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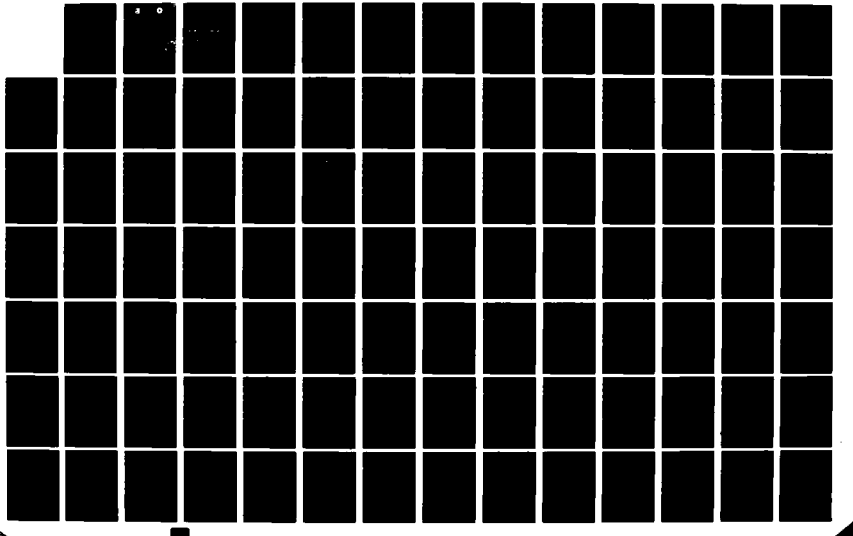

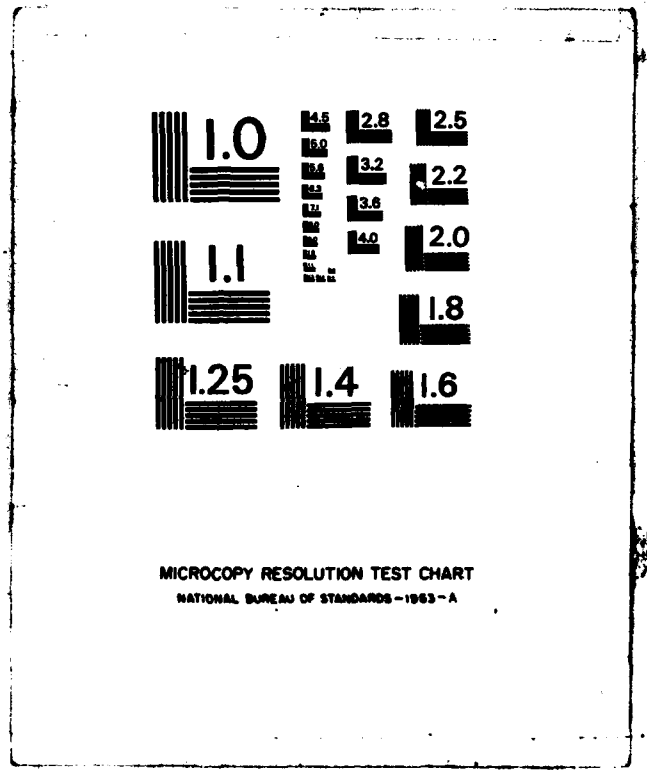
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POST ACCIDENT PROCEDURES FOR CHEMICALS AND PROPELLANTS

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2045 North 15th Street
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September 1982

Interim Report for the Period April 1981 through January 1982

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Prepared for

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
OFFICE OF RESEARCH AND DEVELOPMENT
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FOREWARD

This report was prepared by Systems Technology Laboratory, Inc., 2045 North 15th Street, Arlington, Virginia 22201 under contract F04611-80-C-0046 with the Air Force Rocket Propulsion Laboratory (AFRPL), Edwards Air Force Base, California 93523. Mr. John Marshall was COTR for AFRPL. The project was also jointly sponsored through the Federal Railroad Administration (FRA), Office of Rail Safety Research.

This technical report has been reviewed and is approved for publication in accordance with the distribution statement on the cover and on the DD Form 1473.

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Refer to AFRPL-TR-82-031 which provides database for additional 12 hazardous materials and to AFRPL-TR-82-075 which is the two volume guidelines manual.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

hazardous materials	vapor dispersion
production	hazards assessment
transportation	hazards mitigation
accident assessment	wreckage removal
emergency response	cleanup/disposal

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents production volumes, storage capacities, shipment quantities, containers used for highway and rail shipments, general commodity flow patterns and disposal sites and capabilities for 16 hazardous materials; an overview of emergency response guidelines and resources available to selected industry groups and state and local agencies; key findings based on STL's accident assessment; assessment of methods for implementing crisis management techniques used by police, fire chiefs, and other disaster response officers; and criteria for interactive feedback crisis management system.

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LIST OF ILLUSTRATIONS

LIST OF ACRONYMS

A-50	-	Aerozine-50, rocket fuel consisting of 50/50 mixture of hydrazine and unsymmetrical dimethylhydrazine
AAR	-	Association of American Railroads
AE	-	Acoustic Emission
AFB	-	Air Force Base
AFCRL	-	Air Force Cambridge Research Laboratories
BE	-	AAR Bureau of Explosives
BLEVE	-	Boiling Liquid Expanding Vapor Explosion
CCC	-	Communications Coordination Center
CFR	-	Code of Federal Regulations
CHEMTREC	-	Chemical Transportation Emergency Center
CHRIS	-	Chemical Hazards Response Information System
CMA	-	Chemical Manufacturers Association
DDESB	-	Department of Defense Explosives Safety Board
DOD	-	U.S. Department of Defense
DOT	-	Department of Transportation
EMT	-	Emergency Medical Technician
ERG	-	Emergency Response Guide
EPA	-	Environmental Protection Agency
HACS	-	USCG Hazard Assessment Computer System
HM	-	Hazardous Material
HMER	-	Hazardous Materials Emergency Response System developed by Bell Systems for NRC/CHEMTREC
HMRAC	-	Hazardous Material Risk Advisory Committee (Nashville, TN)
IR	-	Infared
JANNAF	-	Joint Army-Navy-NASA-Air Force
LEL	-	Lower Explosive Limit
LN/SCL	-	Louisville & Nashville/Seaboard Coastline Railroads, part of the Family Lines
LPG	-	Liquefied Petroleum Gas
MMH	-	Monomethylhydrazine
MTB	-	U.S. Department of Transportation Materials Transportation Bureau
NIOSH	-	National Institute of Occupational Safety and Health
NFPA	-	National Fire Protection Association

LIST OF ACRONYMS (cont'd)

NOAA	-	National Oceanic and Atmospheric Administration
NRC	-	National Response Center
NTSB	-	National Transportation Safety Board
OMHTADS	-	Oil and Hazardous Material Technical Assistance Data System
OSC	-	On-Scene Coordinator
OSHA	-	Occupational Safety and Health Administration
PEL	-	Public Emergency Limit
RCRA	-	Resource Conservation and Recovery Act
RAM	-	Radioactive Materials
RMA	-	Rocky Mount Arsenal
SHELL R&D SPILLS	-	Shell Vapor Dispersion Model
SRI	-	Stanford Research Institute
STCC	-	Standard Transportation Commodity Code
TCC	-	Transportation Commodity Code
TLV	-	Threshold Limit Value
UDMH	-	Unsymmetrical Dimethylhydrazine
UEL	-	Upper Explosive Limit
UN	-	United Nations
USAF	-	United States Air Force
USCG	-	United States Coast Guard
UV	-	Ultraviolet

1. EXECUTIVE SUMMARY

The overall objective of this program is to perform a state-of-the-art assessment to develop technology which will minimize hazards and environmental damage from transportation-related accidents or other spills of certain chemicals and propellants. This report has been prepared as an addendum to the Final Interim Report and constitutes the deliverable requirements set forth in CDRL item 11.

An addendum to the Final Interim Report was required because during the performance of the project additional effort on Tasks 1 through 5 was required. In addition, a new set of subtasks was initiated to develop guidelines for managing spills of Titan II propellants. This report represents the additional work completed on Tasks 1 through 3. A separate report will document the work performed during Tasks 4, 5 and 6E of the project. Work accomplished on new Subtasks 6A through 6D has already been delivered in a separate document. The additional chemicals and propellants which were examined are acetone, acetone cyanohydrin, acrylonitrile, aerozine-50, ethyl acrylate, hydrocyanic acid, isobutane, methanol, methyl bromide, monomethylamine nitrate (PRM), propylene, sodium hydrosulfide, sodium hydroxide, styrene monomer, toluene and vinyl acetate. The following paragraphs provide summary data on the additional efforts and new subtasks.

In Task 1A an in-depth literature search was conducted to identify physical/chemical data, production sites and volumes, commodity flow patterns, container types used for highway and rail transport, and accident histories of the above mentioned chemicals and propellants. Data were obtained from numerous federal, state and local government agencies, trade associations, rail and highway carriers, chemical manufacturers, wreckage removal and cleanup and disposal contractors. These data were obtained to develop the transportation picture for these commodities so that their accident histories can be better understood in the context of all hazardous materials transportation.

In Task 2A, in-depth analyses of the initial response, special emergency equipment and materials, on-scene coordination and communications, hazardous material identification, release handling, firefighting, cleanup and disposal, structural integrity assessment and wreckage removal activities used at 19 selected rail and highway accidents involving the additional 16 chemicals and propellants were conducted. This effort was necessary to identify areas in which emergency response personnel have experienced difficulty in handling the complexity of hazards associated with hazardous

materials transportation accidents. The assessment of the 10 accidents investigated earlier in this project were combined with the additional 19 to form a larger accident sample. These 29 accidents were then reviewed to identify trends, improvements or changes in accident management. A few examples of SOA accident management techniques identified include:

- All of the existing contingency plans that have been activated during HM accidents were designed for generic emergencies and none dealt specifically with response to HM transportation accidents.
- The utilization of special emergency equipment, materials, and techniques at serious transportation accidents has not become standard procedure until the last few years and still appears to depend on the resources, sophistication and pre-planning done in the community in which the accident occurs.
- Response personnel at highway accidents have not significantly changed their communications techniques nor are changes indicated in coordinating response efforts at the scene.
- On-scene communication and coordination techniques at railroad accidents have changed significantly.

Also during this task the appropriate hazards mitigation and cleanup/disposal methods for the chemicals and propellants identified were compiled from the U.S. Coast Guard CHRIS system, the EPA Hazardous Material Spill Control Manual, the AAR Emergency Handling of Hazardous Materials in Surface Transportation and the DOT Emergency Response Guidebooks. These guidelines were documented as a means of providing the first personnel arriving on-scene with personal protection and hazards mitigation actions. It should be noted that several of these materials have disproportionately high accident histories in relation to other hazardous materials.

The emergency response/contingency planning; training requirements and capabililities; and sources of specialized personnel, equipment and gear in ten cities in four states were also assessed. This effort was performed to identify existing response capabilities of representative municipalities in the U.S. as a mechanism for recommending improved use of resources and for developing a "model" hazardous materials crisis management plan for communities. This assessment resulted in several recommendations for improved methods for municipal crisis management at the scene of a hazardous materials transportation accident. Examples of a few of the recommendations made include among:

- Volunteer firefighters should be given the same hazardous materials training that paid personnel receive.
- Emergency response personnel should be required to receive follow-up hazardous materials training after a specified period of time.

- A designated communications network should be established which will provide for a mechanism to alert the public and to handle communications between the communications command center, the accident site and other off-scene support organizations.
- Contingency plans should identify radio and television stations that will continuously inform the public during the initial phases of the emergency.

Task 3 involved the development of detailed criteria to serve as the basis for the detailed procedures to be developed in Task 4. These procedures will provide for improved hazardous mitigation, wreckage removal and cleanup and disposal techniques at hazardous materials transportation emergencies. In Task 3A the specific criteria for optimum hazards mitigation, wreckage removal and cleanup and disposal methods were expanded. They originally included criteria for on-scene identification of materials; on-scene communications; assessing toxic, flammable and explosive vapor hazards; determining meteorological conditions for establishing air dispersion limits; handling leaks; assessing container structural integrity; remote sensing of container temperature and pressure; transfer operations; wreckage removal and cleanup and disposal. A logic sequence for determining optimum operational procedures for the accident scene was also developed along with criteria for developing necessary training aids for emergency response teams. Additionally, criteria for methods for implementing crisis management techniques at hazardous materials transportation accidents were developed. The purpose of the additional work was to develop criteria for an interactive feedback crisis management system. Concerning software requirements, a few of the software criteria cited include:

- The data base for which the software will be developed should include at a minimum the following parameters:
  - color of placard on tank or tank car for use in identifying materials hazard class;
  - commodity involved;
  - STCC and/or UN number of the material(s) involved;
  - specification cylinder, tank car, cargo tank or portable tank container involved in accident;
  - quantity of material being shipped;
  - source strength;
  - time since initial release;
  - leak/no leak conditions;
  - wind direction and speed;
  - precipitation/condensation conditions;
  - ambient temperature;

- percent cloud cover;
- proximity and location of population centers to accident site;
- population density at or near accident site;
- local topography;
- arrival time and distance of wreckage removal, cleanup and disposal contractor to site (i.e., inventory of these groups is necessary);
- location and type of neutralizing agent which should be used based upon the material released;
- container structural integrity assessment; and
- environmental pollution considerations.

- Once the commodity has been identified the user should be provided with the material's LEL, UEL, TLV, PEL, at the accident scene, boiling point, freezing point, critical temperature, critical pressure, critical density, vapor pressure and autoignition temperature.
- Be developed so that the systems software can be made available to cities through which hazardous commodities are shipped.

2. INTRODUCTION

The overall objective of this program is to perform a state-of-the-art assessment to develop technology which will minimize hazardous and environmental damage from transportation-related accidents or other spills of certain chemicals and propellants.

This report presents the additional work accomplished in Tasks 1, 2 and 3 and is structured into the following sections:

- Section 1 - Executive Summary
- Section 2 - Introduction
- Section 3 - Chemicals and Propellants Production and Transportation Data
- Section 4 - Accident Assessment
- Section 5 - Methods for Implementing Crisis Management Techniques for Hazardous Materials Transportation Accidents
- Section 6 - Criteria for an Interactive Feedback Crisis Management System
- Appendices A - H

Sections 1 and 2 present highlights and a structural overview of the report. Section 3 lists data sources and presents analysis of production volumes, containers used for highway and rail shipments, general commodity flow patterns, and transportation accident histories of the chemicals and propellants. Section 4 presents an in-depth assessment of selected accidents covering chronological analysis of initial response; emergency special equipment and materials; on-scene coordination and communications; hazardous material identification and location; release handling, firefighting, cleanup and disposal, structural integrity assessment and wreckage removal activities. The accidents selected were 28 NTSB-investigated accidents and the events at Mississauga in Ontario, Canada. Section 5 presents an investigation of the response and planning capabilities of ten cities as a basis of developing state-of-the-art methods for municipalities to implement crisis management techniques at hazardous materials transportation accidents. Section 6 presents criteria for hardware and specific software for use in the eventual development of an interactive feedback crisis management system. Appendices A, B, C and D have been prepared to present the appropriate hazards mitigation, cleanup and disposal guidelines for the additional 16 chemicals and propellants outlined in the DOT, AAR, EPA and CHRIS response manuals, respectively; Appendix E shows selected response procedures used by the City of Baltimore fire department when responding to a hazardous materials transportation accident; Appendix F provides selected hazardous material incident reporting forms used in Bay County (Panama City/ Youngstown),

Florida; Appendix G is an annotated bibliography which summarizes the current state-of-the-art for emergency response methods, procedures and systems, hazards mitigation and cleanup activities for rail and highway accidents and user transfer operations involving releases of the additional 18 selected hazardous commodities; and Appendix H is a glossary of terms used in this report.

3. CHEMICALS AND PROPELLANTS PRODUCTION AND TRANSPORTATION DATA

3.1 DATA SOURCES

A literature search has been conducted and a data base compiled for the additional sixteen chemicals and propellants in this project. The data includes production volume, shipping quantities, shipping containers and general commodity flow patterns. Several Federal and State agencies as well as industrial organizations, trade associations and academic institutions listed below were contacted.

Federal

- Bureau of Census
- United States Air Force (USAF)
- Department of Transportation (DOT)
  - Federal Railroad Administration (FRA)
  - Materials Transportation Bureau (MTB)
- Interstate Commerce Commission (ICC)
- National Transportation Safety Board (NTSB)

State/City

- California
  - Los Angeles
  - Sacramento
- New Jersey
  - Newark
- Maryland
  - Baltimore
- Delaware
  - Wilmington
- Tennessee
  - Nashville
  - Waverly
- Florida
  - Youngstown
  - Tallahassee
  - Pensacola

- Crestview

Trade Associations

- Chemical Manufacturers Association (CMA)

Industrial

- Cleanup/Disposal Contractors
  - IT Corporation

Academic Institutions

- Stanford Research Institute

3.2 PHYSICAL/CHEMICAL DATA

Physical/chemical data were obtained on each of the sixteen commodities and are listed in Appendix G. Other pertinent data such as thermal and chemical reactivity, synergistic/antagonistic effects with other materials, toxicity, exposure and environmental effects were also compiled from the above as well as from the data provided in several of the emergency response systems studied. The hazards mitigation guidelines for each of the commodities found in the response manuals are found in Appendices A, B, C and D.

3.3 PRODUCTION QUANTITIES

Data on annual production volume for the sixteen chemicals and propellants were compiled from the 1981 SRI Directory of Chemical Producers in the U.S. and 1980-81 OPD Chemical Buyers Directory.

The data are presented in the following sections for each commodity (where available) in terms of location of production sites, annual production on a state-by-state basis, and total U.S. annual production.

3.3.1 Acetone

Table 3-1 lists producers, production sites and capacities for acetone. The total annual U.S. production capacity is 1,588,000 metric tons. Figure 3-1 shows annual production capacity by state. Production is highest in the Middle Atlantic and East North Central Regions. The major end uses of acetone include the chemical manufacturing of methyl isobutyl ketone, methyl isobutyl carbinol, methyl methacrylate

TABLE 3-1

PRODUCERS AND PRODUCTION CAPACITY OF ACETONE

Producer	Production Sites	Annual Capacity (Thousands of Metric Tons)
Allied Chem. Corp Chems Co.	Frankford, PA	163
American Cyanamid Co. Organic Chems. Div.	Willow Island, WV	5
Atlantic Richfield, Co. Oxirane International Subsid. Oxirane Chem. Co.	Bayport, TX	18
Clark Oil & Refining Corp. Clark Chem. Corp. Subsid.	Blue Island, IL	24
Dow Chem. U.S.A	Oyster Creek, TX	127
Eastman Kodak Co. Eastman Chem. Products Inc., subsid. Tennessee Eastman Co.	Kingsport, TN	36
Exxon Corp. Exxon Chem Co., div. Exxon Chem. Americas	Bayway, NJ	63
General Electric Co. Engineered Materials Group Plastics Business Operations	Mount Vernon, IN	109
Georgia-Pacific Corp. Chem. div.	Plaquemine, LA	92
Getty Oil Corp. Getty Refining and Marketing Co., subsid.	El Dorado, KS	25
The Goodyear Tire and Rubber Co., subsid.	Bayport, TX	5
Monsanto Co. Monsanto Chem. Intermediates Co.	Chocolate Bayou, TX	136

TABLE 3-1 (cont'd)

Shell Chem. Co.	Deer Park, TX	317
	Wilmington, CA	45
	Wood River, IL	136
Standard Oil Co. of California Chevron Chem. Co. subsid. Petrochems. Div.	Richmond, CA	15
Union Carbide Corp. Chems. and Plastics, div.	Bound Brook, NJ	50
	Institute, WV	77
United States Steel Corp. USS Chems. div.	Haverhill, OH	145
	TOTAL	1,588

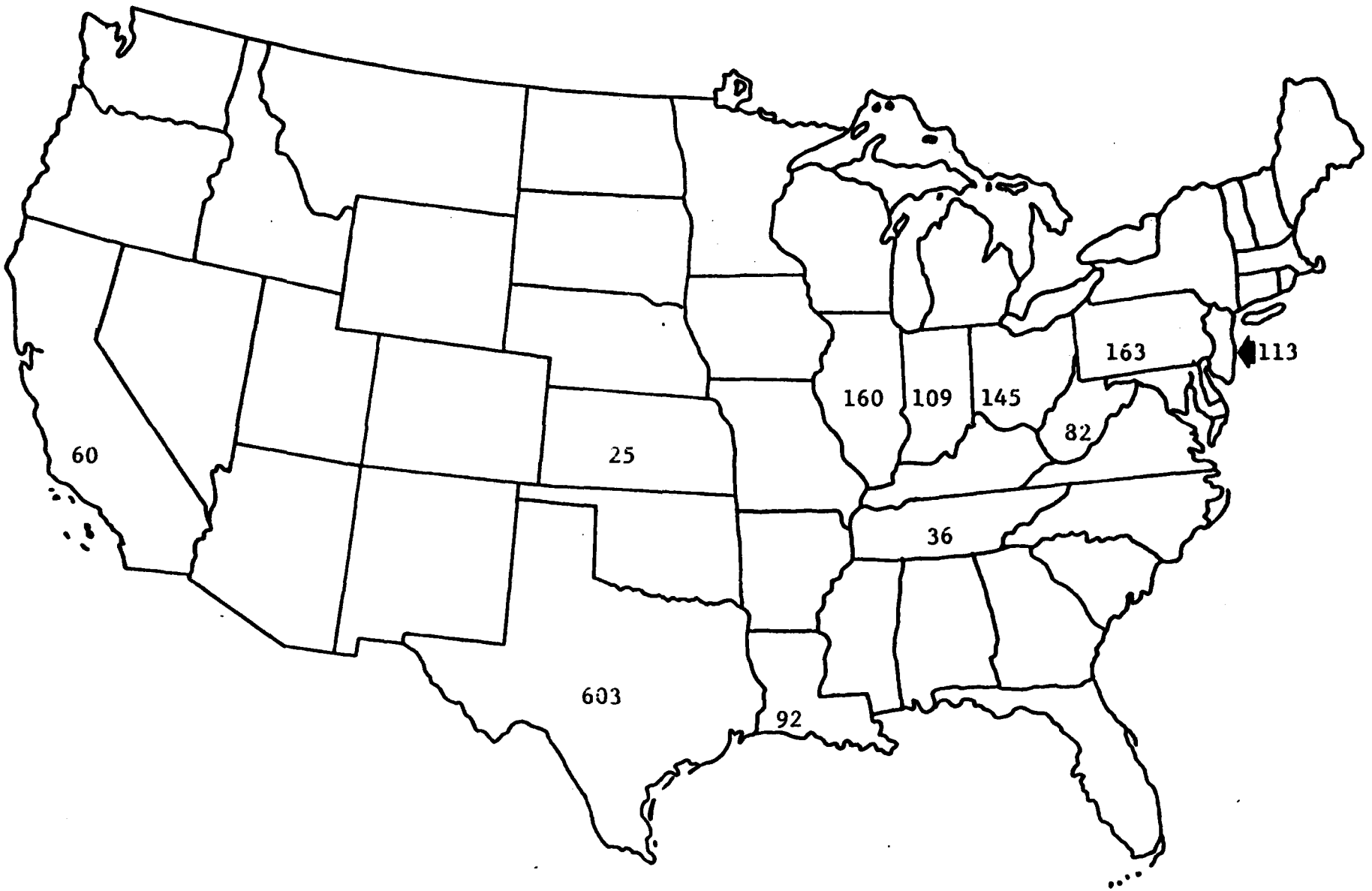


Figure 3-1. Acetone Production-Thousands of Metric Tons/Year
U.S. Total: 1,588

and bisphenol-A; as a paint, varnish and lacquer solvent; for use in manufacturing cellulose acetate, especially as a spinning solvent to clean and dry parts of precision equipment; as a solvent for potassium iodide and permanganate; as a delusterant for cellulose acetate and permanganate and cellulose acetate fibers; and in the specification testing of vulcanized rubber products.

3.3.2 Acetone Cyanohydrin

Acetone cyanohydrin is produced by only four manufacturers in the U.S. They are:

Producer	Production Site
• Cy/Ro Indust., Inc.	Westwego, LA
• E.I. du Pont de Nemours & Co., Inc. Chems. and Pigments Dept.	Memphis, TN
• Monsanto Co. Monsanto Chem. Intermediates Co.	Texas City, TX
• Rohm and Haas Co. Rohm and Haas Texas Inc., subsid.	Deer Park, TX

Since the number of producers is limited to four, data regarding annual production volumes is not presently available from the Census Bureau. The major end uses of acetone cyanohydrin include the manufacture of insecticides and as an intermediate for organic synthesis, especially of methyl methacrylate.

3.3.3 Acrylonitrile (inhibited)

Table 3-2 lists producers, production sites and capacities for acrylonitrile. The total annual U.S. production capacity is 950,000 metric tons. Figure 3-2 shows annual production capacity by state, with 73 percent of the total produced in Texas and Louisiana. The major end uses for acrylonitrile include monomer for acrylic and modacrylic fibers and high-strength whiskers; manufacture of alkyl benzene sulfonate and acrylonitrile-styrene copolymers; production of nitrile rubber; in the cyanoethylation of cotton; in the making of synthetic soil blocks; in organic synthesis; as a fumigant grain; as a monomer for a semiconductive polymer that can be used like inorganic oxide catalysts in dehydrogenation of tert-butyl alcohol to isobutylene in water; and in the production of bottles for soft drinks.

TABLE 3-2

PRODUCERS AND PRODUCTION CAPACITY OF ACRYLONITRILE (INHIBITED)

Producer	Production Site	Annual Capacity (Thousands of Metric Tons
American Cyanamid Co. Indust. Chems. div.	New Orleans, LA	120
E.I. du Pont de Nemours & Co., Inc. Petrochems. Dept. Freon Products div.	Memphis, TN	122
Polymer Intermediates Dept.	Beaumont, TX	159
Monsanto Co.	Chocolate Bayou, TX	209
Monsanto Chem. Intermediates Co.	Texas City, TX	204
The Standard Oil Co. (Ohio) Vistron Corp., Subsid. Chems. Dept.	Lima, OH	136
	TOTAL	950

Figure 3-2. Acrylonitrile (inhibited) Production-Thousands of Metric Tons/Year
U.S. Total: 950

3.3.4 Aerozine-50

Aerozine-50 is primarily used as a propellant and is a 50%/50% mixture of hydrazine and unsymmetrical dimethylhydrazine (UDMH). This propellant is formulated only at Rocky Mountain Arsenal (Denver, Colorado) for exclusive consumption of the USAF. According to the USAF Directorate of Energy Management at Kelly AFB, Texas the 1980 production volume of Aerozine-50 was 246 metric tons (272 tons). Based on USAF projections it can be expected that production will increase considerably in fiscal year 1981 to an estimated 473 metric tons (522 tons).

3.3.5 Ethyl Acrylate (inhibited)

Ethyl acrylate (inhibited) is produced by only four manufacturers in the U.S. They are:

Producer	Production Site
Badische Corp.	Freeport, TX
Celanese Corp. Celanese Chem. Co., Inc.	Clear Lake, TX Pampa, TX
Rohm & Haas Co. Rohm & Haas Texas Inc., subsid.	Deer Park, TX
Union Carbide Corp. Chems. and plastics div.	Taft, LA

Since the number of producers is limited to four, data regarding annual production volumes is not available from the Census Bureau. The major end uses of ethyl acrylate (inhibited) are as polymers; in the manufacture of acrylic paints; and as chemical intermediates.

3.3.6 Hydrocyanic Acid

Table 3-3 shows the producers, production sites and annual production volume for hydrocyanic acid in the U.S. It can be seen that a total of 551,000 metric tons are produced annually. Figure 3-3 shows annual production capacity by state. It can be seen that the majority produced is manufactured in Texas (67%). The major end uses of hydrocyanic acid include manufacturing of acrylonitrile, acrylates, adiponitrile, cyanide salts and dyes and chelating agents. Most of the hydrocyanic acid produced is used captively to produce other chemicals within a plant. It is estimated that 97 percent of

TABLE 3-3

PRODUCERS AND PRODUCTION CAPACITY OF HYDROCYANIC ACID

Producer	Production Site	Annual Capacity (Thousands of Metric Tons)
American Cyanamid Co. Indust. Chems. Div.	New Orleans, LA	15
Ciba-Geigg Corp. Agricultural Div.	St. Gabriel, LA	41
Plastics & Additives Div. Pigments Dept.	Glenn Falls, N.Y.	1
Degussa Corp. Alabama Group	Theodore, AL	24
Dow Chem. USA	Freeport, TX	9
E.I. du Pont de Nemours & Co., Inc. Chems. and Pigments Dept.	Memphis, TN	82
Petrochems. Dept.	Beaumont, TX	22
Polymer Intermediates Dept.	Orange, TX	95
	Victoria, TX	95
Monsanto Co. Monsanto Chem. Intermediates Co.	Chocolate Bayou, TX	29
	Texas City, TX	29
Rohm & Haas Co. Rohm & Haas Texas Inc., subsid.	Deer Park, TX	91
The Standard Oil Co. (Ohio) Vistron Corp., subsid. Chems. Dept.	Lima, OH	18
TOTAL		551

Figure 3-3. Hydrocyanic Acid Production-Thousands of Metric Tons/Year
U.S. Total:551

the HCN is produced as a by-product of other processes, and that 3 percent is sold on the merchant market thereby entering the transportation system.

3.3.7 Isobutane

Isobutane production figures were provided by the National LP-Gas Association on a state regional basis. This data consists of isobutane produced at natural gas processing plants. Total annual U.S. production of isobutane is roughly 288,819 metric tons. Isobutane is produced by only four manufacturers in the U.S.

Producer	Production Site
Air Products & Chemicals, Inc., Specialty Gas Dept. Gardner Cryogenics	Allentown, PA
Matheson	Lyndhurst, NJ
Phillips Chemical Co., Div. Phillips Petroleum Co. Petrochemicals Div. Technical Petroleum Co.	Borger, TX
Union Carbide Corp., Linde Specialty Gases	Linden, NJ

Figure 3-4 shows the annual U.S. production of isobutane by region. The major end uses of isobutane are for organic synthesis; as refrigeranta, fuel, aerosal propellants, and high-octane gasoline (aviation fuel); and in the manufacture of synthetic rubber and instrument calibration fluid.

3.3.8 Methanol

Table 3-4 shows producers, production sites and annual production capacity for methanol in the U.S.. It can be seen that the average annual production capacity of methanol is roughly 5,041,000 metric tons. Figure 3-5 shows production capacity by state. The majority of methanol (71%) is produced in Texas. The major end uses of methanol (also known as methyl alcohol) are in the manufacture of formaldehyde and dimethyl terphthalate; in chemical synthesis of methyl amines, methyl chloride, methyl methacrylate, etc.; as an aviation fuel (for water injection); in the manufacture of automotive antifreeze; as a solvent for nitrocellulose, ethylcellulose, polyvinyl butyral, shellac, rosin, manila resin, dyes; as a denaturant for ethyl alcohol; as a dehydrator for

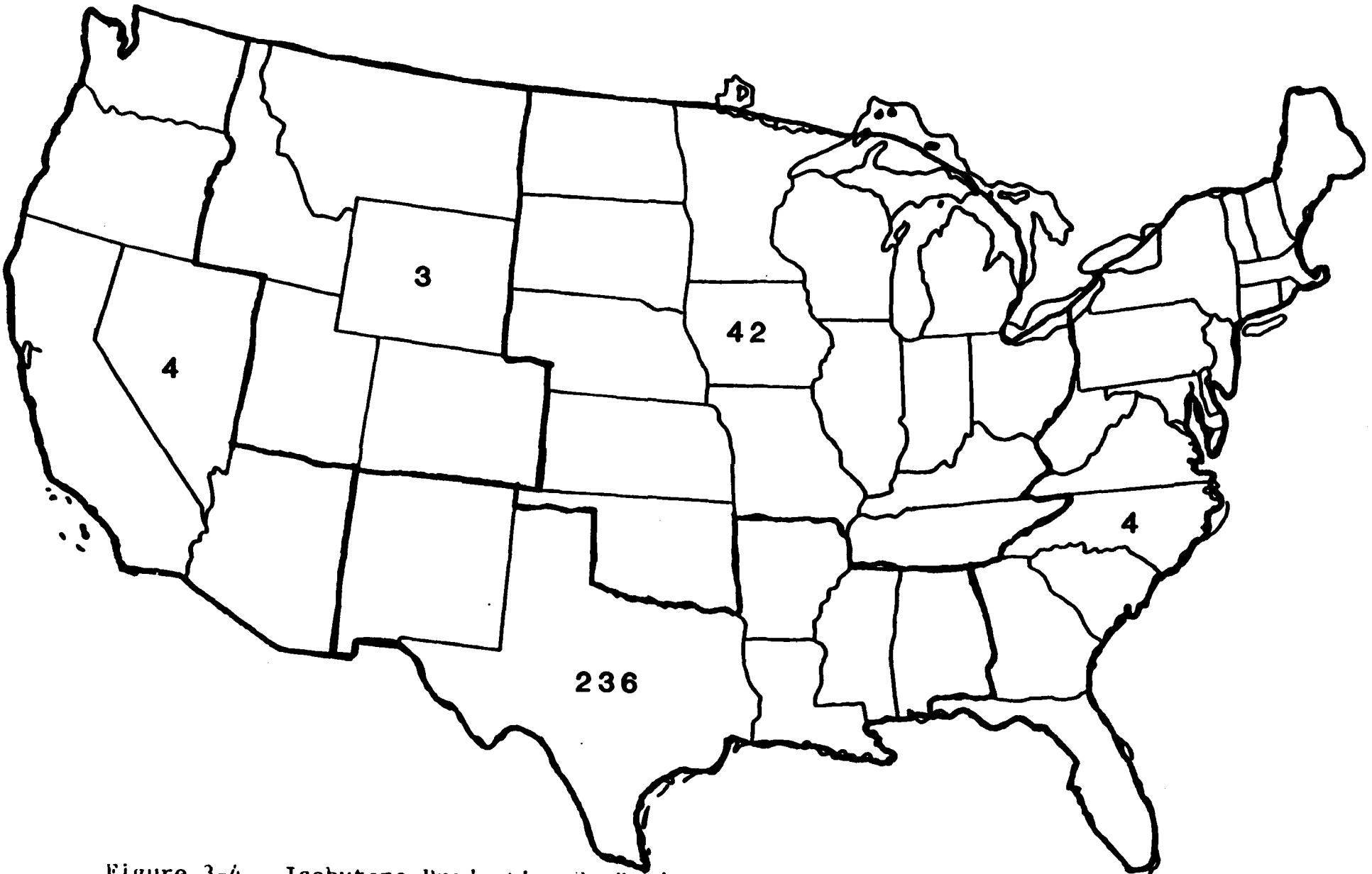


Figure 3-4. Isobutane Production By Region at Natural Gas Processing Plants: Thousands of Metric Tons U.S. Total 289

TABLE 3-4. PRODUCERS AND PRODUCTION CAPACITY OF METHANOL*

Producer	Production Sites	Annual Capacity (Thousands of Metric Tons)
Air Products and Chems., Inc. Plastics Div.	Pensacola, FL	163
Allemania Chem. Co	Plaquemine, LA	290
Borden Inc. Borden Chem. Div. Petrochems Div.	Geismar, LA	580
Celanese Corp.	Bishop, TX	544
Celanese Chem. Co., Inc.	Clear Lake, TX	834
E.I. du Pont de Nemours & Co., Inc. Chems., Dyes and Pigments Dept.	Beaumont, TX	544
	Deer Park, TX	726
Georgia-Pacific Corp. Chem. Div.	Plaquemine, LA	435
Monsanto Co. Monsanto Chem. Intermediates Co.	Texas City, TX	363
Tenneco Inc. Tenneco Chems., Inc.	Pasadena, TX	290
	TOTAL	5,041

* Source: SRI International, 1981 Directory of Chemical Producers.

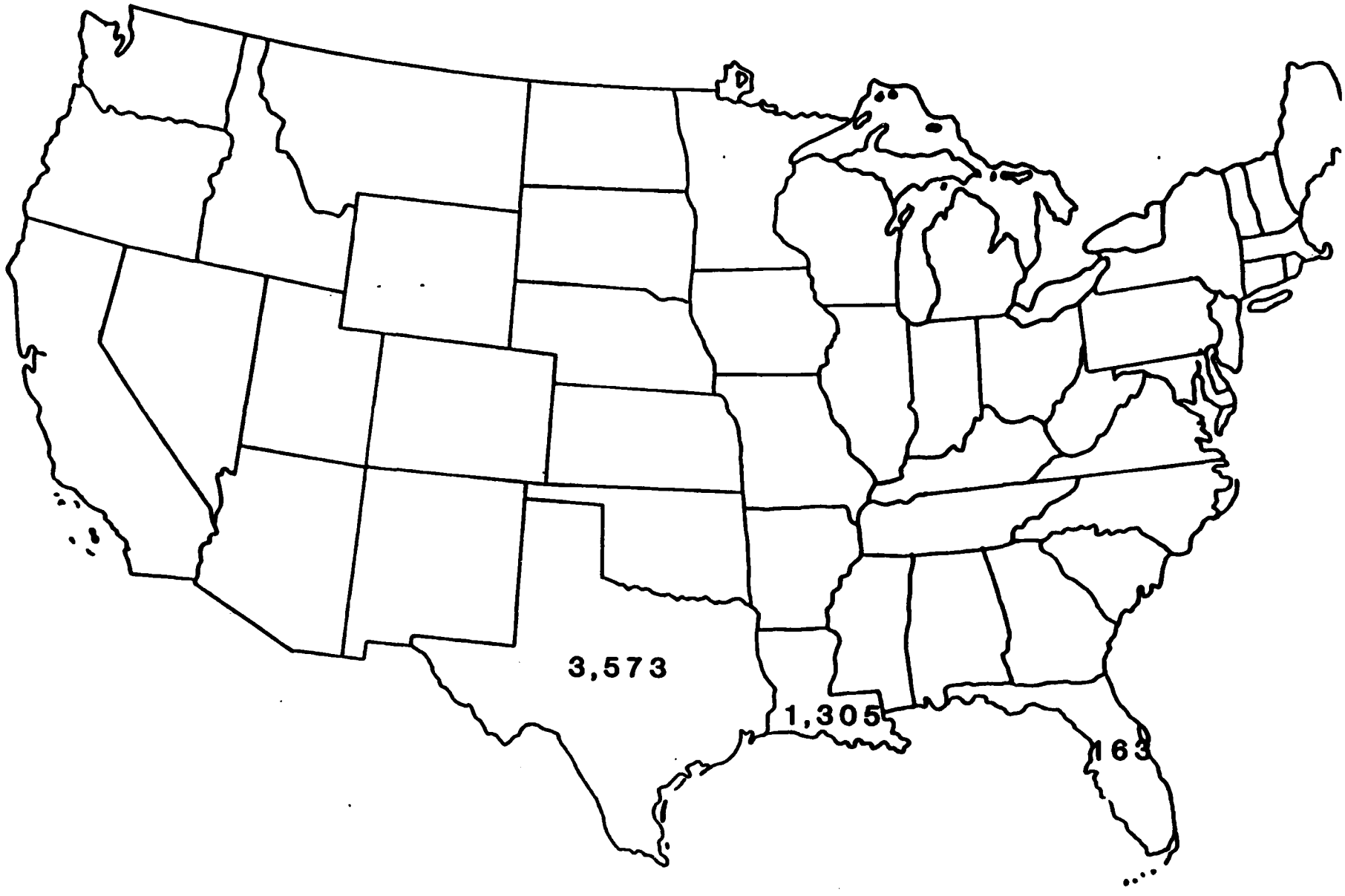


Figure 3-5. Methanol Production: Thousands of Metric Tons/Year
U.S. Total: 5,041

automotive antifreeze; as a solvent for nitrocellulose, ethylcellulose, polyvinyl butyral, shellac, rosin, manila resin, dyes; as a denaturent for ethyl alcohol; as a dehydrator for natural gas; as fuel for utility plants (methyl fuel); and as feedstock for manufacture of synthetic proteins by continuous fermentation.

3.3.9 Methyl Bromide

According to SRI International's 1981 Directory of Chemical Producers, methyl bromide is manufactured by only two manufacturers in the U.S. They are Dow Chemicals, U.S.A. in Midland, MI and Great Lakes Chemical Corp. in El Dorado, AR. Since the number of producers are small, production volumes are not available from the Bureau of Census. The major end uses of methyl bromide are as a soil and space fumigant; in disinfestation of potatoes, tomatoes and other crops; and in organic synthesis.

3.3.10 Monomethylamine Nitrate

According to the NTSB investigation of the Wenatchee, WA transportation accident involving monomethylamine nitrate solution (PRM) (NTSB-RAR-76-1), PRM was originally manufactured by E. I. DuPont in Biwabik, MI and shipped to its operations in Dupont, WA where it was used as a sensitizer in the formulation of an explosive called TOVEX. Prior to August 6, 1974 when an explosion occurred in the Apple Yard at Wenatchee, WA approximately 18 cars per year were shipped to DuPont's plant. Assuming an average of 10,000 gallons of PRM shipped per tank car, this means a total of 180,000 gallons of 86 percent monomethylamine nitrate solution were moved each year (approximately 560 metric tons). However, the DOT special transportation permit for this material was suspended on August 8, 1974, thus suspending shipments.

3.3.11 Propylene

Table 3-5 was prepared to show producers, production sites and annual production volume for propylene in the U.S. It can be seen that approximately 9,980,000 metric tons are produced annually. Of these, 64% are produced in Texas. Figure 3-6 shows propylene production by state. The major end uses of propylene are in the manufacture of isopropyl alcohol, polypropylene, synthetic glycol, acrylonitrile, propylene oxide, heptene, cumene, polymer gasoline, acrylic acid, vinyl resins, and oxo-chemicals.

TABLE 3-5

PROPYLENE PRODUCERS AND PRODUCTION VOLUME

Producer	Production Site	Annual Capacity (Thousands of Metric Tons)
Allied Chem. Corp./ BASF Wyandotte Corp/ Borg-Warner Corp.	Geismar, LA	23
American Petrofina Inc.	Big Spring, TX	59
Cosden Oil & Chem. Co., subsid.	Groves, TX	52
Ashland Oil, Inc.	Ashland, KY	75
Ashland Chem. Co., div Petrochems Div.	Louisville, KY	14
Atlantic Richfield Co.	Channelview, TX	726
Arco Chem. Co., div.	Houston, TX	91
	Wilmington, CA	36
The Charter Co. Charter Oil Co., subsid. Charter International Oil Co., subsid.	Houston, TX	109
Chemplex, Co.	Clinton, IA	79
Cities Service Co. Chems & Minerals Group Petrochems. Div.	Lake Charles, LA	254
Clark Oil & Refining	Blue Island, IL	132
Corp. Clark Chem. Corp. Subsid.	Wood River, IL	29
The Coastal Corp. Coastals States Marketing, Inc. subsid.	Corpus Christi, TX	25
Conoco Inc.	Chocolate Bayou, TX	249
Conoco Chems. Co. Div.	Lake Charles, LA	11
Corpus Christi Petrochem Co.	Corpus Christi, TX	254
Dow Chem. U.S.A.	Freeport, TX	249
	Plaquemine, LA	349

TABLE 3-5 (cont'd)

E.I. du Pont de Nemours & Co., Inc. Polymer Products Dept.	Orange, TX	45
Eastman Kodak Co. Eastman Chem. Products, Inc., subsid. Texas Eastman Co.	Longview, TX	204
El Paso Natural Gas Co. El Paso Products Co., subsid.	Odessa, TX	77
Enterprise Products Co. Enterprise Petrochems Co., subsid.	Mont Belvieu, TX	172
Exxon Corp., Exxon Chem. Co., div. Exxon Chem. Americas	Baton Rouge, LA Baytown, TX Bayway, NJ	726 658 181
Getty Oil Co., Getty Refining & Marketing Co., subsid.	Delaware City, DE El Dorado, KS	54 25
The BF Goodrich Co. BF Goodrich Chem. Group	Calvert City, KY	59
Gulf Oil Corp Gulf Oil Chems. Co. Petrochems. Div.	Cedar Bayou, TX Philadelphia, PA Port Arthur, TX	356 82 286
InterNorth, Inc. Northern Petrochem, Co. subsid. Petrochems. Div.	Morris, IL	91
Marathon Oil Co.	Detroit, MI Texas City, TX	50 68
Mobil Corp., Mobil Oil Corp, Mobil Chem. Co., div. Petrochems., div.	Beaumont, TX	109
Monsanto Co. Monsanto Chem. Intermediates Co.	Chocolate Bayou, TX	249
Phillips Petroleum Co. Petrochems. Div.	Sweeny, TX	254

TABLE 3-5 (cont'd)

Shell Chem. Co.	Deer Park, TX	862
	Norco, LA	227
	Wilmington, CA	50
	Wood River, IL	113
Standard Oil Co. of California. Chevron Chem. Co., subsid. Petrochems. Div.	El Segundo, CA	48
	Richmond, CA	86
Standard Oil Co. (Indiana) Amoco Chems. Corp, subsid.	Chocolate Bayou, TX	363
	Sugar Creek, MO	16
	Texas City, TX	175
Standard Oil Co. (Indiana) Amoco Oil Co., subsid.	Whiting, IN	136
	Wood River, IL	59
	Yorktown, VA	7
The Standard Oil Co. (Ohio)	Lima, OH	122
Sun Co., Inc.	Corpus Christi, TX	45
Sun Oil Co. of PA subsid. Sun Petroleum Products Co., subsid	Marcus Hook, PA	179
	Toledo, OH	23
Texaco Inc.	Port Arthur, TX	227
Texaco Chem. Co. Div.	Port Neches, TX	66
	Westville, NJ	5
Texas City Refining Inc.	Texas City, TX	50
Tosco Corp.	Duncan, OK	34
Union Carbide Corp.	Seadrift, TX	50
Chems and Plastics Div	Taft, LA	191
	Texas City, TX	88
	Torrance, CA	20
Union Oil Co. of CA	Beaumont, TX	29
Union Pacific Corp. Champion Petroleum Co., subsid.	Corpus Christi, TX	73
United States Steel Corp. USS Chems., Div.	Houston, TX	54
	TOTAL	9,980

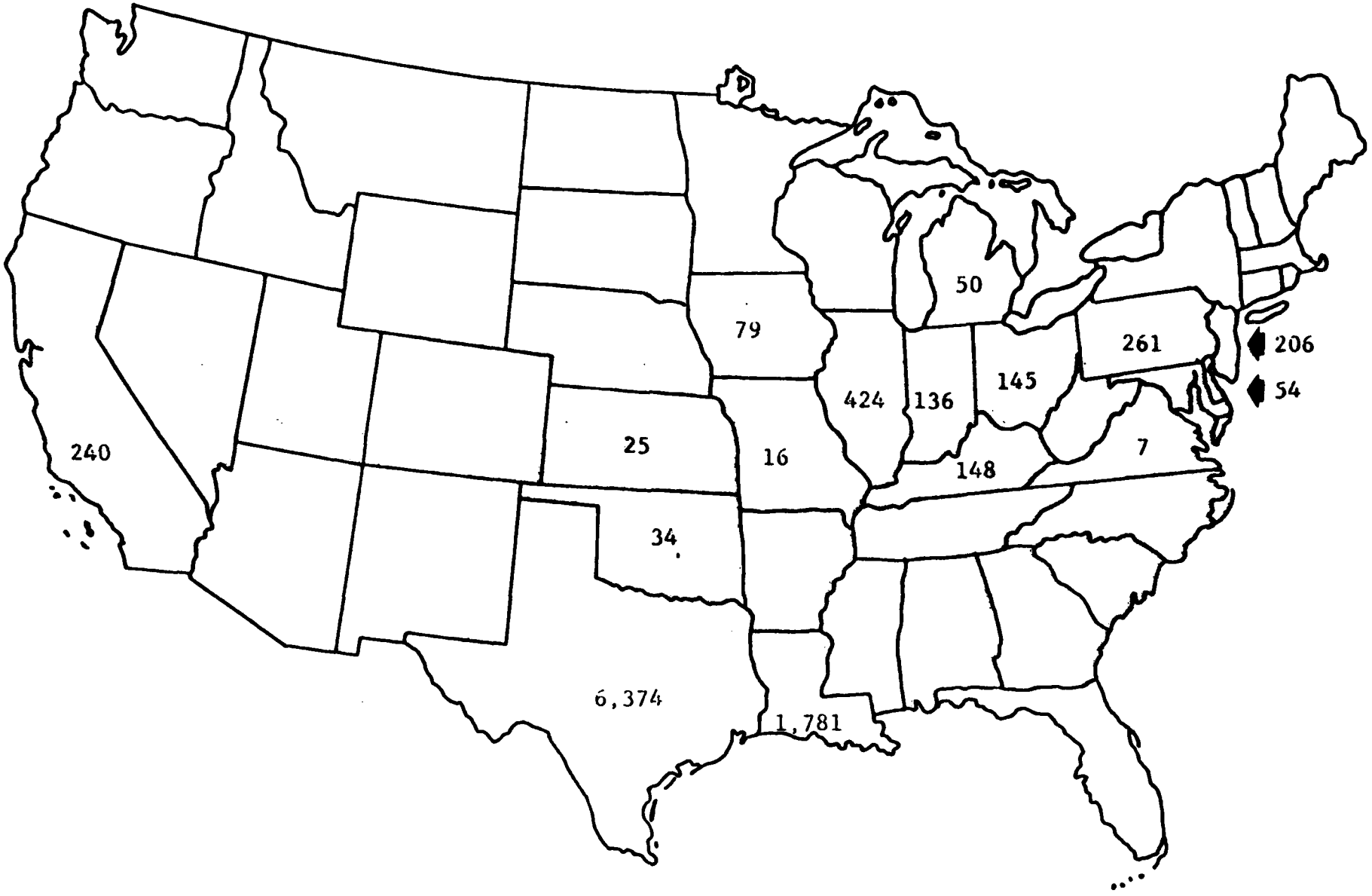


Figure 3-6. Propylene Production: Thousands of Metric Tons/Year
U.S. Total: 9,930

TABLE 3-6

SODIUM HYDROSULFIDE SOLUTION PRODUCERS AND PRODUCTION VOLUME

Producer	Production Site	Annual Capacity (Thousands of Metric Tons)
Chem. Products Corp.	Cartersville, GA	2
Dow Chem. USA	Magnolia, AK	n/a
Merichem Co.	Houston, TX	n/a
PPG Indust., Inc. Chems. Group Chem. Division-U.S.	Natrium, WV	29
Stauffer Chem. Co.	Delaware City, DE	18
Indust. Chem. Div.	Dominguez, CA	4
Tosco Corp.	El Dorado, AK	n/a
West Chem. Products. Inc. West Agro-Chemical Inc., subsid.	Eighty Four, PA	n/a
Witco Chem. Corp. Argus Chem. Div.	Taft, LA	2
	TOTAL	55

Figure 3-7. Sodium hydrosulfide Production-Thousands of Metric Tons/Year
U.S. Total:55

state. It appears that the major production of this commodity occurs in West Virginia and Delaware. Sodium hydrosulfide is used principally in paper pulping; processing of dye stuffs; in rayon and cellophane desulfurizing; for dehairing hides; and as a bleaching reagent.

