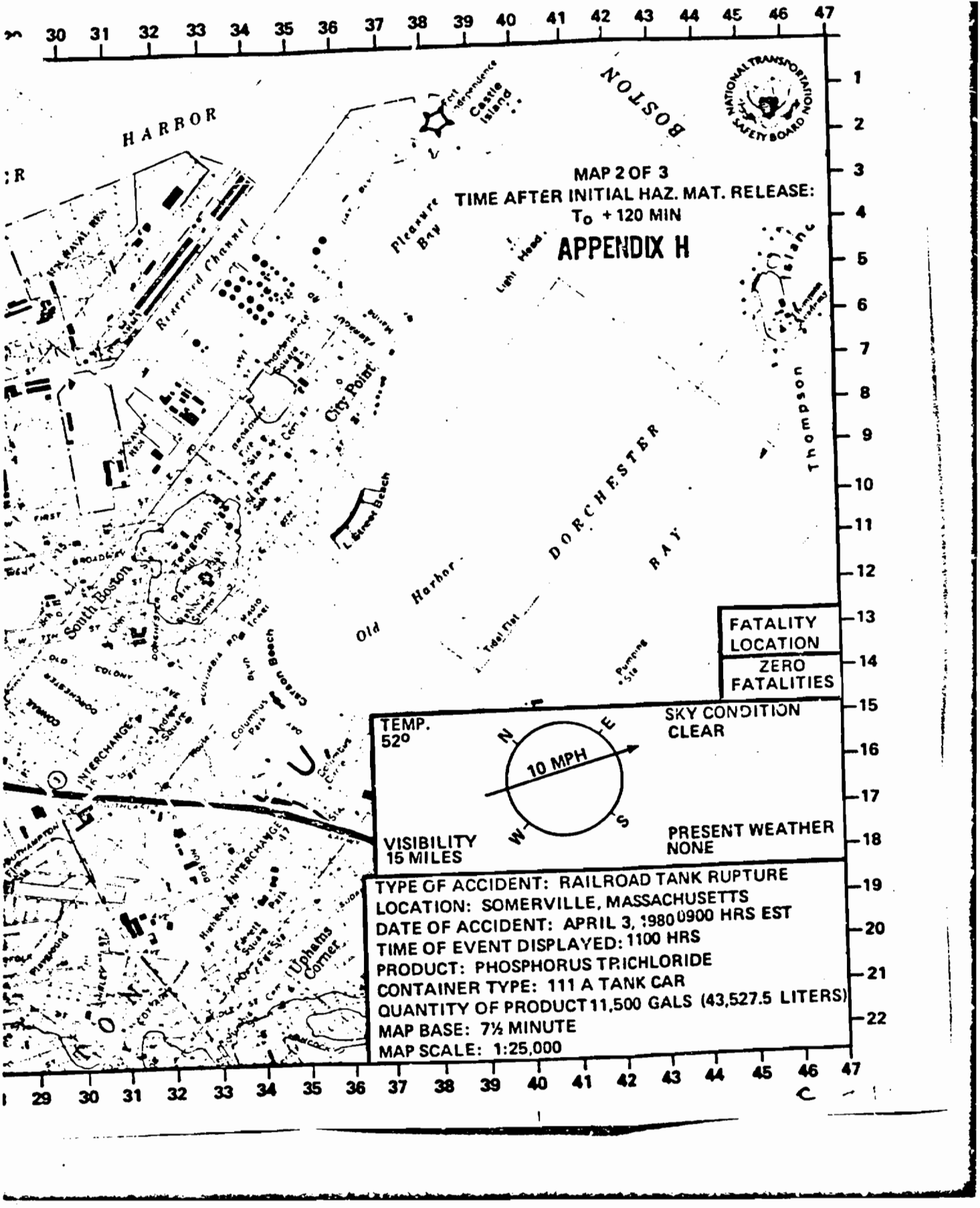


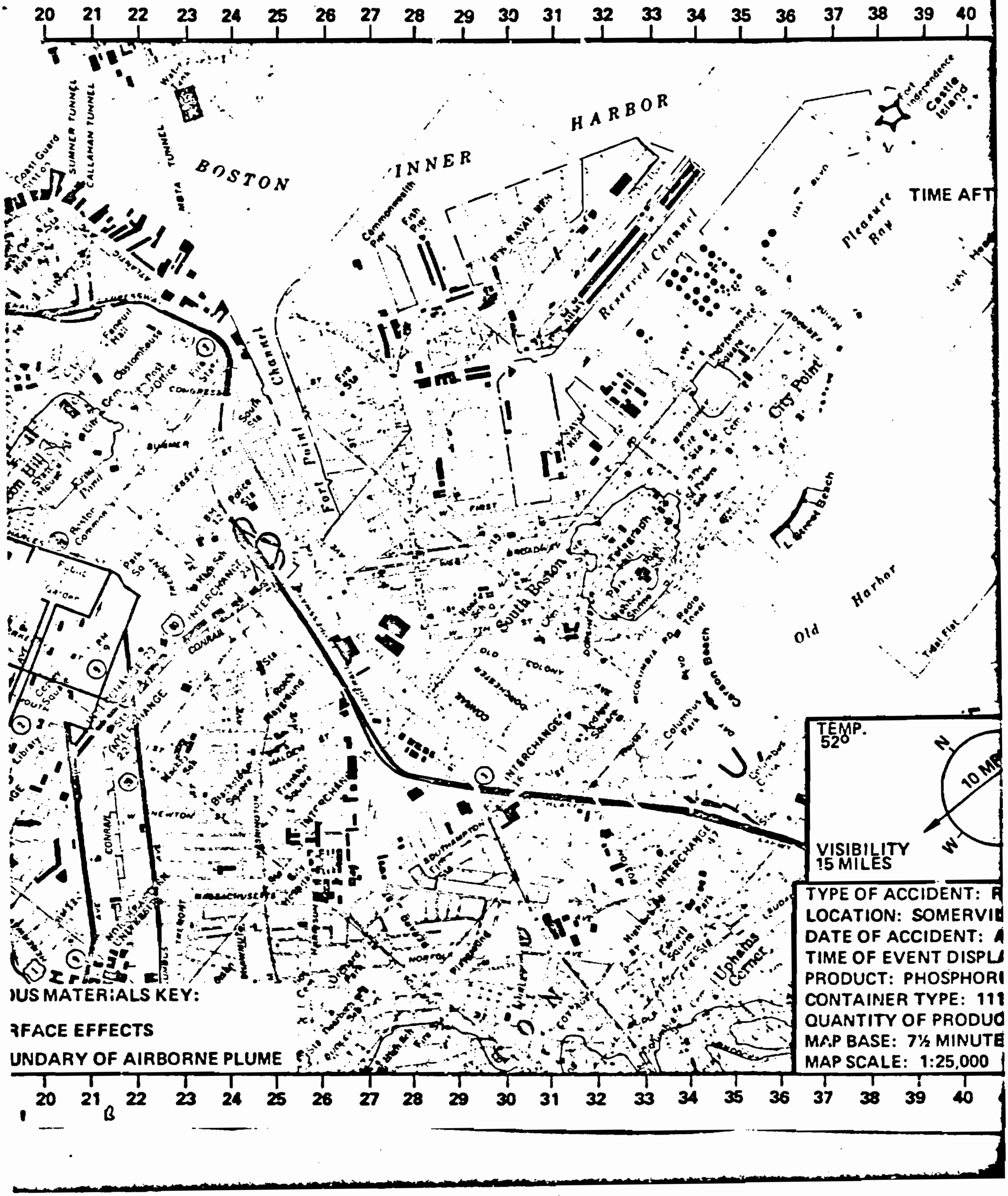

20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
BOSTON INNER HARBOR
Boston Light
Fort Point Channel
Reserved Channel
Pleasure Bay
City Point
L Street Beach
South Boston
Old Harbor
Columbus Park
Andrew Square
Telegraph Hill
Dorchester
Uphams Corner
INTERCHANGE
TEMP. 52°
VISIBILITY 15 MILES
N
W
TYPE OF ACCIDEN
LOCATION: SOME
DATE OF ACCIDEN
TIME OF EVENT DI
PRODUCT: PHOSPI
CONTAINER TYPE:
QUANTITY OF PRO
MAP BASE: 7½ MI
MAP SCALE: 1:25,
ARDOUS MATERIALS KEY:
SURFACE EFFECTS
BOUNDARY OF AIRBORNE PLUME
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39


AIRBORNE 2000' HIGH
LIQUID SPILL
SURFACE FOG
SOMERVILLE
CAMBRIDGE
East Cambridge
Charles River Basin
Back Bay
MYSTIC RIVER
Ten Hills
Powder Hill
Prospect Hill
SCALE 1:25 000
1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 FEET
1 5 0 1 KILOMETER
ROAD CLASSIFICATION
Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route
ESTIMATED SUR
ESTIMATED BOU
HAZARDO

4

APPENDIX H


MAP 2 OF 3
TIME AFTER INITIAL HAZ. MAT. RELEASE:
To + 120 MIN
APPENDIX H
FATALITY LOCATION
ZERO FATALITIES
TEMP. 52°
SKY CONDITION CLEAR
10 MPH
VISIBILITY 15 MILES
PRESENT WEATHER NONE
TYPE OF ACCIDENT: RAILROAD TANK RUPTURE