3.3.13 Sodium Hydroxide Solution

Table 3-7 shows producers, production sites and volumes for sodium hydroxide in the U.S. It can be seen that approximately 13,844,000 metric tons of this commodity are produced annually. Figure 3-8 shows the U.S. distribution of sodium hydroxide manufacture by state. The major end uses of sodium hydroxide are in chemical manufacture; in rayon and cellophane production; in petroleum refining; in pulp and paper; in aluminum; in detergents, soap, and textile processing; in vegetable oil refining; for reclaiming rubber; for regenerating ion exchange resins; in organic fusions; for peeling of fruits and vegetables in the food industry; for laboratory applications; and etching and electroplating.

3.3.14 Styrene Monomer (inhibited)

Table 3-8 shows producers, production sites and volumes for styrene monomer (inhibited) in the U.S. This table shows that approximately 4,078,000 metric tons of styrene monomer are produced annually. Figure 3-9 shows styrene monomer production by state. It can be seen that 94% of the total produced is manufactured in Texas and Louisiana by oil, natural gas and chemical companies. Much of the styrene produced is used captively for production of other chemicals and materials. The major end uses of styrene monomer are for manufacture of polystyrene plastics; in the production of ion exchange, alkyl benzene sulfonate and styrene-acrylonitrile polymer resins; as protective coatings (styrene-butadiene latex; alkyds); in styrenated polyesters; in the production of rubber-modified polystyrene and copolymer resins; and as intermediates.

3.3.15 Toluene

Table 3-9 shows producers, production sites and annual production volume for toluene in the U.S. Approximately 591,000 metric tons of toluene are produced annually. The production of toluene by state is shown in Figure 3-10. It can be seen that 62% of all toluene is manufactured in Texas. Most of the toluene is manufactured from catalytic reformate from oil and natural gas catalytic cracking operations. The major end uses of toluene are in aviation gasoline and high-octane blending stock; in benzene,

TABLE 3-7

SODIUM HYDROXIDE PRODUCERS AND PRODUCTION VOLUME

Producers	Production Sites	Annual Capacity (Thousands of Metric Tons)
Aluminum Co. of America	Point Comfort, TX	165
BASF Wyandotte Corp. Indust. Chems. Group Basic Chems. Div.	Geismar, LA	327
Brunswick Pulp & Paper Inc., Brunswick Chem. Co., div.	Brunswick, GA	31
Champion International Corp. Champion Papers	Canton, NC	29
div.-Chems and Associated Products	Pasadena, TX	22
Chemtech Indust. Inc. Eastern Div.	Solvay, NY	N.A.
Convent Chem. Corp.	Calvert City, KY	127
Diamond Shamrock Corp. Indust Chems & Plastics Unit., Electro Chems Div.	Deer Park, TX	383
	Delaware City, DE	161
	La Porte, TX	533
	Mobile, AL	44
	Muscle Shores, AL	164
Dow Chemical, U.S.A.	Freeport, TX	2,445
	Midland, MI	282
	Oyster Creek, TX	349
	Pittsburg, CA	249
	Plaquemine, LA	1,148
E.I. du Pont de Nenours & Co., Inc. Petrochems. Dept. Freon Products Div.	Corpus Crhistie, TX	326
FMC Corp. Indust. Chem. Group	South Charleston, WV	290
Fort Howard Paper Co.	Green Bay, WI	7
	Muskogee, OK	5

TABLE 3-7 (cont'd)

Gen. Electric. Co. Engineered Materials Group Plastics Business Operations	Mount Vernon, IN	54
Georgia-Pacific Corp. Chem. Div.	Bellingham, WA	78
	Plaquemine, LA	425
Hercules Inc.	Hopewell, VA	32
ICI Americas Inc. Petrochems. Div.	Baton Rouge, LA	154
International Minterals and Chem. Corp. IMC Chem. Group Indust. Chems. Div.	Niagra Falls, NY	N.A.
	Orrington, ME	79
Kaiser Aluminum and Chem. Corp. Kaiser Indust. Chems. Div.	Gramercy, LA	209
K.A. Steel Chems. Inc. Steelco Chem. Corp. subsid.	Lemont, IL	N.A.
Linden Chems and Chems. Div.	Brunswick, GA	104
	Acme, NC	50
	Linden, NJ	163
	Moundsville, WV	86
	Syracuse, NY	91
Monsanto Co. Monsanto Chem. Intermediates Co.	Sauget. IL	44
Occidental Petroleum Corp. Hooker Chem. COrp subsid. Indust. Chems Group Operations Div.	Montague, MI	82
	Niagara Falls, NY	279
	Tacoma, WA	195
	Taft, LA	562
Olin Corp. Olin Chems Group	Augusta, GA	112
	Charleston, TN	253
	McIntosh, AL	508
	Niagra Falls, NY	93
Pennwah Corp. Chems Group Inorganic Chem. Div.	Calvert City, KY	120
	Portland, OR	188
	Tacoma, WA	90
	Wynndotte, MI	100

TABLE 3-7 (cont'd)

PPG Indust. Inc.	Barberton, OH	127
Chems. Group	Lake Charles, LA	1,138
Chem. Division-U.S.	Natrium, WV	267
Richardson-Merrell, Inc.	Phillipsburg, NJ	3
J.T. Baker Chem. Co., subsid.		
Shell Chem. Co.	Deer Park, TX	104
Stauffer Chem. Co.	Henderson, NE	113
Indust. Chem. Div.	Le Moyne, AL	77
	St. Gabriel, LA	165
Vulcan Materials Co.	Denver City, TX	13
Chems. Div.	Geismar, LA	206
	Port Edwards, WI	72
	Wichita, KA	182
Weyeerhaeuser, Co.	Longview, WA	139
	TOTAL	13,844

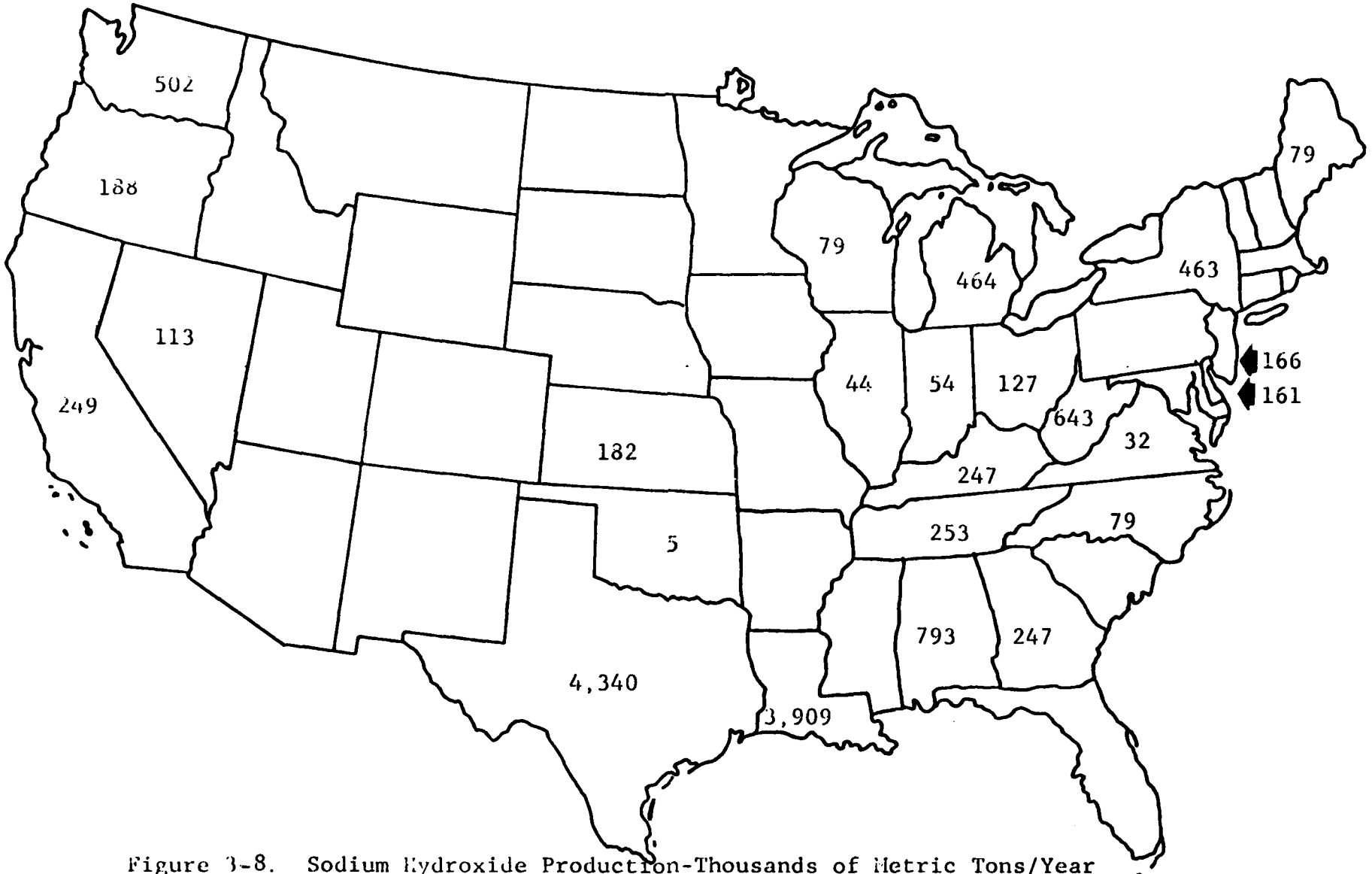


Figure 3-8. Sodium Hydroxide Production-Thousands of Metric Tons/Year
U.S. Total:13,844

TABLE 3-8

STYRENE MONOMER (INHIBITED) PRODUCERS AND PRODUCTION VOLUME

Producers	Production Sites	Annual Capacity (Thousands of Metric Tons)
American Hoechst Corp Indust. Chems. Div. Petrochems. Div. Plast cs Div.	Baton Rouge, LA Bayport, TX	272 408
Atlantic Richfield Co. Arco/Polymers, Inc., subsid.; Oxirane Internat'l., subsid. Oxirane Chem. Co. (Channelview)	Beaver Valley, PA Channelview, TX	100 454
Cos-Mar. Inc.	Carville, LA	590
Dow-Chem. USA	Freeport,TX Midland, MI	689 136
El Paso Natural Gas Co., El Paso Products Co., subsid.	Odessa, TX	115
Gulf Oil Corp. Gulf Oil Chems. Co. Petrochems. Div.	St. James, LA	272
Monsanto Co. Monsanto Chem. Intermediates Co.	Texas City, TX	680
Standard Oil Co. (Indiana) Amoco Chems. Corp., subsid.	Texas City, TX	272
Sun Co., Inc., Sun Oil Co. of Pennsylvania, subsid. Sun Petroleum Products Co., subsid.	Corpus Christi, TX	36
United State Steel Corp. USS Chems., Div.	Houston, TX	54
	TOTAL	4,078

Figure 3-9 Styrene Monomer Production-Thousands of Metric Tons/Year
U.S. Total: 4,078

TABLE 3-9

TOLUENE PRODUCERS AND PRODUCTION VOLUME

Producer	Production Site	Annual Capacity (Thousands of Metric Tons)
American Petrofina Inc.	Beaumont, TX	17
American Petrofina Co. of Texas, subsid.		
Cosden Oil & Chem. Co., subsid.	Big Spring, TX	23
Ashland Oil, Inc.	Ashland, KY	14
Ashland Chem. Co. div.	North Tonawanda, NY	11
Petrochems. div.		
Atlantic Richfield Co.	Channelview, TX	15
Arco Chem. Co., div	Houston, TX	17
	Wilmington, CA	17
Bethlehem Steel Corp.	Sparrows Point, MD	7
CF & I Steel Corp.	Pueblo, CO	N.A.
The Charter Co.	Houston, TX	5
Charter Oil Co., subsid.		
Charter International Oil Co., subsid		
The Coastal Corp.	Corpus Christie, TX	8
Coastal States Marketing Inc., subsid.		
Crown Central Petroleum Corp.	Pasedena, TX	6
Chem.Div.		
Dow Chem. U.S.A.	Freeport, TX	2
Exxon Corp.	Baytown, TX	57
Exxon Co., U.S.A.		
Getty Oil Co.	Deleware City, DE	15
Getty Refining and Marketing Co. subsid.	El Dorado, KS	3
Gulf Oil Corp.	Alliance, CA	27
Gulf Oil Chems. Co.	Philadelphia, PA	13
Petrochems. Div.	Port Arthur, TX	24

TABLE 3-9 (cont'd)

Kerr-McGee Corp. Southwestern Refining Co., Inc., subsid.	Corpus Christie, TX	20
LTV Corp. Jones and Laughlin Steel Corp. subsid. Eastern Div.	Aliquippa, PA	1
Marathon Oil Co.	Texas City, TX	10
Mobil Corp. Mobil Oil Corp. MobilChem. Co., div. Petrochems div.	Beaumont, TX	51
Monsanto Co. Monsanto Chem. Intermediates Co.	Chocolate Bayou, TX	23
Nueoes Petrochem Co.	Corpus Christie, TX	8
Phillips Petroleum Co. Petrochems. Div. Phillips Puerto Rico Core Inc., subsid	Sweeney, TX	5
Shell Chem. Co.	Deer Park, TX	27
Sun Co., Inc. Sun Oil Co. of PA, subdiv, Sun Petroleum Products Co. Subsid.	Corpus Christie, TX Marcus Hook, PA Toledo, OH Tulsa, OK	19 21 34 9
Tenneco Inc. Tenneco Oil Co., div.	Chalmette, LA	16
Texaco Inc. Texaco Chem. Co., div.	Port Arthur, TX Westville, NJ	13 18
Union Carbide Corp. Chems. & Plastics, div.	Taft, LA	9
Union Oil Co. of CA	Beaumont, TX Lemont, IL	N.A. 8
Union Pacific Corp. Champion Petroleum Co., subsid.	Corpus Christie, TX	14
United States Steel Corp. USS Chems., div.	Clarion, PA Geneva, UT	4 N.A
	TOTAL	591

Figure 3-10. Toluene Production-Thousands of Metric Tons/Year
U.S. Total: 591

phenol and caprolactam; as a solvent for paints and coatings, gums, resins, most oils, rubber, vinyl organosols; as a diluent and thinner in nitrocellulose lacquers; as an adhesive solvent in plastic toys and model airplanes; in chemical processing of benzoic acid, benzl and benzoyl derivatives, saccharin, medicines, dyes and perfumes; as a source of toluene diiscyanates (polyurethane resins); in explosives (TNT) manufacture; in the production of toluene sulfonates (detergents); and as a scintillation counter.

3.3.16 Vinyl Acetate

Table 3-10 shows producers, production sites and annual production volume for vinyl acetate in the U.S. This table shows that approximately 1,088,000 metric tons of vinyl acetate are produced annually. Figure 3-11 shows vinyl acetate production volume by state. It can be seen that all production of vinyl acetate occurs in the South Central region, with 1,020,000 metric tons (94% of the total) being manufactured in Texas. The major end uses of vinyl acetate include the manufacture of polyvinyl acetate, polyvinyl alcohol, polyvinyl butyral, and polyvinyl chloride-acetate resins which are used in latex paints; in paper coating; as adhesives; in textile finishing; and in safety glass interlayers.

3.4 SHIPMENT QUANTITIES

Table 3-11 shows the distribution of commodities shipped by various modes of transportation in the U.S. Data was obtained from the Census of Transportation and shipment modes were classified as rail, highway and other. Transport modes classified as "other" include such carrier types as barge, pipeline, and aircraft. Based upon the classification indices used in the census data several commodities were grouped into commodity types. Thus, not all modal distributions are commodity specific, but appear to be indicative of the variation of shipments between different transportation modes. Of the 11 commodity classes it appears that the rail mode resulted in the largest shipment volume in six classes; while both highway and "other" transport classes resulted in the largest shipment frequency in two classes, respectively. Overall, the rail mode resulted in 56 percent of all shipments, while the highway resulted in 30 percent and "other" modes 14 percent

3.5 CONTAINERS REQUIRED FOR SHIPPING

Types of containers which can be used in transporting the chemicals and propellants are outlined in Title 49 of the Code of Federal Regulations. It should be noted that the types of containers which can be used for highway and rail transport will

TABLE 3-10

VINYL ACETATE PRODUCERS AND PRODUCTION VOLUME

Producer	Production Site	Annual Capacity (Thousands of Metric Tons)
Borden Inc., Bordon Chem. Div. Petrochems. Div.	Geismar, LA Bay City, TX	68 193
Celanese Chem. Co., Inc.	Clear Lake, TX	193
E.I. du Pont de Nemours and Co., Inc. Polymere Products Dept.	La Porte, TX	181
National Distillers & Chem. Corp. Chems. Div. U.S. Indust Chems. Co., Div.	Deer Park, TX	272
Union Carbide Corp. Chems & Plastics, div.	Texas City, TX	181
	TOTAL	1,088

Figure 3-11. Vinyl Acetate Production-Thousands of Metric Tons/Year
U.S. Total:1,088

TABLE 3-11

DISTRIBUTION OF COMMODITIES SHIPPED BY
VARIOUS MODES OF TRANSPORTATION IN THE U.S.

Commodity	Thousands of Metric Tons Transported	Rail (Thousands of Metric Tons)	Highway (Thousands of Metric Tons)	Other (Thousands of Metric Tons)
Sodium Compounds (Sod. Hydrosulfide)	55	27	23	5
Miscellaneous Acyclic Organic Chemical Products (Acetone, Acrylonitrile, Ethyl Acrylate)	2,538	1,345	711	482
Miscellaneous Cyclic Organic Chemical Products (Styrene)	4,078	1,020	1,060	1,998
Alcohols (Methanol)	5,041	2,183	1,774	1,084
Organic Acids and Salts (Vinyl Acetate)	1,088	497	214	377
Industrial Organic Chemicals, nec. (Acetone Cyanohyrdin)	na	na	na	na
Industrial Inorganic Acids (Hydrocyanic Acid)	16.5	7	9	0.5
Liquefied Petroleum and Coal Gases (isobutane, propylene)	10,269	6,079	3,574	616

TABLE 3-11 (cont'd)

Commodity	Thousands of Metric Tons Transported	Rail (Thousands of Metric Tons)	Highway (Thousands of Metric Tons)	Other (Thousands of Metric Tons)
Industrial Gases, n.e.c. (methyl bromide)	≥1,629	557	1,065	7
Sodium Alkalies (sodium hydroxide)	13,844	10,009	3,281	554
Crude Products from Coal andn Petroleum tar (toluene)	591	206	125	260

vary based on the type of commodity being shipped. Various shipping containers are available including cylinders, tank cars, cargo tanks, portable tank containers, and overpack containers such as wooden and fiberboard boxes and polystyrene packages. The following discussion identifies the types of cylinders, tank cars, cargo tanks and portable tank containers for shipping each chemical.

Commodity specific requirements for container types and specifications can be found in 49 CFR, Parts 100-179. A list of the applicable container requirements including restrictions on container specifications and volumes for each commodity is given in Table 3-12. An overview of container types approved for the 16 commodities is given in Table 3-13. The container specifications for each chemical are discussed individually.

3.5.1 Acetone

Acetone, a flammable liquid with a flash point of 0°F, can be shipped in packaging and containers as outlined in Section 173.119 of 49 CFR. These include 5 gallon glass carboys; 17E and 17C metal drums; 5, 5A, 5B, 5C, 5M metal barrels or drums; 10 gallon pails; 42B, 42C or 42H aluminum barrels or drums; cylinders, tank cars, tank motor vehicles, and portable tank containers. The cylinders, tank cars, cargo tanks and portable tanks approved for acetone use with the applicable container specifications are shown in Tables 3-14.

3.5.2 Acetone Cyanohydrin

Acetone cyanohydrin, a Poison B, can be shipped in containers specified in Section 173.346 of 49CFR. These include Spec. 5, 5A, 5B, 5C, 17C, 173, 37A, 37B metal drums; 1 quart glass or earthenware and gallon metal inside containers; cylinders, tank cars, cargo tanks and portable tanks. The cylinders specified for acetone cyanohydrin are similar to those for acetone with the exception of specification 4E, 9, 39, 40 or 41 packagings which may not be charged and shipped with a Poison B material. The tank cars, cargo tanks and portable tanks specified for acetone cyanohydrin service and applicable container specifications are shown in Table 3-15.

3.5.3 Acrylonitrile

The types of shipping containers and applicable container specifications for acrylonitrile are the same as those for acetone with the addition of some drums; inside and overpack containers (173.119(b)) because acrylonitrile has a higher flash point than acetone.

TABLE 3-12

REGULATIONS APPLICABLE TO CONTAINER REQUIRMENTS*

Chemical	Hazard Class	Labels Required	Packaging Exceptions	Packaging Specific Requirements
Acetone	Flammable Liquid	Flammable Liquid	173.118	173.119
Acetone Cyanohydrin	Poison B	Poison	None	173.346
Acrylonitrile	Flammable Liquid	Flammable Liquid & Poison	None	173.119
Ethyl Acrylate	Flammable Liquid	Flammable Liquid	173.118	173.119
Hydrocyanic Acid	Poison A	Flammable Gas & Poison	None	173.332
Isobutane	Flammable Gas	Flammable Gas	173.306	173.304 173.314 173.315
Methanol	Flammable Liquid	Flammable Liquid	173.118	173.119
Methyl Bromide	Poison B	Poison	None	173.353
Propylene	Flammable Gas	Flammable Gas	173.306	173.304 173.314 173.315

* Container specifications found in parts 178 and 179 in the commodity specific sections.

TABLE 3-12 (continued)

Chemical	Hazard Class	Labels Required	Packaging Exceptions	Packaging Specific Requirements
Sodium Hydrosulfide	N/A	N/A	N/A	N/A
Sodium Hydroxide	Corrosive	Corrosive	173.244	173.249
Styrene	Flammable Liquid	Flammable Liquid	173.118	173.119
Toluene	Flammable Liquid	Flammable Liquid	173.118	173.119
Vinyl Acetate	Flammable Liquid	Flammable Liquid	173.118	173.119
Monomethylamine Nitrate	N/A	N/A	N/A	N/A

TABLE 3-13

APPROVED CONTAINER TYPES FOR ALL COMMODITIES

Chemical	Tank Motor Vehicles	Tank Cars	Cargo Tank	Portable Tank	Drums/Barrels: Cylinders	Drums/Barrels: Steel	Drums/Barrels: Alum.	Outside Packaging: Wooden Boxes	Outside Packaging: Fiberboard Boxes	Inside Containers: Glass Ampules or Viles	Inside Containers: Cartridges	Inside Containers: Glass Carboys in Boxes	Inside Containers: Glass Bottle	Inside Containers: Expanded Polystyrene	Inside Containers: Polyethlyene Container Only
Acetone	•	•		•	•	•	•	•	•			•	•	•	
Acetone Cyanohydrin	•	•		•	•	•	•	•	•			•		•	
Acrylonitrile	•	•		•	•	•	•	•	•			•	•	•	
Ethyl Acrylate	•	•		•	•	•	•	•	•			•	•	•	
Hychrocyanic Acid		•			•			•	•						
Isobutane		•	•	•											
Methanol	•	•		•	•	•	•	•	•			•	•	•	
Methyl Bromide		•	•		•	•									
Propylene		•	•	•											
Sodium Hydrosulfide															
Sodium Hydroxide		•	•	•		•		•	•						
Styrene															
Toluene	•	•		•	•	•	•	•				•	•	•	
Vinyl Acetate	•	•		•	•	•	•	•	•			•	•	•	

TABLE 3-14

CYLINDERS, TANK CARS, CARGO TANKS, AND PORTABLE TANK CONTAINERS SPECIFIED FOR ACETONE SERVICE

Cylinders (specifications section):	3; 3A (178.36) 3AA (178.37); 3B (178.38); 3BN (178.39); 3D (178.41); 3E (178.42); 4 (178.48); 4A (178.49); 4B (178.50); 4BA (178.51); 4BW (178.61); 4E (178.68); 9; 25; 26; 38; 39 (178.65); 40; 41
Tank Cars (specifications section):	103; 103W; 103ALW; 103DW; 104; 104W; 111A60ALWI; 111A60FI; 111A60WI; 111A100W3; 111A100W4; 111A100W6; 115A60WI; 115A60ALW; 115A60W6 (179.200); 105A100; 105A100ALW; 109A100ALW; 109A300W; 112A200W; 112A400F; 114A340W (179.100); 106A500X; 106A800XNC; 106A800NCI; 110A500W (179.300)
Cargo Tanks (specifications section):	MC300; MC301; MC302; MC303; MC304; MC305 (178.340); MC306 (178.341); MC307 (178.342); MC330; MC331 (178.337)
Portable Tanks (specifications section):	DOT 51 (178.245); DOT 57 (158.253)

TABLE 3-15

TANK CARS, CARGO TANKS AND PORTABLE TANK CONTAINERS SPECIFIED FOR ACETONE CYANOHYDRIN SERVICE

Tank Cars (specifications section):	103; 103W; 103A; 103ALW; 103AW; 103BW; 104; 104W; 109A300ALW; 111A60ALW1; 111A60F1; 111A60W1; 111A60WZ; 111A100W4; 115A60W6 (179.200); 105A100; 105A100W (179.100)
Cargo Tanks (specifications section):	MC300; MC301; MC302; MC303; MC305 (178.340); MC306 (178.341); MC310 (178.342); MC312 (178.343)
Portable Tanks (specifications section):	DOT 51 (178.245)

3.5.4 Aerozine-50

Aerozine-50 is composed of a 50%/50% mixture of UDMH and hydrazine, and is formulated at Rocky Mountain Arsenal for USAF consumption. It can be shipped only in Air Force R-16 and R-17 trailers or commercially owned and operated tank motor vehicles covered under DOT exemption DOT-E3121. The commercially owned vehicles are operated by WS. Hatch Co., Pacific Intermountain Express, and Lemmon Transport Co., Inc.

3.5.5 Ethyl Acrylate

Shipping containers and applicable container specifications for ethyl acrylate are the same as those for acrylonitrile.

3.5.6 Hydrocyanic Acid

Hydrocyanic acid can be shipped in metal cans surrounded by absorbent inert material overpacked in wodden or fiberboard boxes with waterproof liners; metal cylinders or tank cars as a Class A poison. The types of cylinders and their specifications approved for hydrocyanic acid service are 3A480 (Section 178.36), 3AA480 (Section 178.37), and 3A480X (Section 178.43). The tank cars in which hydrocyanic acid can be shipped with the sections of 49CFR detailing the specifications are 105A500W (Section 179.100) and 105A600W (Section 179.101). Each tank car in HCN service must be stencilled "Hydrocyanic Acid" as per Section 172.330 of 49CFR.

3.5.7 Isobutane

Isobutane can be shipped in cylinders, tank cars, cargo tanks and portable tank containers as a flammable gas. Table 3-16 shows the types of cylinders which can be used for shipping isobutane.

The types of tank cars for shipping isobutane along with the specification sections are 105A100 (179.100), 105A100W (179.100), 111A100W4 (179.200), 105A200W (179.100), 105A200ALW (179.100), 105A300W (179.100), 112A340W (179.100), 114A340W (179.100), 114A400W (179.100), 105A400W (179.100), 112A400F (179.100), 112A400W (179.100), 105A500W (179.100), 106A500X (179.300) and 105A600W (179.100).

The cargo tanks and portable tank containers permitted for isobutane service are the DOT 51 (Section 178.245), MC 330 and MC 331 (Section 178.337).

TABLE 3-16

CYLINDERS APPROVED FOR SHIPPING ISOBUTANE
(LIQUEFIED PETROLEUM GAS)

Cylinders (specifications section):	3; 3A (178.36); 3AA (178.37); 3E (178.42); 4 (178.48); 4A (178.49); 4B (178.50); 4BA (178.51); 4B240ET (178.55); 4BW (178.61); 4B240X; 4B24FLW (178.54); 4E (178.68); 9; 25; 26; 38; 39 (178.65); 41

3.5.8 Methanol

Methanol can be shipped in glass carboys, drums and barrels, pails, glass, and earthenware containers, aluminum drums, cylinders, tank cars, cargo tanks and portable tank containers as a flammable liquid with a flash point of 65°F. The specified shipping containers and applicable sections of 49 CFR detailing container specifications are the same as those for acrylonitrile.

3.5.9 Methyl Bromide

Methyl bromide can be transported in specification 5A metal drums; overpacked 1 pound metal cans; cylinders; tank cars; and cargo tanks. The cylinders, tank cars and cargo tanks specified for methyl bromide service with the applicable container specification sections of 49 CFR are shown in Table 3-17.

3.5.10 Monomethylamine Nitrate (PRM)

In 1968 Dupont was authorized by the DOT to ship this material classed as a flammable solid, further identified as an 85-86% aqueous solution of monomethylamine nitrate crystals in DOT specification 103ALW and 103W tank cars (179.200) and MC306, MC307 and MC312 cargo tanks. However, following the explosion at the Apple Yard in Wenatchee, WA in 1974, the special permit DOT5737 was suspended.

3.5.11 Propylene

Propylene, like isobutane, is a liquefied petroleum gas and can be shipped in the same container types as isobutane.

3.5.12 Sodium Hydrosulfide

Sodium hydrosulfide is not a DOT regulated hazardous material and has no required container or container specifications in 49 CFR.

3.5.13 Sodium Hydroxide

Sodium hydroxide solution can be shipped in Specification 5 metal drums, in glass, earthenware, polyethylene or metal inside containers in certain quantities with overpack fiberboard or wooden boxes, tank cars, cargo tanks and portable tank containers as a corrosive liquid. The tank cars, cargo tanks and portable tank containers specified for

TABLE 3-17

CYLINDERS, TANK CARS AND CARGO TANKS
SPECIFIED FOR METHYL BROMIDE SERVICE

Cylinders (specification section):	3A225 (178.36); 3AA225 (178.37); 3B225 (178.38); 3E1800 (178.42); 4A225 (178.49); 4B225 (178.50); 4BA225 (178.51); 4BW225 (178.61)
Tank Cars (specification section):	105A100 (179.100); 105A100W (179.100); 111A100W4 (179.200); 106A500X (179.300)
Cargo Tanks (specification section):	MC 330, MC 331 (178.337)

sodium hydroxide liquid service and the container specification sections in 49 CFR are given in Table 3-18.

3.5.14 Styrene

Styrene, a flammable liquid with a flash point of 93°F can be transported in the same shipping container types as acrylonitrile.

3.5.15 Toluene

Toluene, a flammable liquid with a flash point of 40°F, can be shipped in the same container types under similar constraints as acrylonitrile.

3.5.16 Vinyl Acetate

Vinyl acetate, a flammable liquid with a flash point of 18°F, can be shipped in the same container types with their applicable specifications as acetone.

3.6 COMMODITY FLOW PATTERNS

A generalized orgin-to-destination pattern was established for the chemicals and propellants between the concensus geographic divisions in the United States. The states included in each of the census geographic divisions are shown in Figure 3-12. The categorization of each commodities shipment origin involved identifying the state in which the chemical has a production plant and then grouping these state specific data into a regional format. Thus, region specific production/origin data was formulated.

To determine the quantity shipped to and consumed in each region the classification indices in the Census of Transportation were once again used. Data was provided as to the quantity of each commodity class being consumed in each region. Thus, a generalized origin-to-destination pattern was completed. The origin-to-destination pattern for each commodity class found in the census data are given in Tables 3-19 through 3-29. Figure 3-13 shows the variation between production volume and consumption volume for each commodity class by geographic region. It can be seen that the majority of the commodities are produced in the West South Central Region while total U.S. consumption exceeds ten percent in each of six different regions.

Origin-to-destination patterns in terms of Aerozine-50 were collected from the USAF Directorate of Energy Management at Kelly AFB, Texas. All Aerozine-50 manufactured in the U.S. is produced from hydrazine and UDMH at Rocky Mountain

TABLE 3-18

TANK CARS, CARGO TANKS AND PORTABLE TANK CONTAINERS SPECIFIED FOR SODIUM HYDROXIDE SERVICE

Tank cars (specification section):	103 (179.200); 103W (179.200); 103A (179.200); 103AW (179.200); 103B (179.200); 103BW (179.200); 104 (179.200); 104W (179.200); 105A100 (179.100); 105A100W (179.100); 111A60F1 (179.200); 111A60W1 (179.200); 111A60W2 (179.200); 111A100F2 (179.200); 111A60W5 (179.200); 111A100W4 (179.200)
Cargo Tanks (specification selection):	MC 303; MC 310; MC 311; MC 312 (178.343)
Portable Tanks (specification section):	DOT 57 (178.253); DOT 60 (178.255)

Arsenal near Denver. This data showed that 92 metric tons (101 tons) are shipped by highway trailer and 155 metric tons (170 tons) are shipped by rail tank car. Table 3-30 and Figure 3-14 shows the trailer routes of Aerozine-50 from Rocky Mountain Arsenal to Little Rock AFB, McConnell AFB, Davis-Monthan AFB and Vandenburg AFB.

Figure 3-12. CENSUS REGIONS AND GEOGRAPHIC DIVISIONS OF THE UNITED STATES

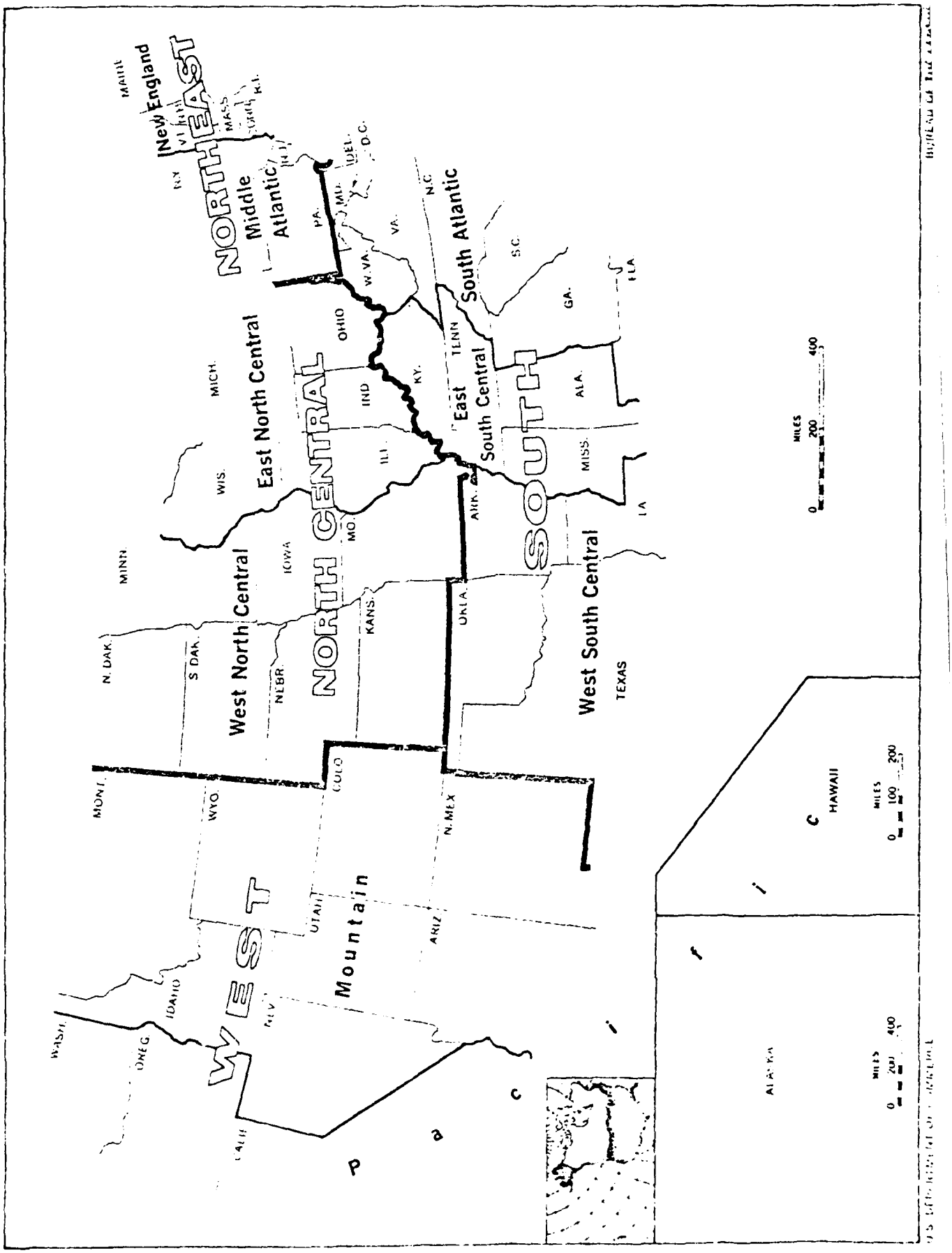


TABLE 3-19

ORIGIN-DESTINATION OF SODIUM COMPOUNDS
(SODIUM HYDROSULFIDE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	4	-
Mountain	-	1
West North Central	-	5
West South Central	2	15
East North Central	-	14
East South Central	-	6
South Atlantic	49	6
Middle Atlantic	-	7
New England	-	1
TOTAL (U.S.)	55	55

TABLE 3-20

ORIGIN-DESTINATION OF MISCELLANEOUS ACRYLIC ORGANIC CHEMICAL PRODUCTS (ACETONE, ACRYLONITRILE, ETHYL ACRYLATE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	60	88
Mountain	-	25
West North Central	25	131
West South Central	1,387	642
East North Central	550	336
East South Central	158	374
South Atlantic	82	399
Middle Atlantic	276	498
New England	-	45
TOTAL (U.S.)	2,538	2,538

TABLE 3-21

ORIGIN-DESTINATION OF MISCELLANEOUS CYCLIC ORGANIC CHEMICAL PRODUCTS (STYRENE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	-	69
Mountain	-	130
West North Central	-	6
West South Central	3,842	180
East North Central	136	107
East South Central	-	86
South Atlantic	-	47
Middle Atlantic	100	2,807
New England	-	646
TOTAL (U.S.)	4,078	4,078

TABLE 3-22

ORIGIN-DESTINATION OF ALCOHOLS
(METHANOL)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	-	2,050
Mountain	-	20
West North Central	-	308
West South Central	4,878	837
East North Central	-	610
East South Central	-	367
South Atlantic	163	418
Middle Atlantic	-	323
New England	-	108
TOTAL (U.S.)	5,041	5,041

TABLE 3-23

ORIGIN-DESTINATION OF ORGANIC ACIDS AND SALTS (VINYL ACETATE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	-	3
Mountain	-	-
West North Central	-	153
West South Central	1,088	804
East North Central	-	16
East South Central	-	19
South Atlantic	-	73
Middle Atlantic	-	20
New England	-	-
TOTAL (U.S.)	1,088	1,088

TABLE 3-24

ORIGIN-DESTINATION OF INDUSTRIAL
ORGANIC CHEMICALS, NEC.
(ACETONE CYANOHYDRIN)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	na	na
Mountain	na	na
West North Central	na	na
West South Central	na	na
East North Central	na	na
East South Central	na	na
South Atlantic	na	na
Middle Atlantic	na	na
New England	na	na

TABLE 3-25

ORIGIN-DESTINATION OF INDUSTRIAL INORGANIC ACIDS (HYDROCYANIC ACID)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons*)
Pacific	-	1
Mountain	-	-
West North Central	-	1.5
West South Central	444	2
East North Central	-	5
East South Central	106	2
South Atlantic	-	2
Middle Atlantic	1	2
New England	-	1
TOTAL (U.S.)	551	16.5

* Ninety-seven percent of the HCN produced is used as a by-product of other processes, and that three percent is sold on the merchant market thereby entering the transportation system. This value represents the three percent transported from all HCN production.

TABLE 3-26

ORIGIN-DESTINATION OF LIQUEFIED PETROLEUM AND COAL GASES (ISOBUTANE, PROPYLENE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	240	1,206
Mountain	7	176
West North Central	162	913
West South Central	8,425	1,512
East North Central	755	572
East South Central	148	2,432
South Atlantic	65	2,397
Middle Atlantic	467	874
New England	-	187
TOTAL (U.S.)	10,269	10,269

TABLE 3-27

ORIGIN-DESTINATION OF INDUSTRIAL GASES, NEC
(METHYL BROMIDE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	na	35
Mountain	na	15
West North Central	na	67
West South Central	na	53
East North Central	na	1,014
East South Central	na	181
South Atlantic	na	264
Middle Atlantic	na	-
New England	na	-
TOTAL (U.S.)		$\geq$ 1,629

TABLE 3-28

ORIGIN-DESTINATION OF SODIUM ALKALIES
(SODIUM HYDROXIDE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	939	1,077
Mountain	-	215
West North Central	295	479
West South Central	8,679	2,168
East North Central	768	2,722
East South Central	1,293	1,062
South Atlantic	1,325	2,506
Middle Atlantic	466	3,204
New England	79	411
TOTAL (U.S.)	13,844	13,844

TABLE 3-29

ORIGIN-DESTINATION OF CRUDE PRODUCTS
FROM COAL AND PETROLEUM TAR
(TOLUENE)

Census Geographic Division	Quantity Produced In Region (Thousands of Metric Tons)	Quantity Consumed In Region (Thousands of Metric Tons)
Pacific	44	-
Mountain	-	-
West North Central	3	-
West South Central	398	372
East North Central	42	-
East South Central	14	154
South Atlantic	22	-
Middle Atlantic	57	65
New England	11	-
TOTAL (U.S.)	591	591

VARIATION BETWEEN COMMODTY PRODUCTION
and
CONSUMPTION BY REGION

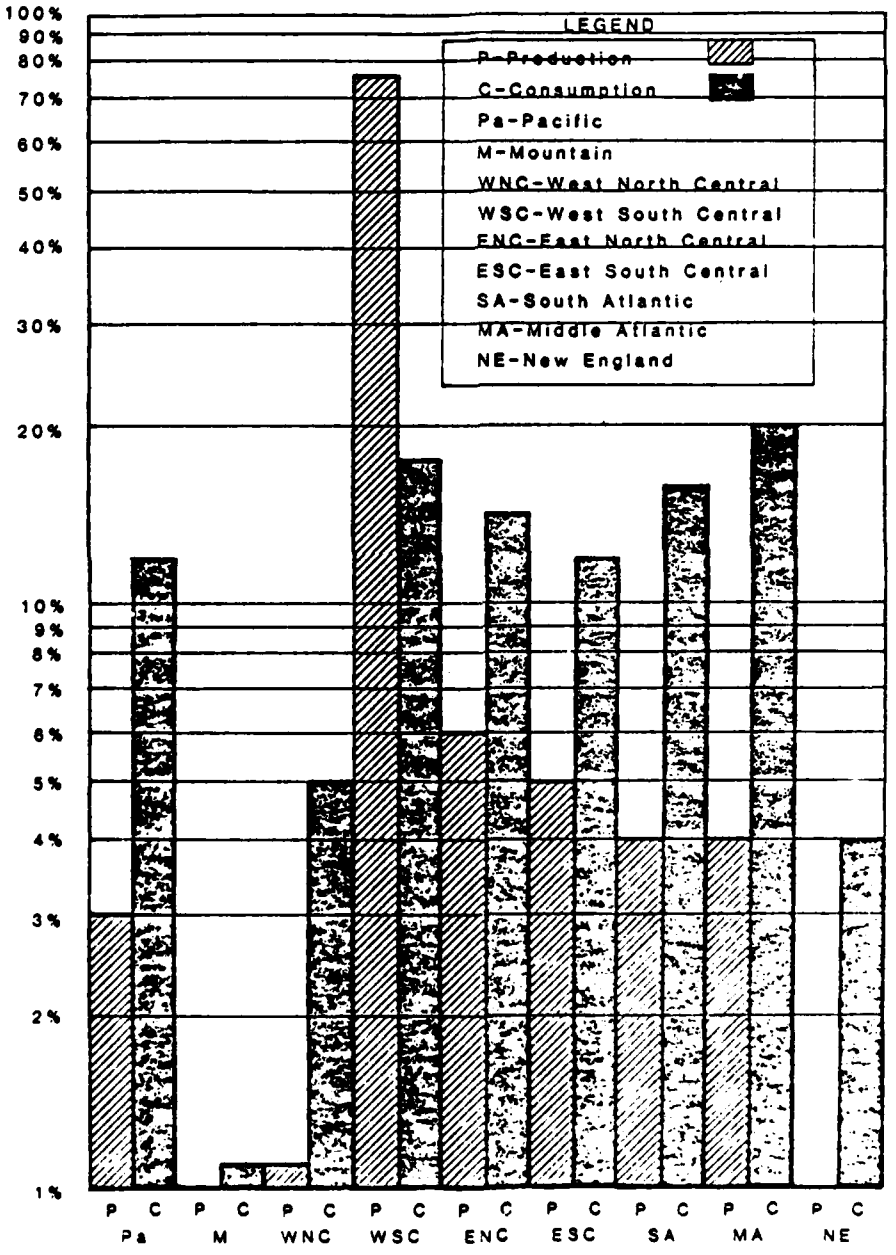


Figure 3-13.

TABLE 3-30
AEROZINE-50 (TITAN II PROPELLANT)

TRAILER SHIPPING ROUTES

ORIGIN: ROCKY MOUNTAIN ARSENAL, DENVER CO

ROUTE AND DESTINATION: I-25
SOUTH TO HWY 87 TO I-40 EAST TO LITTLE ROCK AFB, AR

ROUTE AND DESTINATION: I-70 EAST TO I-135
SOUTH TO McCONNELL AFB, KS

ROUTE AND DESTINATION: I-25 SOUTH TO I-10
WEST TO DAVIS MONTHAN AFB, AZ

ROUTE AND DESTINATION: I-70 WEST TO I-15 TO
HWY 58 TO HWY 14 TO HWY 101 TO VANDENBERG AFB, CA

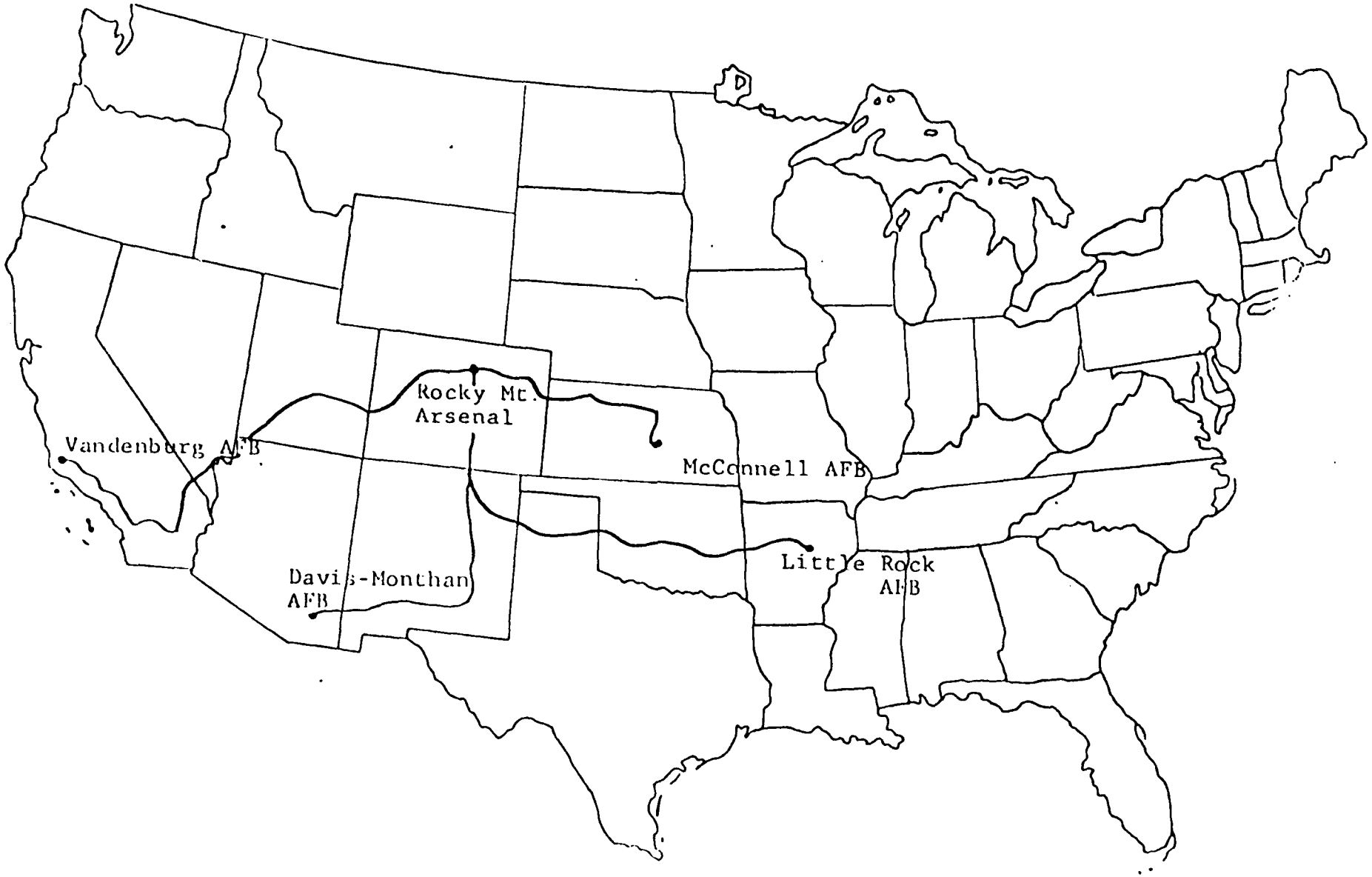


Figure 3-14. Commodity Flow Pattern of Aerozine-50

4. ACCIDENT ASSESSMENT

Accident statistics for 1971 through 1980 involving the additional 16 chemicals and propellants are presented in Table 4-1. This table shows accidents involving methanol (methyl alcohol) accounted for the largest percentage (49%) of the total accidents and for 54 percent of the highway and 42 percent of the rail accidents occurring from 1971 to 1980. Sodium hydroxide involvement in accidents was the next highest with 17 percent of the total accidents, 21 percent of highway and 12 percent of rail accidents. The remaining materials with significant accident rates over this time period included the LPGs isobutane and propylene, acetone, toluene, styrene, vinyl acetate, ethyl acrylate and acrylonitrile. On a modal basis, acetone, methyl bromide, methanol, sodium hydrosulfide, sodium hydroxide and toluene were involved in more accidents by highway, while acetone cyanohydrin, acrylonitrile, ethyl acrylate, hydrocyanic acid, LPGs, styrene and vinyl acetate were involved in more accidents by rail. Most of the fatalities and injuries which occurred in this sample were associated with accidents involving LPGs. This is also true of the accident costs. The total costs of the accidents from 1971-1980 involving these materialsis approximately $25 million which averages $4,700 per accident.

The following sections present an assessment of 29 NTSB-investigated accidents and the events at Mississauga in Ontario, Canada in terms of initial response, emergency special equipment and materials, on-scene coordination and communications, hazardous materials identification and location, release handling procedures, firefighting procedures, cleanup and disposal procedures, structural integrity assessment and wreckage removal procedures.

A listing of the accidents studied can be found in Table 4-2. These accidents involved both rail and highway mode, spanned twelve years (1968-1979), involved in-service derailments, switching accidents, overspeed impacts in yards, semi-trailer tanker truck collisions, overturns and explosions, caused 96 deaths, more than 1,600 injuries, and cost over $40 million in property damage, not to mention third party liability damage suits and environmental clean-up, disposal and monitoring costs. These accidents occurred in both urban and rural areas under widely differing climatic conditions and provide a broad representative sample of accident types and conditions, materials involved, hazards encountered, response efforts mounted, emergency response capabilities and the differing perceptions of the effectiveness of accident handling methods.

TABLE 4-1

CHEMICAL/PROPELLANT ACCIDENTS (1971-1980)

Chemical/ Propellant	Total Number of Accidents	Average Number of Accidents Per Year	MODE OF TRANSPORTATION INVOLVED IN ACCIDENT: HIGHWAY Total Number of Accidents	HIGHWAY Percentage of Total Accidents	RAILROAD Total Number of Accidents	RAILROAD Percentage of Total Accidents	FATALITIES Total Number	FATALITIES Average Number of Fatalities Per Accident	INJURIES Total Number	INJURIES Average Number of Injuries Per Accident	ACCIDENT COST ($1000's) Total Cost of Accidents	ACCIDENT COST ($1000's) Average Cost Per Accident
Acetone	281	28.1	222	79	59	21	0	0	10	0.06	318.56	1.13
Acetone Cyanohydrin	1	0.1	0	0	1	100	0	0	0	0	0	0
Acrylonitrile	83	8.3	31	37	52	63	2	0.02	6	0.07	682.52	8.22
Aerozine-50	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl Acrylate	84	8	19	23	65	77	0	0	7	0.08	152.12	1.81
Hydrocyanic acid	7	0.7	3	43	4	57	0	0	0	0	0.01	0
Isobutane (LPG file)	808*	84	245	30	563	70	55	0.07	668	0.84	18,523.27	23.15

* The values for isobutane and propylene are combined in one category for all liquefied petroleum gases and so were only counted once. Thus, the total number of accidents in artificially higher.

TABLE 4-1 (cont'd)

Chemical/ Propellant	Total Number of Accidents	Average Number of Accidents Per Year	MODE OF TRANSPORTATION INVOLVED IN ACCIDENT: HIGHWAY Total Number of Accidents	HIGHWAY Percentage of Total Accidents	RAILROAD Total Number of Accidents	RAILROAD Percentage of Total Accidents	FATALITIES Total Number	FATALITIES Average Number of Fatalities Per Accident	INJURIES Total Number	INJURIES Average Number of Injuries Per Accident	ACCIDENT COST ($1000's) Total Cost of Accidents	ACCIDENT COST ($1000's) Average Cost Per Accident
Methanol	2,647	264.7	1,752	66	895	34	4	0	314	0.12	3,903.98	1.47
Methyl Bromide	35	3.5	33	94	2	6	0	0	6	0.17	36.16	1.03
Monomethylamine nitrate	0	0	0	0	0	0	0	0	0	0	0	0
Propylene (LPG file)	808*	84	245	30	563	70	55	0.07	668	0.84	18,523.27	23.15
Sodium Hydrosulfide	2	0.2	2	100	0	0	0	0	0	0	1.05	0.53
Sodium Hydroxide	939	93.9	684	73	255	27	2	0	202	0.22	660.36	0.70
Styrene, Monomer	134	13.4	31	23	103	77	0	0	12	0.09	298.89	2.23
Toluene	277	27.7	217	78	60	22	0	0	9	0.03	235.22	0.85
Vinyl Acetate	84	8.4	22	26	62	74	0	0	16	0.19	440.59	5.25
TOTAL	5,382*	538	8,261	61	2,121	39	63*	0.01	1,244	0.23	24,953.84	4.64

TABLE 4-2

ACCIDENTS STUDIED

Date	Place	Type	Conditions
01/01/68	Dunreith, IN	Dr, train collision	tc puncture, release, fire explosion; vinyl chloride, ethylene oxide explodes
01/25/69	Laurel, MS	Dr	15tc LPG; Army EOD vent & burn 2tc
02/18/69	Crete, NE	Dr	tc NH_3 rupture & release; coupler blow, brittle steel at ambient T of 4°F
09/11/69	Glendora, MS	Dr	8tc vinyl chloride; fire & explosion
11/29/69	NJ Turnpike Exit 2	Tank truck/ car collision	LPG; leak (12 gph)/ transfer
05/30/70	Brooklyn, NY	Tank truck	Liquefied oxygen, explosion/fire; tank contamination
04/02/71	Berwick, ME	Tank truck	Sodium hydrosulfide; off-load to contaminated storage tank, hydrogen sulfide gas emitted
08/08/71	Near Gretna, FL	Truck	Cylinders methyl bromide; cargo not adequately secured; improper cylinders
10/19/71	Houston, TX	Dr	2tc vinyl chloride punctured, ignition & fire; 45 min later rupture and rocket of another tc
01/22/72	East St. Louis, IL	Rail yard accident	Coupler override, puncture tc propylene - explosion/ fire
03/09/72	Lynchburg, VA	Semitrailer overturn	LPG 9200 gal spill

TABLE 4-2 (cont'd)

Date	Place	Type	Conditions
09/21/72	NJ Turnpike Exit 8	Semitrailer overturn	Propylene 7,200 gal spill; fire impingement & rupture
02/02/74	Oneonta, NY	Dr	7tc LPG; one tc ruptured, fire
07/19/74	Decatur, IL	Railyard accident	Overspeed impact, coupler override, puncture; 5tc isobutane release, explosion
08/16/74	Wenatchee, WA	Railyard accident	Detonation 10,000 gal monomethylamine nitrate (PRM)
09/21/74	Englewood Yard, Houston, TX	Railyard accident	Overspeed impact, coupler override, puncture; butadiene release, fire, explosion
04/29/75	Near Eagle Pass, TX	Semitrailer overturn	8,748 gal LPG release, fire, explosion
05/11/76	Houston, TX	Tank truck overturn	NH_3 release, 7,500 gal
05/16/76	Glen Ellyn, IL	Dr	tc punctured, 20,000 gal NH_3 released
09/24/77	Beattyville, KY	Tank truck	8,000 gal gasoline released, fire
11/09/77	Pensacola, FL	Dr	2tc NH_3 punctured, release
02/22/78	Waverly, TN	Dr	Subsequent rupture, ignition, explosion LPG tc
02/26/78	Youngstown, FL	Dr	2tc Cl_2 punctured, release
03/29/78	Lewisville, AK	Dr.	tc vinyl chloride rupture, explosion, fire

TABLE 4-2 (cont'd)

Date	Place	Type	Conditions
10/17/78	Claxton, KY (Dawson Springs, KY; Princeton, KY)	Dr	Vinyl chloride, ethyl acrylate; vent and burn tc vinyl chloride
04/08/79	Crestview, FL	Dr	2tc NH_3 rupture, rocket 1tc Cl_2 leaking
11/08/79	Inwood, IN	Dr	Fire, release acetic anhydride, isobutyl alcohol, ethylacrylate, methacrylic acid, butyl cellosolve
11/10/79	Mississauga Ontario, Canada	Dr	22tc LPG, Cl_2, styrene, toluene, caustic soda; 7tc LPG ruptured; 3tc LPG ruptured, exploded; tc CI_2 punctured, leaking
11/11/79	Molino, FL	Dr	6 LPG tc, tc ethanol, styrene monomer, acetone; 4 LPG tc on fire; vent and burn all 9tc

NOTE: Dr = derailment
tc = tank car
LPG = liquefied petroleum gas
NH_3 = ammonia
Cl_2 = chlorine

The methodology used in the assessment of the mitigation activities in the accidents involved:

- Cataloging the accidents chronologically.
- Identifying and cataloging information relevant to each accident and each accident mitigation activity on a hazardous material transportation accident evaluation data sheet.
- Performing an assessment of each activity for the purpose of identifying chronological changes/improvements in any area of hazardous materials transportation accident mitigation.

The following sections present the results of this in-depth analysis.

4.1 NOTIFICATION/EMERGENCY RESPONDERS

As a result of an in-depth procedural analysis of hazardous materials transportation accidents it was observed that emergency response personnel were, for the most part, notified of the accident by either the railroad conductor, truck driver, carrier's dispatcher or local citizens. Other individuals and organizations were also involved incidentally in the reporting of hazardous materials accidents to local emergency response organizations. These included fire department personnel, passing motorists, local residents, state police department personnel and other railroad employees, but the occurrence of these individuals/organizations notifying emergency response personnel was less frequent than notification by the carrier personnel involved.

For all the accidents reviewed notification time of emergency response personnel ranged between one and thirty (30) minutes. It was found that notification time did not significantly change over the accident time span reviewed. However, notification time should always be minimized so that emergency response personnel can be called and arrive on-scene within a few minutes after an accident occurs. Improved guidelines for notification of emergency response personnel need to be developed to ensure that properly trained and equipped personnel can be dispatched to an accident involving hazardous materials promptly, with as many accurate details as possible. The on-scene arrival times for fire, police, and other emergency response teams were relatively short once notification was effected. The need for accurate information, especially the identity and hazards of the material(s) involved, was repeatedly highlighted as fire fighters were not aware of the extent or intensity of hazards of LPG fires or teams arrived on-scene without sufficient breathing apparatus.

An empirical analysis of the accidents shows that the initial notification time for railroad hazardous materials transportation accidents is approximately 10 and for

highway accidents roughly seven minutes, a difference of three minutes between the two modes of transportation. This difference is probably because rail traffic is in more remote areas, generally. However, time series analyses of railroad accident notification times show that, for the accidents reviewed, initial notification time has increased since 1975. From 1968 through 1974, notification time averaged approximately one minute. However, for the period 1975 through 1980, notification time following railroad accidents increased to an average of 15 minutes. An examination of notification time for highway accidents showed an average of seven minutes from 1968 through 1980. Once response authorities were notified of the occurrence of an accident, it took an average of 14 minutes for response teams to arrive at the scene. This resulted in a minimum of 29 minutes from occurrence of a rail accident to the arrival of police, fire, and/or other response teams on-scene and 21 minutes for a highway accident. It needs to be emphasized that the NFPA considers 3 minutes to be the maximum time necessary to respond to a fire. Therefore, guidelines are needed to decrease notification and response time to hazardous materials transportation accidents. These guidelines should facilitate more accurate information from the scene, more rapid deployment of personnel, equipment and gear to the scene and increase personal safety of responding individuals.

4.2 EMERGENCY RESPONSE/CONTINGENCY PLAN

The second area assessed was the awareness and utilization of the federal/state/community contingency plan by a locality at the scene of a hazardous material transportation accident. Any unique provisions of contingency plans for special handling of specific hazardous materials, community/shipper response agreements, and mutual aid agreements between nearby communities and between communities and neighboring military installations were identified.

During the period 1968 through 1973, a total of 36 percent of the communities in which serious hazardous materials transportation accidents occurred had existing local or state contingency plans which were implemented/used on-scene. However, for the period 1974 through 1979, this figure increased to 63 percent.

Since the update and expansion of the National Oil and Hazardous Substances Pollution Contingency Plan in 1978, the number of communities having contingency plans has increased. However, this analysis also indicates that all of the existing contingency plans that have been activated during HM accidents were designed for generic emergencies such as nuclear attack, natural disaster, warfare, and terrorism and none dealt specifically with response to hazardous materials transportation accidents. In this

regard, it is recommended that specific annexes be developed for integration into each state/community contingency plan which deals specifically with response to hazardous materials transporation accidents. It is believed that hazardous material contingency plans are needed for timely and safe response to hazardous materials transportation accidents. The description of components and mechanisms for developing and utilizing hazardous material transportation accident contingency plans by local communities are discussed in detail in Section 5 of this report.

4.3 EMERGENCY SPECIAL EQUIPMENT AND MATERIALS

For 9 (31 percent) of the 29 accidents reviewed in-depth it was observed that no reference was made to specialized equipment and materials available on-scene at the transportation emergency. In fact, at an additional 9 (31 percent) of the transportation accidents reviewed the only emergency special equipment and materials available on-scene were normal operational firefighting apparatus and ambulances. Of the remaining 11 (38 percent) of the hazardous material transportation accidents reviewed emergency special equipment and materials included gas masks; self-contained breathing apparatus; communications equipment; material identification information such as "chem cards;" use of a helicopter for air surveillance of vapor clouds and evacuation; mobile hazardous material emergency response van; analytical monitoring equipment; mobile command post; and explosive devices for "vent and burn" operations.

The utilization of special emergency equipment, materials, and techniques at serious transportation accidents has not become standard procedure until the last few years and still appears to depend on the resources, sophistication and pre-planning done in the community in which the accident occurs.

For information concernings the types of personal protective clothing, gear, equipment and treatment chemicals which should be used on-scene refer to Sections 3.1.6 and 3.1.7 of the Task 4 "Draft Guidelines Manual."

4.4 ON-SCENE COORDINATION AND COMMUNICATIONS

4.4.1 Highway Accidents

The local county or state police are typically the first emergency response personnel to arrive on-scene. This may occur because a police patrol vehicle is in the vicinity of the accident and the officer has seen or heard the accident, passing motorists may pass on the information or he may have been notified of the accident via radio

transmission from the police dispatcher, in which case he will proceed directly to the accident.

The local fire department typically arrives after the first police unit(s) and in general has the responsibility for mitigating the potential dangers associated with the accident.

From the NTSB highway accident reports reviewed, it appears that response personnel have not significantly changed their communications techniques nor are changes indicated in coordinating response efforts at the scene. Response to the highway accidents studied was in general rapid, well-coordinated and effective in addressing the situation.

4.4.2 Railroad Accidents

From the NTSB railroad accident reports reviewed, it appears that on-scene communication and coordination techniques have been changing significantly. Prior to 1977, communication and coordination between response personnel was ill-defined, haphazard and subject to change. Communications at large accidents (e.g., Waverly, TN) involving multiple fire, police and rescue unit response have been disastrous as each community had a distinct radio frequency, thus eliminating effective coordination of firefighting and rescue resources. Additional problems have occurred in terms of "who's in charge" at large rail accidents. Both cases of no one in charge (e.g., Oneonta, NY) and too many "chiefs" (e.g., Youngstown, FL) were equally destructive to safety and effective handling of a dangerous situation. There are exceptions to this, but these exceptions are generally in areas where railroads or the community have available radio and communication equipment which can be made available to response personnel. The utilization of communications equipment at an accident site requires more effective coordination between response crews, thus improving communications and providing more complete assessment of the accident site from several strategic locations.

During the years following 1977, a trend begins to emerge with each accident site presided over by an on-scene coordinator designated by law or appointed of necessity. This is in large part due to the requirements of National Oil and Hazardous Substances Pollution Contingency Plan, but also because of the increasing awareness and knowledge of response officials cast in the role of handling these emergencies. In the past, this function has often fallen within the domain of the local fire department. More recently, if the accident warrents activating the National or Regional Response Team, the On-Scene Coordinator (OSC) is an official with the Environmental Protection Agency (EPA)

or the U.S. Coast Guard. In other cases, OSCs are typically a member of different response agencies (i.e., fire department, Civil Defense Agency, state police) and are designated in the local/state emergency plan.

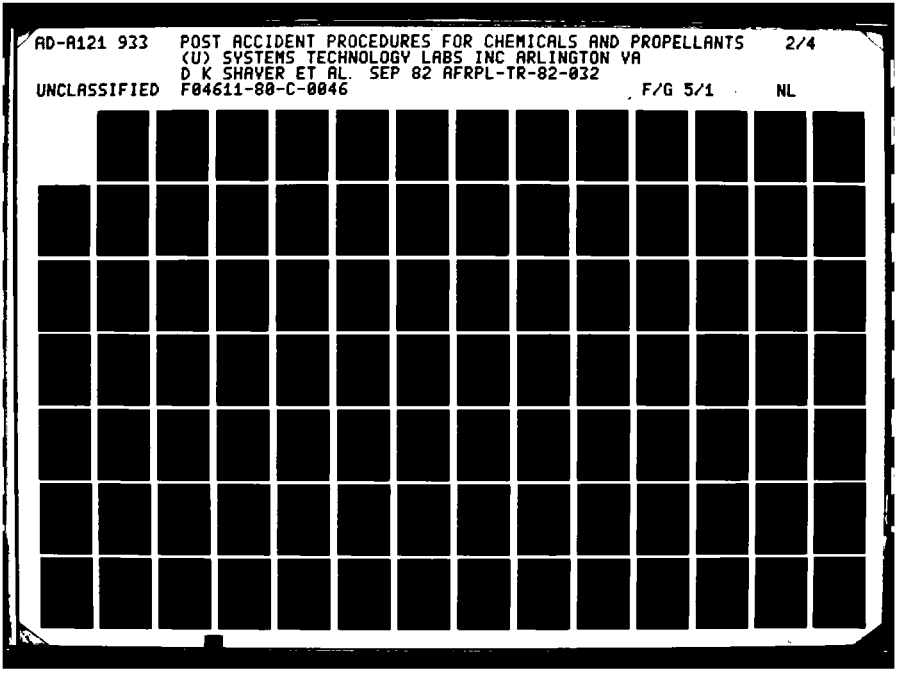
Railroads have complained in the past about the sometimes inconsistent direction of the OSC which may conflict with state and local official dictates. Thus it is necessary that effective interface between the federal, state and local authorities be pre-planned to preclude confusion and inconsistency. The management priorities of the accident also ought to be detailed and understood by all parties involved since each has his own "primary" priority and this can lead to teams working against one another or unwittingly undoing previous accomplishments.

4.5 HAZARDOUS MATERIAL IDENTIFICATION AND LOCATION

An analysis of the methods used for identifying and locating hazardous materials involved in railroad and highway transportation accidents was performed. It was observed that methods for identifying a hazardous material ranged from the use of tank placards; smell of material; use of waybill, bill-of-lading, consist or "chem card" documentation; specific service stencilling; to contact with CHEMTREC. In one instance DOT placards were burned in a fire requiring the use of other documentation for identifying the commodity hazard class. For both the highway and rail modes it appears that no major improvements were made during 1968 through 1979 for visually identifying the hazardous materials involved. Recent enactment of the DOT regulation which requires the use of UN identification numbers on DOT placards may prove to be a significant improvement in the identification of hazardous materials involved on-scene, but this improvement will require increased distribution of manuals which provide the code key for identifying the hazardous materials by UN numbers. This information can be found in the DOT Emergency Response Handbook. Other methods for identifying HM are needed, especially those which can be used remotely. At this time, however, any such techniques are still in the developmental stages.

4.6 RELEASE HANDLING PROCEDURES

The examination of release handling procedures used at rail and highway accidents yielded the following methods: (1) allowing the material to burn out; (2) venting and burning the tanks with explosive charges; (3) applying fog spray to released vapors to dilute their concentration as well as for the purpose of introducing turbulence into the material to allow more rapid dispersal; (4) applying patches or plugs to holes; and 5) in-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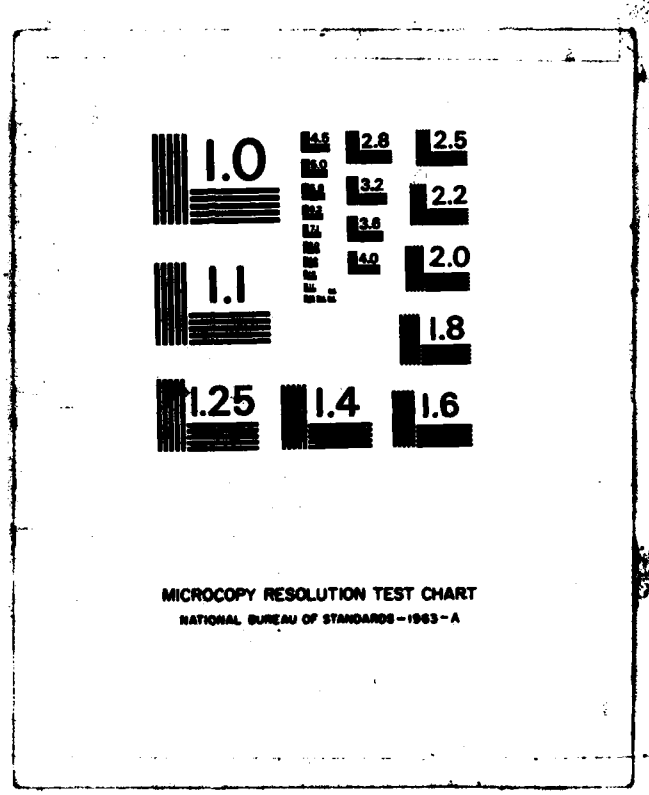
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field transfer to other containers. Several of the accidents, however, resulted in rupture release, explosion and fire and no release handling procedures could be applied.

The methods used for handling releases of HMs appear to be dependent on the accident conditions, the nature and condition of the HM released and availability of equipment and materials for approaching and patching/plugging leaks and equipment for in-field transfer of lading.

The philosophy of handling releases of compressed, flammable gases involving fire appears to have shifted from allowing the material to burn out at equilibrium to accelerating burning by further venting the container. By allowing material to burn out under ambient conditions exposures to unprotected individuals would be long-term small concentration exposures. The problem with this approach is that it often took several days for the material to burn completely and this stopped commerce on the same rail line or highway; necessitated citizens being away from their homes for long periods of time; and substantially increased the overall costs associated with the accident.

The options for handling releases of hazardous material can be prioritized based upon financial and time constraints, probable exposure to resident population and safety risk to responding personnel. This ranking shown below has been developed based on the aforementioned factors.

Release Handling Approach	Financial and Time Constraints	Probable Exposures to Population	Safety Risk to Responding Personnel
Patch or plug leak	Low cost, relatively quick	Low short-term exposure	High short-term exposure
Off-load material	Low cost, can be time-consuming	Low short-term exposure	High short-term exposure
Vent and burn	Costly method, lessens time considerably	High short-term exposure	High short-term exposure
Allow material to burn out	Low cost method, extremely time-consuming	Low very long-term exposure	Low long-term exposure

It must be noted, however, that vent and burn operations can be performed only under rigorous controls in remote areas of low population density because the risk associated with this method to unprotected individuals is very high.

4.7 FIREFIGHTING PROCEDURES

The analysis of firefighting procedures used on-scene reveals that two activities were always performed at the accident site. First, intact tank containers near or impinged by fire were cooled with deluge water spray. This was done to cool and maintain the temperature of the tank, thus minimizing the risk of a tank rupture or a BLEVE. Second, hazardous material fires were extinguished when possible with either the use of foam or water. In some cases, the car was inaccessible, the fire too intense to allow firefighters to approach or ensuing explosions caused firefighters to draw back and reposition. Other spot fires on-scene or nearby were also handled effectively by the firefighting teams.

Firefighters also use fog water spray to knock down hazardous vapors such as ammonia and chlorine at an accident scene. However, care must be taken when directing water streams at leaking containers or problems like the one in Mississauga may occur. The accident in Mississauga saw the puncture of a car of chlorine along with several LPG fires and other HM releases. To reduce Cl_2 vapors, firefighters applied water to the tank car. Water entered the tank car, reacted with Cl_2 to form a solid chlorine hydrate. The car was subsequently patched, but it took 4 days to vacuum pump the Cl_2 to a tank truck because of the solid residue.

Fire hazards were increased at some of the accidents reviewed because the accident occurred in inaccessible areas where no fire hydrants were available on-scene. At one such accident water had to be pumped from a nearby river while, at another incident, hose lines had to be pulled several hundred feet to a rail yard to fight a fire.

These situations may still exist, but fire fighting technology has progressed markedly in the last few years. Another problem historically associated with firefighting at hazardous materials transportation accidents is the lack of adequate training of response personnel. However, many training programs have been developed by the DOT, DOD and NFPA on this subject and fire fighting personnel appear to be better prepared today for handling fires associated with hazardous materials accidents.

4.8 CLEANUP AND DISPOSAL

The analysis of cleanup and disposal activities indicated very little information concerning this phase of accident management. Some difficulties identified during the cleanup and disposal operations for the accidents under investigation include: adding water to a concentrated pool of spilled material causing violent splattering and boiling; inability to arrive at a consensus on cleanup and disposal method by all parties involved due to the lack of written guidelines; unnecessary venting of material in a highly populated area; uncontrolled runoff of contaminated firefighting and tank cooling water into water bodies; and contamination of underground water supplies.

Based upon the availability of information, it was observed that not until 1978 did any major efforts in the cleanup and disposal methods area occur. This was probably due to two factors. First, the National Oil and Hazardous Substances Pollution Contingency Plan was updated and expanded in 1978. This measure established a coordinated mechanism for on-site accident management through the National Response Team and the designated regional response team and on-scene coordinator with a specific mandate to mitigate hazards while minimizing environmental pollution. Second, EPA was and is performing extensive research on cleanup and disposal technology and this information is being published as well as being presented and publicized at national meetings and seminars.

Further emphasis has been placed upon the need for adequate disposal of hazardous residues following the passage of the Resource Conservation and Recovery Act (1976) and promulgation of regulations by EPA in 1980 concerning disposal of hazardous wastes. The regulations place stringent requirements on the where, how and in what hazardous wastes may be disposed. Thus, these regulations along with the requirements the Clean Water Act of 1978 and the Superfund bill of 1979, clearly put a considerable additional burden upon the responder to an accident. That responder must now carefully consider his mitigation activities to minimize his cleanup and disposal needs. An entire new industry has been born to fill this need for cleanup and disposal expertise, and their appearance at HM transportation emergencies is becoming common place.

Based upon this review, it can be seen that cleanup and disposal technology has significantly improved in the last five years and will continue to progress. However, technology must be continuously updated because of the continual development, manufacture and transportation of new hazardous materials. Recommended cleanup and disposal methods should be commodity specific due to the complex properties and hazards associated with each material, but should also take into account possible synergistic or antagonistic effects in the presence of other materials.

4.9 STRUCTURAL INTEGRITY

The examination of activities related to the on-site assessment of tank car and highway tank truck structural integrity indicate that very little, if any, effort has historically been made in terms of identifying damage modes and assessing the structural integrity of tanks damaged in accidents. This review showed that tanks have suffered damage in several ways including coupler impact and puncture of tank head; wheel cuts and burns; impact damage from other vehicles; fire impingement; rail punctures; and disorientation and damage to pressure relief valves. It should be noted that several vehicle retrofits have been recommended and implemented to resolve many of these failure modes including the use of thermal coating protection of tank car shells; top and bottom shelf couplers; head shields; and the AAR guidelines related to the visual assessment of tank car structural integrity. The AAR methodology for visually assessing tank car structural integrity was analyzed using fracture mechanics. Based upon this investigation it was found that the AAR approach is practical for on-site application only if the inspector is willing to approach the tank. By so doing, the inspector is significantly increasing personal risk because there is no way to indicate imminent tank failure. The potential application of acoustic emission (AE) technology to the remote identification of tank car structural integrity is being examined as an alternate method. This approach would provide the safe and continuous monitoring of tank car structural integrity, thus allowing rapid evacuations of personnel and equipment if necessary.

Improved guidelines and additional testing of methods for assessing tank structural integrity are needed.

4.10 WRECKAGE REMOVAL

Wreckage removal is one accident mitigation activity about which very little is known by organizations other than those which perform wreckage removal services. Removal of wreckage from a highway accident is typically handled by a local wrecking service in the area where the accident occurred. However, wreckage removal operations at railroad accidents are much more complex than highway accidents due to the multitude of cars and hazardous materials which may be involved at one time. Several commercial organizations have characteristically responded to rail transportation accidents. These organizations include Hulcher Emergency Services and Isringhausen Crane Manufacturing Company. A few railroads, however, have developed their own response teams and have wreckage removal equipment for use. Based on the review of

the NTSB-investigated accidents, it appears that the major improvement in wreck-clearing operations since 1968 has been the use of analytical monitoring equipment for the purpose of measuring toxic and flammable concentrations in the accident area prior to entering the scene. It was observed at a 1968 accident that wreckage removal was performed during product transfer operations from a damaged tank car into a semi-trailer tanker. This could present an extremely hazardous situation to wreckage removal personnel because, if a leak had occurred, the vapor concentrations could have greatly exceeded the TLV or pressurizing a damaged vessel for transfer could stress the vessel beyond its capacity and cause a rupture.

The one NTSB report which commented on wreckage removal practices was Waverly, TN in which a damaged tank car believed stabilized ruptured and exploded just before transfer operations were to begin. The tank car which later ruptured was moved using cable slings around the north end and using the other end as a pivot. Wooden crossties supported the north end with the remainder on the ground. This appeared to be acceptable wrecking practice, with no indication of any problem or mishandling. The issue then becomes one of the stresses exerted, mechanical damage due to the wheel cut and the overall structural integrity of the car rather than one of wreckage removal or transfer techniques.

It appears that the basic philosophy of wreckage removal personnel is that the scene of a hazardous material accident is not approached until all toxic and flammable vapor hazards are dissipated. This is a major improvement in protecting wreckage removal personnel. However, increased knowledge of wreckage removal activities along with better techniques for damage and structural integrity assessment need to be provided to industry so that improvements can be developed.

4.11 KEY FINDINGS OF ACCIDENT ASSESSMENT

Based upon STL's accident assessment it can be seen that several conclusions can be made concerning SOA accident management techniques from the accidents reviewed. These include:

1. Notification time for contacting emergency response personnel did not significantly change between 1968 and 1979.
2. The on-scene arrival times for fire, police and other emergency response teams were relatively short once notification was effected.
3. All of the existing contingency plans that have been activated during HM accidents were designed for generic emergencies and none dealt specifically with response to HM transportation accidents.

4. The utilization of special emergency equipment, materials, and techniques at serious transportation accidents has not become standard procedure until the last few years and still appears to depend on the resources, sophistication and pre-planning done in the community in which the accident occurs.

5. Response personnel at highway accidents have not significantly changed their communications techniques nor are changes indicated in coordinating response efforts at the scene.

6. On-scene communication and coordination techniques at railroad accidents have changed significantly.

7. During 1968 through 1979 no major improvements were made for visually identifying the HM involved on-scene.

8. The method used for handling releases of HMs appear to be dependent on the accident conditions, the nature and condition of the HM released and availability of equipment and materials for approaching and patching/plugging leaks and equipment for in-field transfer of lading.

9. It was not until 1978 until any major efforts in cleanup and disposal methods occurred.

10. Very little, if any, effort has historically been made in terms of identifying damage modes and assessing the structural integrity of tanks damaged in accidents.

Based upon this accident analysis, it can be seen that trends, improvements and changes have been made in accident management activities since 1968. Unfortunately, not all geographic areas and emergency response organizations have experienced a uniform growth in their accident management capabilities. Thus, a SOA of local HM response capabilities was performed to identify in greater detail the specific areas and concerns of municipal emergency response organizations for handling HM transportation accidents as a mechanism for providing improved crisis management techniques. The results of this investigation are presented in Section 5.

5. ASSESSMENT OF METHODS FOR IMPLEMENTING CRISIS MANAGEMENT TECHNIQUES USED BY POLICE, FIRE CHIEFS, MAYORS AND OTHER DISASTER RESPONSE OFFICERS

This section presents an assessment of various methods to implement crisis management techniques for hazardous material transportation accidents. The assessment involved the following steps:

- Methodology for the collection of information from each of the ten cities visited;
- Identification of each community's emergency response capabilities for handling hazardous materials transportation accidents; and
- Assessment of each community's emergency training programs and resources. As a result of this assessment, methods for implementing crisis management techniques for handling hazardous materials transportation accidents are being recommended. These methods will provide cities and communities with a mechanism to update their hazardous materials transportation accident contingency plans based upon the latest available technology.

The ten cities selected for analysis were:

- Baltimore, MD
- Los Angeles, CA
- Nashville, TN
- Newark, NJ
- Pensacola, FL
- Sacramento, CA
- Tallahassee, FL
- Waverly, TN
- Wilmington, DE
- Youngstown (Panama City), FL

This selection was made because these localities either: (1) have significant amounts of hazardous materials traffic through them; (2) have been sites of past serious accidents from which past performance and planning improvements could be evaluated; or (3) have already done specific work in contingency planning or crisis management of hazardous materials transportation accidents.

5.1 METHODOLOGY FOR OBTAINING INFORMATION

The approach used to identify each city's emergency response capabilities initially involved the identification of key city, county and state decision-makers such as civil defense and emergency preparedness directors, police chiefs, fire chiefs, mayors, and

health officials. Contacts were initiated by telephone and letter and were followed up with personal visits, interviews and additional correspondence. Written and verbal procedures, methods and guidelines existing in each city, county or state for handling hazardous materials transportation emergencies were obtained.

At the beginning of each meeting a brief presentation, entitled "Assessment of Techniques, Plans, Training Aids and Resources for Hazardous Material Accidents," was given to local decision-makers in each city. This briefing addressed STL's approach for performing the assessment; an overview of the "Post-Accident Procedures for Chemicals and Propellants" project; and identified the types of information desired from each city. It was emphasized at each meeting that the project will result in a summary of the best techniques, plans, training aids and resources for management of hazardous material transportation accidents, which will enable local decision-makers to assess their programs and make improvements, when possible.

The type of information requested fell into the following categories: contingency planning; personnel training; specialized personnel, equipment and gear; and problems encounted or foreseen in handling hazardous materials transportation accidents.

Each community was asked if they had developed a specific local contingency plan for handling hazardous materials transportation accidents or if the basic fire plan, state contingency plan or the National Oil and Hazardous Materials Substances Pollution Contingency Plan (1510 Plan) would be used in the event of a hazardous materials transportation accident. Also, organizational responsibilities of all local emergency response service organizations who would be on-scene and at what level they would interact with Federal, State and industrial response groups were identified.

The nature and extent of response personnel training programs especially in handling hazardous materials were also examined. A listing of hazardous material guidebooks and source reference material carried in emergency response vehicles in each city was also compiled.

An inventory of specialized response personnel, equipment and materials was taken for each community. This indicated the level of sophistication in handling an emergency. This inventory, however, could not be used as a basis of assessing "total response capabilities" because it was found that cities having a high population and purchasing power also had an equally high level of sophistication with respect to specialized personnel, equipment and gear. Small population centers in proximity to large cities often relied on the response capabilities of larger nearby cities. For

example, Youngstown, FL relies on Panama City, FL and Waverly, TN relies on Nashville, TN.

Each city was also asked to identify difficulties which had been encountered or could be encountered at a future hazardous materials transportation accident. This information was necessary so that recommendations for improved crisis management techniques could address these issues. These recommendations could be used as a mechanism by local decision-makers for updating their existing techniques, plans, training aids and resources.

5.2 EMERGENCY RESPONSE CAPABILITIES IN TEN SELECTED CITIES

Figure 5-1 shows the geographic location of the cities selected for examination. Information on each city's crisis management techniques, plans and training aids for hazardous material transportation accidents is provided in the following sections.

5.2.1 Baltimore, MD

- There is a basic Baltimore City Emergency Operations Plan which deals with all emergencies. This plan has specific guidelines for handling hazardous materials transportation emergencies.
- The Office of Civil Defense will not become involved in a hazardous materials accident unless a "state of emergency" is declared by the Governor.
- The Office of Civil Defense is in-charge of contingency planning and coordination of agencies on-scene as well as procuring required resources for use on-scene such as personnel, equipment and materials (e.g., arrange for living accomodations, obtain cranes and trailers, etc.).
- The Baltimore Fire Department has an advisory committee (i.e., Hazardous Materials Task Force) which has specialized personnel, equipment and gear for responding and coordinating activities on-scene. They also have a CHLOREP patching kit for chlorine emergencies.
- The fire chief serves as the on-scene commander.
- All emergency response vehicles carry the DOT Emergency Response Guidebook. However, if a water pollution threat occurs the City of Baltimore has access to the USCG CHRIS system.
- The fire department is familiar with and has used CHEMTREC (Chemical Transportation Emergency Center) for technical assistance at hazardous materials transportation accidents.
- Concerning hazardous materials training, all fire department personnel take the NFPA hazardous material course entitled "Handling Hazardous Materials Transportation Emergencies."
- The USCG has identified the hazardous materials transported in the Baltimore area and is equipped with a pollution response van with specialized equipment and gear.

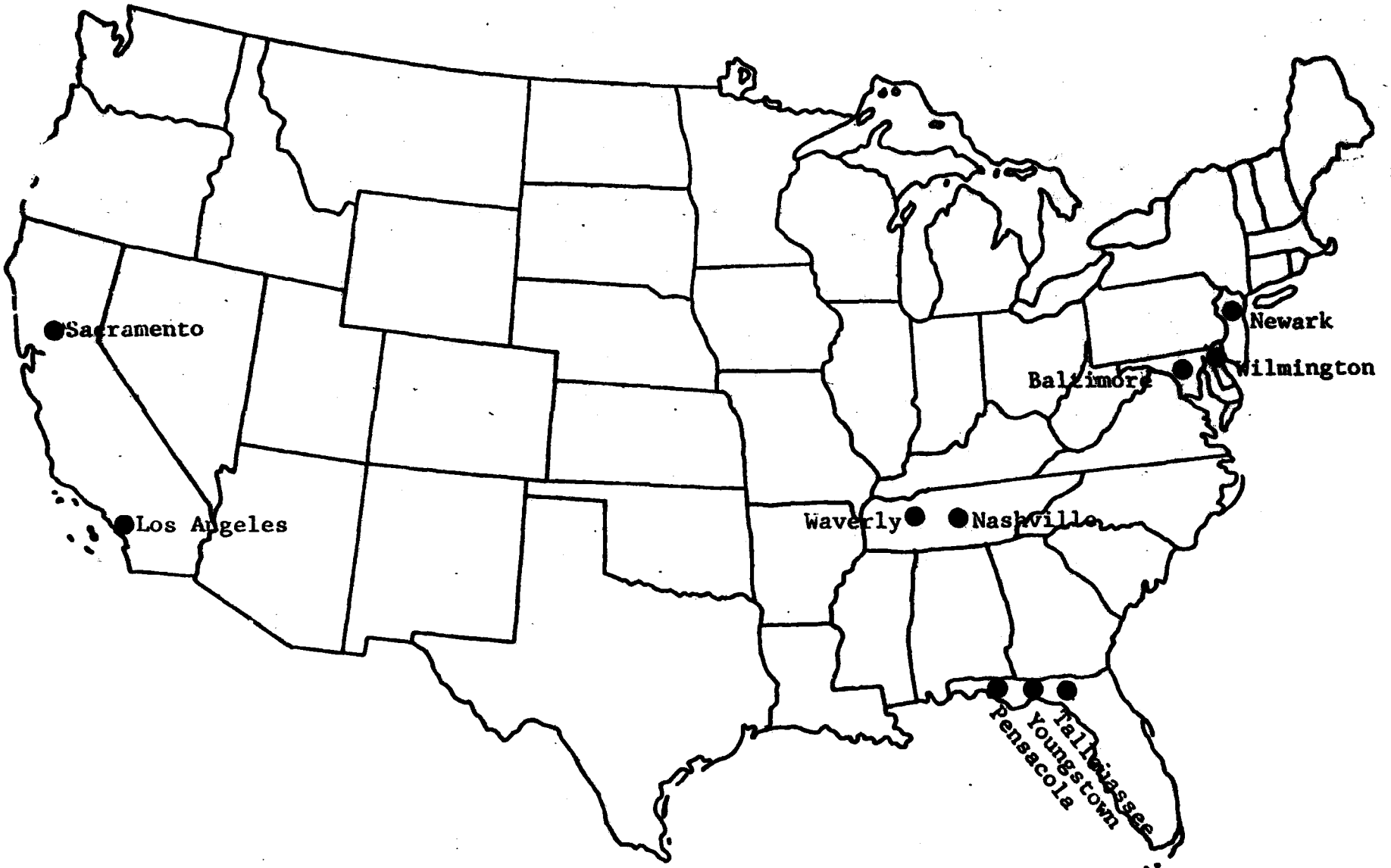

Figure 5-1. Geographic Location of Cities Selected for Review of Crisis Management Techniques to Hazardous Materials Transportation Accidents

- The USCG believes that it is not geared up for immediate response to most hazardous material accidents. They will typically respond with specialized personnel and the CHRIS response system. Their responsibilities on-scene are to support primary hazardous materials control groups.
- The Baltimore police department provides traffic control, escort, crowd control and bomb removal at a hazardous materials transportation accident.
- All police officers are required to complete a minimum of eight hours of hazardous materials training. The department utilizes the same NFPA training course as does the fire department.
- Four area hospitals are on 24 hour/day stand-by alert in readiness for an impending accident.
- The Coast Guard has an agreement with the Baltimore City Fire Department that it will respond on an advisory basis at the fire department's request even if the incident is not within its jurisdiction.
- If an evacuation becomes necessary, the Baltimore Office of Disaster Control would activate an order to execute evacuation procedures.
- The following are operating procedures to be used on-scene by the hazardous materials task force (HMTF). These procedures are prescribed in Manual of Procedure (MOP) 625-11.
  - Until proper identification of the product or material has been made, it should be considered toxic and explosive.
  - Members should ANTICIPATE and not delay in calling for assistance as a limited situation can quickly become a major problem if not handled expeditiously. If evacuation is deemed necessary, it should be started immediately, moving those closest to the problem first and working away from the incident.
  - All protective clothing, including breathing apparatus, will be worn in handling these incidents. If initial dispatch indicated a hazardous chemical, air masks will be donned before entering the contaminated area.
  - Upon arrival, the Deputy Chief will assume charge of the incident, assisted by the task force Battalion Chief. The officer in charge will designate the staging area and designate an officer in charge.
  - Points considered in selecting a staging area include wind direction and velocity, topography, and accessibility. First-aid equipment, stand-by manpower, and logistical support will be marshalled here.
  - Subsequent arriving units will, in the absence of specific instructions, report to the staging area.
  - Chief officers will be cognizant of available monitoring equipment (radiological, explosimeter, etc.) and utilize them to best advantage, as well as the available supportive resources; i.e., CHEMTREC, Hazardous Materials Guides, local technical assistance.
  - Chief officers will closely monitor casualties in case the Natural Disaster Plan should be implemented.
  - Use of hose streams for flushing, cooling, or absorption should be considered and stretched where indicated.