LOCATION: SOMERVILLE, MASSACHUSETTS
DATE OF ACCIDENT: APRIL 3, 1980 0900 HRS EST
TIME OF EVENT DISPLAYED: 1100 HRS
PRODUCT: PHOSPHORUS TRICHLORIDE
CONTAINER TYPE: 111 A TANK CAR
QUANTITY OF PRODUCT 11,500 GALS (43,527.5 LITERS)
MAP BASE: 7½ MINUTE
MAP SCALE: 1:25,000
HARBOR
BOSTON
Pleasure Bay
Castle Island
City Point
DORCHESTER BAY
Old Harbor
South Boston
Thompson Island
Uphams Corner
INTERCHANGE
Tide Flat
Pumping Sta
L Street Beach
Carson Beach
Columbus Park
Telegraph Hill Park
Reserved Channel


20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
BOSTON
INNER
HARBOR
TIME AFT
Pleasure Bay
Castle Island
Fort Independence
Reserved Channel
Fort Point Channel
City Point
South Boston
Telegraph Hill
L Street Beach
Old Harbor
Tidal Flat
Carson Beach
Columbus Park
Upham's Corner
SUMNER TUNNEL
CALLAHAN TUNNEL
MBTA TUNNEL
Coast Guard Station
Commonwealth Pier
Fish Pier
Faneuil Hall
Custom House
Post Office
South Sta
Public Garden
INTERCHANGE
TEMP. 52°
VISIBILITY 15 MILES
10 MP
N
W
TYPE OF ACCIDENT: R
LOCATION: SOMERVIL
DATE OF ACCIDENT: A
TIME OF EVENT DISPLA
PRODUCT: PHOSPHORI
CONTAINER TYPE: 111
QUANTITY OF PRODUC
MAP BASE: 7½ MINUTE
MAP SCALE: 1:25,000
OUS MATERIALS KEY:
RFACE EFFECTS
UNDARY OF AIRBORNE PLUME
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40