- **FIRES INVOLVING FLAMMABLE GASES SHOULD NOT BE EXTINGUISHED UNLESS THE FLOW OF GAS CAN BE STOPPED**

  Communications will be maintained at all times between operating task force and Fire Communications Bureau.

  As wind direction and velocity are extremely important in relation to chemical spills or leaks, the following format will be used by Fire Communications Bureau when giving wind conditions:

  "wind from north to south at 12 MPH," or
  "wind from east to west at 6 MPH," etc.

  The above information will be obtained from Weather Bureau, Baltimore Washington International Airport:

  PHONE: 962-2177 (24-hour number)
  787-7257

  This information will be transmitted:

  1. **At time of dispatch.**
  2. **When command post is established.**
  3. **When requested by fireground commander.**

  The Captain Fire Communications will insure that when obtaining weather information, the actual readings at time of request are recorded. The fireground commander will be apprised of any changes that might affect fireground operations.

  If type of material is known, all pertinent information; such as fire, explosion, and/or health hazards known about the material or incident will be transmitted:

  1. **At time of dispatch.**
  2. **Via radio, after the response of the Battalion Chief has been verified.**
  3. **When requested by the fireground commander.**

- **Specific procedures are also identified for chlorine leaks (MOP 628-1), spill incident-sorbent booms (MOP 600-4), disposable surgical masks (MOP 600-7), prevention of contamination of domestic water supplies (MOP 603-4), harbor protection-fireboats (MOP 605), accidents-derailments railroad right-of-way (MOP 633-1) and oil, chemical and noxious material spill incidents (MOP 644, 644-1, 644-2, 644-2-1, 644-3, 644-4, 644-5, 644-5-1 and 644-5-3).**

- **In case of an accident-derailment along the railroad right-of-way the following procedures are applicable:**

  - **The Officer in Charge of Unit or Units that respond to an incident along a railroad right-of-way will immediately advise Fire Communications of:**

    - **The correct name of the railroad involved.**
    - **Location of incident.**
    - **Nature and extent of the incident.**

  - **Should the incident be of a serious nature and the emergency operations must be conducted on or across the railroad tracks, the Commanding Officer will notify Fire Communications to have train movement stopped.**

- Fire Communications will notify the railroad involved by calling one of the following numbers:
  - Baltimore and Ohio - 237-3433, Chief Train Dispatcher
  - Canton - 342-4458, Train Master
  - Western Maryland - 237-3938, Yardmaster
  - Penn Central - 685-4827, Power Director
- When the incident involves the Penn Central Railroad, emergency operations must be performed in accordance with (MOP 632-1) "Penn Central Electrified Territory." Until it has been absolutely ascertained that train movement has been stopped, men will be stationed at opposite ends of the incident to alert fire personnel of on-coming trains (using portable radios, if necessary). DANGER: DUE TO THE HIGH SPEED OF SOME TRAINS (UP TO 140 MPH), IT MAY BE NECESSARY TO REQUEST THAT ADDITIONAL UNITS BE DISPATCHED A MINIMUM OF THREE MILES TO EITHER SIDE OF THE INCIDENT IN ORDER TO RADIO AN ADEQUATE WARNING OF ON-COMING TRAINS TO THE UNITS WORKING AT THE INCIDENT.
- The Fire Department is not equipped with apparatus or tools to lift heavy railroad equipment; i.e., freight cars, locomotives, heavy machinery, etc. Therefore, the Officer in Charge shall advise Fire Communications to request proper heavy equipment from railroad involved.
- When the accident or derailment involves freight or tank cars transporting explosives, hazardous chemicals, flammable liquids, or gases and there is spillage of chemicals, oils, or noxious materials, (MOP 644-1) "Spill Procedure" must be initiated.
- Hose lines must be placed under rails between ties to prevent hose from being run over by passing trains while performing firefighting operations.

- The NFPA hazardous material training course given to emergency response personnel provides information on hazardous materials in-transit; definitions, classes and dangerous properties of hazardous materials incidents; command and control of hazardous materials incidents; and planning for hazardous materials emergencies.

5.2.2 Los Angeles, CA

- The Los Angeles Fire Department has experienced problems with hazardous materials identification and container integrity assessment at accidents.
- The California Highway Patrol (CHP) serves as statewide information, assistance and notification coordinator for hazardous spills occurring on all highways throughout the state.
- Los Angeles has only a basic fire plan, with no specific contingency plan devoted to hazardous materials response.
- All fire chief vehicles carry the DOT Emergency Response Guidebook.
- Los Angeles is equipped with one Mobile response van which has analytical testing equipment (GC-MS), technical reference library (EPA, AAR, USCG CHRIS, DOT, etc.), personal protective clothing, breathing apparatus, communications support.

- Response van is operational 24-hours a day. Four men support the van and each assumes command of the van on a weekly rotating basis. These four personnel make up a react team in the area.
- Local cleanup and disposal companies provide basic training to response personnel in the area.
- Los Angeles personnel have taken the NFPA hazardous materials training program and used portions of it as the basis for developing their own.
- Los Angeles personnel have a close working relationship with the chemical manufacturers in the area so they will provide technical assistance on-scene if requested by the incident commander.
- The CHP felt that personal protective clothing, gear and equipment were inadequate for handling an emergency situation but that adequate resources cannot be purchased due to funding restrictions.
- CHP has predesignated highway routes in California where highway vehicles transporting explosive materials may travel as well as stop for fuel and rest. These routes and stops are identified in CHP publication HPH 84.8 entitled "Explosives Routes and Stopping Places."
- CHP has also developed a manual entitled "Hazardous Material Transportation" (HPM 84.2) which was designed to provide guidance and assign responsibilities for enforcement of legal requirements relating to the transportation of hazardous materials and to prevent injury or loss of life resulting from accidents involving hazardous materials. The contents of this manual provide information on policy, laws and regulations, enforcement, commodity identification, explosives, loading, cargo and portable tanks, selection of explosives routes and emergencies.
- From this manual (HPM 84.2) the following information was ascertained in terms of response activities at hazardous materials transportation emergencies:
  - The California Department of Transportation (CALTRANS) is responsible for identifying, containing, removing, or causing to be removed all materials spilled on State highways. This includes reloading or other disposal of hazardous materials cargos in accident-disabled vehicles and long-term traffic control.
  - CHP will assume the responsibility for immediate notification to local fire departments in event of cargo or vehicle fires.
  - CHP has a hazardous materials emergency operations plan in which response requirements are subdivided into three phases. The three response phases and the activities of organizations under each are:

    A. Phase I. The officer arriving at the scene takes immediate action to best control the incident, then promptly identifies the commodity and radios its shipping name and hazard class to the dispatch center. Using available reference data, dispatch will advise the field unit of the hazards and precautions to be taken.

    B. Phase II. The dispatch center promptly notifies appropriate agencies to respond to the scene. Initial and subsequent reports from the officer at the scene, and other inputs from supervisory and industry personnel, determine activity at this point. When necessary, a Departmental supervisor should respond to the scene and establish a command post. For

guidance of dispatch personnel, responding organizations have the following capabilities:

(1) CALTRANS. CALTRANS personnel can assist in identification, containment, removal and reloading and should routinely be notified as soon as possible of any emergency on a State highway.

(2) Local Fire Departments/Division of Forestry. In urban areas, local fire departments should be notified of spills of flammable materials or cargo fires involving hazardous materials. In other areas, California Division of Forestry units may be requested to provide fire fighting or standby service. Support from these organizations will not normally include reloading, removal, or decontamination. In many cities fire services may provide the following assistance:

(a) Fire protection services.
(b) Protective clothing and equipment.
(c) Ability to enter contaminated area for rescue and/or commodity identification.
(d) First aid to the injured.
(e) Coordination with the poison control center.

(3) CHEMTREC. The Chemical Transportation Emergency Center (CHEMTREC) is a voluntary project of industry, sponsored and supported by the Chemical Manufacturers Association, and is located in Washington, D.C. CHEMTREC can provide immediate advice as to precautions to be taken at any emergency scene, can arrange manufacturer or shipper assistance, and operates around the clock: (800) 424-9300 (toll free).

(a) CHEMTREC does not directly dispatch assistance, but acts as an information source and coordinating center.

(b) Information obtained from CHEMTREC depends upon accurate details provided to CHEMTREC during the initial call for assistance. These details should include type of containers, quantity, name of transporter and shipper or manufacturer, and accurate description (chemical, trade, or shipping name and hazard class, if any). If shipper or manufacturer assistance is required, this should be clearly stated.

(c) Assistance in dealing with chlorine incidents under the Chlorine Emergency Plan (CHLOREP) can be obtained through CHEMTREC.

(d) Assistance from the National Agricultural Chemicals Association's Pesticide Safety Team Network can be obtained through CHEMTREC. These teams - some of which are located in California - will assume responsibility for the cleanup of agricultural chemicals.

(4) Shippers. Shippers may be able to assist in emergencies, especially if transporting their own products as private carriers. With for-hire carriers, it may be possible to determine shipper from shipping documents.

(5) Federal Department of Energy (DOE). Assistance in emergencies involving radioactive materials being transported under its auspices may be obtained from the Department of Energy (formerly Energy Research and Development Administration): (415) 273-4237.

(6) Office of Emergency Services. If transportation of radioactive materials is not under DOE jurisdiction (above), the Office of Emergency Services (OES) should be contacted in emergencies: (916) 421-4990. In addition, OES should be routinely contacted regarding spills of any chemical into or along any surface waterway: (800) 852-7550. OES then notifies the information to concerned Federal and State agencies but does not dispatch assistance.

(7) The Military. Reloading and other assistance in incidents involving military explosives may be obtained from the Army. The 548th Ordnance Detachment, Presidio of San Francisco, (415) 561-4203 or 561-4312, shall be contacted in all such cases. Dispatch of disposal teams from the nearest base will be coordinated from this central point.

(8) Division Motor Carrier Safety Units. Motor Carrier Safety Personnel may be able to help identify products and their hazards, especially when products are unknown or marginally dangerous, or when it is necessary to locate the shipper or carrier.

C. Phase III. The final phase is reloading and cleanup, including decontamination if necessary. When a highway has been restored to safe use, Departmental participation may be terminated with the concurrence of CALTRANS or other public agency personnel concerned with cleanup and disposal.

- CHP provides guidelines for tank structural assessment while impinged with fire. These include:

  - Tank - No Fire. A tank in any position, even completely overturned, is relatively safe if there is no fire.
  - Upright Tank - Moderate Fire. An upright tank with only moderate fire exposure, even if safety valve discharge catches fire, is not extremely hazardous.
  - Upright Tank - Intense Fire. A tank exposed to an intense fire, and which contains certain unstable materials, may be hazardous. The Chem card manual contains specific information on these materials. Tank rupture is possible and evacuation to a distance of 1,500 feet is advisable.

- Overturned Tank - Intense Fire. A partially or completely overturned tank subject to intense fire is extremely dangerous for two reasons. First, heating of tank heads and shells causes rapid and extreme weakening of the metal (tensile strength of aluminum and steel alloys at several hundred degrees is but a fraction of what it is at normal temperatures). This weakening is pronounced on portions of a tank above the liquid level. Second, relief valves at the top of the tank normally connect with the vapor space above the liquid level. When the tank is overturned, the relief valves no longer connect with the vapor space and the valves cannot function to keep tank pressure from rising to dangerous levels. Under these conditions, tank rupture and the strewing of contents and tank fragments for up to several hundred feet is probable; evacuation to a distance of 1,500 feet is imperative.

- Training is given to all emergency response personnel.
- Emergency response personnel are trained in the areas of personal and personnel protection; incident appraisal; hazardous substance identification methods; rescue techniques; scene control; coordination post establishment and operation; coordination; requesting available resources; containment; cleanup methodology and equipment decontamination; disposal; news media relations; knowledge of liability; and accident reporting.

5.2.3 Nashville, TN

- No specific contingency plan has been developed for hazardous materials response. However, a general firefighting plan does exist which designates fire and emergency medical responsibilities on-scene.
- Two problem areas in which Nashville feels that improvements are needed include communications on-scene between organizations and hazardous materials identification. The difficulty in on-scene communications occurs because each of the organizations responding communicate on different radio frequencies which causes confusion when trying to coordinate on-scene activities. This occurred following the derailment, explosion and fire in Waverly, TN. Concerning hazardous materials identification problems have occurred when a material is not marked properly or when limited material hazard information is known and the manufacturer can not be contacted. This significantly increases the time of "uncertainty" for emergency response personnel.
- Nashville has a six man specialized react team with equipment and gear for response on-scene. This team has special training in mitigating hazards associated with releases of hazardous materials. Also, the team utilizes two mobile response vans. These vans are equipped with a CHLOREP kit, burn-off equipment, breathing apparatus, cutting torch, personal protective clothing, disposal drums and lime for neutralization. The Nashville area has established an agreement with the State which provides that the State of Tennessee will provide the emergency response equipment if Nashville will be in charge of responding to hazardous material incidents in central Tennessee. Nashville estimates that they can normally respond to an incident in less than 12 minutes (county is 542 $mi.^2$). The Nashville metropolitan area has established a computer-operated emergency response network in which the telephone numbers of CHEMTREC, industrial manufacturers and other emergency response organizations can be activated by pushing only one button for each organization. All emergency vehicles carry the DOT Emergency

Response Guidebook, but the react team has a library of other emergency response source material including a chemical dictionary, USCG CHRIS, EPA and AAR manuals and others. Nashville feels that the use of the UN numbering system on DOT placards will be beneficial. The metropolitan area has established a Hazardous Material Risk Advisory Committee (HMRAC) which identifies policy for handling hazardous materials. HMRAC is comprised of personnel from emergency response, academic and industrial concerns.

- Concerning training of emergency response personnel, all react team members have or are working for an Associates Degree in Fire Science. These members take the NFPA course and an additional 80 hours of hazardous materials training by a chemistry professor. The react team members must then be recertified every two years. All other fire service personnel take the NFPA hazardous materials training course.
- The Metropolitan Nashville-Davidson County Division of Civil Defense and Emergency Preparedness has been designated as the Emergency Coordinating Agency having primary responsibility and authority for planning of disaster preparedness, response and recovery; for coordination and liaison with related agencies of Metropolitan, State and Federal Government and such agencies of other cities, counties and concerned private agencies.

5.2.4 Newark, NJ

- Newark has a general contingency plan for emergencies which does not specifically address hazardous materials emergencies.
- The City of Newark is in the process of developing guidelines for hazardous materials accidents. This is mainly a result of a few significant accidents in the area, one of which involved the release of ethylene oxide in a railroad yard forcing the closing of the Newark International Airport.
- A mutual aid agreement exists between the fire department and local chemical manufacturing companies so that the manufacturers will provide response teams in the event of an emergency. The chemical manufacturers train, provide technical assistance and information to emergency response personnel.
- The City of Newark has their own hazardous materials training program. All response personnel are trained.
- All city emergency response vehicles carry the DOT Emergency Response Guidebook.
- The fire service utilizes positive pressure breathing apparatus rather than Scott air packs. Firefighters are required at all times to wear breathing apparatus even though a fire may not be visible.
- The state of New Jersey has one hazardous materials response van for use on-scene. The van, operated by the New Jersey environmental organization, is based in Trenton, approximately one hour from Newark.
- The Newark Office of Environmental Affairs, Department of Engineering, acts as liaison with New Jersey concerning hazardous materials situations.
- A difficulty which Newark felt was a hindrance to hazards mitigation is that technical assistance is usually not available after normal business hours on weekdays and no assistance is available on the weekends.

5.2.5 Pensacola, FL (Escambia County)

- Pensacola has an unusually high probability of a hazardous materials transportation accident occurring because an extremely large volume of petroleum products traverse its boundaries and a major interstate highway bisects Pensacola.
- It was estimated that an average 150 car train consist going through Pensacola would include at least 80 cars of HMs.
- Mock-up exercises are held regularly by city and county emergency response personnel.
- Escambia County has an operating 911 emergency communcations network.
- In the city of Pensacola the fire department consists of one station of paid firefighters while the county fire department consists of 15 stations of volunteer firefighters. These two, however, are linked together by a firefighting association.
- In terms of response teams, Civil Defense estimates that the average response time of any firefighting unit in the county is 5 minutes.
- The procedure for notifying a station company of an emergency follows:

  1. Dispatcher receives call.
  2. Dispatcher notifies service company within one minute after receiving initial notification call.
  3. Station notified must then, in then, call back dispatcher within two minutes after notification.
  4. If the station company does not return the dispatcher's call within two minutes the dispatcher again notifies the service compnay. This problem occurs only 5-10% of the time.

- Mutual aid agreement exists between the county and city emergency response units.
- When technical expertise is needed on-scene, the county has established a mutual aid agreement with chemical manufacturers in the region. These manufacturers include St. Regis, Monsanto and Air Products. Each of these manufacturers have industrial response teams equipped with acid suits and other personal protective clothing.
- Civil Defense feels that the following organizational structure for on-scene coordination is a logical delegation of responsibilities:

  - The county has been subdivided into 14 response regions, each having a fire chief. The fire chief in each region has been designated the OSC for that region.

- All emergency response vehicles carry the AAR's Emergency Handling of Hazardous Materials in Surface Transportation.
- Pensacola does not recommend the use of the DOT Emergency Response Guidebook (ERG) because they question the validity of a guide book which has a designated guide (Guide No. 11) which addresses no hazardous commodity.
- The county has a mobile van which supplies breathing tanks on-scene and can replenish cylinders in which the air has been depleted. This is known as the "cascade system."
- The county keeps an inventory of individuals and 24-hour access telephone numbers which can be used for search and rescue operations as well as members of industrial response teams.

- Escambia county operates their own hazardous materials training program. This consists of both the NFPA courses in HM and RAM. More extensive training, given at State conferences and seminars, is provided for all fire chiefs, representatives of the firefighting association, civil defense training officer and EMT representative, who is the RAM training individual. All individuals are required to take at a minimum the NFPA courses.
- The county is equipped with a mobile response van, mobile ambulance (which can transport 10 individuals at once - carries 100 stretchers), and has a mobile command post.
- The mobile command post (which was used at Molino, FL) is a 55-foot modified bus which is equipped with a meeting room, teletype and 8 monitoring stations. Meteorological data is obtained from NOAA. The post uses microwave communications. Estimated cost of mobile command post is $30,000.
- County communications consist of a $1.4 million microwave communications network. Currently, the system provides 100 communications channels, but has the capability to handle 300 channels. It has been found that this system decreases cost while increasing the efficiency of Escambia County's communications network. Prior to installation of this system, a telephone call from one end of the county to the other was long distance (due to three telephone companies servicing the area). Now an individual can call the entire length of the county on a local basis.
- All calls for emergency response personnel are filtered through the county's Office of Civil Defense and Disaster Preparedness. This provides for coordinated response activities.

5.2.6 Sacramento, CA

- Each emergency response vehicle carrys the DOT Emergency Response Guidebook.
- Battalion chief vehicle also carries the AAR Emergency Handling of Hazardous Materials in Surface Transporatation.
- Both of the aforementioned publications are also in the dispatchers office.
- Sacramento has no primary hazardous materials analytical testing equipment. They do have an agreement with a chemist in the city engineering dept., several colleges which have laboratory facilities and the I.T. Corp., for testing and identifying materials. The response time that I.T. Corp. requires to arrive at Sacramento is roughly two hours.
- Sacramento has not developed specific guidelines for handling hazardous materials transportation accidents, but relies on the response guidelines identified in the DOT and AAR response manuals for on-scene actions. However, Sacramento has developed guidelines for approaching, locating and securing fire apparatus near the scene of an accident.
- Sacramento has develped a 106 hour hazardous materials training course. This course was developed for members of the two react teams. The 106 hour training program was developed from prepackaged programs such as those developed from NFPA,California Fire Marshall's office, etc. Each captain is also given this training. All other fire personnel are given limited training which consists of familiarizing personnel with the reponse manuals and departmental developed guidelines regarding approaching, locating and securing fire apparatus on-scene.

- The area has two air compressor units which provide a cascade system (capable of replenishing air packs on-scene).
- Two mobile response vans exist. Each van is equipped with 10,000 kw generator, carbon arc search lights, passive cascade system (i.e., cannot produce air but can store enough to replenish 60 tanks), positive pressure breathing apparatus, hydraulic tools, personal protective clothing, MSA breathing apparatus, umbilical cords that air can be forced through (positive pressure - 300 foot maximum length).

5.2.7 Tallahassee, FL (Leon County)

- Leon County has a population in excess of 151,000 while the city of Tallahassee comprises 81,000 or 54% of the total county population.
- Tallahassee is bounded on the north by Interstate Highway 10 while LN/SCL have railroad tracks going through the center of town.
- Not one township in Leon County has either volunteers or paid emergency response personnel, exclusive of Tallahassee.
- All emergency response vehicles carry both the 1976 and 1980 version of DOT's Emergency Response Guidebook.
- Tallahassee officials have experienced difficulty in using the 1980 "Guidebook" at night because it was hard to reference the UN number listings in the beginning of the book in the dark or under stressful circumstances.
- There are no chemical manufacturing plants in the immediate areas.
- All fire personnel are given the NFPA Hazardous Materials training course. Fire personnel are required to attend additional hazardous materials training annually.
- Limited hazardous materials training is given to either police or sheriff department personnel, mainly because their on-scene role consists of evacuation and perimeter control.
- Police and sheriff department personnel, however, do get their limited training from full-time training officers of the fire department.
- The fire department has 5 full-time hazardous materials training officers.
- Cooperative agreement has been established between Leon County and LN/SCL about improving track conditions.
- In conjunction with neighboring counties Tallahassee regularly performs mock-up exercises of hazardous materials transportation accidents.
- If foam trucks are required on-scene they are available from the municipal airport.
- Fire department is equipped with a mobile response van and has analytical testing equipment, Scott air packs and acid suits.
- Leon County has an Emergency Operations Plan which considers hazardous material transportation accidents occurring in region.
- Director of Civil Defense was unfamiliar with either the EPA or CHRIS response manuals.
- The 911 emergency telephone system is used in the county.
- The communications commmand center is located at the Civil Defense's Directors office and is manned 24-hours/day.

- Leon County Emergency Operations Plan identifies designated responsibilities for fire, police, emergency medical and health/rehabilitative services personnel.
- The Tallahassee fire department is equipped with Scott air packs, acid suits and other personal protective clothing, gear and equipment.
- Standard operating procedures for notifying a railroad of an accident involving hazardous materials in the county consists of identifying information on how many cars are involved; nature of contents; possibliity of fire; toxic materials; response agencies on-scene and immediate response needs.

5.2.8 Waverly, TN

- Waverly has no specific guidelines for handling hazardous materials accidents, but relies upon guidelines for responding to fires.
- Civil Defense has the capability to utilize the HMER system in the event of an emergency.
- All emergency response vehicles carry the DOT Emergency Response Guidebook.
- Mock-up exercises have been utilized to train firefighters for possible accidents.
- Waverly employs a training officer who instructs personnel on hazardous materials handling. This training consists of utilizing the NFPA hazardous materials training program, State developed programs, etc.
- Three chemical companies are within the Waverly area, and an agreement has been reached with these manufacturers that they will provide technical assistance and response teams if requested.
- Waverly has meteorological monitoring equipment capabilities and could place the equipment on-scene to identify and monitor climatic conditons and estimate vapor dispersion patterns.
- Waverly has limited specialized personnel, gear and equipment. Sophisticated resources are obtainable from Nashville (response team roughly 1.5 hours), and were made available through a State agreement. The County, however, does have positive pressure breathing appparatus and Scott air packs.
- Waverly had budgeted to purchase personal protective suits, but due to a budget cut of 50% in the fire department's operating revenue these services had to be sacrificed.
- Firefighting personnel are paid volunteers (i.e., paid for time of service).
- The police department has no guidelines; training; or specialized personnel, gear and equipment for handling a hazardous materials release.

5.2.9 Wilmington, DE

- All emergency response vehicles carry the DOT Emergency Respnse Guidebook.
- Wilmington employs the only paid fire department in the state.
- The State Fire Training Academy handles training of all firefighters. This training includes hazardous materials courses in its curriculum.
- There is a general contingency plan in the city, but this plan does not specifically address response to hazardous materials transportation accidents.

- Neither the fire nor police departments have specific procedures for handling hazardous materials releases except for radioactive materials.
- Two hazardous materials training courses are taught by the Delaware Fire Training Academy. One is geared to all emergency response personnel and instructs personnel in such areas as material characteristics and identification, labeling and placarding. The second course is geared towards individuals which would serve as OSCs at a hazardous materials incident. This course teaches actual tactics and strategies.
- There is no mandatory follow-up training. Firefighters, however, may repeat the course to refresh their memory as they deem necessary.

5.2.10 Youngstown, FL (Panana City-Bay County)

- The Bay County Natural Disaster Operations Plan contains a hazardous materials spill emergency response plan (Annex G).
- The Director of Civil Defense is the on-scene coordinator at hazardous material transportation accidents in the county.
- The county maintains a listing of individuals capable of providing technical assistance if an emergency occurrs.
- The plans identifies designated responsibilities for organizations that would be involved in on-scene assistance.
- The plan permits the utilization of heavy equipment resources within the public works agencies for salvage, repair and debris removal operations.
- Guidelines for immediate on-scene actions to be taken by emergency personnel at the scene include the following instructions:

  1. Take any feasible steps necessary to protect or save human life and safeguard property.
  2. Restrict traffic in and about the scene.
  3. Take all necessary actions to contain and/or prevent the spread of the material.
  4. If the incident involves fire or material subject to blowing in the wind, conduct operations from an upwind position.
  5. Isolate and hold all contaminated persons for further examination by specialists.
  6. If there are casualties requiring medical attention, take only necessary life-saving actions prior to the arrival of a qualified hazardous materials specialist and/or physician.

- Attachment No. 1 of Annex G to the Bay County Natural Disaster Operations Plan consists of a Hazardous Substance Spill Report which catalogs on-site accident information including the name and contact number of the reporter, location of incident, type and cause of incident, casualities, personnel and equipment availability. An example of the Hazardous Substance Spill Report is given in Table 5-1.
- Attachment No. 2 of Annex G to the Bay County Natural Disasters Operations Plan contains details of emergency procedures for local authorities when handling hazardous materials. These include:

TABLE 5-1

HAZARDOUS SUBSTANCE SPILL REPORT

I. REPORTER

A. _____, _____
(Agency)
can be contacted for further information at _____
(Phone)

_____.
(Location)

II. LOCATION OF INCIDENT

A. Structure

Building or Company Name _____

Address _____

City _____ County _____

B. Roadway

Highway or Street Name _____

Nearest Intersection _____

C. Off-Shore

Nearest identifying landmarks (Beach name, pier, nearby road, street, etc. _____

_____

III. TYPE OF INCIDENT

A. Oil Spill

Substance _____ Quantity _____

_____ Ship _____ Oilfield _____ Pipeline _____ Railroad

Name of ship, etc. _____

B. Radiological Incident

1. Nature of Incident:

a. Loss of control _____

b. Lost source _____

c. Radiation producing device _____

d. Exposure _____

e. Transportation accident _____

f. Nuclear weapon _____

2. Radioactive material involved _____ amount _____?

TABLE 5-1 (cont'd)

C. Other Hazardous Material

Substance _____ Quantity _____

Generic Names _____

_____ Solid _____ Liquid _____ Gas

IV. CAUSE OF INCIDENT

Describe _____

_____

_____

V. INJURIES

Injured _____ (number) To which hospital were injured taken? _____

_____

Are injured persons contaminated? Yes __ No __ Nos. _____

Were injured persons exposed? Yes __ No __ Nos. _____.

If yes, was the hospital and ambulance crew so advised?

_____

Dead _____ Were dead contaminated? _____

VI. PERSONNEL AND EQUIPMENT

What emergency personnel and equipment are at the scene?

_____

_____

Type of additional assistance requested? _____

_____

VII. ADDITIONAL INFORMATION AND COMMENTS

_____

_____

_____

1. Take all feasible steps necessary to protect or save human life. Safeguard property insofar as practical.

2. Take actions to contain and/or prevent the spread of the material. Spread sand or other collection agents, build dike, etc.

3. Keep the public as far from the scene of the incident as reasonably possible. Prevent souvenir hunting and handling of debris. In the case of a nuclear weapons incident, keep the public at least 2,000 feet away.

4. Isolate for further examination those persons who may have had contact with the material. Obtain names and address of those involved.

5. Remove injured persons from the areas with as little direct personal contact as possible. Hold them at a transfer point for first aid. If serious injury has occurred, demanding more than first aid measures, the patient should be sent at once to the nearest emergency room for medical attention. Advise medical attendants and facilties of possible contamination.

   Medical first aid is directed primarily at restoration of breathing, control of hemorrhage, splinting for fractures, prevention of shock and control of pain. These are carried out for an exposed person in the same basic fashion as for a non-exposed individual.

   First aid for contaiminated persons consists of cleansing the skin of obvious dirt (possibly contamination) and if feasible, carefully remove the outer garments and shoes of the patient and wrapping him mummy-fashion in a blanket, sheet, canvas, or large coat. By this measure, any remaining contamination is contained and if the wrapping is carefully done, the victim can be moved with little likelihood of spreading contamination.

6. If incidents involve fire or material subject to blowing in the wind, conduct operations from an upwind position. Keep out of smoke, fumes, or dust resulting from the incident. Segregate clothing and tools used at the scene until they can be checked for contamination. Do not handle suspected material until it has been inspected and relased by qualified technical experts.

7. In a vehicle accident involving hazardous material, detour all traffic around the accident scene. If this is not possible, move the vehicle or vehicles involved the shortest distance necessary to clear the right-of-way. If the material is spilled, prevent the passage of vehicles and people through the area until it has been surveyed. If right-of-way must be cleared before the assistance team arrives, wash spillage to the shoulders. Do allow wash water to enter drainage system.

8. Do not eat, drink, or smoke in the accident area. Do not use food or drinking water that may have been in contact with material from the incident area.

9. Take only necessary emergency actions prior to the arrival of a qualified hazardous materials specialist and/or physician.

- The County Plan has a listing of 24-hour/day telephone access numbers to county, State and Federal emergency agencies. Under the listing of Federal Agencies the telephone numbers of Tyndall AFB-DP and Naval Coastal Systems Center is given.
- The Civil Defense has prepared a listing of absorbents, congealing agents, gelling agents, liquids and other equipment which may be required on-scene. This listing has been distributed to each of the service organizations so that they could inventory their resources and have pre-identified materials which may be needed on-scene prior to the occurrence of an accident.
- Fire department equipment consists of breathing apparatus and turn-out gear.
- Civil Defense operates and cooordinates specialized equipment utilization on-scene and is equipped with a communications van, breathing apparatus and jump suits.
- The county has only two copies of the DOT Emergency Response Guidebook.
- Emergency response vehicles are not equipped with the DOT guide.
- The County does not train emergency response personnel to handle hazardous materials accidents. Bay County, however, has established a group of decision-makers from the service organizations in the county (one from each organization) to serve on a hazardous material advisory board. The members of this advisory board are the only response personnel who receive formalized HM training.

5.3 ASSESSMENT OF METHODS OF CRISIS MANAGEMENT

This section provides a critical assessment of methods used in each city for implementing crisis management techniques for hazardous materials transportation accidents. Data were collected from each of the ten cities concerning specific guidelines/plans for handling hazardous materials accidents; hazardous materials training programs; and specialized response personnel, equipment and gear for use on-scene. Also, any problems the cities may have encountered or expected to encounter in handling hazardous materials transportation accidents were identified.

Each of the ten cities reviewed has experienced a hazardous material transportation accident involving at least one of the 28 chemicals and propellants being examined by this study. Of the 28 hazardous materials, the following 16 materials were involved in incidents in any of the ten cities: acetone, acrylonitrile, anhydrous ammonia, chlorine, ethylene oxide, liquefied hydrogen, hydrazine, methanol, methyl bromide, propane, propylene, sodium hydroxide, styrene, toluene, UDMH and vinyl acetate. The remaining 12, acetone cyanohydrin, aerozine-50, ethyl acrylate, hydrocyanic acid, isobutane, monomethylamine nitrate, sodium hydrosulfide, monomethylhydrazine, liquefied oxygen, vinyl chloride, N_2O_4 and butadiene were not involved in accidents in these cities during 1971-1980. Table 5-2 has been prepared to show the accident involvement by hazardous materials frequency for the ten cities visited. Table 5-3 has also been prepared to show the distribution of accidents for the chemicals and

TABLE 5-2

MATERIAL INVOLVEMENT IN ALL CITIES

Rank	Material	Number of Accidents	Pct. of Sample
1	Sodium hydroxide	26	23.5
2	Methanol	15	13.5
3	Acetone	14	12.6
4	Anhydrous Ammonia	13	11.7
5	Toluene	9	8.1
	Propane	9	8.1
7	Acrylonitrile	4	3.6
	Chlorine	4	3.6
9	Propylene	3	2.7
	Styrene	3	2.7
	Vinyl Acetate	3	2.7
12	Methyl bromide	2	1.8
	UDMH	2	1.8
	LH_2	2	1.8
15	Ethylene oxide	1	0.9
	Hydrazine	1	0.9
TOTAL		111	100%

TABLE 5-3

ACCIDENT HISTORIES OF THE CHEMICALS AND PROPELLANTS IN THE CITIES EXAMINED

	Baltimore, MD	Los Angeles, CA	Nashville, TN	Newark, NJ	Pensacola, FL	Sacramento, CA	Tallahassee, FL	Waverly, TN	Wilmington, DE	Youngstown, FL	Total
Acetone	6	3		3		1			1		14
Acrylonitrile	1				1				2		4
Anhydrous Ammonia	2	4		1	3	3					13
Chlorine	1	1		1						1	4
Ethylene Oxide			1								1
Hydrazine		1									1
Liquefied Hydrogen		1	1								2
Methanol	3	3	3	2		3			1		15
Methyl Bromide		1				1					2
Propane		2			1		1	1			9
Propylene		2	1								3
Sodium Hydroxide	6	8	4	2	1	3	1		1		26
Styrene		3									3
Toluene	2	1		3	1				2		9
Unsymmetrical Dimethlhydrazine			1	1							2
Vinyl Acetate		2							1		3
TOTAL	21	32	16	13	7	11	2	1	8	1	111

propellants by city. The DOT Materials Transportation Bureau's data base for the period 1970 through 1980 was used. Using the average hazardous materials accident cost of $41,900 for 1976 through 1980 and based on the number of accidents in each of the ten cities, the estimated accident cost resulting from the 16 chemicals and propellants was in excess of $4.6 million.

Table 5-4 shows the estimated loss to each city as a result of accidents involving the 16 chemicals and propellants. Thus it can be seen that each of these communities does have the need for response capabilities for handling possible hazardous materials transportation accidents. The analysis of the response capabilities in each of the cities is presented in the following sections.

5.3.1 Contingency Planning for Hazardous Materials Transportation Accidents

5.3.1.1 Overview of Community Emergency Response Planning and Recommendations for Improved Community Plans

STL's "Draft Guidelines Manual" conducted for project F04611-80-C-0046 showed that municipalities having pre-established contingency plans for handling emergency situations were better prepared for handling the hazardous environment surrounding the occurrence of hazardous materials transportation accidents than those areas that had not pre-planned. With the increasing awareness of the potential consequences of an accident involving hazardous materials, many communities (e.g., Nashville, TN; Sacramento, CA; Baltimore, MD) have developed plans specifically aimed at dealing with the hazards posed during an accident involving hazardous materials. However, many localities have not prepared or are not aware of existing hazardous materials transportation accident contingency plans. This fact can be exemplified by such transportation accidents as Beattyville, KY and Youngstown, FL. In fact, communities which have contingency plans usually have a large community-minded chemical manufacturer in the area or have had a major transportation accident which has forced community involvement and awareness.

It is recommended that a viable community contingency plan for hazardous materials transportation accidents be developed for every locality and that this plan contain the following information:

- Hazardous material shipping routes and volumes through community;
- Community transportation network in terms of possible evacuation routes and access by emergency services;
- Location of specialized personnel, materials, and equipment in community or nearest location adequate to handle hazardous materials emergencies;

TABLE 5-4

ESTIMATED LOSSES DUE TO INCIDENTS
INVOLVING THE 16 CHEMICALS AND PROPELLANTS

City	Accidents	Estimated Loss ($1,000's)
Baltimore, MD	21	879.9
Los Angeles, CA	32	1,340.8
Nashville, TN	16	670.4
Newark, NJ	13	544.7
Pensacola, FL	7	293.3*
Sacramento, CA	11	460.9
Tallahassee, FL	2	83.8
Waverly, TN	1	41.9*
Wilmington, DE	8	335.2
Youngstown, FL	1	41.9*

* Actual costs were significantly higher due to additional third party liability law suits and environmental cleanup costs.

- **Appropriate segments of the emergency response community, with clearly defined individual roles, responsibilities and statutory authorities;**
- **Methods for accessing relevant technical assistance sources; and**
- **Designated communications network (radio frequency, network channel siren) to alert the public and to handle communications between/from the Communications Command Center, the accident site and other off-scene support organizations.**

These topics are discussed in subsequent paragraphs in this section. At least two states, California and Virginia, have conducted studies to assess the volume of hazardous materials traveling along various segments of the state's transportation network. However, because local emergency responders (i.e., fire, police, medical) are the first groups on-scene, it is recommended that an inventory of hazardous material traffic be conducted at the local community level as well as the state level. The city or regional planning office might be the logical organization to be charged with performing this duty and possibly some other duties associated with municipal contigency pre-planning. Statutes may dictate someone else. The important thing is to have some organization responsible.

It is recommended that an inventory of the community transportation network be conducted. Also, thermophysical/chemical data should be compiled for the hazardous commodities being transported through a community. Based on current emergency response practices, this information should be carried in the cars of each emergency service "chief" (i.e., designated on-scene coordinator or his representative). The types of commodity information which the "chief" should carry include specific gravity, vapor density, explosive limits, toxicity levels and firefighting/first-aid information.

The catalog of appropriate segments of the response community, their responsibilities and authority should also include an inventory of specialized hazardous material response teams in, or available to, the community including local emergency services (fire, police, medical), industrial teams, trade association teams and federal, state and local government personnel. The type of information which should be collected for each specialized responding organization should include the following:

- **name and address of key persons/contacts,**
- **24-hour emergency phone numbers**
- **800 toll-free telephone numbers, if available**
- **what resources they can provide**

Other personnel or organizational information which should be indexed includes:

- **response speciality (e.g., firefighting, wreck handling, cleanup, disposal)**

- specific commodity expertise
- availability of specialized equipment and materials

The inventory of specialized equipment and materials suitable for hazardous materials traveling through a community should identify:

- materials and equipment needed for each hazardous materials being shipped
- location and availability of materials and equipment at public facilities and commercial/industrial facilities

Technical assistance may be obtained in several ways. The Chemical Transportation Emergency Center (CHEMTREC 800/424-9300) which is operated on a 24-hour, 7-day-a-week basis by the Chemical Manufacturers Association, can provide some initial response actions for an identified HM and get the shipper in direct contact with the emergency scene. If the HM happens to be one for which a segment of the chemical industry has developed special response teams (e.g., the CHLOREP teams of the chlorine industry through the Chlorine Institute), CHEMTREC alerts such groups. The chemical manufacturers and shippers are the most knowledgeable about the HM(s) they produce and ship and are in the best position to provide technical assistance at the accident scene. CHEMTREC information per se is "cookbook" for specific commodities and no judgments or recommendations are offered.

The National Response Center (NRC), operated by the U.S. Coast Guard (800/424-8802) in conjunction with its joint responsbilities with EPA in handling water spills of hazardous substances, likewise is operated around-the-clock and has a direct tie-in with CHEMTREC through a written agreement.

The Coast Guard and EPA have joint regional response teams, with designated on-scene coordinators (OSC), which are dispatched to th scene if either EPA or the Coast Guard deems it necessary. These teams can provide technical advice and/or actually conduct cleanup and disposal operations, if necessary. In addition, the NRC has computer programs for predicting the dispersion of spilled HMs (currently this is essentially confined to water spills, but is being expanded to handle land spills). The computerized data system makes available more detailed technical information than CHEMTREC can provide. EPA and the Coast Guard also have technical experts who may be contacted for technical advice.

There are several cleanup and disposal contractors who specialize in handling and/or advising regarding these aspects of HM spills. Some shippers utilize such contractors when they do not have in-house specialized teams. However, carriers rarely have such capability and would have to rely on a contractor. Normally, the shipper and carrier agree on how the matter will be handled, so it does not become a problem.

A number of shippers provide a company 800 emergency number on shipping papers and sometimes on the tank cars or cargo tanks.

Without adequate, fully-coordinated communications, it is impossible to handle a HM transportation emergency successfully. The communications network must enable those groups at the scene to communicate within their respective disciplines, and between disciplines and with the OSC. Additionally, the OSC must have direct contact with all the off-scene support activities (e.g., aerial surveillance, weather service, and hospitals) and shipper, carrier, local, State and Federal officials and response centers (e.g., NRC and CHEMTREC) and the news media. All of these communications must be on a non-interfering basis.

Most of the emergency services organizations have communciations systems. The important thing is to tie all communication into a centralized communication center. A system of priorities must be established as to who and what takes precedence. If possible, assignment of specific frequencies to the various groups is recommended. "Ham" operators, particularly, may be a valuable resource. The CB system might be of value under special circumstances.

5.3.1.2 Critical Analysis of Community Plans

Based upon the criteria for effective crisis management techniques to hazardous material transportation accidents given in Section 5.3.1.1, Table 5-5 has been prepared to show the state-of-the-art in community contingency plans for each of the ten cities examined. Based upon a critical assesment of each community's contingency plan for handling hazardous materials transportation accidents it appears that the majority of cities have inadequate on-scene communications capabilities and do not sufficently provide for the dissemination of accident information to the public. The cities reviewed do have the following components in their contingency plan:

- Knowledge of type of hazardous materials and their transport routes in proximity of the community;
- Specific emergency response guidelines for handling all hazardous materials transportation accidents;
- Inventory of specialized personnel, equipment and materials which could be used on-scene; and
- On-site responsibilities of local emergency response organizations.

The cities which did not have specific guidelines concerning response to hazardous materials would either utilize guidelines for response to fires or the emergency response guidelines identified in Federal and industrial response guidebooks (i.e., AAR,DOT,EPA and USCG).

TABLE 5-5

ASSESSMENT OF COMMUNITY CONTINGENCY PLANS
BASED UPON CRISIS MANAGEMENT CRITERIA

Criteria	Baltimore, MD	Los Angeles, CA	Nashville, TN	Newark, NJ	Pensacola, FL	Sacramento, CA	Tallahassee, FL	Waverly, TN	Wilmington, DE	Youngstown, FL (Panama City)
Identified hazardous material shipping routes and volumes	•		•	•	•		•			•
Community transportation network in terms of possible evacuation routes and also access to emergency services	•	•	•	•	•	•	•		•	•
Specific hazardous materials response guidelines/contingency plan	•		•	•	•		•		•	•
Location of specialized personnel, materials and equipment in community or nearest location adequate to handle hazardous material emergencies	•	•	•	•	•	•	•	•	•	•
Appropriate segments of the emergency response community, with clearly defined individual roles, responsibilities and statutory authorities	•	•	•	•	•		•			•
Methods for assessing relevant technical assistance sources	•	•	•		•		•			•
Designated communications network to alert the public and to handle communications between the Communications Command Center, the accident site and other off-scene support organizations					•					

TABLE 5-5 (cont'd)

Criteria	Baltimore, MD	Los Angeles, CA	Nashville, TN	Newark, NJ	Pensacola, FL	Sacramento, CA	Tallahassee, FL	Waverly, TN	Wilmington, DE	Youngstown, FL (Panama City)
List of specialized response personnel:										
- name and address of key persons/contacts	●	●	●	●	●		●	●	●	●
- 24-hour emergency phone numbers	●	●	●	●	●		●		●	●
- resources of group listed	●		●	●	●					●
Contingency plan components:										
- statement of purpose and scope	●		●	●	●		●			●
- enabling acts and authority	●		●	●	●					●
- identity and functions of the officials involved	●		●	●	●		●			●
- evacuation plan with pre-designated shelters and logistical support	●		●		●					●
- identification of radio and television stations that will continuously inform the public during the initial trauma										●
- identificaton of the pre-designated local on-scene coordinator (LOSC) by name and/or position	●		●	●	●		●			●
- a mechanism for updating	●		●		●					
- a document showing how the local plan interfaces with the federal and state plans	●		●	●	●		●			●
- identification of a liason official to work with the state and federal OSC	●		●	●	●		●			●
- continually updated phone numbers of key officials	●				●					●
- check-in location where key officials can be located or tracked once they have appeared on-scene	●		●	●	●		●			●
- a method for identifying and accounting for individuals who may have authority on-scene					●					●

5.3.2 Training of Emergency Response Personnel

There are a number of training courses available which are taught by government, industry, educational institutes and consulting organizations aimed specifically at responders to hazardous materials incidents. These courses vary from formal academic class sessions to slide-tape presentations, with an insructor's guide and student workbook, to the home-study (correspondence) course. The slide-tape courses run from five to twenty hours of class time. They may or may not be modular (i.e., deal with topical areas such as hazardous materials identification, decision-making and seeking technical assistance).

Hazardous material training courses stress planning but also present some basic information concerning the nature of hazardous materials; how to identify spilled/leaking material; where to find technical help; danger assessment; decision-making; and to a cetain extent some general procedures for on-scene actions such as controlling access to the area, evacuation, surveillance of vapor clouds, firefighting, rescue and communications. In some instances, there is hands-on training such as use of polyurethane foam for sealing holes in drums or diking liquid pools, applying metal patches to tank car holes by means of bolts or stopping leaks with wooden plugs. These are useful techniques, but have limited application to specific situations. Heavy reliance must still be placed on the specialists from the varous disciplines involved. These specialists operate and make decisions based predominately on their own experience and knowledge and, with few exceptions, perform tasks without the benefit of written procedures, particularly with respect to cargo transfer, wreckage removal, cleanup and disposal. Although these courses give some attention to restoring the scene to normal, there is a lack of procedural training in these four activities.

There are many training aids available in addition to the courses themselves. Examples are nomographs, slide rules, pocket manuals, checklists, brochures, guides, films, video tapes, slide-tape combinations, reference books, data bases, resource lists and charts. The U.S. Department of Transportation's Materials Transportation Bureau provides, free-of-charge, quantities of a number of hazardous materials training aids to emergency service organizations. Others may be purchased from the Government or private companies. Rail carriers, in conjunction with the Chemical Manufacturers Association, are putting on hazardous materials transportation emergency training courses in communities where chemical shippers are located or through which rail lines run.

The U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau has compiled a list of 342 organizations offering training courses on hazardous materials transportation.

Regardless of the type of activity -- immediate response, hazard mitigation, cargo transfer, wreckage removal, cleanup and disposal or the specialist discipline involved -- training must assure that procedures are understood and utilized to accomplish the following four items:

1. Provide adequate on-scene communications
2. Evaluate/assess the situation, hazards and actions
3. Make decisions
4. Take appropriate actions

These are discussed in the following paragraphs.

5.3.2.1 Communications Training

An incident must be recognized and promptly reported to the proper authority. It is very essential that specific information about the accident be provided in this report so that the response network may be activated and those involved can have a reasonable idea of the nature of the accident and hazardous materials involved. Training in how, when, what and to whom to report a hazardous material accident is the first criterion. It involves the ordinary citizen, who by chance may stumble upon an accident scene, as well as those who might become involved as professionals. Communications within a particular response discipline, between groups and with the on-scene coordinator (OSC) are complex but vital. Therefore, training is required in the proper use of communications equipment. Also, the assignment of proper frequencies and responsibility for coordination of communications must be clearly identified in the emergency action plan. The persons responsible for coordinating communications need training:

- To understand the interface between different communication modes, frequencies and equipment;
- To understand, interpret and relay facts and requests being made by or sent to the numerous groups and individual specialists involved in the emergency;
- To recognize and expedite priority communicati s;
- To deal effectively with the news media, by providing appropriate factual information and by utilizing the news media as a means of mitigating hazards to the public such as preventing panic and providing proper instructions or warnings; and

- To know how to use communications to coordinate effectively the many activities taking place on-scene and as backup, so that such activities do not interfere with or jeopardize safety of each group and that resources are used most effectively.

The various response groups and individual specialists need communications training in order to learn proper procedures for maintaining constant contact with in their particular groups so that everyone is always accounted for, prompt escape action may be taken if the need arises, and the OSC can be provided with the latest facts on conditions, progress, problems and needs.

The public needs training in such areas as simple self-protection actions (i.e., stuffing cracks in windows or doors) in the event of a hazardous material spill; getting and keeping away from the scene; obeying evacuation orders; and, as previously mentioned, reporting an incident.

The news media can be a real help or can compound the problem. Making the news media aware of and, where possible, a participant in hazardous material spill response training, can make it a strong positive force in a real emergency. Training courses need to contain a portion showing how the news media can assist in the event of an accident. News media representatives should be included in the preparation of the community's HM emergency response plan and in training courses that are given.

All persons who will be concerned with a spill must have further training in evaluation/assessment methods, decision-making, the procedures required in their specific activities and awareness of how their actions impact others.

5.3.2.2 Training for Decision-Makers

It is imperative that training be designed to meet the needs of all decision-makers. Depending upon the individual responsibilities and the particular types of activities involved, training can range from checkoff lists to computer-aided decision-making methods. Essential to all decision-making is consideration of the situation or problem, the alternative courses of action, how the action will be accomplished, when and by whom, and what will be the expected impact or results of each. Evaluation and assessment of the situation are the key factors upon which sound decisions are based. Therefore, a detailed discussion of training requirements for decision-makers in evaluation and assessment is presented.

A chemical, propellant or other hazardous material transportation accident requires initial and continued assessment of the situation and evaluation of the

requirements and effectiveness of corrective actions. Essentially, these involve obtaining facts and analyzing them. Training is vital to assure that those involved with the emergency know what information is necessary, how it may be obtained and how to analyze it for determining the existing hazards, potential dangers, what damage has been sustained, the magnitude of the spill, who and what are exposed, what resources exist and how they can be used most effectively, what additional resources are required, and the effectiveness of corrective actions. Such training should involve how to:

- identify at a distance any HM's involved or that have been released;
- determine the integrity of the HM containers;
- establish the danger perimeter;
- predict the downwind toxic or flammable vapor concentration versus distance as well as cloud size and travel rate;
- use resources most effectively;
- determine the applicability and effectiveness of corrective actions;
- use remote sensing/detection/analytical equipment;
- interpret data;
- spot changing conditions which pose additional dangers;
- assess risks;
- determine hazards; and
- monitor the scene for toxic or flammable vapor levels and for evidence of personnel exposure.

Such training includes teaching formalized methodologies where appropriate (i.e., risk/hazards analysis).

5.3.2.3 Response Activities Training

Training is required to assure effective and safe performance of all the on-scene and support activities in handling hazardous materials transportation spills. This fourth aspect of training deals with the actual field operations and what type of procedural training deals with the a :tual field operations and what type of procedural training is appropriate to each of the specialized groups and individual experts involved. This training involves ways to select, use and identify the limitations of equipment and materials (i.e., use only transfer equipment which is compatible with the particular hazardous material or use gravity flow, pressure flow or pumping as cargo transfer means). Training can help train crew members and truck drivers:

- to understand the HM's aboard, their hazards and the precautionary procedures they can use in the event of an accident;
- assist them in seeking response help;

- convey HM information to response personnel; and
- otherwise cooperate with authorities on-scene.

There are continued hazards at chemical and propellant spill scenes and the degree or nature may change. Training for on-scene personnel needs to include procedures for recognizing the actual and potential hazards and the eventuality of a significant change. Their training needs to assure that each person understands not only how to perform his own task efficiently, but to recognize the absolute necessity for safety and accomplishing the task without jeopardizing the safety of others at the scene or creating problems for them, while at the same time protecting the environment and property. Training on the selection and use of proper protective clothing, breathing apparatus, gear, tools, equipment and materials is vital to personnel safety and the successful handling of the spill. Training is needed in the techniques, limitations and safety precautions for cargo transfer, wreckage removal, cleanup and disposal operations. Hazard mitigation involves any means for reducing or eliminating the hazard or threat, so it cuts across the full spectrum of on-scene activities. Training needs to concentrate on the use of common sense coupled with good information and sound technical analysis.

5.3.2.4 Training of Emergency Response Personnel in the Cities Reviewed

All of the ten cities reviewed utilized some form of training program for response personnel who deal with hazardous materials under emergency conditions. Eight of the ten cities reviewed stated that they trained personnel in the use of the Department of Transportation's 1980 Emergency Response Guidebook. Of the two cities which did not train emergency response personnel in the use of the DOT Guidebook (i.e., Pensacola, FL and Youngstown (Panama City, FL)), Pensacola does not recommend the use of the DOT Guidebook because they question the Guidebook's utility while Youngstown (Panama City) does not use the guide because they do not have sufficient copies available for all response personnel. It is recommended that if Youngstown (Panama City) chose to utilize the DOT Guidebook that they procure enough manuals to supply each of the emergency response vehicles in the area. The Pensacola area prefers to utilize the Association of American Railraod's Bureau of Explosives response guide entitled Emergency Handling of Hazardous Materials in Surface Transportation. In terms of actual training programs seven of the ten cities utilize at a minimum the NFPA hazardous materials training program entitled Handling Hazardous Material Transportation Emergencies. According to the DOT Material Transportation Bureau the NFPA training course was designed to:

"assist those ...who assume and accept, often at great personal risk, the responsibility of responding to and dealing with transportation accidents involving hazardous materials... provide guidelines for handling hazardous materials during emergency situations and to assist persons with varous emergency services responsibilities in better understanding their roles in the development and implementation of comprehensive and community emergency action plans."

The NFPA hazardous materials training course provides emergency response personnel with information on hazardous materials in-transit; definitions, classes and dangerous properties of hazardous materials; recognizing and identifying hazardous materials incidents; command and control of hazardous materials incidents; and planning for hazardous materials emergencies.

Of the seven cities which utilize the NFPA hazardous materials training course, five use this curriculum in conjunction with specially designed city programs which were developed to meet the specific requirements of each city. Of the ten cities reviewed only Wilmington, DE relies upon the training services of a State Training Academy for the purpose of preparing emergency response personnel in the handling of hazardous materials emergencies.

In all of the cities reviewed except Youngstown (Panama City), FL all emergency response personnel are given some form of hazardous materials training. In Youngstown (Panama City), FL training is provided only to members of a hazardous materials advisory board. It is recommended to the Youngstown (Panama City), FL area that all emergency respnse personnel be provided with at least the NFPA hazardous materials training course.

5.3.3 Availability of On-Site Resource Requirements

5.3.3.1 Protective Clothing, Gear and Equipment Availability and Uses

When entering a hazardous environment, appropriate protective clothing, gear, breathing apparatus and equipment must be used. This section does not discuss the specific items required for working in specific hazardous environments, but identifies the types which should be available on-scene and their uses.

In terms of personal protection, emergency services should have available protective clothing, acid suits, chemical/gas suits, cooling systems (heat exchangers) and fire entry suits for use by responding personnel. In terms of breathing apparatuses, regulated manifold air supply systems, assorted cannister masks and cartridges should be available.

Several commercial manufacturers/suppliers produce this type of equipment. A sample listing of a few manufacturers/suppliers is given in Table 5-6. Table 5-6 is not an endorsement of any of these items or manufacturers and the types of personal protective clothing, equipment and gear which they supply. Chemical manufacturers, the U.S. General Services Administration catalogues, telephone yellow pages, EPA and USCG Regional Offices are other sources of this type of information.

Local emergency services should obtain the obvious personal protective clothing, equipment and gear required for handling the types of hazardous commodities being transported through or consumed in a community. Clothing, equipment and gear should be thoroughly inspected and tested periodically to assure that it will provide the required level of personal safety. Protective clothing, equipment, breathing apparatus or gear which does not meet these strict safety standards should be either discarded or repaired. Once repaired, inspection and testing should be conducted to assure that the repair was adequate. Penalities should be imposed on individuals/organizations which do not abide by these guidelines and who subject personnel to unnecessary hazards due to negligence in enforcing these requirements. These items are expensive and the various segments of the emergency response community have much to gain by pooling resources.

5.3.3.2 Specialized Treatment Chemicals, Equipment, Resources Availability and Uses

Specialized treatment chemicals, equipment and resources are needed at a hazardous materials transportation accident. This section identifies treatment chemicals, sorbents and analytical and heavy equipment which can be utilized on-scene.

5.3.3.3 Treatment Chemicals and Methods

Several treatment chemicals and methods exist for mitigating the hazards associated with a spill and the decision to use one specific method must be based on technical need, material availability, State and Federal limits for materials in the environment, cost versus effectiveness and residues requiring disposal.

Once the treatment considerations have been analyzed based on the accident conditions and the aforementioned factors, it is then possible to select the appropriate treatment method. Table 5-7 lists some treatment methods for handling spills of hazardous materials.

It needs to be emphasized that only compatible treatment chemicals should be used with the spilled material; mixing incompatible materials may result in worsening the

TABLE 5-6

SOURCES OF PROTECTIVE CLOTHING,
BREATHING APPARATUS, GEAR AND EQUIPMENT

Item	Manufacturer	Location
Portable resuscitation units	Robert Shaw	Anaheim, CA
Gas/vapor respirators	3M Company	St. Paul, MN
Breathing Apparatuses (15-60 minute capacity)	Lab Safety Supply	Janesville, WN
Gas Mask (30 minute capacity)		
Organic Vapor Respirator		
Acid Gas Respirator		
Gloves		
-neoprene (corrosives)		
-nitrate (aromatic, petroleum and solvents)		
-polyethylene		
-PVA coated (organic solvents, aromatics, ketonics and chlorinated solvents)		
Face Shields		
Safety Caps		
Splash Suits		
First Aid Kits		
Breathing Apparatus	Mine Safety Appliances (MSA)	Pittsburgh, PA

TABLE 5-7

HAZARDOUS MATERIAL TREATMENT METHODS

- Carbon absorption
- PH adjustment
- Air stripping and aeration
- Precipitation
- Neutralization
- Biological
- Destruction
- Solution/Dilution
- Mixing
- Land Spraying

situation. Local contingency plans should identify the local and availability of chemicals for treating any hazardous materials which flow through a community. Some common spill control materials available are acid and caustic neutralizing agents, diatomaceous earth, vermiculite, Portland cement, sawdust, activated carbon and various commercial sorbents.

5.3.3.4 Sorbent Materials

Use of sorbent materials to soak up and contain spilled hazardous materials during initial response, product transfer, cleanup and disposal operations at the accident site is common practice. Typical sorbent devices include spill control pillows, which absorb 98% of their capacity in 30 seconds (a number of these can be combined to form a dike); spill squeegee and absorbent paper. It is recommended that a stockpile of such materials be kept by the local community at all times. However, if this is not feasible, the community should identify the location where these supplies can be obtained in a timely fashion, establish cooperative agreements with local chemical manufacturers who would have a supply in-house, or obtain these materials from the product transfer, cleanup and disposal contractor directly.

5.3.3.5 Monitoring Devices

Monitoring devices are a necessity at hazardous materials transportation accidents. Analytical monitoring devices serve such functions as identifying hazardous materials on-site and providing continuous monitoring for toxic, flammable and explosive vapors during all phases of accident response. Table 5-8 is a partial listing of analytical monitoring devices that communities should have available for use in the event of a hazardous materials transportation accident. In the event of a hazardous materials transportation emergency, communities should seek to have most of this equipment available for their use. Analytical monitoring equipment may be purchased exclusively for the use of a city's emergency services, borrowed from a community chemical manufacturer or chemical laboratory, obtained from a region's state emergency preparedness/civil defense office or acquired for use from a nearby military installation. Fire departments have flammable vapor detectors. It is recommended that communities obtain and pool as much of this equipment as possible. However, when a locality cannot fund such purchasing it is recommended that agreements be pre-established with state preparedness/civil defense and military installations for their use and any technical assistance in their operation, as needed.

5.3.3.6 Heavy Equipment

Similarly, heavy equipment are a necessity at hazardous materials transportation accidents. Table 5-9 is a partial listing of heavy equipment that communities should have available for use in the event of a hazardous materials transportation accident. Heavy equipment can usually be obtained through the state or local Department of Highways and Transportation or through a local construction contractor.

5.3.3.7 Wreckage Removal Contractors

When a transportation accident occurs and the services of a wreckage removal contractor are required on-scene, the choice of a wreckage removal contractor will depend upon the transportation mode involved in the accident, the accident severity in terms of structural damage to equipment, proximity of accident site to contractor's facility, and contractor's available resources. For purposes of this report we are concerned with wreckage removal contractors who respond to rail and highway hazardous materials transportation accidents. Most often, and it is sound safety practice, these contractors will not respond on-scene until all toxic, flammable and explosive vapors related to hazardous materials have been dissipated from the accident site, and the area is considered to be a safe working environment. When wreckage removal contractors are required at rail transportation accidents, special heavy equipment is needed. Two organizations which have historically provided on-site wreckage removal activities to rail transportation accidents are:

Rail Wreckage Removal Contractors

- Isringhausen Crane Manufacturers, Inc.
  One Industrial Drive
  Jerseyville, Illinois 62052
  (618) 498-6441

- Hulcher Emergency Services, Inc.
  Box 191
  Virden, Illinois 62690
  (217) 965-3361
  (800) 252-3371 in Illinois
  (800) 637-5471 outside Illinois

Wreckage removal contractors involved in the response to accidents of highway vehicles are typically local towing or wreckage services. Listing of these organizations can be found in the local telephone directory yellow pages. Unfortunately, their response capabilities are less sophisticated than the groups which respond to railroad accidents.

TABLE 5-8

ANALYTICAL MONITORING EQUIPMENT

- Gas detector
- Combustible gas/oxygen detector
- Oxygen deficiency monitor
- Electrical safety hazard analyzer
- Radiation/contamination survey meters
- Infrared radiometer
- Explosimeter
- Mass spectrometer
- Colorimetric tubes

TABLE 5-9

HEAVY EQUIPMENT

- Bulldozer
- Crane
- Backhoe
- Highloader
- Dump trucks

Local contingency plans should have these telephone numbers available for use in the event of an accident and only those considered to be qualified and reliable should be listed.

Accident severity influences the level of sophistication required for equipment to be brought on-scene. Proximity of the accident site to the contractor's location influences response time and availability of personnel, equipment and materials. State and local emergency response plans should have pre-identified wreckage removal firms which are capable of responding to transportation accidents that occur in a specific area.

The personnel, equipment and material resources available to the wreckage removal contractor at the time of the accident may influence the choice of a firm to perform the wreckage-removal operations. This can be illustrated by a situation where a wreckage-removal contractor's facility is located one mile from a railroad accident, but due to their inability to provide heavy lifting equipment to the scene, it is concluded that this firm does not have long-term on-scene response capabilities. Since heavy equipment would be needed in this instance, a wreckage-removal contractor having heavy equipment would have to be contacted, even if this firm's facility is located 450 miles from the accident scene. Of course, response time will be increased significantly, but this should not create a big problem because wreckage removal should not begin until the situation is stabilized. The on-scene coordinator should not automatically discount the value of a wreckage removal contractor who does not have the heavy equipment, for this firm may be able to assist in the short-term until the better equipped wreckage removal contractor can arrive on-scene.

Acquiring a wreckage removal contractor is just one of the many decisions which the on-scene coordinator must make regarding the use of outside technical experts.

5.3.3.8 Product Transfer, Cleanup and Disposal Contractors

At most hazardous materials transportation accidents the services of product transfer, cleanup and disposal personnel are required. In many cases, the shipper or association to which the shipper belongs may provide such specialized service. The carrier should involve the shipper in the selection of a product transfer, cleanup and disposal contractor.

The community contingency plan should identify product transfer, cleanup and disposal contractor(s) who are capable of meeting the locality's requirements, based on the hazardous materials being transported in the area, and in the event the shipper and carrier elect not to handle the arrangement or request a recommendation.

In terms of on-site product transfer, cleanup and disposal operations, the following information should be available to the on-scene coordinator and others who must make decisions regarding these activities:

- Waste disposal sites capable of handling the spilled materials as well as state solid waste management agencies;
- Shipping container specifications required for transport of each chemical shipped through the area; and
- Applicable Federal, State and local regulations pertinent to the transport of these commodities.

Local decision makers should familiarize themselves with this information, so that, when local contingency plans are developed, data on the location and capabilities of local waste disposal facilities and availability of shipping containers required for disposal based on the community's hazardous materials transportation needs will have been identified. By so doing it is anticipated that product transfer, cleanup, and disposal activities may be performed at the greatest level of cost-effectiveness and personal safety.

5.3.3.9 Specialized Response Capabilities of Each of the Cities Reviewed

The analysis of the availability of specialized response personnel, equipment and gear in each of the ten communities reviewed concentrated on identifying whether or not each of the cities had the following resources available:

- Hazardous material react team
- Mobile response van
- Specialized equipment and gear (i.e., CHLOREP patching kit, positive pressure breathing apparatus, heavy lifting equipment, foam trucks, analytical testing equipment, hazardous material reference library, personal protective clothing, acid suits, Scott air packs, etc.).

In fifty percent of the cities visited, hazardous materials react teams are available through the local fire service. These cities are Baltimore, MD; Los Angeles, CA; Nashville, TN; Sacramento, CA; and Tallahassee, FL. In Newark, NJ the response team and mobile response van are operated by the state and these resources are located approximately two hours away from Newark. In Pensacola, FL response to hazardous materials transportation accidents are handled by the fire service with the local chemical manufacturers providing technical assistance. Nashville, TN provides response capabilities to the entire central portion of Tennessee under a local/state agreement in which Nashville provides the trained emergency response personnel in exchange for being supplied specialized emergency response equipment at state expense to respond to incidents in the central portion of the state. Under this local/state agreement, the

metropolitan Nashville area has the responsibility for responding to hazardous materials incidents at cities like Waverly, TN. This agreement was probably a result of the tragic accident at Waverly in which they did not have the capabilities to adequately handle the assessment required. Waverly, TN also has an agreement with three chemical manufacturers in the area which provides industrial response assistance if an emergency were to occur. In the Youngstown (Panama City), FL area a react team has been developed which consists of one representative from each of the emergency response service organizations in the area.

All of the cities except Newark, NJ; Waverly, TN; and Youngstown (Panama City), FL have direct access to a mobile hazardous materials response van. A response van is available to Newark, NJ but is stationed at Trenton - nearly two hours south.

The majority of cities visited had positive pressure breathing apparatus, personal protective clothing and Scott air packs. Resources which some of the cities had but were more limited included CHLOREP patching kits, analytical testing equipment, extensive hazardous materials reference libraries, acid suits, cascade systems, mobile communications vehicle/command post and a converted bus for use as an ambulance. It is recommended that each city purchase or make a mutual aid agreement so that these aforementioned resources would be available for use in a hazardous materials transportation emergency.

5.3.4 Identification of Problems Encountered by Cities in Actual On-Scene Response to Hazardous Materials Transportation Emergencies

During visits to each of the ten cities an attempt was made to identify problems which have been encountered or could be encountered at a hazardous materials transportation accident. A list of the most frequently mentioned problem areas include:

- Identification of hazardous materials involved in the accident;
- Visual assessment of container structural integrity;
- On-scene interagency communications; and
- Unavailability to technical assistance after normal business hours.

5.3.5 Innovative Approaches to Handling Hazardous Material Transportation Accidents

During the review of each community's contingency plan, hazardous materials training programs and specialized response personnel, gear and equipment, certain innovative approaches to handling hazardous materials transportation accidents were identified. These approaches are listed here in the hope that they may assist a

community in their actual on-scene response activities. This information is intended for cities which may not have been aware of these approaches. In each situation where an innovative approach or equipment is cited a contact and telephone number in the representative city is noted.

1. Development of a procedures manual which contains guidelines for emergency response activities at hazardous materials transportation accidents.

An example of specific guidelines applicable to hazardous materials transportation accident emergency response activities can be found in Appendix E. For additional information on this subject contact Captain James Henry, Baltimore Fire Department (Fire Prevention Bureau) at (301) 396-5752.

2. Deployment of a fire house in the given metropolitan community which has the responsibility of responding exclusively to transportation accidents and other releases involving hazardous materials.

Information on an example of this fire house and its capabilities should be addressed to Chief Cooper, Nashville Fire Department, at (615) 383-8922.

3. Establishment of a cooperative agreement between a metropolitan government and the county (represented by the county fire department) and the State in which the state will provide emergency response equipment if the metropolitan area will be in charge of responding to hazardous materials incidents in a specified geographic region of the state.

This distribution of specialized response personnel, gear and equipment is innovative in that it provides response capabilities on a regional basis rather than upon the individual purchasing power of a specific city. An example of this type of system and further information on this subject can be obtained from Chief Cooper of Nashville.

4. An area's integration into their hazardous materials response plan of the contact and 24-hour/day telephone number of specific types of specialized response equipment such as air compressor, bomb disposal, boom trucks, etc.

An example of an inventory of specialized response equipment in a contingency plan is available from Chief Cooper of Nashville.

5. A community's attempt to identify the location and storage capacity of chemical manufacturers as well as the quantitiy and type of hazardous material shipped through the area.

An example of a city which is attempting to identify the location and quantity of chemical manufacturers in the area is Newark, NJ. Comments should be addressed to Dr. Leonard Dauerman, Director of the Law and Technology Center of the New Jersey Institute of Technology (NJIT) at (201) 645-5522.

6. A metropolitan region which has been subdivided into 14 response regions, each having a fire chief who serves as on-scene coordinator if a hazardous materials transportation accident occurs. The area also has available for use on-scene a converted bus which can serve as a 10-passenger ambulance and a mobile command/support post.

For example, such capabilities are available in Pensacola, FL (Escambia County). Details of these capabilities can be obtained through contacting Buck Renfro, Coordinator of Civil Defense for Escambia County at (904) 436-9711.

7. Metropolitan areas having "cascade" systems which can replenish oxygen into breathing apparatus on-scene.

Two such areas are Pensacola, FL and Sacramento, CA. Contact either Buck Renfro of Pensacola, FL at (904) 436-9711 or Captain Jan Dunbar of Sacramento, CA at (916) 449-5267 for further information.

8. An area having reports for hazardous substances spills, response checklists and emergency resources found in their Disaster Operations Plan.

Samples of these reports can be found in Appendix F for Panama City (Youngstown, FL). Further information of this technical documentation can be obtained from Mr. Jim Heisler, Director of Defense Civil Preparedness of Bay County at (904) 769-2181.

5.4 RECOMMENDATIONS FOR IMPROVED MUNICIPAL METHODS FOR IMPLEMENTING CRISIS MANAGEMENT TECHNIQUES

Based upon the extensive review and assessment of methods for implementing crisis management techniques for hazardous materials transportation accidents in the ten selected cities some deficiencies in response capabilities appear to be widespread while others tend to be localized in one or two cities. The recommendations made are general in nature as they apply to all cities and no provision has been made to address any city/area in specific. Based upon this review the following are recommendations which all cities/areas can adopt to provide improved methods for implementing crisis management techniques to address hazardous materials transportation accidents.

1. Even though there are special emergency response numbers, in the event of emergency situations the 911 emergency telephone system is of great value for emergency notification and communications.
2. Many cities need to develop hazardous materials contingency plans.
3. Specific guidelines should be developed for handling the hazards associated with the release of hazardous materials shipped through or stored in the given area.

4. Improved hazardous materials training programs and aids should be provided to municipal police personnel.

5. Cities/communities should regularly stage mock-up hazardous materials transportation accidents or other chemical releases as part of their continuous training and readiness programs.

6. Guidelines should be developed and refined for visually assessing the structural integrity of tanks involved in hazardous materials accidents.

7. Communications capabilities and coordination on-scene should be improved so that the OSC can be aware of the activities of all response organizations involved in hazards mitigation on-scene.

8. Fire service personnel should use positive pressure breathing apparatus when approaching the scene of a hazardous materials release.

9. Volunteer firefighters should be given the same hazardous materials training that paid personnel receive.

10. Emergency response personnel should be required to receive follow-up hazardous materials training after a specified period of time.

11. A designated communications network should be established which will provide for a mechanism to alert the public and to handle communications between the communications command center, the accident site and other off-scene support organizations.

12. Contingency plans should identify radio and television stations that will continuously inform the public during the initial phases of the emergency.

13. Contingency plans should provide for an update mechanism.

14. Contingency plans should provide for a method of identifying individuals who have authority on-scene.

15. Contingency plans should give telephone numbers and names of personnel or organizations which would be required to respond on-scene.

16. It appears that cities preferred to carry the DOT Emergency Response Guidebook. However, a sufficient supply of these was not available in all the cities reviewed. Thus, every effort should be made to procure these manuals for initial notification and response purposes.

17. Cities/communities should provide some form of hazardous materials specific training.

18. Municipalities which do not have specialized personnel, equipment and gear for use on-scene may want to pool their resources for the purchase of needed resources.

19. Methods for improved access to technical assistance after normal business hours should be obtained.

During the in-depth review of local methods for implementing crisis management techniques for hazardous materials transportation accidents it can be seen that all cities are not adequately prepared for handling HM accidents. One promising method that would provide greater response capabilities and could serve as a training tool is discussed in the next section.

6. CRITERIA FOR INTERACTIVE FEEDBACK CRISIS MANAGEMENT SYSTEM

This section presents criteria for an interactive feedback crisis management system. The eventual development of such a system could serve not only as a training tool for emergency response personnel to simulate the mitigation of hazardous materials transportation accidents, but it could be used by emergency response personnel at actual hazardous material accidents.

The first part of this chapter gives an overview and assessment of state-of-the-art (SOA) interactive feedback crisis management systems in existence; their capabilities and potential utility on-scene. Subsequently, criteria are developed for an interactive feedback crisis management system including hardware/software component requirements.

6.1 OVERVIEW AND ASSESSMENT OF SOA INTERACTIVE FEEDBACK CRISIS MANAGEMENT SYSTEMS

This assessment is necessary so that the adequacy or inadequacy of existing interactive systems utilized by emergency response personnel and other individuals can be determined. Interactive feedback systems can vary in complexity. The simplest may be for on-line data retrieval. The more sophisticated may be used as training simulators; some are actually used on-scene for management of the hazardous materials accident.

Information retrieval systems such as the Oil and Hazardous Material Technical Assistance Data Systems (OHMTADS), USCG's Hazardous Assessment Computer System (HACS), Chemical Transportation Emergency Center (CHEMTREC), etc. are not discussed here because as stated by the EPA "information retrieval sources should be considered secondary sources of information because information is from the published literature or past events, and because interaction is limited since the contact usually has no special expertise in spills technology or hazardous chemicals." Thus it is proposed that existing SOA interactive feedback systems, of the information retrieval type, do not at this time warrant additional development efforts because the data base information provided by these systems does appear adequate (i.e., except for predicting the vapor dispersion patterns of certain dense gases including topographic effects), and the sources of information are sufficient in number to meet the needs of Federal, state and local emergency response personnel as well as others involved in hazards mitigation activities on-scene. A detailed overview of SOA information retrieval systems and an assessment of their applicability to hazardous materials accident management is given in Section 3.1.5 of the "Draft Guidelines Manual" for the "Post-Accident Procedures for Chemicals and Propellants" project (F04611-80-C-0046).

The review of SOA interactive feedback systems demonstrated that the actual number of existing systems which have potential application to on-site hazards mitigation activities is quite limited. One system designed to provide an on-scene coordinator and other emergency response personnel information required on-scene is called the "Emergency Management System," developed by Information Systems, Inc. of Washington, D.C. This system consists of hardware and generic software programs for the following types of emergencies: fire; controlled or uncontrolled radioactive radiation release; airport/aircraft emergencies; military installations emergencies; local emergency operations centers; railroad and surface transportation emergencies; building emergencies (hotel, apartment, commercial); hospital/medical emergencies; and industrial manufacturing plant emergencies. The system does not currently have the capability for use by emergency response personnel at a hazardous materials transportation accident because of software limitations.

6.2 FEASIBILITY OF INTERACTIVE FEEDBACK SYSTEM AS A TRAINING AID/ACCIDENT SIMULATOR

6.2.1 Interactive Feedback System Capabilities

Interactive feedback systems, as implemented in computer graphics, have been used for manipulation of basic data presentations, i.e. bar chart, pie chart and network modelling. It is a fact that personnel utilizing interactive computer graphics systems can retrieve and segregate large data bases extremely rapidly. The graphics of displaying the data allows the operator to scan and mentally absorb trends, location, relative position, etc. of the displayed data. This information can effectively be used to aid in the development of a logical plan for managing an ongoing accident.

Part of the data to be utilized in a hazardous-material-response interactive graphics system should be locality specific. Examples of this may be the location of emergency response equipment, schools, population centers, unusual topographical features with respect to the designated locality. A locality could very well be a county area or an entire state. One visual display could depict the accident site and then on command one could superimpose the desired locality specific item. Also, the operator will be able to choose specific items that are to be displayed and reformat them in an alternative configuration on the visual graphic terminal.

Another requirement for the system software is the ability to plot vapor cloud dispersion with respect to the local topographical and meteorological conditions. This

cloud should be displayed on the graphics terminal to allow the operator to identify areas that may be encompassed by the anticipated movement of the vapor cloud and need to be evacuated. Population densities should be plotted in color on the visual graphic terminal and overlayed with the vapor cloud to allow emergency response personnel to easily determine where they can be most effective in reducing possible exposure to local residents from the hazardous vapor cloud. This can easily be expanded to include dangerous situations associated with possible explosion caused by the damaged tank car also it would portray impact areas that could be effected by "vent and burn" methods of dissipating hazardous material cargo.

6.2.2 Feasibility of Interactive Feedback System as a Training Aid/Accident Simulator

An interactive feedback system may have several applications to hazardous materials transportation accident mitigation activities. These applications include utility in community contingency pre-planning, training of civic and emergency response community leaders as well as a real-time accident emergency response tool.

Concerning the use of an interactive feedback system for community pre-planning purposes a system of this type would be useful in providing data base information to local officials who would be involved in pre-planning for hazardous materials transportation accidents. The types of information which would be beneficial to these individuals includes:

- Hazardous material shipping routes and volumes through community;
- Community transportation networks and designated evacuation routes;
- Location of specialized personnel, materials and equipment in the community adequate to handle hazardous material emergency;
- Listing of appropriate segments of the emergency response community, their responsibilities and authority;
- Sources of technical assistance for specific commodity emergencies;
- Listing of communications organizations in community (i.e., radio and television) which could alert the public of the accident and provide communications support between the communications command post and the accident site;
- Hazard mitigation guidelines for each known substance;
- Guidelines and areas designated for evacuation due to threat of toxic vapor dispersion (i.e., schools, hospitals and large population centers); and
- Recommended evacuation routes as a function of accident location and environmental, topographic, meteorological and demographic considerations.

Regarding the use of an interactive feedback system for training of civic and emergency response community leaders the system could provide great utility in the development and testing of alternative decision/response scenarios based on varying the hazardous material involved and environmental conditions. In the phase where an interactive feedback system is used in the development and testing of alternative decision/response systems it could be used for training emergency response personnel in handling the hazards associated with the accident as well as a simulation technique to represent an accident which has various hazardous materials, envirionmental, topographical, meteorological and demographic conditions.

For use in normative exercises an interactive feedback system would provide the benefit as a practical simulation system that follows a carefully designed logical sequence with a pre-specified "best" solution while at the same time giving interactive guidance to participants during the exercise to the "best" solution.

The normative exercise concept is shown graphically in Figure 6-1. The players can be thought of as the key personnel in charge of managing the emergency; these players would typically be fire chiefs, transportation officials, environmental protection officials, perhaps the local sheriff, and perhaps even the mayor.

These players would be located in the command post which for each state might be in the Office of Emergency Service (OES). In the normative exercise an accident environment is simulated at the command post to train the players how to respond. Each player submits information to the simulation control (SIMCON) on the part of the environment with which he is familiar, each through a series of terminals and graphics interfaces connected to a central processing unit of a computer. Out of this, the computer generates a strategy to guide the players in their response to the emergency, which eventually leads to the "good" solution. Now through the simulation tool, a perturbation is put into the environment; this causes the players to have to redefine their input to the CPU. From here the simulation control provides updated guidance to the players to put them on the path of the "good" solution. The perturbances to the environment might consist of a change in wind patterns (this could affect toxic gas dispersion and fire behavior), onset of heay rain, change from day to night when populations might migrate in or out of the accident zone, etc. It is expected that through this simulation tool the players in charge of the emergency response can be taken through man such scenarios or normative exercises thereby preparing them for proper response during an actual emergency. In the actual accident situation the environmental perturbation comes not from the simulation control but from feedback on

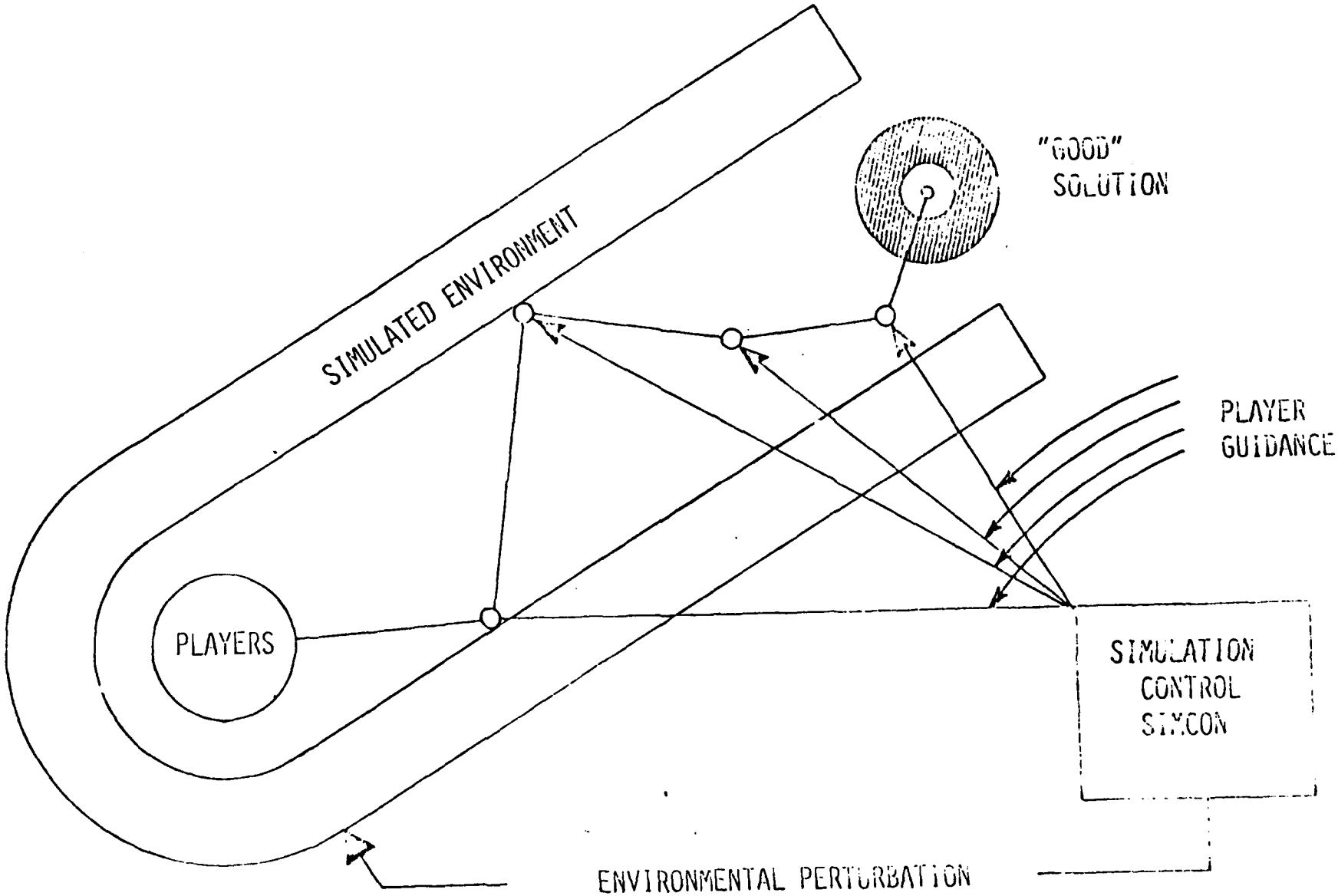

FIGURE 6-1. NORMATIVE EXERCISE CONCEPT

actual conditions and their fluctuations at the accident scene. The overall flow for the accident/response interaction is shown in Figure 6-2.

As a real-time accident emergency tool an interactive feedback system would provide ready access to existing on-line data bases; serve as an on-site interface between the data bases and communications command post; and provide increased capability and access to information for estimating downwind vapor concentrations; establishing evacuation radii based on population densities downwind from the accident site; etc.

Thus, it can be seen that an interctive feedback system can be a versatile tool for use in community contingency pre-planning, training and real-time emergency response. To implement such a system hardware and software need to be developed. The development of software will require extensive experience in hazardous materials response to transportation accidents, familiarity with local topography, demography and response capabilities available. Interactive computer hardware systems are available but relevant software must be developed.

6.3 POTENTIAL USERS OF INTERACTIVE FEEDBACK SYSTEM

This section identifies the individuals which would best be served by using an interactive feedback system in emergency response activities at hazardous materials transportation accidents. The time frame of accident mitigation in which the user would best be served in using such a system has also been identified. To establish both the user groups and the time considerations which would best be served, the NTSB investigated hazardous material accidents as well as the events at Mississauga in Ontario, Canada have been reviewed to identify the time at which specific organizations respond on-scene. The results of this analysis are shown in Figure 6-3.

The analysis showed that fire, police, industrial response teams, civil defense, highway patrol, sheriff, red cross, carriers representative, salvation army and other sources of technical assistance arrive on-scene within one and one-half hours after the accident occurs. It is also observed that it takes anywhere from 11-13 hours for representatives of the shippers and the Bureau of Explosives to arrive on-scene. Effort will be given in the development of guidelines to identify the optimum time period for which a system could most optimally provide utility to on-scene response personnel. However, the system should be available at all times during accident mitigation so that decision-makers can be posted as to changing on-site conditions and make proper restoration decisions based on the latest available data and technology.

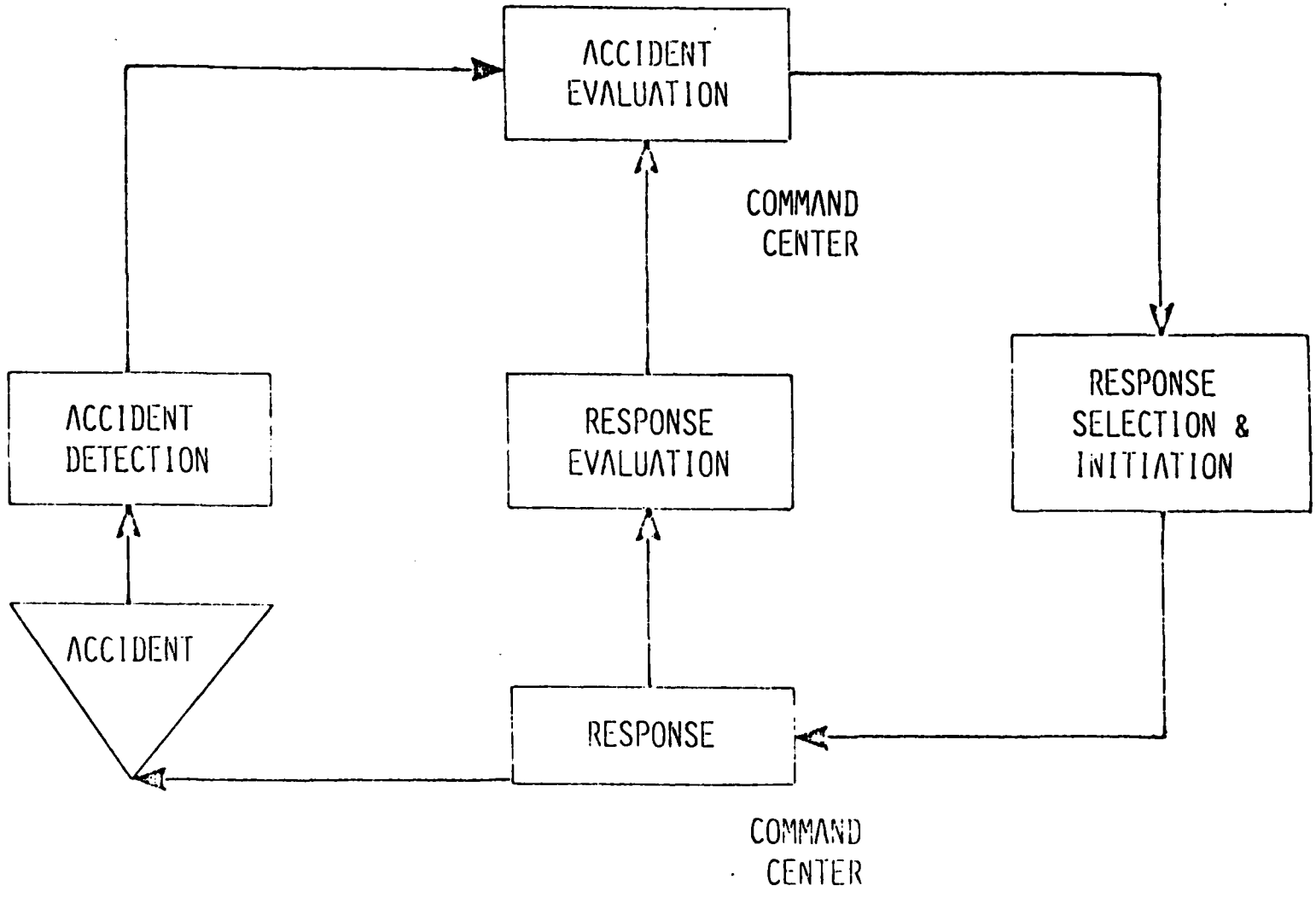

FIGURE 6-2. ACCIDENT/RESPONSE INTERACTIONS

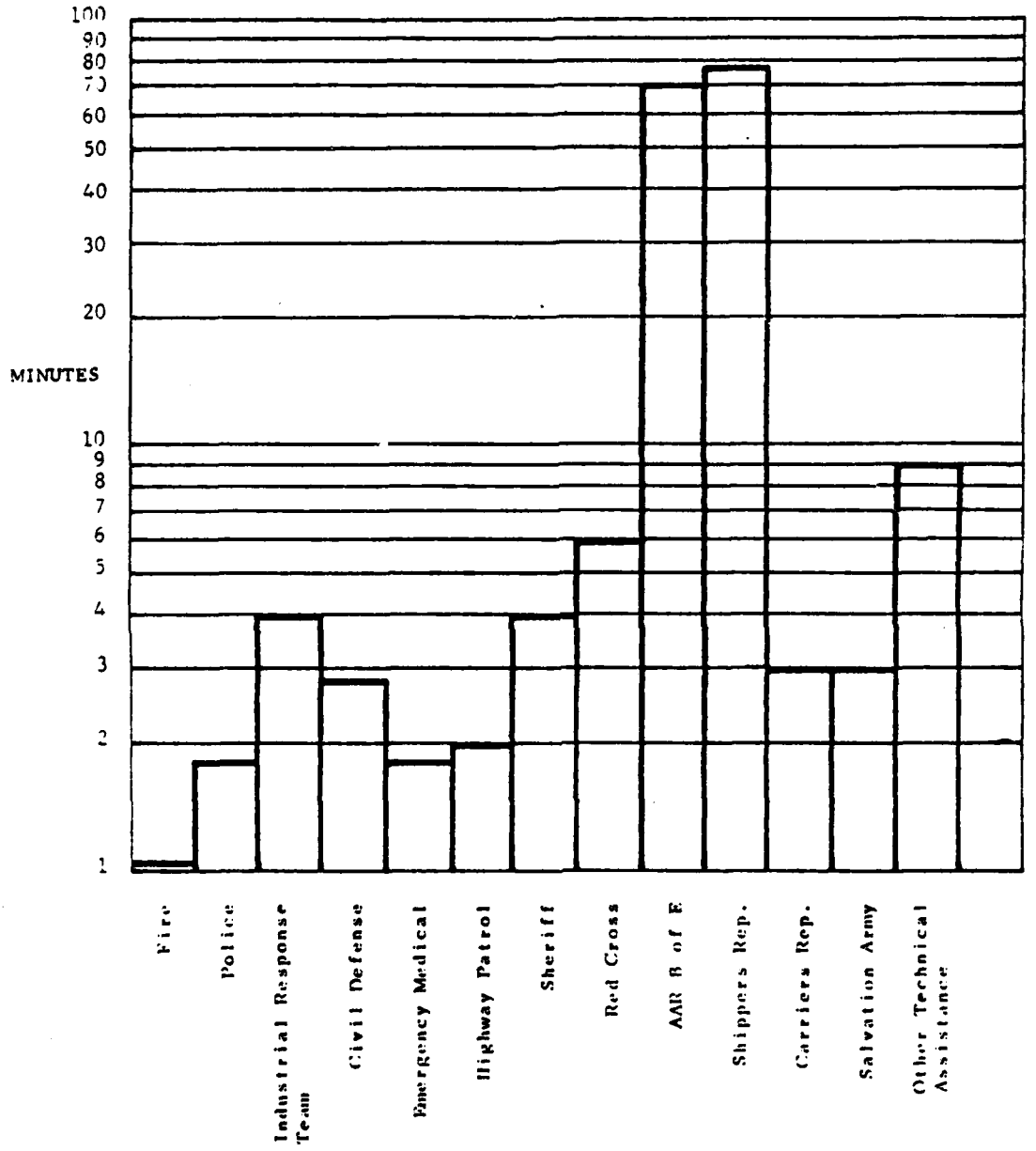

FIGURE 6-3. RESPONSE TIMES OF VARIOUS EMERGENCY RESPONSE ORGANIZATIONS TO IMI TRANSPORTATION ACCIDENTS

6.4 CRITERIA FOR INTERACTIVE FEEDBACK CRISIS MANAGEMENT SYSTEM

This section identifies criteria for an interactive feedback crisis management system including hardware/software component requirements as well as training aid/simulation modes.

6.4.1 Criteria for Hardware/Software Component Requirements

Previous discussion has shown that an interactive feedback system has many practical applications in hazardous materials accident management including use as an on-line data base information retrieval system for pre-planning, training of civic and emergency response community leaders as well as a real-time accident emergency tool. Hardware criteria for a system which could be used in pre-planning and training would be similar to existing components because these systems could be located in a fixed facility and consist of similar components. Hardware criteria for this system and applications should have the following characteristics:

1. Easily maintained;
2. Rechargeable power sources;
3. Cost-effective;
4. Readout should not require technical interpretation or computation;
5. Hard copy of the results should be available; and
6. Have a user oriented interface for ease of input.

In addition to the above criteria, criteria for an interactive feedback system as a real-time emergency tool must also have the following characteristics:

1. Portable (less than 50 lbs.) so that it can be carried over obstacles and irregular terrain easily to obtain accessibility;
2. Be able to function over a wide range of temperatures, vibration and environmental conditions;
3. Be intrinsically safe; and
4. Have constant monitoring capabilities

Concerning software requirements, the software should be developed in such a manner that the following criteria be met:

1. Be formatted in a computer language which is easily understood with a minimum of technical assistance and training.
2. Be based on actual accident experience and cover all phases of hazards mitigation from initial notification through resumption of normal operations.
3. Be interactive in the sense that the computer would prompt the user to make decisions on mitigating hazards.

4. Software is dynamic and can be easily updated based on varying data.

5. Data base be tailored on a community specific basis.

6. Various colors be used for differentiating data elements and quantities.

7. Minimal knowledge of computer programming is required to operate the system.

8. Video display should be subdivided into two sections. In the middle of the video screen will be a vertical line which will serve as a separator for the interactive question/answer mode displayed on the left of the line and a catalog of accident site conditions displayed on the right of the line.

9. The data base for which the software will be developed should include at a minimum the following parameters:

   - color of placard on tank or tank car for use in identifying materials hazard class;
   - commodity involved;
   - STCC and/or UN number of the material(s) involved;
   - specification cylinder, tank car, cargo tank or portable tank container involved in accident;
   - quantity of material being shipped;
   - source strength;
   - time since initial release;
   - leak/no leak conditions;
   - wind direction and speed;
   - precipitation/condensation conditions;
   - ambient temperature;
   - percent cloud cover;
   - proximity and location of population centers to accident site;
   - population density at or near accident site;
   - local topography;
   - arrival time and distance of wreckage removal, cleanup and disposal contractor to site (i.e., inventory of these groups is necessary);
   - location and type of neutralizing agent which should be used based upon the material released;
   - container structural integrity assessment; and
   - environmental pollution considerations.

10. Once the commodity has been identified the user should be provided with the material's LEL, UEL, TLV, PEL at the accident scene, boiling point, freezing point, critical temperature, critical pressure, critical density, vapor pressure and autoignition temperature.

11. Be developed so that the systems software can be made available to cities through which hazardous commodities are shipped.

Based upon these criteria, a responsive system could be developed which would be useful as a training tool, as a community pre-planning aid, as a real-time accident response tool and as a way to bring state-of-the-art technology to states and communities who need the information and assistance.

APPENDIX A

DOT-HAZARDOUS MATERIALS EMERGENCY RESPONSE GUIDE

DOT RESPONSE GUIDE 26

ACETONE - UN 1090

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion hazard indoors, outdoors or in sewers.
- Runoff to sewer may create fire or explosion hazard.

Health Hazards

- Vapors may cause dizziness or suffocation.
- Contact may irritate or burn skin and eyes.
- Fire may produce irritating or poinsonous gases.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- Keep unnecessary people away.
- Stay upwind; keep out of low areas.
- Isolate hazard area and deny entry.
- Wear self-contained breathing apparatus and full protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
- Also, in case of water pollution, call local authorities.

Fire

- **Small Fires:** Dry chemical, CO2, water spray or alcohol foam.
- **Large Fires:** Water spray, fog or alcohol foam.
- Move container from fire area if you can do it without risk.
- Stay away from ends of tanks.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

ACETONE - UN 1090

Spill or Leak

- No flares, smoking or flames in hazard area.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathing, give artificial respiration.
- If breathing is difficult, give oxygen.
- In case of contact with material, immediately flush skin and eyes with running water for at least 15 minutes.
- Remove and isolate contaminated clothing and shoes.

DOT RESPONSE GUIDE 55

ACETONE CYANOHYDRIN - UN 1541

POTENTIAL HAZARDS

Fire or Explosion

- Some of these materials may burn but do not ignite readily.
- Cylinder may explode in heat of fire.

Health Hazards

- Poison.
- May be fatal if inhaled, swallowed or absorbed through skin.
- Contact may cause burns to skin and eyes.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- 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

- **Small Fires:** Dry chemical, CO2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Fight fire from maximum distance.

Spill or Leak

- Do not touch spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.
- **Small Dry Spills:** Shovel into dry containers and cover; move containers; then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

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

DOT RESPONSE GUIDE 30

ACRYLONITRILE - UN 1093

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion and poison hazardous indoors, outdoors or in sewers.
- Runoff to sewer may create fire or explosion hazard.

Health Hazards

- Poison.
- May be fatal if inhaled, swallowed or absorbed through skin.
- Contact may cause burns to skin and eyes.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- Keep unnecessary people away; isolate hazard area and deny entry.
- Stay upwind; keep out of low areas.
- Wear positive pressure breathing apparatus and special protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
- Also, in case of water pollution, call local authorities.

Fire

- **Small Fires:** Dry chemical, CO2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Stay away from ends of tanks.
- Do not get water inside container.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- If this is impossible, withdraw from area and let fire burn.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

DOT RESPONSE GUIDE 30 (continued)

ACRYLONITRILE - UN 1093

Spill or Leak

- No flares, smoking or flames in hazard area.
- Do not touch spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Flush area with flooding amounts of water.
- Do not get water inside containers.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Keep victim quiet and maintain normal body temperature.
- Effects may be delayed, keep victim under observation.

DOT RESPONSE GUIDE 27

ETHYL ACRYLATE - UN 1917
STYRENE - UN 2055
TOLUENE - UN 1294

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion hazard indoors, outdoors or in sewers.
- Runoff to sewer may create fire or explosion hazard.

Health Hazard

- Vapors may cause dizziness or suffocation.
- Contact may irritate or burn skin and eyes.
- Fire may produce irritating or poisonous gases.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- Keep unnecessary people away.
- Stay upwind; keep out of low areas.
- Isolate hazard area and deny entry.
- Wear self-contained breathing apparatus and full protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
- Also, in case of water pollution, call local authorities.

Fire

- **Small Fires:** Dry chemical, CO2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do so without risk.
- Stay away from ends of tanks.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- If this is impossible, withdraw from area and let fire burn.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

DOT RESPONSE GUIDE 27 (continued)

ETHYL ACRYLATE - UN 1917
STYRENE - UN 2055
TOLUENE - UN 1294

Spill or Leak

- No flares, smoking or flames in hazard area.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Remove and isolate contaminated clothing and shoes.

DOT RESPONSE GUIDE 13
HYDROCYANIC ACID - UN 1051

POTENTIAL HAZARDS

Fire or Explosion

- Some of these materials are extremely flammable.
- May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion and poison hazardous indoors, outdoors or in sewers.

Health Hazards

- Poison; extremely hazardous.
- May be fatal if inhaled or absorbed through skin.
- Vapors non-irritating, deaden sense of smell.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- 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.
- Evacuate area endangered by gas (See Isolation and Evacuation Table in back of guidebook; find the material by name).
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.

Fire

- Let burn unless leak can be stopped immediately.
- **Small Fires:** Dry chemical or CO2.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Stay away from ends of tanks.
- Cool container with water using unmanned device until well after fire is out.
- Isolate area until gas has dispersed.

DOT RESPONSE GUIDE 13 (continued)
HYDROCYANIC ACID - UN 1051

Spill or Leak

- Do not touch spilled material.
- No flares, smoking or flames in hazard area.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- Isolate area until gas has dispersed.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Keep victim quiet and maintain normal body temperature.
- Effects may be delayed, keep victim under observation.

DOT RESPONSE GUIDE 22

ISOBUTANE - UN 1969
PROPYLENE - UN 1077

POTENTIAL HAZARDS

Fire or Explosion

- **Extremely flammable.**
- **May be ignited by heat, sparks and flames.**
- **Flammable vapor may spread away from spill.**
- **Container may explode in heat of fire.**
- **Vapor explosion hazard indoors, outdoors or in sewers.**

Health Hazards

- **Vapors may cause dizziness or suffocation.**
- **Contact will cause severe frostbite.**
- **Fire may produce irritating or poisonous gases.**

IN CASE OF ACCIDENT

- Keep unnecessary people away.
- Stay upwind; keep out of low areas.
- Isolate hazard area and deny entry.
- Wear positive pressure breathing apparatus and full protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.

Fire

- Let burn unless leak can be stopped immediately.
- **Small Fires:** Dry chemical or CO2.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Stay away from ends of tanks.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- If this is impossible, withdraw from area and let fire burn.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

DOT RESPONSE GUIDE 22 (continued)

ISOBUTANE - UN 1969
PROPYLENE - UN 1077

Spill or Leak

- No flares, smoking or flames in hazard afea.
- Do not touch spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- Isolate area until gas has dispersed.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- In case of frostbite, thaw frosted parts with water.
- Keep victim quiet and maintain normal body temperature.

DOT RESPONSE GUIDE 28

METHANOL - UN 1230

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion and poison hazardous indoors, outdoors or in sewers.
- Runoff to sewer may create fire or explosion hazard.

Health Hazards

- Poison.
- May be fatal if inhaled, swallowed or absorbed through skin.
- Contact may cause burns to skin and eyes.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- Keep unnecessary people away; isolate hazard area and deny entry.
- Stay upwind; keep out of low areas.
- Wear positive pressure breathing apparatus and special protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
- Also, in case of water pollution, call local authorities.

Fire

- **Small Fires:** Dry chemical, CO_2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Stay away from ends of tanks.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

Spill or Leak

- No flares, smoking or flames in hazard area.
- Do not touch spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.

DOT RESPONSE GUIDE 28 (continued)

METHANOL - UN 1230

- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Keep victim quiet and maintain normal body temperature.
- Effects may be delayed, keep victim under observation.

DOT RESPONSE GUIDE 55

METHYL BROMIDE - UN 1062

POTENTIAL HAZARDS

Health Hazards

- Poison.
- May be fatal if inhaled, swallowed or absorbed through skin.
- 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.
- Cylinder may explode in heat of fire.

IN CASE OF ACCIDENT

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

Fire

- **Small Fires:** Dry chemical, CO2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Fight fire from maximum distance.

Spill or Leak

- Do not touch spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material; then flush area with water.
- **Small Dry Spills:** Shovel into dry containers and cover; move containers; then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim ...
- If not breathing ...
- If breathing ...
- In case of ... water for at ...
- Speed in rem...
- Remove and ...
- Keep victim ...
- Effects may be ...

DOT RESPONSE GUIDE 34

SODIUM HYDROSULFIDE - UN 2318

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- May burn rapidly with flare-burning effect.

Health Hazards

- Poisonous if swallowed.
- Skin contact poisonous.
- Contact may cause burns to skin and eyes.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

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

Fire

- **Small Fires:** Dry chemical, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- 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.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- If this is impossible, withdraw from area and let fire burn.

Spill or Leak

- No flares, smoking or flames in hazard area.
- Do not touch spilled material.
- **Small Dry Spills:** Shovel into dry containers and cover; move containers; then flush area with water.
- **Large Spills:** Wet down with water and dike for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Remove and isolate contaminated clothing and shoes.

DOT RESPONSE GUIDE 60

SODIUM HYDROXIDE - UN 1823

POTENTIAL HAZARDS

Fire or Explosion

- Some of these materials may burn but do not ignite readily.
- Explosive concentrations of gas may accumulate in tanks.
- Some of these materials may ignite combustibles (wood, paper, oil, etc.).

Health Hazards

- Contact may cause burns to skin and eyes.
- If inhaled, may be harmful.
- Fire may produce irritating or poisonous gases.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

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

Fire

- Some of these materials may react violently with water.
- **Small Fires:** Dry chemical, CO_2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- 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 touch spilled material.
- Stop leak if you can do it without risk.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.

  Small Dry Spills: Shovel into dry containers and cover; move containers; then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Keep victim quiet and maintain normal body temperature.

DOT RESPONSE GUIDE 26

VINYL ACETATE - UN 1301

POTENTIAL HAZARDS

Fire or Explosion

- Will burn. May be ignited by heat, sparks and flames.
- Flammable vapor may spread away from spill.
- Container may explode in heat of fire.
- Vapor explosion and poison hazardous indoors, outdoors or in sewers.
- Runoff to sewer may create fire or explosion hazard.

Health Hazards

- Vapors may cause dizziness or suffocation.
- Contact may irritate or burn skin and eyes.
- Fire may produce irritating or poisonous gases.
- Runoff from fire control or dilution water may cause pollution.

IN CASE OF ACCIDENT

- Keep unnecessary people away.
- Stay upwind; keep out of low areas.
- Isolate hazard area and deny entry.
- Wear positive pressure breathing apparatus and full protective clothing.
- **Isolate for 1/2 mile in all directions if tank or tank car is involved in fire.**
- FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
- Also, in case of water pollution, call local authorities.

Fire

- **Small Fires:** Dry chemical, CO2, water spray or foam.
- **Large Fires:** Water spray, fog or foam.
- Move container from fire area if you can do it without risk.
- Stay away from ends of tanks.
- Cool containers that are exposed to flames with water from the side until well after fire is out.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
- If this is impossible, withdraw from area and let fire burn.
- Withdraw immediately in case of rising sound from venting safety device or discoloration of tank.

DOT RESPONSE GUIDE 26 (continued)

VINYL ACETATE - UN 1301

Spill or Leak

- No flares, smoking or flames in hazard area.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors.
- **Small Spills:** Take up with sand, or other noncombustible absorbent material, then flush area with water.
- **Large Spills:** Dike far ahead of spill for later disposal.

First Aid

- Move victim to fresh air; call emergency medical care.
- If not breathng, give artificial respiration.
- If breathing is difficult, give oxygen.
- In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.
- Remove and isolate contaminated clothing and shoes.

AAR - EMERGENCY HANDLING OF HAZARDOUS MATERIALS IN SURFACE TRANSPORTATION

ACETONE
FLAMMABLE LIQUID
STCC 4908105
UN 1090

Acetone is a clear, colorless liquid with a pleasant odor. It is used to make other chemicals, in paint and nail polish removers, as a solvent. It is quite volatile and has a flash point of 0 deg. F. It is lighter than water and soluble in water. Its vapors are heavier than air.

If Material On Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may be ineffective
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to disperse vapors and dilute standing pools of liquid

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- 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

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 1500 feet
- If material leaking (not on fire), downwind evacuation must be considered

ACETONE CYANOHYDRIN
POISON B, COMBUSTIBLE
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-104.54)
STCC 4921401
UN 1541

Acetone cyanohydrin is a colorless liquid. It has a flash point of 165 deg. F. It slowly dissociates to acetone, a flammable liquid, and hydrogen cyanide, a flammable poisonous gas, under normal storage and transportation conditions. The rate of dissociation is increased by contact with alkalis and/or heat. It is lethal by inhalation and less readily by skin absorption. It is lighter than water and is soluble in water. Its vapors are heavier than air. Toxic oxides of nitrogen are produced during combustion of this material.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may be ineffective
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to disperse vapors and dilute standing pools of liquid

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear self-contained breathing apparatus
- Avoid bodily contact with the material
- 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

Evacuation

- If material leaking (not on fire), downwind evacuation must be considered

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash or cement powder

Environmental Considerations - Water Spill

- Use natural barriers or oil spill control booms to limit spill motion
- Use surface active agent (e.g., detergent, soaps, alcohols) to compress and thicken spilled material
- If dissolved, apply activated carbon at ten times the spilled amount in region of 10ppm or greater concentration
- Adjust ph to neutral (ph-7)
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

ACRYLONITRILE
FLAMMABLE LIQUID, POISONOUS POLYMERIZABLE
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-100/45.4)
STCC 4906420
UN 1093

Acrylonitrile is a clear colorless liquid with a strong, pungent odor. It is used in insecticides and to make plastics, fibers and other chemicals. It has a flash point of 32. deg. F. It may polymerize if contaminated with strong bases or if the container is subject to heat, as in fire conditions. Prolonged exposure to the vapors or skin contact may result in death. It is lighter than water and is soluble in water. The vapors are heavier than air. Toxic oxides of nitrogen are produced during combustion of this material.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may be ineffective
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire or Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to disperse vapors and dilute standing pools of liquid

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear self-contained breathing apparatus
- Avoid bodily contact with the material
- Wear full protective clothing
- 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 and water

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2500 feet
- If material leaking (not on fire), downwind evacuation must be considered

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents
- Apply "universal" gelling agent to immobilize spill

Environmental Considerations - Water Spill

- Use natural barriers or oil spill control booms to limit spill motion
- Use surface active agent (e.g., detergent, soaps, alcohols) to compressand thicken spilled material
- Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms
- Add calcium hypochlorite
- If dissolved, apply activated carbon at ten times the spilled amount in region of 10ppm or greater concentration
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors
- Combustion products include corrosive or toxic vapors

ETHYL ACRYLATE, INHIBITED
FLAMMABLE LIQUID, POLYMERIZABLE
STCC 4907215
UN 1917

Ethyl acrylate is a clear colorless liquid with an acrid odor. It is used to make paints and plastics. It has a flash point of 60 deg. F. If the material is subjected to heat for prolonged periods or becomes contaminated it is subject to polymerization with evolution of heat. If the polymerization takes place inside a container the container may violently rupture. The material is lighter than water and slightly soluble in water. The vapors are heavier than air.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may spread fire
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames nd other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to disperse vapors and dilute standing pools of liquid

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- 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

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius fo 2500 feet
- If material leaking (not on fire), downwind evacuation must be considered

HYDROCYANIC ACID SOLUTION
POISON A, FLAMMABLE
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-10/4.54)
STCC 4920130
UN 1613

Hydrocyanic acid, solution is hydrocyanic acid, a gas dissolved in water. It is a clear colorless liquid with a faint aromatic odor. It is flammable through the lower concentrations may require some effort to ignite. The vapor is lighter than air, but a flame can flash back to the source of the leak very easily. Lethal amounts may be absorbed throughthe skin as well as by inhalation.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Cool affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Solid streams of water may be ineffective
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear self-contained breathing apparatus
- Avoid bodily contact with the material
- Wear full protective clothing
- 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

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2500 feet
- If material leaking (not on fire), evacuate for a radius of 2500 feet

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash or cement powder

Environmental Considerations - Water Spill

- Neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors
- Vapor knockdown water is corrosive or toxic and should be diked for containment

AD-A121 933 POST ACCIDENT PROCEDURES FOR CHEMICALS AND PROPELLANTS 3/4
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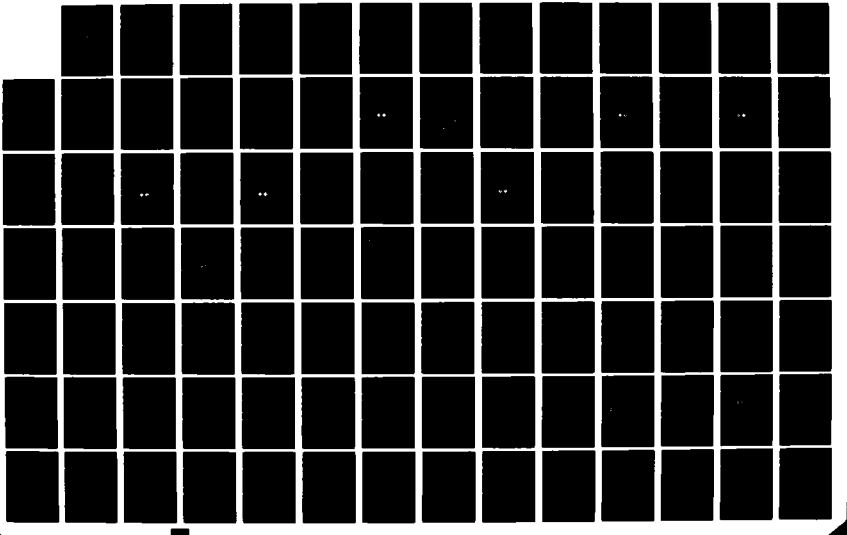

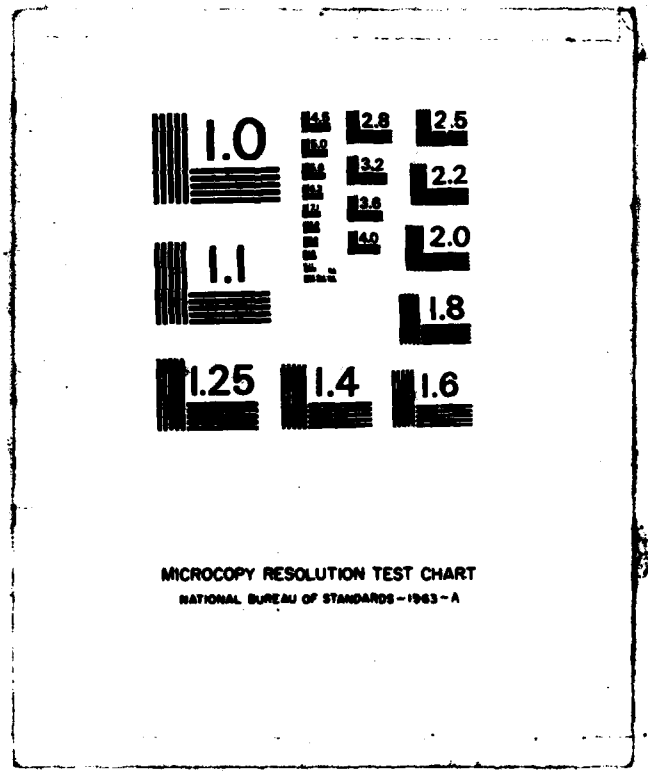
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ISOBUTANE
FLAMMABLE GAS
STCC 4905747
UN 1075

Isobutane is a colorless gas with a faint petroleum like odor. It is shipped as a liquefied gas under its vapor pressure. Contact with the liquid can cause frostbite. It is easily ignited. Its vapor is heavier than air and a flame can flash back to the source of leak very easily. The leak can either be a liquid or vapor leak. It can asphyxiate by the displacement of air. Under fire conditions the cylinders or tank car may violently rupture and rocket.

If Material on Fire of Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear protective gloves and safety glasses
- Do not handle broken packages without protective equipment
- Approach fire with caution

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2500 feet
- If material leaking (not on fire), downwind evacuation must be considered

SODIUM HYDROSULFIDE SOLUTION
CORROSIVE METAL, BASIC
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-5000/2270)
STCC 4935268
NA 2922

Sodium hydrosulfide in solution is a colorless to light yellow colored liquid. It is used in paper pulping, manufacturing dyes and dehairing hides. It is soluble in water. It is corrosive to metals and tissue.

If Material on Fire of Involved in Fire

- Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty)
- Use water in flooding quantities as fog
- Apply water from as far a distance as possible

If Material Not on Fire and Not Involved in Fire

- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary

Personnel Protection

- Avoid breathing vapors or dusts
- Avoid bodily contact with the material
- Wear boots, protective gloves, and goggles
- 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

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash or cement powder

Environmental Considerations - Water Spill

- Add soda ash
- Allow to aerate
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors
- Evolves flammable hydrogen sulfide gas on contact with acids

SODIUM HYDROXIDE LIQUID
CORROSIVE MATERIAL, BASIC
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)
STCC 4935240
UN 1824

Sodium hydroxide liquid is the water solution of sodium hydroxide. It is used in chemical manufacturing, petroleum refining, paper making, cleaning compounds, and for many other uses. The concentrated solutions will dissolve in additional water with the evolution of heat. It is corrosive to metals and tissue.

If Material Involved in Fire

- Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty).
- Use water in flooding quantities as fog
- 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

Personnel Protection

- Avoid breathing vapors or dusts
- Avoid bodily contact with the material
- Wear boots, protective gloves and safety glass
- 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

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash or cement powder
- Neutralize with vinegar or other dilute acid

Environmental Considerations - Water Spill

- Neutralize with dilute acid or removable strong acid

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors

STYRENE MONOMER INHIBITED
FLAMMABLE LIQUID, POLYMERIZABLE
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)
STCC 4907265
UN 2055

Styrene monomer inhibited is a clear colorless liquid with an aromatic odor. It is used to make plastics, paints, and synthetic rubber, and to make other chemicals. It has a flash point of 90 deg. F. Its vapors are irritating to the eyes and mucous membranes. If it becomes contaminated or is sujected to heat, it may polymerize. If the polymerization takes place inside a container, the container is subject to violent rupture. It is lighter than water and insoluble in water. Its vapors are heavier than air.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may spread fire
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear boots, protective gloves and safety glasses
- Do not handle broken packages without protective equipment
- Wash away any material whch may have contacted the body with copious amounts of water or soap and water

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2500 feet
- If material leaking (not on fire), downwind evacuation must be considered

STYRENE MONOMER INHIBITED (cont'd)

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents
- Apply "universal" gelling agent to immobilize spill
- Apply fluorocarbon-water foam to diminish vapor and fire hazard

Environmental Considerations - Water Spill

- Use natural barriers or oil spill control booms to limit spill motion
- Use surface active agent (e.g., detergent, soaps, alcohols) to compress and thicken spilled material
- Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms
- If dissolved, apply activated carbon at ten times the spilled amount in region of 10ppm or greater concentration
- Remove trapped material with suction hoses
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors

PROPYLENE
FLAMMABLE GAS
STCC 4905782
UN 1075

Propylene is a colorless gas with a faint petroleum like odor. It is used to make other chemicals. It is shipped as a liquefied gas under its own vapor pressure. For transportation it may be stenched. Contact with the liquid can cause frostbite. It is easily ignited. Its vapors are heavier than air, and a flame can flash back to the source of leak very easily. This leak can be either a liquid or vapor leak. It can asphyxiate by the displacement of air. Under fire conditions the cylinders or tank cars may violently rupture and rocket.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear protective gloves and goggles
- Do not handle broken packages without protective equipment
- Approach fire with caution

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2,500 feet
- If material leaking (not on fire), downwind evacuation must be considered

TOLUENE
FLAMMABLE LIQUID
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)
STCC 4909305
UN 1294

Toluene is a clear colorless liquid with a characteristic aromatic odor. It is used in aviation and automotive fuels, as a solvent for many materials, and to make other chemicals. It has a flash point of 40 deg. F. It is lighter than water and insoluble in water. Its vapors are heavier than air.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may spread fire
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- 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 copius amounts of water or soap and water

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents
- Apply "universal" gelling agent to immobilize spill
- Apply fluorocarbon-water foam to diminish vapor and fire hazard

TOLUENE (cont'd)

Environmental Considerations - Water Spill

- Use natural barriers or oil spill control booms to limit spill motion
- Use surface active agent (e.g., detergent, soaps, alcohols) to compress and thicken spilled material
- Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms
- If dissolved, apply activated carbon at ten times the spilled amount in region of 10ppm or greater concentration
- Remove trapped material with suction hoses
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

Environmental Consideration - Air Spill

- Apply water spray or mist to knock down vapors

VINYL ACETATE
FLAMMABLE LIQUID, POLYMERIZABLE
ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)
STCC 4907270
UN 1310

Vinyl acetate is a clear colorless liquid. It is used to make adhesives, paints and plastics. It has a flash point of 18 deg. F. Its vapors are irritating to the eyes and respiratory system. If it is subjected to heat or becomes contaminated it is subject to polymerization. If the polymerization takes place inside a container, the container is subject to violent rupture. It is lighter than water and slightly soluble in water. Its vapors are heavier than air.

If Material on Fire or Involved in Fire

- Do not extinguish fire unless flow can be stopped
- Use water in flooding quantities as fog
- Solid streams of water may spread fire
- Cool all affected containers with flooding quantities of water
- Apply water from as far a distance as possible
- Use 'alcohol' foam, carbon dioxide or dry chemical

If Material Not on Fire and Not Involved in Fire

- Keep sparks, flames, and other sources of ignition away
- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to disperse vapors and dilute standing pools of liquid

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- 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

Evacuation

- If fire becomes uncontrollable or container is exposed to direct flame - evacuate for a radius of 2500 feet
- If material leaking (not on fire), downwind evacuation must be considered

Environmental Considerations - Land Spill

- Dig a pit, pond, lagoon, holding area to contain liquid or solid material
- Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete
- Absorb bulk liquid with fly ash, cement powder, sawdust, or commercial sorbents
- Apply "universal" gelling agent to immobilize spill
- Apply fluorocarbon-water foam to diminish vapor and fire hazard

Environmental Considerations - Water Spill

- Use natural barriers or oil spill control booms to limit spill motion
- Use surface active agent (e.g., detergent, soaps, alcohols) to compress and thicken spilled material
- Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms
- If dissolved, apply activated carbon at ten times the spilled amount in region of 10ppm or greater concentration
- Remove trapped material with suction hoses
- Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates

Environmental Considerations - Air Spill

- Apply water spray or mist to knock down vapors

METHYL BROMIDE, LIQUID (INCLUDING UP TO 2% CHLOROPICRIN)
POISON B
STCC 4921440
UN 1062

Methyl bromide is colorless liquid with a chloroform-like odor. Under most circumstances it is non-combustible. It is very slightly soluble in water. It is toxic by inhalation. Prolonged or repeated skin contact can cause severe burns and possible absorption of toxic quantities of the material.

If Material Involved in Fire

- Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty)
- Use water in flooding quantities as fog
- Cool all affected containers with flooding quantities of water
- Use foam, carbon dioxide or dry chemical

If Material Not Involved in Fire

- Keep material out of water sources and sewers
- Build dikes to contain flow as necessary
- Attempt to stop leak if without hazard
- Use water spray to knock-down vapors

Personnel Protection

- Avoid breathing vapors
- Keep upwind
- Wear self-contained breathing apparatus
- Avoid bodily contact with the material
- Wear full protective clothing
- 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

Evacuation

- If material leaking (not on fire), downwind evacuation must be considered

TABLE C-1 SPILLS ON LAND

TYPE	APPLICATION OR CONSTRUCTION METHOD	USE	ADVANTAGES	DISADVANTAGES
Dikes Earthen	Create with bulldozer or earth-moving equipment to compact earth (height depends on earth type)	Flat or sloped surface	1. Material on site 2. Construct with common equipment 3. Construct quickly	1. Natural permeability of soil 2. Seepage through ground 3. Surface composition of soil not suitable in all cases
Foamed Polyurethane	Use trained personnel to construct	Hard, dry surfaces	1. Hold up to several feet of water (1)	1. Leaks on wet ground 2. Hard to obtain dispersion device
Foamed Concrete	Use trained personnel to construct	Flat ground Slow moving spill	1. Better adhesion to substrates (clay/shale/grass)	1. Hard to obtain foam and dispersion device 2. Must set for a time period Will not hold high hydraulic heads (15)
Evacuation	Bulldover or earthmoving equipment - line if possible	Soft ground Natural cavitation	1. Material on site 2. Construct with common equipment	1. Move large amounts of material 2. Natural permeability of soil 3. Surface of soil not suitable in all cases
Evacuation & Dikes	Bulldozer or earthmoving equipment - line if possible	Soft ground	1. Need less space than separate 2. Material on site 3. Construct with common equipment	1. Move large amounts of material 2. Natural permeability of soil 3. Surface of soil not suitable in all cases

TABLE C-2 SPILLS IN WATER-HEAVIER THAN WATER SPILLS

TECHNIQUE	APPLICATION OR CONSTRUCTION METHOD	USE	ADVANTAGES	DISADVANTAGES
Natural Excavations and Dikes	None	Where a natural barrier exists	No construction needed	Can't control the area which contains the spill
Construction of Excavation and Dikes	Dedges: hydraulic or vacuum pumps Divers with pumps then place concrete or sand bags around to form dike if bottom material is not sufficient	If bottom can be moved	Material is on site	1. Hard to construct 2. Stirred up bottom may cause dispersion and increased turbidity

TABLE C-3 SPILLS IN WATER-SOLUBLE OR MISCIBLE SPILLS

METHOD	APPLICATION OR CONSTRUCTION MATERIALS	USE	ADVANTAGES	DISADVANTAGES
Sealed booms	Boom Device to anchor	Contain depth limited volumes leaking containers	Contain entire depth of water	1. Deployment difficult 2. Not used for large bodies 3. Difficult to get good seal(16)
Diversion of Uncontaminated Flow	Earthmoving Equipment	Special area where topograph is right	1. Can put cleaned water into diverted stream 2. Used for flowing water	1. Difficult to move large amounts of earth 2. Clear area needed 3. Impermeability of ground
Diversion of Contaminated Flow	Block entrance with sandbags, sealed booms or dikes	Special area where topography is right	1. Can put clean water back into stream 2. Used for flowing water	1. Difficult to move large amount of earth 2. Clear area needed 3. Impermeability of ground 4. Adverse environmental impact
Gelling Agent (40)	Gels, Dispersion Devices; use experienced personnel	If small volumes	1. Stop flowing containment 2. Stop permeation	1. Hard to obtain 2. Can't use in large area 3. Must haul to dispose
Containment of Entire Waterbody	Diking Materials Earthmoving Equipment Sandbags, etc. Lining	For entirely contaminated area	1. Can allow containment of a large waterbody 2. Materials on site 3. Easily constructed	1. Not all waterbodies have containable overflow 2. Permeability 3. May be an unstable condition

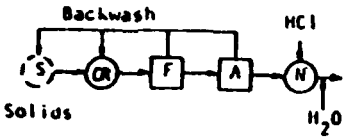
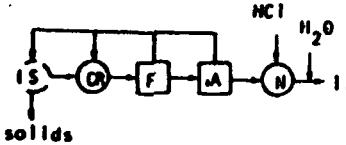
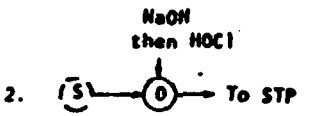
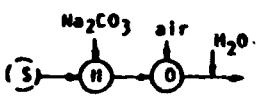
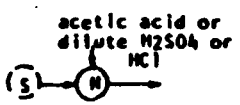
TABLE C-4 SPILLS IN WATER-FLOATING SPILLS

METHOD	APPLICATION OF CONSTRUCTION MATERIALS	USE	REFERENCE*	ADVANTAGES	DISADVANTAGES
Booms	Varies; need deployment device	Not too much current	CG-446-4 (41) p. 6-10 to 6-25	Used on large area; Many varieties	1. Only in waves < 2-4 feet 2. Current speed < 0.7 knots
Weirs	Weir & Boat	Calm	CG-446-4 (41) p.6-25	Not easily clogged; Collects & contains	Not used in rough water
Pneumatic Barriers	Air compressor diffuser deployment method	Only shallow water	CG-446-4 (41) p.6-25	Do not create a physical barrier to vessels	1. Not in rough water 2. Only shallow water 3. Only thin layers or materials
Spill Herding Methods	Chemicals on water spray or prop. wash	To protect shore or other facilities	CG-446-4 (41) p. 6-31 to 6-35	Useful in rough water	1. Not easily obtainable 2. Not 100% effective

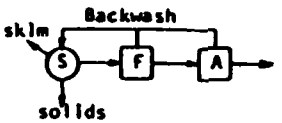
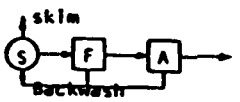
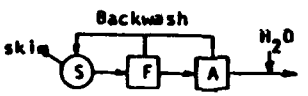
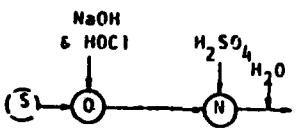
TABLE C-5 SPILLS IN AIR

TECHNIQUE	METHOD	USE	ADVANTAGES	DISADVANTAGES
Mist Knock Down	Spray fine mist into air	Water soluble or low lying vapors	Removes hazard from air	Create water pollution problem and must be contained in solution
Fans or Blowers	Disperse air by directing blower toward it	Very calm and sheltered areas	Can direct air away from populated areas	1. Not at all effective if any wind 2. Need large capacity of blowers 3. Hard to control

EPA-SUGGESTED TREATMENT SCHEMES

Hazardous Chemical	Amenable To Biological Trmt. at Municipal STP	Treatment Scheme	Treatment Specifications	Comments
Acetone Cyanohydrin	May require acclimatization		Neutralize with NaOH to pH 8.5 Adsorb/neutralize to pH 7. C:10-100 #/# Sol. Matl.	Raise pH to suppress cyanide gas formation but not greater than pH 9
Acrylonitrile	When diluted/ may need to be acclimated	1.  2. 	1. Add NaOH to pH 8.5/adsorb/ neutralize to pH 7 with HCl C: 10-100 #/# sol. matl. 2. Add NaOH to pH 10 then add HOCl to a residual react 30 min./ discharge to STP	Liquid is flammable and explosive - Careful to avoid HCN evolution or direct contact with NaOH. Option 2 produces cyanates which are less toxic
Sodium Hydrosulfide	When reduced		Add Na_2CO_3 to pH 7-- air to 70% max. DO level	Remove any solids to land fill
Sodium Hydroxide	When neutralized		Add acid to pH 7/ discharge	Be careful not to create strong reaction

EPA-SUGGESTED TREATMENT SCHEMES

Hazardous Chemical	Amenable To Biological Trmt. at Municipal STP	Treatment Scheme	Treatment Specifications	Comments
Styrene	If diluted		C: 10-100 #/# sol. matl.	Skim surface of water body
Toluene	When dilute		C: 10-100 #/# sol. matl.	Skim off surface of water body
Vinyl Acetate	When dilute		C: 10-35 #/# sol. matl.	Skim off from water body; light may cause polymerization to solid so dredging may be required
Hydrogen Cyanide (Hydrocyanic Acid)	If acclimated		Add NaOH to pH 8-8.5 then add HOCl to a residual/add 10% XS HOCl/react 1 hr/neutralize w/H_2SO_4 prior to discharge	Do not allow pH to drop below neutral or NH_4 will be formed /add large excess NOCl to avoid the liberation of toxic cyanogen chloride

ACT — ACETONE

Common Synonyms	Watery liquid	Colorless	Sweet odor
Dimethyl ketone Propanone	Floats and mixes with water. Flammable, irritating vapor is produced.		

Stay upwind and use water spray to "knock down" vapor.
Shut off ignition sources and call fire department. Keep people away.
Stop discharge if possible.
Isolate and remove discharged material.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Extinguish with dry chemical, alcohol foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, may cause difficult breathing or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to eyes.
Not irritating to skin.
IF IN EYES, hold eyelids open and flush with plenty of water.

Water Pollution

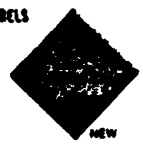
Dangerous to aquatic life in high concentrations.
May be dangerous if it enters water intakes.
Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

Issue warning - high flammability
Disperse and flush

2. LABELS


PRESENT


NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Dimethyl ketone; 2-Propanone
3.2 **Coast Guard Compatibility Classification:** Ketone
3.3 **Chemical Formula:** CH_3COCH_3
3.4 **IMCO/United Nations Numerical Designation:** 3.1/1090

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Sweetish; pleasant, resembling that of mint or fruit; pungent; sharp, penetrating residual, ketonic, pleasant, non-residual

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor canister or air-supplied mask; synthetic rubber gloves; chemical safety goggles or face splash shield.
5.2 **Symptoms Following Exposure:** INHALATION: vapor irritating to eyes and mucous membranes; acts as an anesthetic in very high concentrations. INGESTION: low order of toxicity but very irritating to mucous membranes. SKIN: prolonged excessive contact causes defatting of the skin, possibly leading to dermatitis.
5.3 **Treatment for Exposure:** INHALATION: if victim is overcome, remove to fresh air and call a physician; administer artificial respiration if breathing is irregular or stopped. INGESTION: if victim has swallowed large amounts and is conscious and not having convulsions, induce vomiting and get medical help promptly; no specific antidote known. SKIN: wash well with water. EYES: flush with water immediately for at least 15 min. Consult a physician.
5.4 **Toxicity by Inhalation (Threshold Limit Value):** 1000 ppm
5.5 **Short-Term Inhalation Limits:** 1000 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 1; LD_{50} 5 to 15 g/kg (dog)
5.7 **Late Toxicity:** Not pertinent
5.8 **Vapor (Gas) Irritant Characteristics:** If present in high concentrations, vapors cause moderate irritation of the eyes or respiratory system. Effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to the skin because it is very volatile and evaporates quickly from the skin.
5.10 **Odor Threshold:** 100 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 4°F O.C.; 0°F C.C.
6.2 **Flammable Limits in Air:** 2.6% - 12.8%
6.3 **Fire Extinguishing Agents:** Alcohol foam, dry chemical, carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water in straight hose stream will scatter and spread fire and should not be used.
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** [illegible]°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 3.9 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 14,250 ppm/24 hr/sunfish/killed/tap water; 13,000 ppm/48 hr/mosquito fish/TL_m/turbid water
8.2 **Waterfowl Toxicity:** Not pertinent
8.3 **Biological Oxygen Demand (BOD):** (Theor) 122%, 5 days
8.4 **Food Chain Concentration Potential:** None noted

9. SELECTED MANUFACTURERS

1. Allied Chemical Corp., Specialty Chemicals Div., Wilmington Turnpike, Marcus Hook, Pa. 19061
2. Shell Chemical Co., Industrial Chemicals Div., Houston, Texas 77001
3. Union Carbide Corp., Chemicals and Plastics Div., 270 Park Ave., New York, N.Y. 10017

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** Technical: 99.5% plus 0.5% water; Reagent: 99.5% plus 0.5% water
10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Open (flame arrester) or pressure-vacuum

11. HAZARD ASSESSMENT CODE

A-P-U-R-S

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable liquid
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	0
Poisons	0
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	2
Water	0
Self-Reaction	1

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

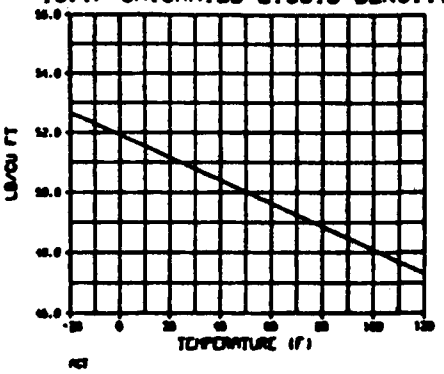
13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** 58.08
13.3 **Boiling Point at 1 atm:** 133°F = 56.1°C = 329.3°K
13.4 **Freezing Point:** −138°F = −94.7°C = 178.5°K
13.5 **Critical Temperature:** 455°F = 235°C = 508°K
13.6 **Critical Pressure:** 682 psia = 46.4 atm = 4.70 MN/m^2
13.7 **Specific Gravity:** 0.791 at 20°C (liquid)
13.8 **Liquid Surface Tension:** Not pertinent
13.9 **Liquid-Water Interfacial Tension:** Not pertinent
13.10 **Vapor (Gas) Specific Gravity:** 2.0
13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.127
13.12 **Latent Heat of Vaporization:** 220 Btu/lb = 122 cal/g = 5.11×10^5 J/kg
13.13 **Heat of Combustion:** −12,250 Btu/lb = −6808 cal/g = −285.0 × 10^5 J/kg [illegible]
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

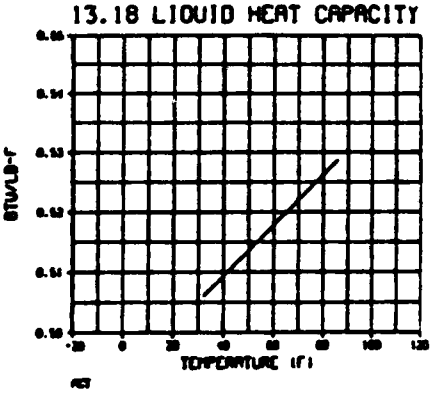
(Continued on pages 3 and 4)

NOTES

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

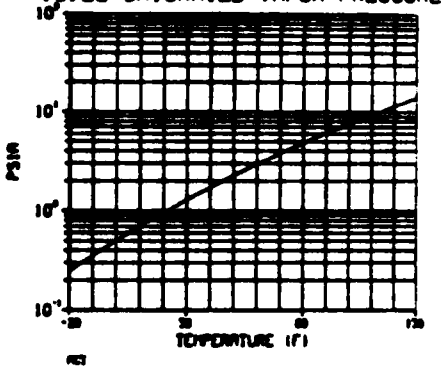
13.20 LIQUID VISCOSITY

NOT PERTINENT

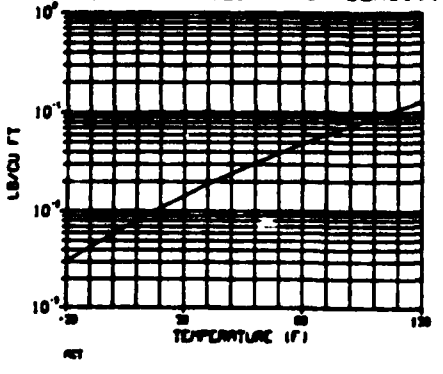
13.21 SOLUBILITY IN WATER

MISCIBLE

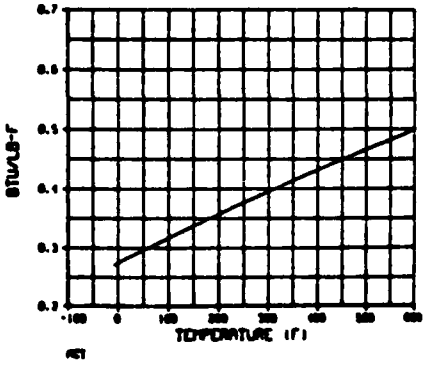
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



ACY	# ACETONE CYANOHYDRIN

Common Synonyms
2-Methyl lactonitrile
Alpha-hydroxy isobutyronitrile

Watery liquid | Colorless | Mild, almond odor.

Floats and mixes with water. Poisonous vapor is produced.

AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY.
Wear chemical protective suit with self-contained breathing apparatus.
Stop discharge if possible.
Stay upwind and use water spray to "knock-down" vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED WHEN HEATED.
Vapor may explode if ignited in an enclosed area.

WEAR CHEMICAL PROTECTIVE SUIT WITH SELF-CONTAINED BREATHING APPARATUS.
Combat fires from safe distance or from protected location.
Extinguish with water, dry chemical, alcohol foam, or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.
VAPOR
POISONOUS IF INHALED.
Irritating to eyes, nose and throat.

Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED.
Will burn skin and eyes.

Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
If SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

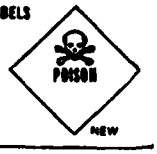
HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning: poison
Restrict access
Should be removed - human toxicity

2. LABELS



PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** alpha-Hydroxyisobutyronitrile
2-Methyllactonitrile

3.2 **Coast Guard Compatibility Classification:** Cyanohydrin

3.3 **Chemical Formula:** $(CH_3)_2C(OH)CN$

3.4 **IMCO/United Nations Numerical Designation:** 6.1/1541

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Colorless

4.3 **Odor:** Characteristic; distinct, strong cyanide

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air-supplied mask with canister approved for use with acrylonitrile in less than 2% concentrations, rubber or plastic gloves, cover goggles or face mask, rubber boots, slicker suit, safety helmet

5.2 **Symptoms Following Exposure:** At low dosages the earliest symptoms may be weakness, headaches, confusion and occasionally nausea and vomiting. Respiratory rate and depth will usually be increased at the beginning and at later stages become slow and gasping

5.3 **Treatment for Exposure:** Call a physician for all cases of exposure. INHALATION: remove victim to fresh air. (Rescuer should wear suitable mask.) INGESTION: if victim is conscious, induce vomiting by having him drink strong salt water. SKIN: remove contaminated clothing and wash affected skin thoroughly with soap and water. EYES: hold eyelids apart and wash with continuous, gentle stream of water for at least 15 min.
If breathing has stopped, give artificial respiration until physician arrives. If victim is unconscious, administer amyl nitrite by crushing an ampule in a cloth and holding it under his nose for 15 seconds in every minute. Do not interrupt artificial respiration during this procedure. Replace ampule when its strength is spent; continue treatment until victim's condition improves or physician arrives.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** Data not available

5.5 **Short-Term Inhalation Limits:** Data not available

5.6 **Toxicity by Ingestion:** Grade 4; below 50 mg/kg (mice)

5.7 **Late Toxicity:** Data not available

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors irritate the eyes and respiratory system of persons in high concentrations. The effect is temporary.

(Continued on page 4)

6. FIRE HAZARDS

6.1 **Flash Point:** 165°F C C

6.2 **Flammable Limits in Air:** 2.2% – 12%

6.3 **Fire Extinguishing Agents:** Water spray, dry chemical, alcohol foam, carbon dioxide

6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent

6.5 **Special Hazards of Combustion Products:** Toxic hydrogen cyanide is generated when heated

6.6 **Behavior in Fire:** Not pertinent

6.7 **Ignition Temperature:** 1270°F

6.8 **Electrical Hazard:** Not pertinent

6.9 **Burning Rate:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Not pertinent

7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available

8.2 **Waterfowl Toxicity:** Not pertinent

8.3 **Biological Oxygen Demand (BOD):** Data not available

8.4 **Food Chain Concentration Potential:** Data not available

9. SELECTED MANUFACTURERS

1. Aldrich Chemical Co
940 West St. Paul Ave.
Milwaukee, Wis. 53233
2. Eastman Kodak Co
Rochester, New York 14650
3. Rohm and Haas Co
Independence Mall West
Philadelphia, Pa. 19105

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** 98–99%

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-P-Q

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Poisonous liquid or solid, Class B

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	2
Poisons	4
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	3
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	3
Self-Reaction	0

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	1
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** 85.11

13.3 **Boiling Point at 1 atm:** Decomposes

13.4 **Freezing Point:** −5.8°F = −21°C = 252°K

13.5 **Critical Temperature:** Not pertinent

13.6 **Critical Pressure:** Not pertinent

13.7 **Specific Gravity:** 0.925 at 25°C (liquid)

13.8 **Liquid Surface Tension:** Not pertinent

13.9 **Liquid-Water Interfacial Tension:** Not pertinent

13.10 **Vapor (Gas) Specific Gravity:** Not pertinent

13.11 **Ratio of Specific Heats of Vapor (Gas):** (est.) 1.074

13.12 **Latent Heat of Vaporization:** (est.) 265.6 Btu/lb = 147.5 cal/g = 6.17 × 10⁵ J/kg

13.13 **Heat of Combustion:** (est.) −11,580 Btu/lb = −6,430 cal/g = −270 × 10⁵ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 1 and 6)

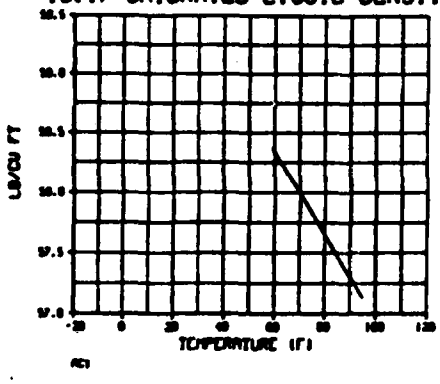
5. HEALTH HAZARDS (Cont'd.)

5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure and may cause secondary burns on long exposure.

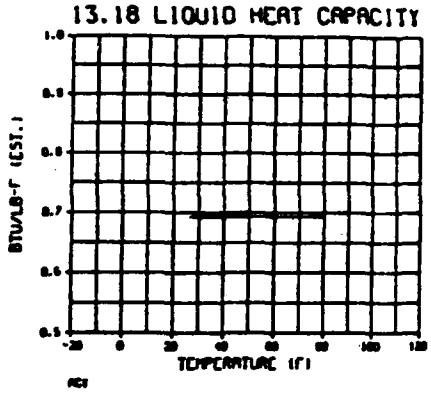
5.10 **Odor Threshold:** Data not available

ACETONE CYANOHYDRIN - ACY

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

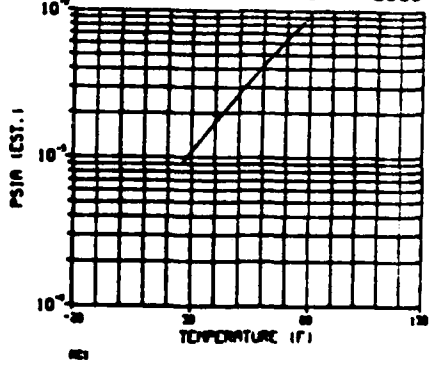
13.20 LIQUID VISCOSITY

NOT PERTINENT

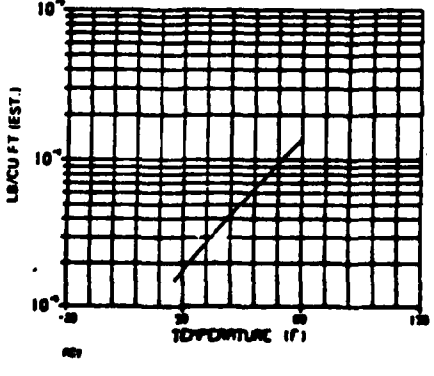
13.21 SOLUBILITY IN WATER

MISCIBLE

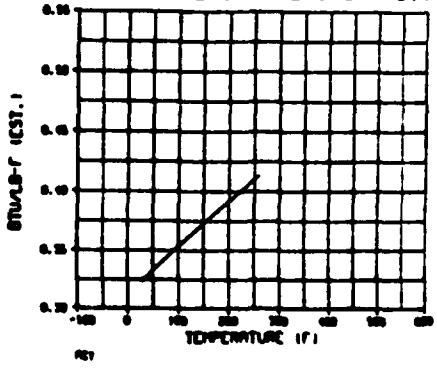
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



ACN	ACRYLONITRILE

Common Synonyms	Watery liquid Colorless to light yellow Irritating odor Floats on water. Poisonous, flammable vapor is produced.

AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY
Wear goggles, self-contained breathing apparatus and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible
Stay upwind and use water spray to "knock down" vapor.
Evacuate area in case of large discharge.
Isolate and remove discharged material
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
POISONOUS GASES MAY BE PRODUCED IN FIRE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Combat fires from a safe distance or protected location.
Extinguish with dry chemical, alcohol foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
POISONOUS IF INHALED.
Irritating to eyes.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED
Irritating to skin and eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk, and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning—poison; highly flammable
Restrict access
Disperse and flush

2. LABELS

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Cyanoethylene
Fumigran
Ventox
Vinyl cyanide

3.2 **Coast Guard Compatibility Classification:** Monomer

3.3 **Chemical Formula:** $CH_2=CHCN$

3.4 **IMCO/United Nations Numerical Designation:** 3 1/1093

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Colorless

4.3 **Odor:** Mild; pungent, resembling that of peach seed kernels

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air-supplied mask, industrial chemical type, with approved canister for acrylonitrile in low (less than 2%) concentrations, rubber or plastic gloves, cover goggles or face mask, rubber boots, slicker suit; safety helmet

5.2 **Symptoms Following Exposure:** Similar to those of hydrogen cyanide. Vapor inhalation may cause weakness, headache, sneezing, abdominal pain, and vomiting. Similar symptoms shown if large amounts of liquid are absorbed through the skin; lower amounts cause stinging and sometimes blisters; contact with eyes causes severe irritation. Ingestion produces nausea, vomiting and abdominal pain.

5.3 **Treatment for Exposure:** Skilled medical treatment is necessary; call physician for all cases of exposure. INHALATION: remove victim to fresh air (Wear an oxygen or fresh-air-supplied mask when entering contaminated area.) INGESTION: induce vomiting by administering strong solution of salt water, but only if victim is conscious. SKIN: remove contaminated clothing and wash affected area thoroughly with soap and water. EYES: hold eyelids apart and wash with continuous gentle stream of water for at least 15 min.
If victim is not breathing, give artificial respiration until physician arrives. If he is unconscious, crush an amyl nitrite ampule in a cloth and hold it under his nose for 15 seconds in every minute. Do not interrupt artificial respiration while doing this. Replace ampule when its strength is spent and continue treatment until condition improves or physician arrives.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 20 ppm

5.5 **Short-Term Inhalation Limits:** 40 ppm for 30 minutes

5.6 **Toxicity by Ingestion:** Grade 3. LD_{50} 30 to 500 mg/kg (rat, guinea pig)

5.7 **Late Toxicity:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** 30°F C.C.; 31°F O.C.

6.2 **Flammable Limits in Air:** 3.05%—17.0%

6.3 **Fire Extinguishing Agents:** Dry chemical, alcohol foam, carbon dioxide

6.4 **Fire Extinguishing Agents Not to be Used:** Water or foam may cause frothing

6.5 **Special Hazards of Combustion Products:** When heated or burned, ACN may evolve toxic hydrogen cyanide gas and oxides of nitrogen

6.6 **Behavior in Fire:** Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. May polymerize and explode

6.7 **Ignition Temperature:** 898°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** Attacks copper and copper alloys; these metals should not be used. Penetrates leather, so contaminated leather shoes and gloves should be destroyed. Attacks aluminum in high concentrations.

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** May occur spontaneously in absence of oxygen or on exposure to visible light or excessive heat; violently in the presence of alkali.
Pure ACN is subject to self-polymerization with rapid pressure development. The commercial product is inhibited and not subject to this reaction.

7.6 **Inhibitor of Polymerization:** Methylhydroquinone (35-45 ppm)

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 100 ppm/24 hr/all fish/100% killed/fresh water
0.05-1 ppm/24 hr/bluegill/lethal/salt water

8.2 **Waterfowl Toxicity:** Not pertinent

8.3 **Biological Oxygen Demand (BOD):** 70%, 5 days

8.4 **Food Chain Concentration Potential:** None noted

9. SELECTED MANUFACTURERS

1. E. I. duPont de Nemours & Co., Inc
Electrochemicals Dept
Wilmington, Del 19898
2. Monsanto Co.
Monsanto Polymers & Petrochemicals Co
800 North Lindbergh Blvd
St. Louis, Mo 63166
3. Vistron Corp
Cleveland, Ohio 44115

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** Technical 98-100%

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-P-Q-R-S-Z

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable liquid

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	3
Liquid or Solid Irritant	1
Poisons	3
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	3
Water	0
Self-Reaction	3

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	3
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** 53.06

13.3 **Boiling Point at 1 atm:** 171°F = 77.4°C = 350.6°K

13.4 **Freezing Point:** −118°F = −83.6°C = 189.6°K

13.5 **Critical Temperature:** 503°F = 263°C = 536°K

13.6 **Critical Pressure:** 660 psia = 45 atm = 4.6 MN/m²

13.7 **Specific Gravity:** 0.8075 at 20°C (liquid)

13.8 **Liquid Surface Tension:** Not pertinent

13.9 **Liquid-Water Interfacial Tension:** Not pertinent

13.10 **Vapor (Gas) Specific Gravity:** 1.8

13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.151

13.12 **Latent Heat of Vaporization:** 265 Btu/lb = 147 cal/g = 6.16 × 10⁵ J/kg

13.13 **Heat of Combustion:** (est.) −9,930 Btu/lb = −5,500 cal/g = −230 × 10⁵ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 5 and 6)

5. HEALTH HAZARDS (Cont'd.)

5.8 **Vapor (Gas) Irritant Characteristics:** Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.

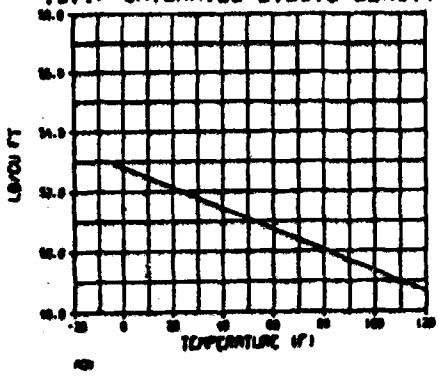
5.9 **Liquid or Solid Irritant Characteristics:** If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. Large amounts may be absorbed through the skin and cause poisoning.

5.10 **Odor Threshold:** 21.4 ppm (Sense of smell fatigues rapidly)

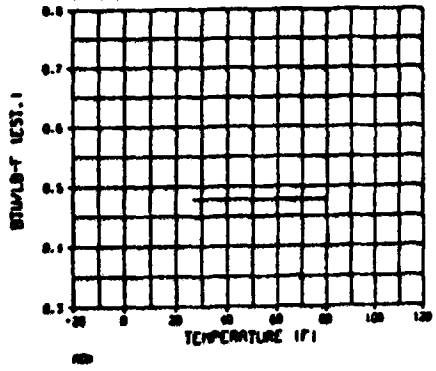
ACRYLONITRILE

ACN

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

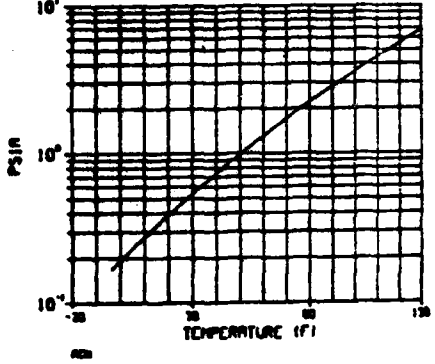
13.20 LIQUID VISCOSITY

NOT PERTINENT

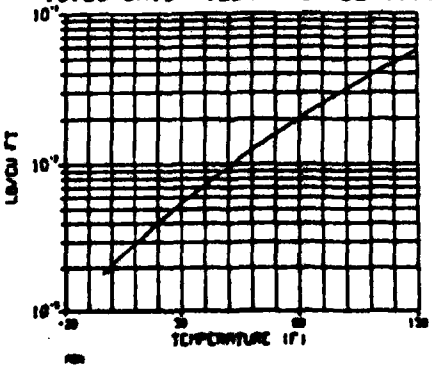
13.21 SOLUBILITY IN WATER

8 LB/100 LB WATER AT 70°F

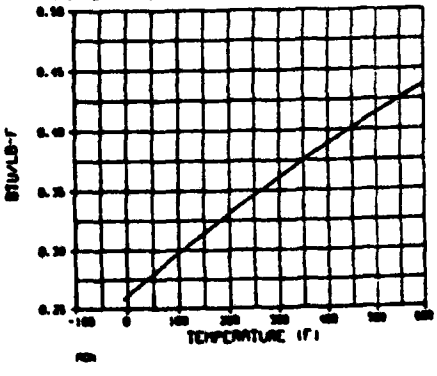
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



EAC ETHYL ACRYLATE

Common Synonyms
Acrylic acid, ethyl ester
Ethyl 2-propenoate

Liquid | Colorless | Fruity odor

Floats on water. Flammable. Irritating vapor is produced.

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Containers may explode in fire.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Combat fires from safe distance or protected location.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache or nausea.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

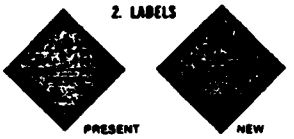
Effect of low concentrations on aquatic life is unknown.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 448-4)

Issue warning – high flammability
Restrict access
Evacuate area
Disperse and flush

2. LABELS



3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Acrylic acid, ethyl ester; Ethyl 2-propenoate
3.2 **Coast Guard Compatibility Classification:** Monomer
3.3 **Chemical Formula:** $CH_2=CHCOOCH_2CH_3$
3.4 **IMCO/United Nations Numerical Designation:** 3 2/1917

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Characteristic acrylic odor; sharp, fragrant; acrid; slightly nauseating, sharp, ester-type

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic canister or air-supplied mask; acid goggles; impervious gloves
5.2 **Symptoms Following Exposure:** May cause irritation and burns of eyes and skin. Exposure to excessive vapor concentrations can also cause drowsiness accompanied by nausea, headache, or extreme irritation of the respiratory tract.
5.3 **Treatment for Exposure:** INHALATION: remove victim to fresh air and administer artificial respiration if necessary. SKIN AND EYES: wash for 15 min with copious quantities of water. Call a physician.
5.4 **Toxicity by Inhalation (Threshold Limit Value):** 25 ppm
5.5 **Short-Term Inhalation Limits:** 50 ppm for 15 min
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.5 to 5 g/kg (rat)
5.7 **Late Toxicity:** Repeated exposure may develop sensitivity.
5.8 **Vapor (Gas) Irritant Characteristics:** Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.
5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure and may cause secondary burns on long exposure.
5.10 **Odor Threshold:** 0.00024 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 44°F O.C.
6.2 **Flammable Limits in Air:** 1.8% – 9.5% (calc.)
6.3 **Fire Extinguishing Agents:** Dry chemical, foam or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic and irritating vapors generated when heated
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. May polymerize and cause container to explode.
6.7 **Ignition Temperature:** 721°F
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** 4.3 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** May occur; exclude moisture, light, avoid exposure to high temperatures, store in presence of air
7.6 **Inhibitor of Polymerization:** 13-17 ppm monomethyl ether of hydroquinone

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1 Celanese Corp
Celanese Chemical Co. Division
245 Park Ave
New York, N.Y. 10017

2 Dow Badische Co
Williamsburg, Va. 23185

3 Rohm and Haas Co
Independence Mall West
Philadelphia, Pa. 19105

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** 98.5 – 99.9%
10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 448-3)

A-P-Q-T-U-Z

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable liquid
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	3
Liquid or Solid Irritant	2
Poisons	3
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	0
Self-Reaction	3

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** 100.12
13.3 **Boiling Point at 1 atm:** 211.3°F = 99.6°C = 372.8°K
13.4 **Freezing Point:** −98°F = −72°C = 201°K
13.5 **Critical Temperature:** 534°F = 279°C = 552°K
13.6 **Critical Pressure:** 544 psia = 37 atm = 3.7 MN/m²
13.7 **Specific Gravity:** 0.923 at 20°C (liquid)
13.8 **Liquid Surface Tension:** 25 dynes/cm = 0.025 N/m at 20°C
13.9 **Liquid-Water Interfacial Tension:** (est.) 8.6 dynes/cm = 0.0086 N/m at 20°C
13.10 **Vapor (Gas) Specific Gravity:** Not pertinent
13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.080
13.12 **Latent Heat of Vaporization:** 149 Btu/lb = 82.9 cal/g = 3.47 × 10⁵ J/kg
13.13 **Heat of Combustion:** −11,950 Btu/lb = −6640 cal/g = −278.3 × 10⁵ J/kg
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** −335 Btu/lb = −186 cal/g = −7.79 × 10⁵ J/kg

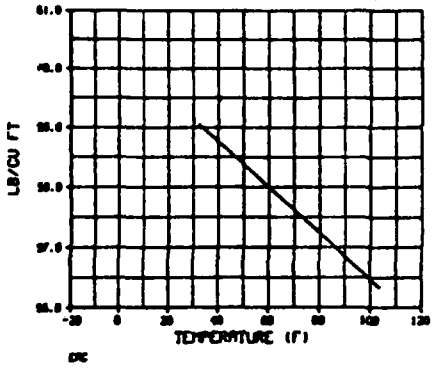
(Continued on pages 5 and 6)

NOTES

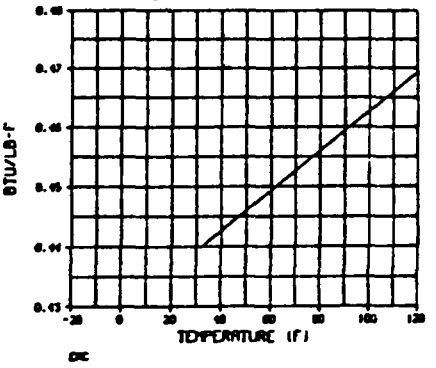
ETHYL ACRYLATE

EAC

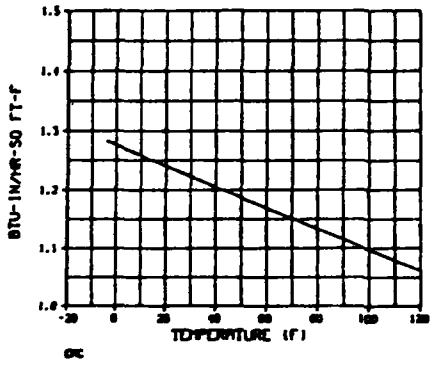
13.17 SATURATED LIQUID DENSITY



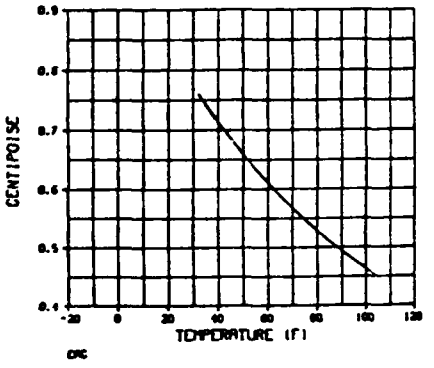
13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY



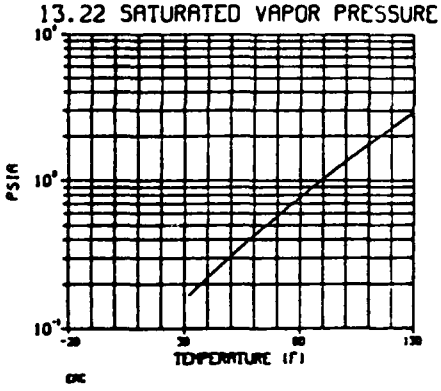
13.20 LIQUID VISCOSITY



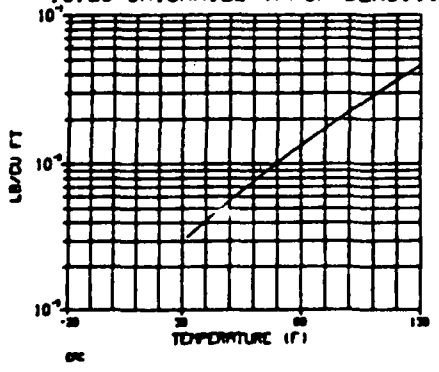
13.21 SOLUBILITY IN WATER

2 LB/100 LB WATER AT 68°F

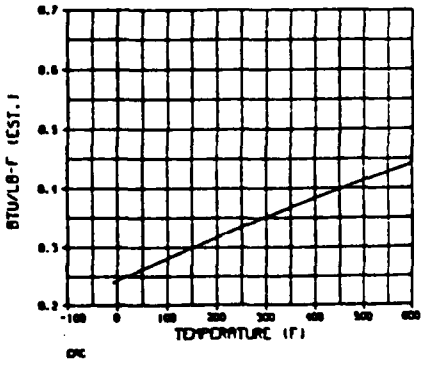
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



HCN — HYDROGEN CYANIDE

Common Synonyms
Hydrocyanic acid
Prussic acid

Watery liquid, or gas — Colorless — Bitter almond odor

Sinks and mixes with water. Poisonous, flammable vapor is produced and rises. Boiling point is 78° F.

AVOID CONTACT WITH LIQUID AND VAPOR. EVACUATE AREA.
WEAR CHEMICAL PROTECTIVE SUIT WITH SELF-CONTAINED BREATHING APPARATUS
Stop discharge if possible. Call fire department.
Shut off ignition sources.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
WEAR CHEMICAL PROTECTIVE SUIT WITH SELF-CONTAINED BREATHING APPARATUS.
Stop discharge if possible
Cool exposed containers and protect men effecting shutoff with water.
Let fire burn.

Exposure

CALL FOR MEDICAL AID.

VAPOR
POISONOUS IF INHALED OR IF SKIN IS EXPOSED.
Irritating to eyes.
Move to fresh air.
If breathing has stopped, give artificial respiration (but NOT mouth to mouth).
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Irritating to eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning — high flammability, water contaminant
Restrict access
Evacuate area

2. LABELS

PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Hydrocyanic acid; Prussic acid
3.2 **Coast Guard Compatibility Classification:** Not applicable
3.3 **Chemical Formula:** HCN
3.4 **IMCO/United Nations Numerical Designation:** 2.0/1051

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless to bluish white
4.3 **Odor:** Characteristic sweetish, like almond

5. HEALTH HAZARDS

CAUTION — Class A poison. Asphyxiation can be caused by ingestion, inhalation, or absorption of liquid or vapor through skin particularly eyes, mucous membranes, and feet.

5.1 **Personal Protective Equipment:** Escape purposes only — air escape mask with 5-minute air cylinder. Work purposes — vapor-proof emergency suit or vinyl-coated coverall, plus air mask with clear-view facepiece, speaking diaphragm, demand regulator, and 30-minute air cylinder. Rubber gloves, chemical safety goggles, quick-opening safety shower.

5.2 **Symptoms Following Exposure:** Irritation of throat, palpitation, difficult breathing, reddening of eyes, salivation, nausea, headache, weakness of arms and legs, giddiness — followed by collapse and convulsions.

5.3 **Treatment for Exposure:** Call a doctor. If breathing has stopped, give artificial respiration until doctor arrives. INHALATION: remove patient to fresh air. SKIN CONTACT: remove contaminated clothing and wash skin thoroughly with copious quantities of water and soap. EYE CONTACT: hold eyelids apart and wash eye with continuous gentle stream of water for at least 15 min.
If patient is unconscious, administer amyl nitrite by crushing a pearl (ampule) in a cloth and holding this under patient's nose for 15 seconds in every minute. Do not interrupt artificial respiration. Replace amyl nitrite pearl when its strength is spent. Continue treatment until patient's condition improves or doctor arrives.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 10 ppm
5.5 **Short-Term Inhalation Limits:** 20 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 4. LD_{50} less than 50 mg/kg

(Continued on page 4)

6. FIRE HAZARDS

6.1 **Flash Point:** 0°F C.C.
6.2 **Flammable Limits in Air:** 5.6% - 40.0%
6.3 **Fire Extinguishing Agents:** Stop flow of gas
6.4 **Fire Extinguishing Agents Not to be Used:** None
6.5 **Special Hazards of Combustion Products:** Extremely toxic vapors are generated even at ordinary temperatures
6.6 **Behavior in Fire:** Containers may explode with ignition of contents
6.7 **Ignition Temperature:** 1004°F
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** 1.5 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** Dissolves with a moderate reaction
7.2 **Reactivity with Common Materials:** None
7.3 **Stability During Transport:** May become unstable and subject to explosion if stored for extended time or exposed to high temp. and pressure
7.4 **Neutralizing Agents for Acids and Caustics:** The weak acidity can be neutralized by slaked lime, but this does not destroy the poisonous property.
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
0.16 ppm/72 hr/young bass TL_m fresh water
0.069 ppm/24 hr/pumpkinseed perch TL_m salt water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. E. I. duPont de Nemours & Co. Inc.
Electrochemicals Dept.
Wilmington, Del. 19898
2. Monsanto Polymers & Petrochemicals Co.
800 North Lindbergh Blvd.
St. Louis, Mo. 63166
3. Rohm and Haas Co.
Independence Mall West
Philadelphia, Pa. 19105

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** 96% sometimes shipped as a water solution, or absorbed on an inert solid. All forms are extremely toxic.
10.2 **Storage Temperature:** Data not available
10.3 **Inert Atmosphere:** May be padded
10.4 **Venting:** Data not available

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-B-C-K-L-M-N

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Poisonous gas or liquid, Class A
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	4
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	4
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	4
Aesthetic Effect	1
Reactivity	
Other Chemicals	3
Water	0
Self-Reaction	3

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	4
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** 27.03
13.3 **Boiling Point at 1 atm:** 78.3°F = 25.7°C = 298.9°K
13.4 **Freezing Point:** 8.1°F = −13.3°C = 259.9°K
13.5 **Critical Temperature:** 362.3°F = 183.5°C = 456.7°K
13.6 **Critical Pressure:** 735 psia = 50 atm = 5.07 MN/m²
13.7 **Specific Gravity:** 0.687 at 20°C (liquid)
13.8 **Liquid Surface Tension:** Not pertinent
13.9 **Liquid-Water Interfacial Tension:** Not pertinent
13.10 **Vapor (Gas) Specific Gravity:** 0.9
13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.303
13.12 **Latent Heat of Vaporization:** 444 Btu/lb = 247 cal/g = 10.3 × 10⁵ J/kg
13.13 **Heat of Combustion:** −10,560 Btu/lb = −5864 cal/g = −245.3 × 10⁵ J/kg
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

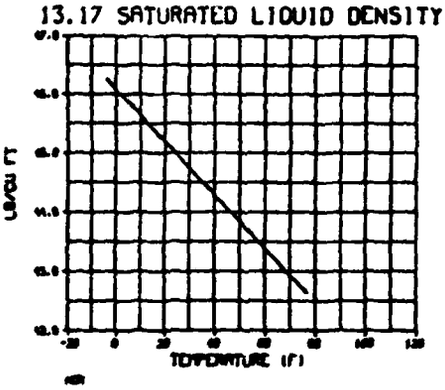
(Continued on page 3 and 4)

5. HEALTH HAZARDS (Cont'd.)

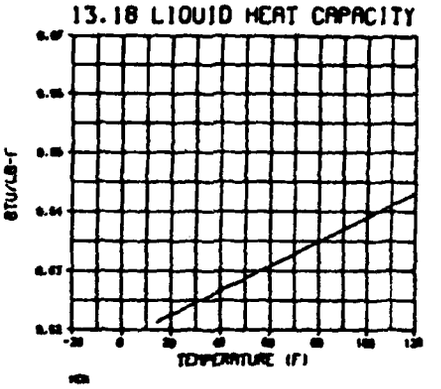
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapor is not very irritating but is extremely poisonous.
5.9 **Liquid or Solid Irritant Characteristics:** Liquid is not irritating but is extremely poisonous if absorbed through skin or eyes.
5.10 **Odor Threshold:** Data not available

HYDROGEN CYANIDE | HCN

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

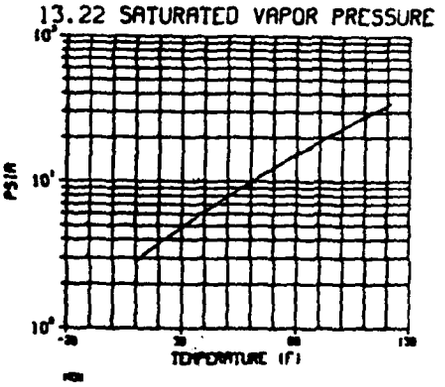
13.20 LIQUID VISCOSITY

NOT PERTINENT

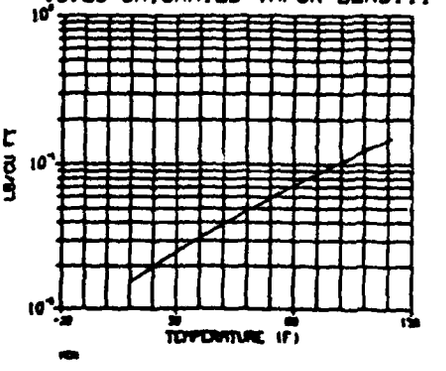
13.21 SOLUBILITY IN WATER

MISCIBLE

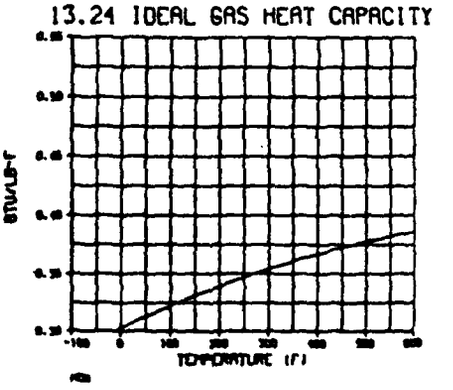
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



IBT	# ISOBUTANE

Common Synonyms
2-Methylpropane

Liquefied compressed gas Colorless Odorless

Floats and boils on water. Flammable visible vapor cloud is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Stop flow of gas if possible.
Cool exposed containers and men effecting shutoff with water.
Let fire burn.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes.
If inhaled, will cause dizziness, difficult breathing or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
IF IN EYES, hold eyelids open and flush with plenty of water.

Water Pollution

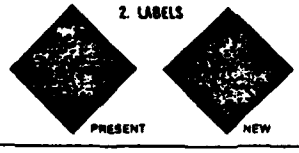
Not harmful to aquatic life.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook CG 446-4)

Issue warning - high flammability
Restrict access
Evacuate area

2. LABELS



PRESENT NEW

3. CHEMICAL DESIGNATIONS

- 3.1 **Synonyms:** 2-Methylpropane
- 3.2 **Coast Guard Compatibility Classification:** Saturated hydrocarbon
- 3.3 **Chemical Formula:** $CH_3CH(CH_3)_2$
- 3.4 **IMCO/United Nations Numerical Designation:** 2.0/1969

4. OBSERVABLE CHARACTERISTICS

- 4.1 **Physical State (as shipped):** Liquid under pressure
- 4.2 **Color:** Colorless
- 4.3 **Odor:** Like gasoline

5. HEALTH HAZARDS

- 5.1 **Personal Protective Equipment:** Self-contained breathing apparatus, safety goggles
- 5.2 **Symptoms Following Exposure:** Central nervous system depression ranging from dizziness and incoordination to anesthesia and respiratory arrest, depending on concentration and extent of inhalation. Irregular heartbeat is rare but is a dangerous complication at anesthetic levels.
- 5.3 **Treatment for Exposure:** INHALATION: protect victim against self-injury if he is stuporous, confused, or anesthetized; apply artificial respiration if breathing has stopped, avoid administration of epinephrine or other sympathomimetic amines, prevent aspiration of vomitus by proper positioning of head, give symptomatic and supportive treatment. INGESTION OR ASPIRATION: no treatment required
- 5.4 **Toxicity by Inhalation (Threshold Limit Value):** Data not available
- 5.5 **Short-Term Inhalation Limits:** Data not available
- 5.6 **Toxicity by Ingestion:** Not pertinent
- 5.7 **Late Toxicity:** None
- 5.8 **Vapor (Gas) Irritant Characteristics:** None
- 5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to skin because it is very volatile and evaporates quickly. Some frostbite possible.
- 5.10 **Odor Threshold:** Data not available

6. FIRE HAZARDS

- 6.1 **Flash Point:** −117°F C.C.
- 6.2 **Flammable Limits in Air:** 1.8% - 8.4%
- 6.3 **Fire Extinguishing Agents:** Stop flow of gas
- 6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
- 6.5 **Special Hazards of Combustion Products:** Not pertinent
- 6.6 **Behavior in Fire:** Not pertinent
- 6.7 **Ignition Temperature:** 860°F
- 6.8 **Electrical Hazard:** Not pertinent
- 6.9 **Burning Rate:** 9.3 mm/min

7. CHEMICAL REACTIVITY

- 7.1 **Reactivity with Water:** No reaction
- 7.2 **Reactivity with Common Materials:** No reaction
- 7.3 **Stability During Transport:** Stable
- 7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
- 7.5 **Polymerization:** Not pertinent
- 7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

- 8.1 **Aquatic Toxicity:** None
- 8.2 **Waterfowl Toxicity:** None
- 8.3 **Biological Oxygen Demand (BOD):** None
- 8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Atlantic Richfield Co.
   ARCO Chemical Co. Division
   260 South Broad St.
   Philadelphia, Pa. 19101
2. Cities Service Co. Inc.
   Petrochemicals Division
   60 Wall St.
   New York, N. Y. 10005
3. Phillips Petroleum Co.
   Bartlesville, Okla. 74004

10. SHIPPING INFORMATION

- 10.1 **Grades of Purity:** Pure, technical
- 10.2 **Storage Temperature:** Ambient
- 10.3 **Inert Atmosphere:** No requirement
- 10.4 **Venting:** Safety relief

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook CG 446-3)

A-B-C-D-E-F-G

12. HAZARD CLASSIFICATIONS

- 12.1 **Code of Federal Regulations:** Flammable compressed gas
- 12.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed
- 12.3 **NFPA Hazard Classifications:** Not listed

13. PHYSICAL AND CHEMICAL PROPERTIES

- 13.1 **Physical State at 15°C and 1 atm:** Gas
- 13.2 **Molecular Weight:** 58.12
- 13.3 **Boiling Point at 1 atm:** 10.9°F = −11.7°C = 261.4°K
- 13.4 **Freezing Point:** −427.5°F = −255.3°C = 17.9°K
- 13.5 **Critical Temperature:** 274°F = 135°C = 408°K
- 13.6 **Critical Pressure:** 529 psia = 36 atm = 3.65 MN/m²
- 13.7 **Specific Gravity:** 0.557 at 20°C (liquid)
- 13.8 **Liquid Surface Tension:** 14 dynes/cm = 0.014 N/m at −12°C
- 13.9 **Liquid-Water Interfacial Tension:** 50 dynes/cm = 0.05 N/m at 20°C
- 13.10 **Vapor (Gas) Specific Gravity:** 2.01
- 13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.095
- 13.12 **Latent Heat of Vaporization:** 156 Btu/lb = 87 cal/g = 1.36 × 10⁵ J/kg
- 13.13 **Heat of Combustion:** 21,653 Btu/lb = −10,810 cal/g = −452.5 × 10³ J/kg
- 13.14 **Heat of Decomposition:** Not pertinent
- 13.15 **Heat of Solution:** Not pertinent
- 13.16 **Heat of Polymerization:** Not pertinent

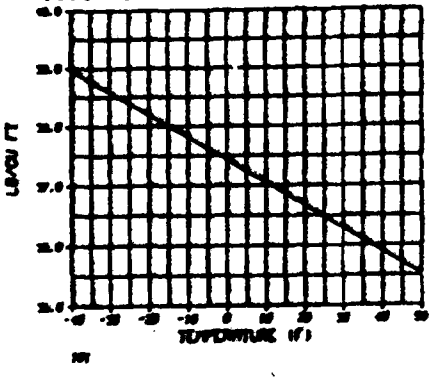
(Continued on Page 1 and 4)

NOTES

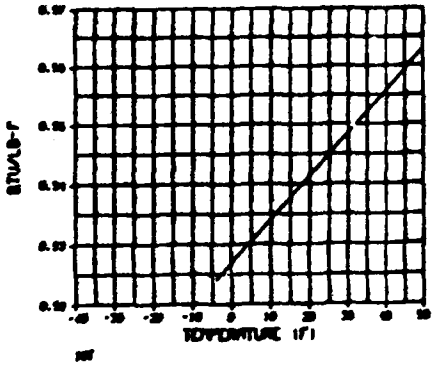
ISOBUTANE

IBT

13.17 SATURATED LIQUID DENSITY



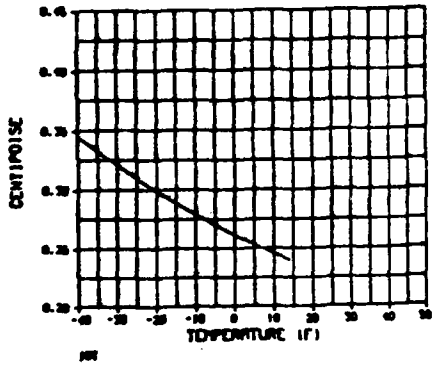
13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

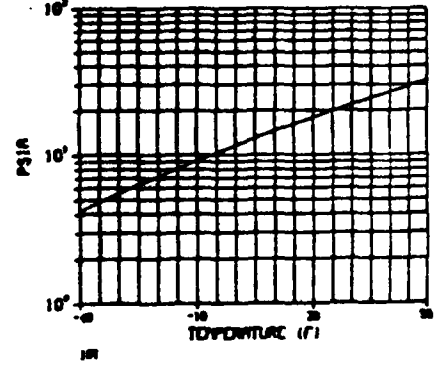
13.20 LIQUID VISCOSITY



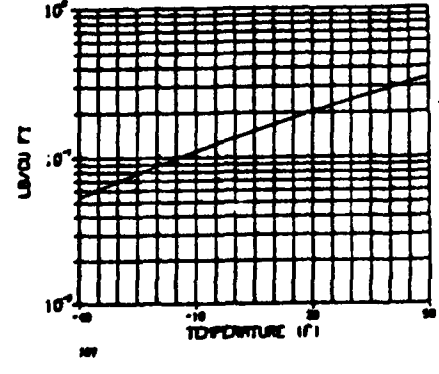
13.21 SOLUBILITY IN WATER

INSOLUBLE

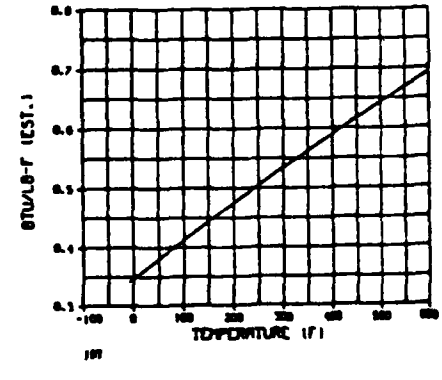
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



MAL METHYL ALCOHOL

Common Synonyms			
Methanol Wood alcohol Wood naphtha Wood spirit Pyroxylic spirit	Wavy liquid	Colorless	Alcohol odor

Flows and mixes with water. Flammable, smoldering vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Vapor may explode if ignited in an enclosed area.
Flashback along vapor trail may occur.
Extinguish with dry chemical, alcohol foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED.
Irritating to skin and eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Dangerous to aquatic life in high concentrations.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning—high flammability
Restrict access
Evacuate area
Disperse and flush

2. LABELS

PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Colonial spirit, Columbian spirit, Methanol, Wood alcohol, Wood naphtha, Wood spirit
3.2 **Coast Guard Compatibility Classification:** Alcohol
3.3 **Chemical Formula:** CH_3OH
3.4 **IMCO/United Nations Numerical Designation:** 3.2/1230

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Faint alcohol; like ethyl alcohol, faintly sweet; characteristic pungent

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister mask for high vapor concentrations; safety goggles; rubber gloves.
5.2 **Symptoms Following Exposure:** Exposure to excessive vapor causes eye irritation, headache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage. 30,000 ppm will probably cause death in 1 to 2 hrs. Can be absorbed through skin. Swallowing may cause death or eye damage.
5.3 **Treatment for Exposure:** Remove victim from exposure and apply artificial respiration if breathing has ceased. INGESTION induce vomiting, then give 2 teaspoons of baking soda in glass of water, call a physician. SKIN OR EYES flush with water for 15 min.
5.4 **Toxicity by Inhalation (Threshold Limit Value):** 200 ppm
5.5 **Short-Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 1, 5 to 15 g/kg (rat)
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 100 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 54°F C.C.; 61°F O.C.
6.2 **Flammable Limits in Air:** 6.0%—36.5%
6.3 **Fire Extinguishing Agents:** Alcohol foam, dry chemical, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective.
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Containers may explode
6.7 **Ignition Temperature:** 867°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 1.7 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 250 ppm/11 hr/goldfish/dead/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** (Theor.) 80%, 5 days, 0.1—1.1 lb/lb, 5 days, 67% (theor.), 20 days
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1 Borden Inc
Borden Chemical Division
Gonmar, La 70734

2 Celanese Corp
Celanese Chemical Co. Division
245 Park Ave
New York, N. Y. 10017

3 E. I. du Pont de Nemours & Co., Inc
Industrial and Biochemical Dept
Wilmington, Del 19898

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** CP, Crude, ACS at 99.9%
10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Open (flame arrester) or pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-P-Q-R-S

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable liquid
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	2
Water	0
Self-Reaction	0

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

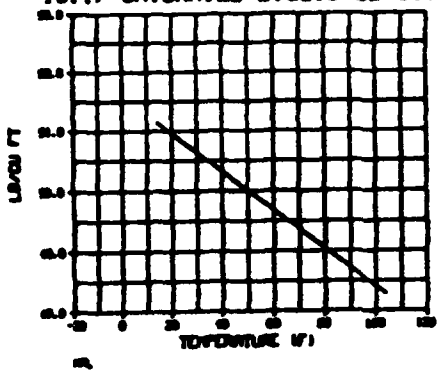
13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** 32.04
13.3 **Boiling Point at 1 atm:** 148.1°F = 64.5°C = 337.7°K
13.4 **Freezing Point:** -144.0°F = -97.8°C = 175.4°K
13.5 **Critical Temperature:** 464°F = 240°C = 513°K
13.6 **Critical Pressure:** 1142.0 psia = 77.7 atm = 7.87 MN/m²
13.7 **Specific Gravity:** 0.792 at 20°C (liquid)
13.8 **Liquid Surface Tension:** Not pertinent
13.9 **Liquid-Water Interfacial Tension:** Not pertinent
13.10 **Vapor (Gas) Specific Gravity:** 1.1
13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.234
13.12 **Latent Heat of Vaporization:** 473.0 Btu/lb = 262.8 cal/g = 11.00 × 10³ J/kg
13.13 **Heat of Combustion:** -8419 Btu/lb = -4677 cal/g = -195.8 × 10³ J/kg
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** (est.) -9 Btu/lb = -5 cal/g = -0.2 × 10³ J/kg
13.16 **Heat of Polymerization:** Not pertinent

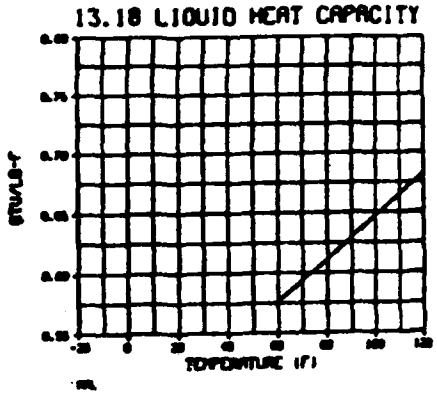
(Continued on pages 3 and 4)

NOTES

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

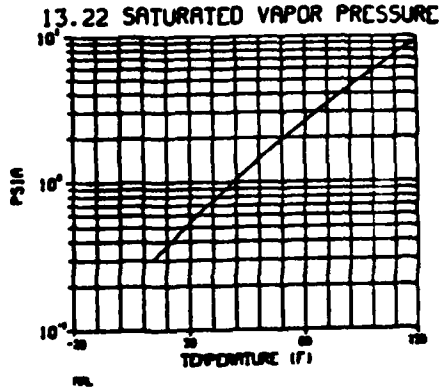
13.20 LIQUID VISCOSITY

NOT PERTINENT

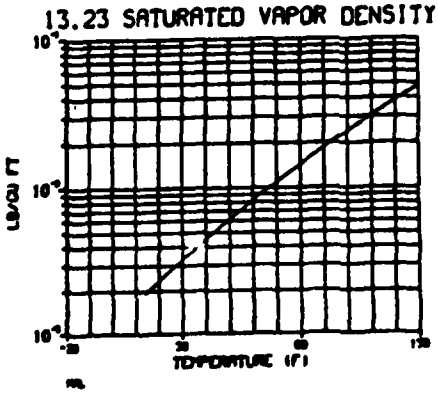
13.21 SOLUBILITY IN WATER

MISCIBLE

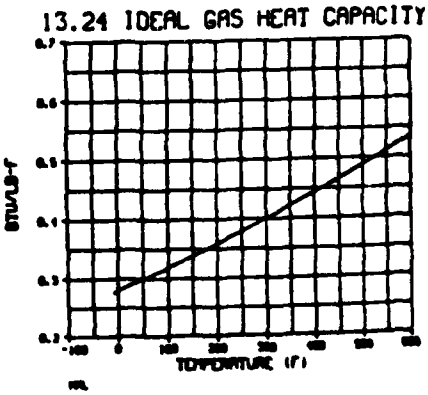
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



MTB	METHYL BROMIDE

Common Synonyms
Bromomethane
Embafume

Liquefied gas | Colorless | Odorless to sweet odor

Sinks and boils in water. Poisonous vapor cloud is formed.
Boiling point is 39° F.

AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible. Call fire department.
Evacuate area in case of large leaks.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS AND IRRITATING GASES ARE PRODUCED IN FIRE.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
EXTINGUISH WITH WATER, FOAM, OR CARBON DIOXIDE.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
POISONOUS IF INHALED.
Irritating to eyes.
Move to fresh air.
If breathing has stopped, give artificial respiration (but NOT mouth-to-mouth).
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
DO NOT RUB AFFECTED AREAS.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Not harmful to aquatic life.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 448-4)

Issue warning--poison.
Restrict access.

2. LABELS

PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Bromomethane
Embafume
M-B-C Fumigant
Monobromomethane

3.2 **Coast Guard Compatibility Classification:** Halogenated compound

3.3 **Chemical Formula:** CH_3Br

3.4 **IMCO/United Nations Numerical Designation:** 2.0/1062

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquefied gas

4.2 **Color:** Colorless

4.3 **Odor:** Relatively odorless; sweet, chloroform-like

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Self-contained breathing apparatus; goggles.

5.2 **Symptoms Following Exposure:** Inhalation of vapor causes lung congestion and pulmonary edema. Higher concentrations cause rapid narcosis and death. Contact with liquid irritates eyes and burns skin.

5.3 **Treatment for Exposure:** INHALATION: remove victim to fresh air; give artificial respiration if needed. SKIN OR EYES: flush with water for at least 15 min.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 15 ppm

5.5 **Short-Term Inhalation Limits:** 20 ppm for 5 min.

5.6 **Toxicity by Ingestion:** Data not available.

5.7 **Late Toxicity:** Data not available.

5.8 **Vapor (Gas) Irritant Characteristics:** Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.

5.9 **Liquid or Solid Irritant Characteristics:** Fairly severe skin irritant, may cause pain and second-degree burns after a few minutes' contact.

5.10 **Odor Threshold:** Data not available.

6. FIRE HAZARDS

6.1 **Flash Point:** Practically not flammable

6.2 **Flammable Limits in Air:** 10% – 15%

6.3 **Fire Extinguishing Agents:** Not pertinent

6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent

6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases are generated when exposed to fire or heat.

6.6 **Behavior in Fire:** Containers may explode.

6.7 **Ignition Temperature:** 999°F

6.8 **Electrical Hazard:** Not pertinent

6.9 **Burning Rate:** Not pertinent

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Not pertinent

7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** None

8.2 **Waterfowl Toxicity:** None

8.3 **Biological Oxygen Demand (BOD):** None

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1 Dow Chemical Co
Midland, Mich 48640

2 Great Lakes Chemical Corp
West Lafayette, Ind 47906

3 Northwest Industries, Inc
Michigan Chemical Corp
351 E. Ohio St.
Chicago, Ill 60611

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** Commercial not less than 99.5%

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Safety relief

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 448-3)

A-B-C-I-J

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Poisonous liquid or solid, Class B

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	3
Liquid or Solid Irritant	3
Poisons	4
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self-Reaction	0

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	1
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Gas

13.2 **Molecular Weight:** 94.95

13.3 **Boiling Point at 1 atm:** 38.5°F = 3.6°C = 276.8°K

13.4 **Freezing Point:** −135°F = −93°C = 180°K

13.5 **Critical Temperature:** 376°F = 191°C = 464°K

13.6 **Critical Pressure:** Not pertinent

13.7 **Specific Gravity:** 1.68 at 20°C (liquid)

13.8 **Liquid Surface Tension:** 24.5 dynes/cm = 0.0245 N/m at 15°C

13.9 **Liquid-Water Interfacial Tension:** Not pertinent

13.10 **Vapor (Gas) Specific Gravity:** 3.3

13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.24

13.12 **Latent Heat of Vaporization:** 108 Btu/lb = 59.7 cal/g = 2.50×10^5 J/kg

13.13 **Heat of Combustion:** −3188 Btu/lb = −1771 cal/g = -74.15×10^5 J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

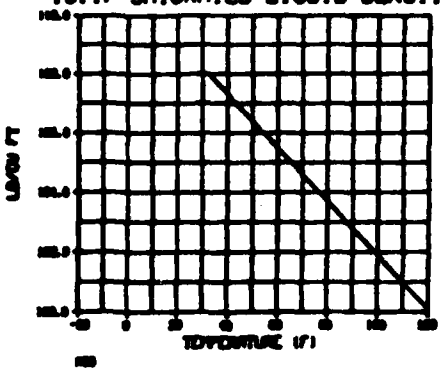
(Continued on pages 5 and 6)

NOTES

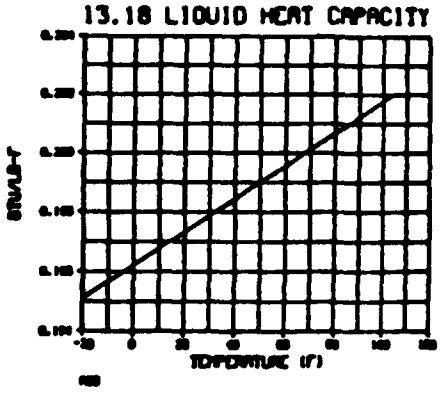
METHYL BROMIDE

MTB

13.17 SATURATED LIQUID DENSITY



13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

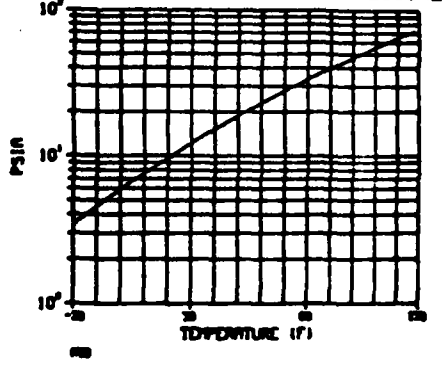
13.20 LIQUID VISCOSITY

NOT PERTINENT

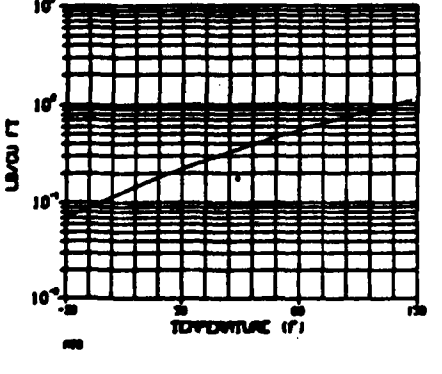
13.21 SOLUBILITY IN WATER

0.09 LB/100 LB WATER AT 68°F

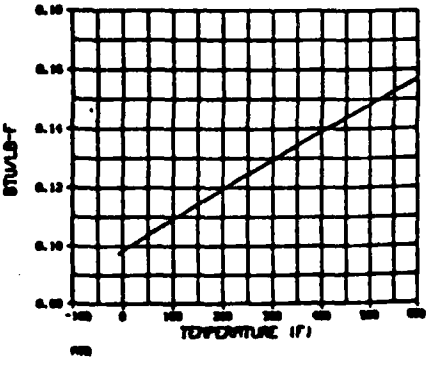
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



PPL PROPYLENE

Common Synonyms: Propene, Methylethylene	Liquefied compressed gas. Colorless. Mild odor. Floats and boils on water. Flammable, visible vapor cloud is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Evacuate area in case of large discharge.
Avoid contact with liquid.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Container may explode in fire.
Flashback along vapor trail may occur.
May explode if ignited in an enclosed area.
Stop flow of gas if possible.
Cool exposed containers and protect men effecting shutoff with water.
Let fire burn.

Exposure

CALL FOR MEDICAL AID

VAPOR
If inhaled, will cause dizziness or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will cause frostbite.
Flush affected areas with plenty of water.
DO NOT RUB AFFECTED AREAS.

Water Pollution

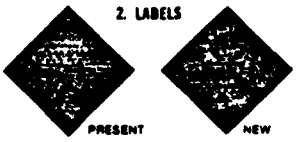
Not harmful to aquatic life.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning — high flammability
Evacuate area

2. LABELS



3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Methylethylene
Propene

3.2 **Coast Guard Compatibility Classification:** Olefin

3.3 **Chemical Formula:** $CH_3CH{=}CH_2$

3.4 **IMCO/United Nations Numerical Designation:** 2.0/1077

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquefied gas

4.2 **Color:** Colorless

4.3 **Odor:** Weak gassy

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor canister or air-supplied mask, goggles or face shield (for liquid), protective clothing (for liquid).

5.2 **Symptoms Following Exposure:** Moderate concentration in air causes dizziness, drowsiness, and unconsciousness. Contact with liquefied propylene will cause "freezing burn."

5.3 **Treatment for Exposure:** INHALATION: remove victim from exposure, if breathing is irregular or has stopped, start resuscitation, give oxygen; call a doctor.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 4000 ppm

5.5 **Short-Term Inhalation Limits:** Data not available

5.6 **Toxicity by Ingestion:** Not pertinent

5.7 **Late Toxicity:** None

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors are nonirritating to the eyes and throat.

5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to the skin because it evaporates quickly.

5.10 **Odor Threshold:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** −162°F C.C.

6.2 **Flammable Limits in Air:** 2.0% - 11%

6.3 **Fire Extinguishing Agents:** Stop flow of gas.

6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent.

6.5 **Special Hazards of Combustion Products:** Not pertinent.

6.6 **Behavior in Fire:** Containers may explode. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.

6.7 **Ignition Temperature:** 927°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** 8 mm/min (liquid)

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent.

7.5 **Polymerization:** Not pertinent.

7.6 **Inhibitor of Polymerization:** Not pertinent.

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** None

8.2 **Waterfowl Toxicity:** None

8.3 **Biological Oxygen Demand (BOD):** None

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Dow Chemical Co
Midland, Mich. 48640
2. Exxon Chemical Co
Houston, Tex. 77001
3. Union Carbide Corp
Chemicals and Plastics Division
270 Park Ave
New York, N.Y. 10017

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** Chemical 92+%, polymerization 99+%, research 99+%, propylene concentrate 80+%.

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Safety relief

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-B-C-D-E-F-G

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable compressed gas

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	4
Health	
Vapor Irritant	0
Liquid or Solid Irritant	0
Poisons	1
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	1
Aesthetic Effect	0
Reactivity	
Other Chemicals	1
Water	0
Self-Reaction	1

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	4
Reactivity (Yellow)	1

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 18°C and 1 atm:** Gas

13.2 **Molecular Weight:** 42.08

13.3 **Boiling Point at 1 atm:** −53.9°F = −47.7°C = 225.5°K

13.4 **Freezing Point:** −301.4°F = −185.2°C = 88°K

13.5 **Critical Temperature:** 197.2°F = 91.8°C = 365.0°K

13.6 **Critical Pressure:** 670 psia = 45.6 atm = 4.62 MN/m²

13.7 **Specific Gravity:** 0.6N at −47°C (liquid)

13.8 **Liquid Surface Tension:** 16.7 dynes/cm = 0.0167 N/m at −47°C

13.9 **Liquid-Water Interfacial Tension:** Not pertinent

13.10 **Vapor (Gas) Specific Gravity:** 1.4

13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.152

13.12 **Latent Heat of Vaporization:** 187 Btu/lb = 104 cal/g = 435 × 10³ J/kg

13.13 **Heat of Combustion:** −19,692 Btu/lb = −10,940 cal/g = −458.04 × 10³ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

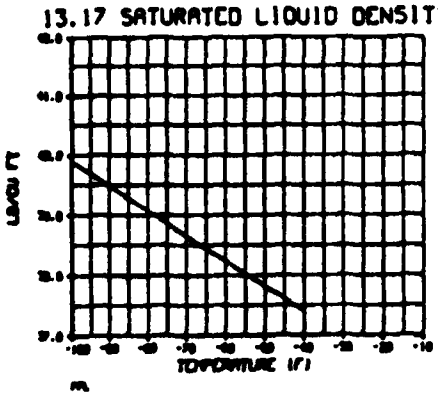
(Continued on pages 5 and 6.)

NOTES

PROPYLENE

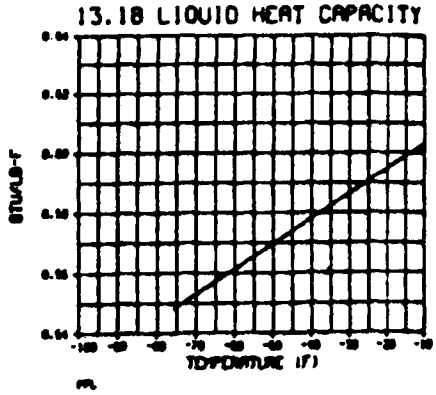
PPL

13.17 SATURATED LIQUID DENSITY



PPL

13.18 LIQUID HEAT CAPACITY



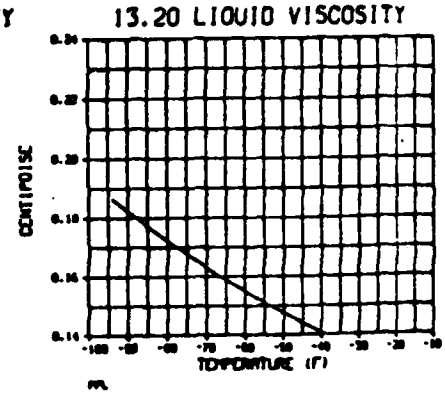
PPL

13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

PPL

13.20 LIQUID VISCOSITY



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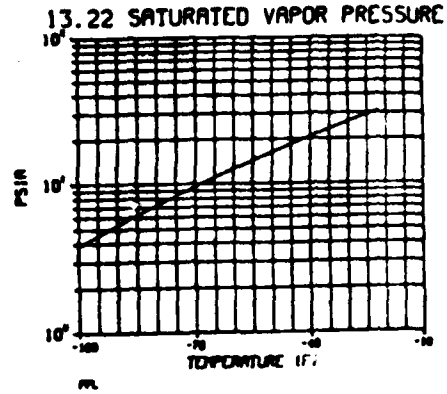
13.21 SOLUBILITY IN WATER

INSOLUBLE

PPL

13.22 SATURATED VAPOR PRESSURE



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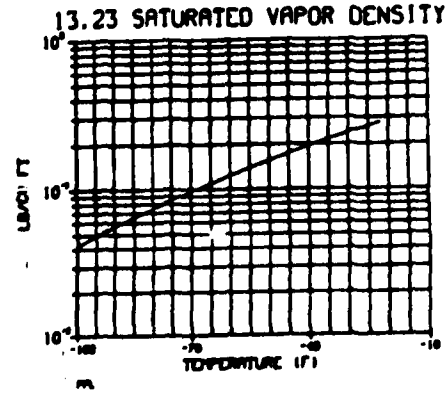
13.23 SATURATED VAPOR DENSITY



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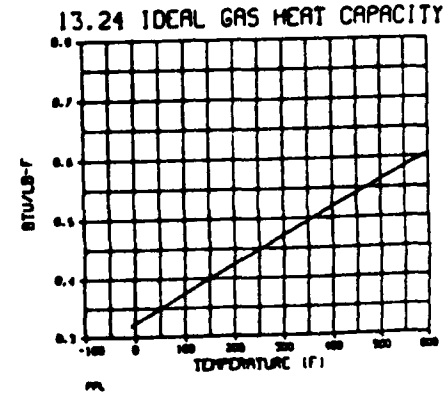
13.24 IDEAL GAS HEAT CAPACITY



PPL

SHS — SODIUM HYDROSULFIDE SOLUTION

Common Synonyms: Sodium bisulfide; Sodium sulfhydrate; Sodium hydrogen sulfide

Liquid — Light yellow to red — Rotten egg odor

Mixes with water

Stop discharge if possible. Keep people away.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable

Exposure

Call for medical aid.

LIQUID
Irritating to skin and eyes.
If swallowed will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Dangerous to aquatic life in high concentrations.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning — water contaminant, corrosive
Restrict access
Disperse and flush

2. LABELS

No label required by Code of Federal Regulations

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Sodium bisulfide; Sodium hydrogen sulfide; Sodium sulfhydrate
3.2 **Coast Guard Compatibility Classification:** To be developed
3.3 **Chemical Formula:** NaSH–H_2O
3.4 **IMCO/United Nations Numerical Designation:** Not listed

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid (water solution)
4.2 **Color:** Light lemon, pale yellow, amber to dark red
4.3 **Odor:** Rotten eggs

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Rubber protective equipment such as apron, boots, splash-proof goggles, gloves; canister-type respirator or self-contained breathing apparatus.

5.2 **Symptoms Following Exposure:** Inhalation of mist causes irritation of respiratory tract and possible systemic poisoning. Hydrogen sulfide gas, which may be given off when acid is present, causes headache, dizziness, nausea, vomiting; continued exposure can lead to loss of consciousness, respiratory failure, and death.
Liquid causes marked eye irritation, itching, inflammation [illegible] and corneal [illegible] causing blurring of vision are the most common effects [illegible] exposure [illegible] may increase the [illegible] effect. Contact of liquid with skin causes irritation and corrosion of tissue; continued exposure may cause dermatitis. Ingestion causes severe burning and corrosion of all portions of the gastrointestinal tract; pain in the throat and abdomen, nausea, and vomiting, followed by diarrhea; in severe cases collapse, unconsciousness, and paralysis of respiration may be expected.

5.3 **Treatment for Exposure:** INHALATION: move victim from contaminated atmosphere; call physician; if breathing has ceased, start mouth-to-mouth resuscitation. EYES: immediately flush with large quantities of running water for a minimum of 15 min.; obtain medical attention as soon as possible; while awaiting instructions from physician, patient may be kept in a dark room and ice compresses applied to the eyes and forehead. SKIN: immediately flush affected areas with water; obtain medical attention if irritation persists. INGESTION: obtain medical attention as soon as possible; if patient is conscious, induce vomiting by giving large amounts of water or warm salty water (2 tablespoons of table salt to a pint of water); if this measure is unsuccessful, vomiting may be induced by tickling back of patient's throat with a finger. Vomiting should be encouraged until the vomitus is clear.

5. HEALTH HAZARDS (Cont.)

If patient is unconscious, do not give anything but ensure there is no obstruction to breathing (his tongue should be kept forward and false teeth removed). He will be less likely to aspirate vomitus if he is placed in a face-down position.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** Data not available
5.5 **Short-Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.5 to 5 g/kg
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** [illegible] severe skin irritant. May cause second-degree burns after a few minutes contact.
5.10 **Odor Threshold:** [illegible] ppm

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not pertinent
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not pertinent

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
7.2 **Reactivity with Common Materials:** Corrodes most metals but reaction is not hazardous
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Flood with water
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 206 mg/l [illegible] water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Stauffer Chemical Company, Industrial Chemical Division, Westport, Conn. 06880
2. PPG Industries, Incorporated, Industrial Chemical Division, One Gateway Center, Pittsburgh, Pa. 15222
3. Chemical Products Corporation, King Philip Rd., East Providence, R.I. 02914

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** 40–70% solutions in water
10.2 **Storage Temperature:** [illegible]
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-P

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Not listed
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	0
Health	
Vapor Irritant	2
Liquid or Solid Irritant	3
Poisons	4
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

12.3 **NFPA Hazard Classifications:** Not listed

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** Not pertinent
13.3 **Boiling Point at 1 atm:** (approx.) 212°F = 100°C = 373°K
13.4 **Freezing Point:** (approx.) 63°F = 17°C = 290°K
13.5 **Critical Temperature:** Not pertinent
13.6 **Critical Pressure:** Not pertinent
13.7 **Specific Gravity:** [illegible] at 15°C (liquid)
13.8 **Liquid Surface Tension:** Data not available
13.9 **Liquid-Water Interfacial Tension:** Not pertinent
13.10 **Vapor (Gas) Specific Gravity:** Not pertinent
13.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
13.12 **Latent Heat of Vaporization:** Not pertinent
13.13 **Heat of Combustion:** Not pertinent
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

SHD — SODIUM HYDROXIDE

Common Synonyms			
Caustic soda Lye	Solid flakes or pellets	White	Odorless
	Sinks and mixes with water		

Avoid contact with solid and dust. Keep people away.
Wear rubber overclothing (including gloves).
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
May cause fire on contact with combustibles.
Flammable gas may be produced on contact with metals.
Wear rubber overclothing (including gloves).
Flood discharge area with water.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.
DUST:
Irritating to eyes, nose and throat.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
IF IN EYES, hold eyelids open and flush with plenty of water.
SOLID:
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook CG-446-4)

Issue warning: corrosive
Restrict access
Disperse and flush

2. LABELS

No hazard label required by Code of Federal Regulations

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Caustic soda
3.2 **Coast Guard Compatibility Classification:** Not applicable
3.3 **Chemical Formula:** NaOH
3.4 **IMCO United Nations Numerical Designation:** 8.0/1823

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Solid
4.2 **Color:** White
4.3 **Odor:** Odorless

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Chemical safety goggles, face shield, filter or dust-type respirator, rubber boots, rubber gloves.

5.2 **Symptoms Following Exposure:** Strong corrosive action on contacted tissues. INHALATION: dust may cause damage to upper respiratory tract and lung itself, producing from mild nose irritation to pneumonitis. INGESTION: severe damage to mucous membranes, severe scar formation or perforation may occur. EYE CONTACT: produces severe damage.

5.3 **Treatment for Exposure:** INHALATION: remove from exposure, support respiration, call physician. INGESTION: give water or milk followed by dilute vinegar or fruit juice; do NOT induce vomiting. SKIN: wash immediately with large quantities of water under emergency safety shower while removing clothing; continue washing until medical help arrives; call physician. EYES: irrigate immediately with copious amounts of water for at least 15 min.; call physician.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** Not pertinent

5.5 **Short-Term Inhalation Limits:** Not pertinent

5.6 **Toxicity by Ingestion:** Data not available

5.7 **Late Toxicity:** None

5.8 **Vapor (Gas) Irritant Characteristics:** Non-volatile

5.9 **Liquid or Solid Irritant Characteristics:** Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes.

5.10 **Odor Threshold:** Not pertinent

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not flammable
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not flammable

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** Dissolves with liberation of much heat, may steam and splatter.
7.2 **Reactivity with Common Materials:** When wet, attacks metals such as aluminum, tin, lead, and zinc to produce flammable hydrogen gas.
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Flush with water, rinse with dilute acetic acid.
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
125 ppm/96 hr/mosquito fish TL$_m$/fresh water
180 ppm/23 hr/oysters/lethal/salt water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Diamond Shamrock Corp.
Electro Chemicals Division
Deer Park, Tex. 77536
2. Dow Chemical Co.
Midland, Mich. 48640
3. PPG Industries, Inc.
Industrial Chemical Division
Barberton, Ohio 44203

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** Technical flakes, USP pellets
10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Open

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook CG-446-3)

SS

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Not listed
12.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed
12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	0
Reactivity (Yellow)	1

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Solid
13.2 **Molecular Weight:** 40.00
13.3 **Boiling Point at 1 atm:** Very high
13.4 **Freezing Point:** 604°F = 318°C = 591°K
13.5 **Critical Temperature:** Not pertinent
13.6 **Critical Pressure:** Not pertinent
13.7 **Specific Gravity:** 2.13 at 20°C (solid)
13.8 **Liquid Surface Tension:** Not pertinent
13.9 **Liquid-Water Interfacial Tension:** Not pertinent
13.10 **Vapor (Gas) Specific Gravity:** Not pertinent
13.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
13.12 **Latent Heat of Vaporization:** Not pertinent
13.13 **Heat of Combustion:** Not pertinent
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

Continued on page 1 and 8.

NOTES

13.17 SATURATED LIQUID DENSITY

NOT PERTINENT

13.18 LIQUID HEAT CAPACITY

NOT PERTINENT

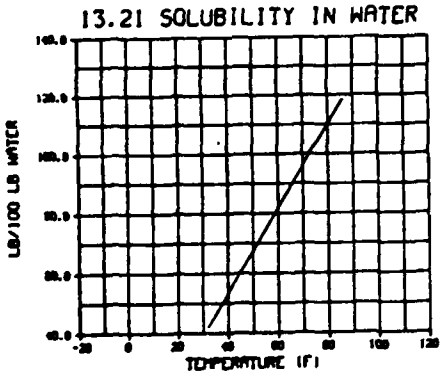
13.19 LIQUID THERMAL CONDUCTIVITY

NOT PERTINENT

13.20 LIQUID VISCOSITY

NOT PERTINENT

13.21 SOLUBILITY IN WATER



13.22 SATURATED VAPOR PRESSURE

NOT PERTINENT

13.23 SATURATED VAPOR DENSITY

NOT PERTINENT

13.24 IDEAL GAS HEAT CAPACITY

NOT PERTINENT

STY — STYRENE

Common Synonyms
Styrol
Vinylbenzene
Phenylethylene

Watery liquid Colorless to light yellow Sweet pleasant odor

Floats on water Flammable, irritating vapor is produced

- Avoid contact with liquid and vapor. Keep people away.
- Wear chemical protective suit with self-contained breathing apparatus.
- Stop discharge if possible.
- Call fire department.
- Isolate and remove discharged material.
- Notify local health and pollution control agencies.

Fire

Combustible.
CONTAINERS MAY EXPLODE IN FIRE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear chemical protective suit with self-contained breathing apparatus.
Combat fires from safe distance or protected location.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-4)

Issue warning - air contaminant
Mechanical containment
Should be removed
Chemical and physical treatment

2. LABELS

No hazard label required by Code of Federal Regulations

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Phenethylene, Phenylethylene, Styrol, Styrolene, Vinylbenzene

3.2 **Coast Guard Compatibility Classification:** Monomer

3.3 **Chemical Formula:** $C_6H_5CH{=}CH_2$

3.4 **IMCO/United Nations Numerical Designation:** 3.3/2055

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Colorless

4.3 **Odor:** Sweet at low concentrations, characteristic pungent, sharp, disagreeable

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air-supplied mask or approved canister, rubber or plastic gloves, boots, goggles or face shield

5.2 **Symptoms Following Exposure:** Moderate irritation of eyes and skin. High vapor concentrations cause dizziness, drunkenness, and anesthesia.

5.3 **Treatment for Exposure:** INHALATION: remove to fresh air, keep warm and quiet, use artificial respiration if needed. INGESTION: do NOT induce vomiting, call physician, no known antidote. SKIN OR EYE CONTACT: flush with plenty of water, for eyes get medical attention.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 100 ppm

5.5 **Short-Term Inhalation Limits:** 100 ppm for 30 min

5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.3 to 5 g/kg

5.7 **Late Toxicity:** Data not available

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.

5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.

5.10 **Odor Threshold:** 0.149 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 93°F O.C., 88°F C.C.

6.2 **Flammable Limits in Air:** 1.1% - 6.1%

6.3 **Fire Extinguishing Agents:** Water, foam, carbon dioxide, or dry chemical

6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective

6.5 **Special Hazards of Combustion Products:** Not pertinent

6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. At elevated temperatures such as in fire conditions, polymerization may take place which may lead to container explosion.

6.7 **Ignition Temperature:** 914°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** 5.2 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** May occur if heated above 150°F. Can cause rupture of container. Metal salts, peroxides, and strong acids may also cause polymerization.

7.6 **Inhibitor of Polymerization:** Tertiary-butylcatechol, 10-15 ppm

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 22 ppm/96 hr/Bluegill/TL_m/fresh water

8.2 **Waterfowl Toxicity:** Data not available

8.3 **Biological Oxygen Demand (BOD):** 1.6% (theor.) 1.412 g/g

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Amoco Chemicals Corp
910 South Michigan Ave
Chicago, Ill. 60605
2. Dow Chemical Co
Midland, Mich. 48640
3. Monsanto Co
Monsanto Polymers & Petrochemicals Co
800 North Lindbergh Blvd
St. Louis, Mo. 63166

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** 99.5+%

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Open (flame arrester)

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-2)

A-T-U-Z

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Not listed

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	0
Self-Reaction	3

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** 104.15

13.3 **Boiling Point at 1 atm:** 293.4°K = 145.2°C = 418.4°K

13.4 **Freezing Point:** −23.1°F = −30.6°C = 242.6°K

13.5 **Critical Temperature:** 703°F = 373°C = 646°K

13.6 **Critical Pressure:** 580 psia = 39.46 atm = 4.00 MN/m²

13.7 **Specific Gravity:** 0.906 at 20°C (liquid)

13.8 **Liquid Surface Tension:** 32.14 dynes/cm = 0.03214 N/m at 20°C

13.9 **Liquid-Water Interfacial Tension:** 35.43 dynes/cm = 0.03543 N/m at 19°C

13.10 **Vapor (Gas) Specific Gravity:** Not pertinent

13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.024

13.12 **Latent Heat of Vaporization:** 156 Btu/lb = 86.8 cal/g = 3.63 × 10⁵ J/kg

13.13 **Heat of Combustion:** Not pertinent

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** −297 Btu/lb = −154 cal/g = −6.45 × 10⁵ J/kg

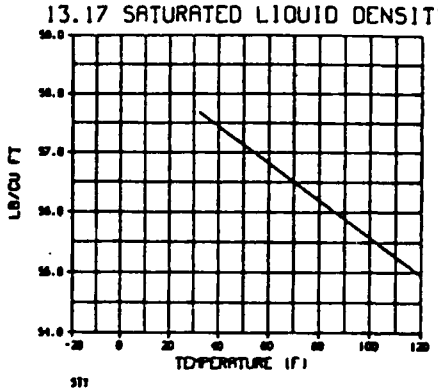
(Continued on page 1 and 6)

NOTES

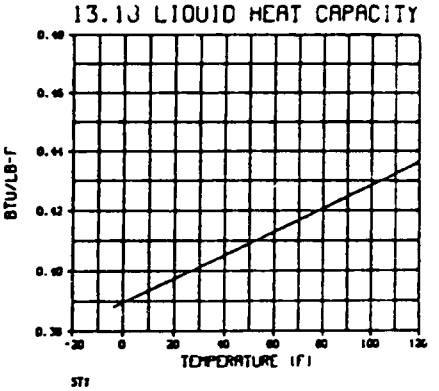
STYRENE

STY

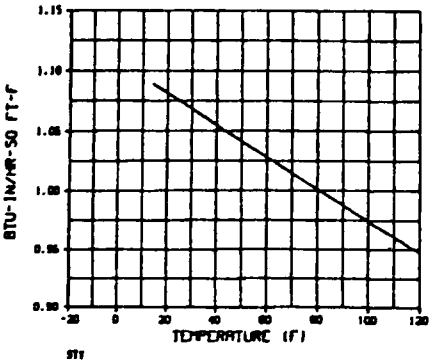
13.17 SATURATED LIQUID DENSITY



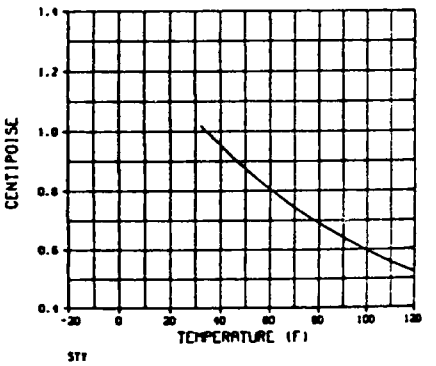
13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY



13.20 LIQUID VISCOSITY

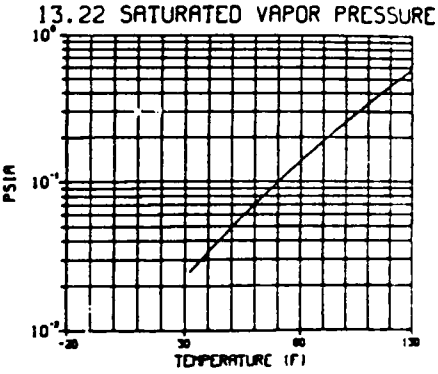


13.21 SOLUBILITY IN WATER

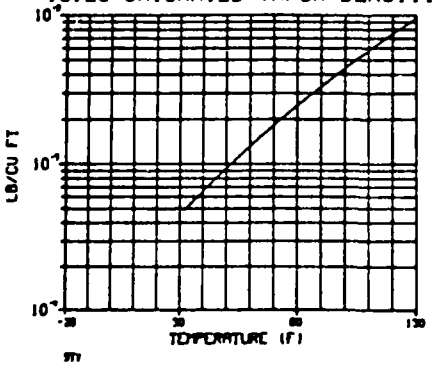
0.3 LB/100 LB WATER AT 68°F

STY

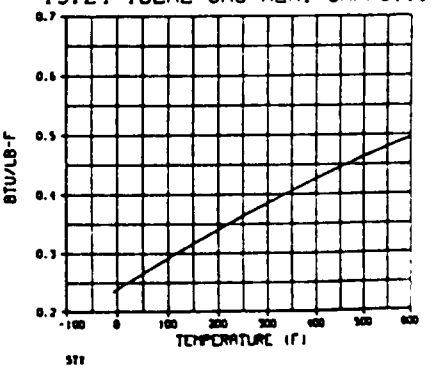
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



TOL	TOLUENE

Common Synonyms
Toluol
Methylbenzene
o-tolylhydride

Watery liquid | Colorless | Pleasant odor

Floats on water. Flammable, irritating vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES: hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

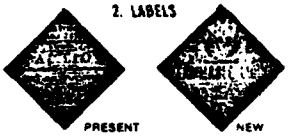
Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG-446-4)

Issue warning - high flammability
Evacuate area

2. LABELS



PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Methylbenzene
Methylbenzol
Toluol

3.2 **Coast Guard Compatibility Classification:** Aromatic hydrocarbon

3.3 **Chemical Formula:** $C_6H_5CH_3$

3.4 **IMCO/United Nations Numerical Designation:** 3.2, 1294

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Colorless

4.3 **Odor:** Pungent, aromatic, benzene-like, distinct, pleasant

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air-supplied mask, goggles or face shield, plastic gloves

5.2 **Symptoms Following Exposure:** Vapors irritate eyes and upper respiratory tract, cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.

5.3 **Treatment for Exposure:** INHALATION: remove to fresh air, give artificial respiration and oxygen if needed, call a doctor. INGESTION: do NOT induce vomiting, call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 100 ppm

5.5 **Short-Term Inhalation Limits:** 600 ppm for 30 min

5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.5 to 5 g/kg

5.7 **Late Toxicity:** Kidney and liver damage may follow ingestion.

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.

5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

5.10 **Odor Threshold:** 0.17 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 40°F C.C., 55°F O.C.

6.2 **Flammable Limits in Air:** 1.27% - 7%

6.3 **Fire Extinguishing Agents:** Carbon dioxide or dry chemical for small fires, ordinary foam for large fires.

6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective.

6.5 **Special Hazards of Combustion Products:** Not pertinent.

6.6 **Behavior in Fire:** Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.

6.7 **Ignition Temperature:** 997°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** 5.7 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Not pertinent

7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 1,180 mg/l/96 hr-sunfish, TLm, fresh water

8.2 **Waterfowl Toxicity:** Data not available

8.3 **Biological Oxygen Demand (BOD):** 0% 5 days, 38% (theor.) 10 days

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1 Exxon Chemical Co
Houston, Tex. 77001

2 Shell Chemical Co
Petrochemicals Division
Houston, Tex. 77001

3 Sun Oil Co
St. Davids, Pa. 19087

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** Research reagent, nitration, all 99+%, industrial, contains 94+% with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons, 90-120° less pure than industrial

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Open (flame arrester) or pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG-446-3)

A-T-U

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Flammable liquid

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self-Reaction	0

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** 92.14

13.3 **Boiling Point at 1 atm:** 231.1°F = 110.6°C = 383.8°K

13.4 **Freezing Point:** -139°F = -93.0°C = 179.2°K

13.5 **Critical Temperature:** 605.4°F = 318.6°C = 591.8°K

13.6 **Critical Pressure:** 595.1 psia = 40.55 atm = 4.108 MN/m²

13.7 **Specific Gravity:** 0.867 at 20°C (liquid)

13.8 **Liquid Surface Tension:** 29.0 dynes/cm = 0.0290 N/m at 20°C

13.9 **Liquid-Water Interfacial Tension:** 36.1 dynes/cm = 0.0361 N/m at 25°C

13.10 **Vapor (Gas) Specific Gravity:** Not pertinent

13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.089

13.12 **Latent Heat of Vaporization:** 155 Btu/lb = 86.1 cal/g = 3.61 × 10⁵ J/kg

13.13 **Heat of Combustion:** -17,430 Btu/lb = -9686 cal/g = -405.5 × 10³ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

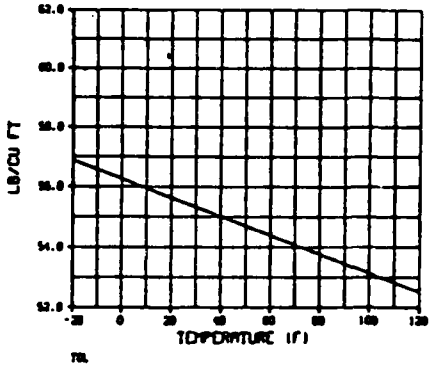
Continued on pages 5 and 6

NOTES

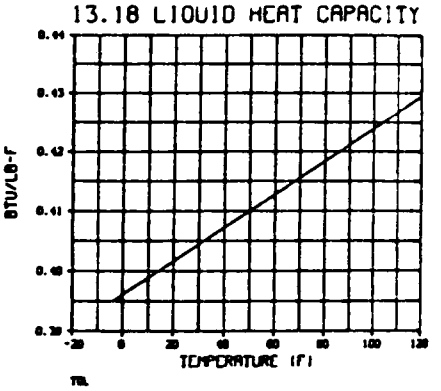
TOLUENE

TOL

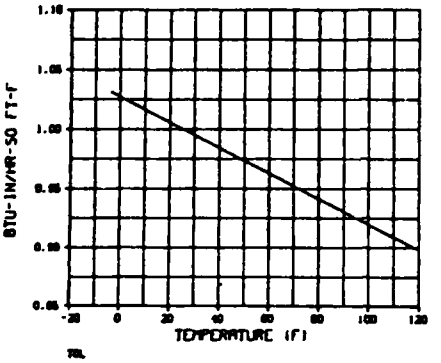
13.17 SATURATED LIQUID DENSITY



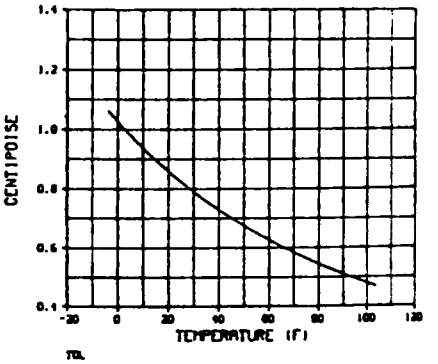
13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY



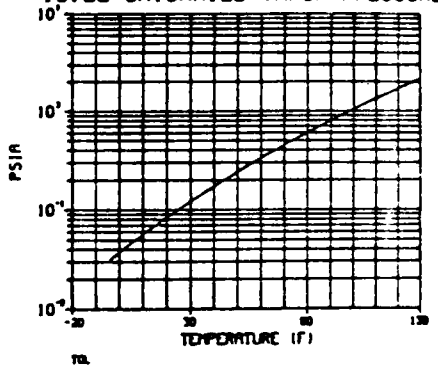
13.20 LIQUID VISCOSITY



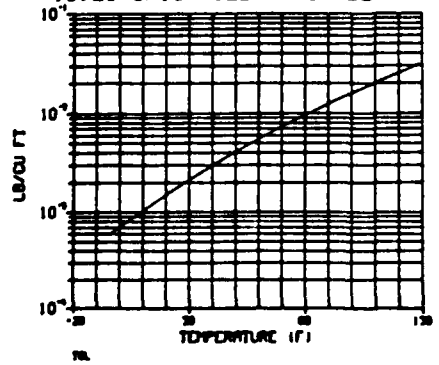
13.21 SOLUBILITY IN WATER

0.05 LB/100 LB WATER AT 68°F

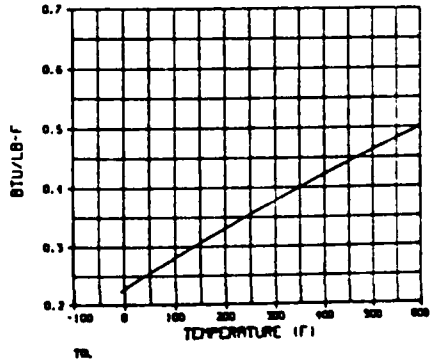
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



VAM — VINYL ACETATE

Common Synonyms
VyAc
Vinyl A monomer

Watery liquid | Colorless | Pleasant fruity odor

Floats on water. Flammable, irritating vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Containers may explode in fire.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Combat fires from safe distance or protected location.
Extinguish with dry chemical, foam, carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed or if spilled on skin.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

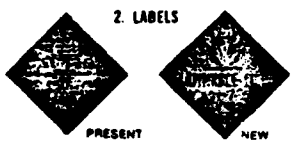
HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG 446-6)

Issue warning – high flammability
air contaminant
Evacuate area

2. LABELS



PRESENT NEW

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** VAM
Vinyl A monomer
Vy Ac

3.2 **Coast Guard Compatibility Classification:** Polymerizable ester

3.3 **Chemical Formula:** $CH_3COOCH{=}CH_2$

3.4 **IMCO/United Nations Numerical Designation:** 32/1301

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Colorless

4.3 **Odor:** Not unpleasant, sweet smell in small quantities, pleasant fruity, characteristic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister or air-supplied mask, goggles or face shield, rubber or plastic gloves

5.2 **Symptoms Following Exposure:** High vapor concentrations cause narcosis. Liquid irritates eyes and may irritate skin

5.3 **Treatment for Exposure:** INHALATION: remove victim to fresh air, give artificial respiration if required. EYES: flush with water for at least 15 min

5.4 **Toxicity by Inhalation (Threshold Limit Value):** 10 ppm

5.5 **Short-Term Inhalation Limits:** Data not available

5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.5 to 5 g/kg (rat)

5.7 **Late Toxicity:** Data not available

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.

5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

5.10 **Odor Threshold:** 0.12 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 18°F C.C., 23°F O.C.

6.2 **Flammable Limits in Air:** 2.6% – 13.4%

6.3 **Fire Extinguishing Agents:** Carbon dioxide or dry chemical for small fires, ordinary foam for large fires

6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective

6.5 **Special Hazards of Combustion Products:** Not pertinent

6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. May polymerize when heated in a fire or if ruptured container

6.7 **Ignition Temperature:** 800°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** 3.8 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Can occur when in contact with peroxides and strong acids, but only under extreme conditions

7.6 **Inhibitor of Polymerization:** 3–5 ppm or 14–17 ppm hydroquinone. Shipments usually also contain 200 ppm of diphenylamine

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
18 ppm/96 hr, bluegill TL_m fresh water
> 100 ppm/48 hr/flounder LC_{50} salt water

8.2 **Waterfowl Toxicity:** Data not available

8.3 **Biological Oxygen Demand (BOD):** 27% (theor.), 19 days

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Celanese Corp.
Celanese Chemical Co. Division
245 Park Ave.
New York, N.Y. 10017
2. National Distillers & Chemical Corp.
U.S. Industrial Chemicals Co. Division
Houston, Tex. 77001
3. Union Carbide Corp.
Chemicals and Plastics Division
270 Park Ave.
New York, N.Y. 10017

10. SHIPPING INFORMATION

10.1 **Grades of Purity:**
Grade A (Diphenylamine inhibited) 99.8%
Grade H (Hydroquinone inhibited) 99.8%

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Pressure-vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-P-Q-T-U-V-W-Z

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:**
Flammable liquid

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	0
Self-Reaction	3

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	2

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** 86.09

13.3 **Boiling Point at 1 atm:**
63.2°F = 72.9°C = 346.1°K

13.4 **Freezing Point:**
−133.0°F = −92.8°C = 180.4°K

13.5 **Critical Temperature:**
486°F = 252°C = 525°K

13.6 **Critical Pressure:**
57.7 atm = 42 psia = 4.25 MN/m²

13.7 **Specific Gravity:** 0.934 at 20°C (liquid)

13.8 **Liquid Surface Tension:**
23.95 dynes/cm = 0.02395 N/m at 20°C

13.9 **Liquid-Water Interfacial Tension:**
(est.) 10 dynes/cm = 0.01 N/m at 20°C

13.10 **Vapor (Gas) Specific Gravity:**
Not pertinent

13.11 **Ratio of Specific Heats of Vapor (Gas):**
1.03

13.12 **Latent Heat of Vaporization:** 167 Btu/lb
= 90.6 cal/g = 3.79 × 10⁵ J/kg

13.13 **Heat of Combustion:** −9754 Btu/lb
= −5419 cal/g = −226.9 × 10³ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** −349 Btu/lb
= −244 cal/g = −10.2 × 10³ J/kg

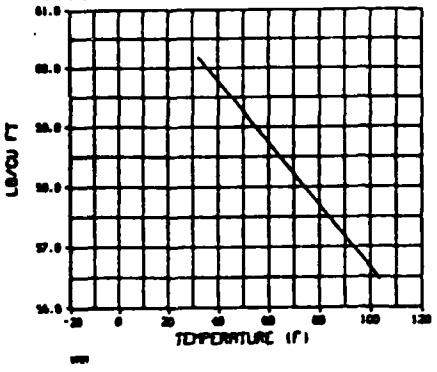
(Continued on page 1 and 4)

NOTES

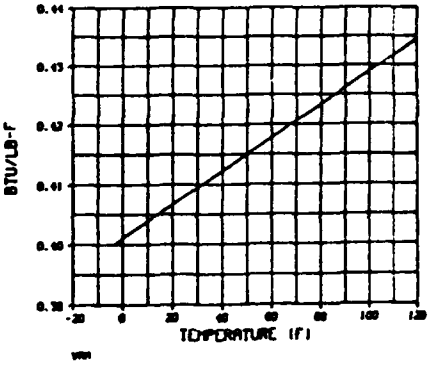
VINYL ACETATE

VAM

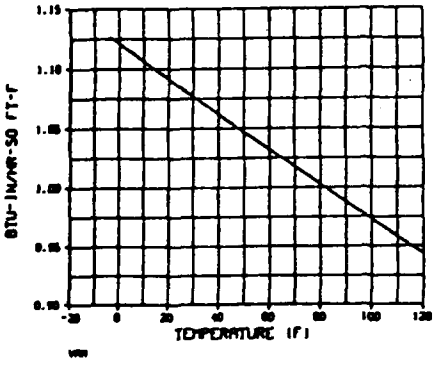
13.17 SATURATED LIQUID DENSITY



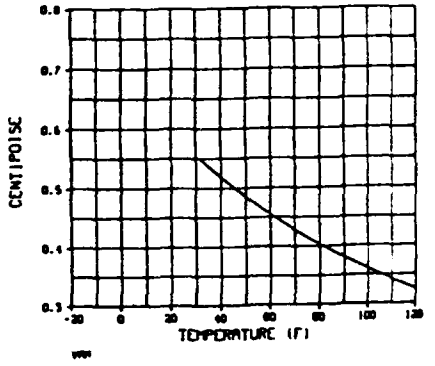
13.18 LIQUID HEAT CAPACITY



13.19 LIQUID THERMAL CONDUCTIVITY



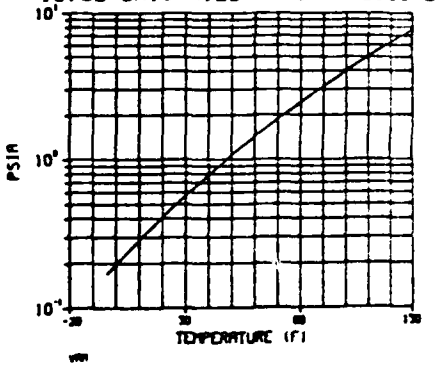
13.20 LIQUID VISCOSITY



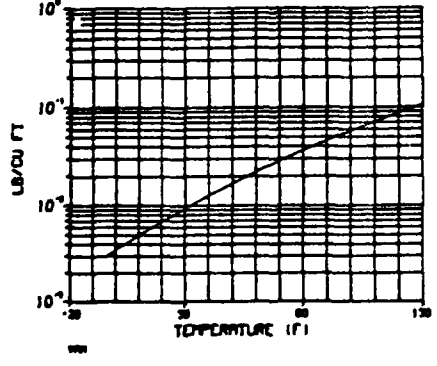
13.21 SOLUBILITY IN WATER

2.3 LB/100 LB WATER AT 68°F

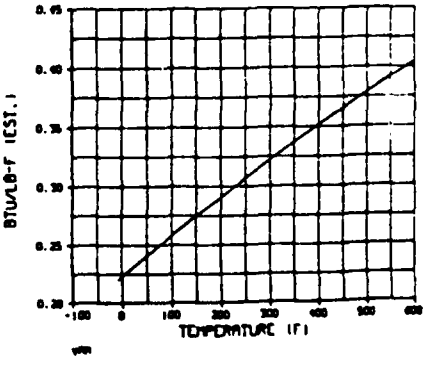
13.22 SATURATED VAPOR PRESSURE



13.23 SATURATED VAPOR DENSITY



13.24 IDEAL GAS HEAT CAPACITY



DOT ISOLATION AND EVACUATION DISTANCES

Material	Initial Isolation	First Isolate in All Directions (feet)	Then Evacuate in a Downwind Direction width miles	length miles
Acrylonitrile	30	60	0.1	0.2
Hydrocyanic acid	90	190	0.5	0.7
Methyl bromide	50	90	0.2	0.3

MOP 600-4

Manual of Procedure BROADCAST

SECTION: EMERGENCY SERVICES

SUBJECT: SPILL INCIDENTS - SORBENT BOOMS

TAKE THE FOLLOWING ACTIONS IMMEDIATELY TO BRING YOUR MANUAL UP-TO-DATE:

PLACE THIS DOCUMENT IN NUMERICAL ORDER AFTER THE DIVIDER FOR SECTION 600 - EMERGENCY SERVICES.

In Section 644-3 across the top of page 1, mark SEE BROADCAST 600-4.

A 10-foot sorbent boom for use at oil spill incidents is supplied to the Fire Department by the Maryland Water Resources Administration.

This boom will not absorb water and can be used for booming as well as sorption by linking together in overlap configuration, or for sorption alone by towing through spill area linked end-to-end. Will work on spills of virtually any thickness. Distillates and crudes above 40°F.(4°C.) are those most effectively sorbed. Heavier oils can be equally well boomed, but sorption is not efficient.

PURPOSE:

The primary reasons for supplying sorbent booms to Fire Department units are as follows:

- To provide immediate, complete control of small oil spills by booming the gutter, streams, runs, stuffing boom into storm drain inlet or discharge rivulets, sanitary sewer openings, or linking together for forming levee or dike for a catchment area.
- To provide immediate initial control measures to contain larger oil spills in accordance with MOP 644-1 until clean-up forces of the responsible party, the State, or Federal Government can be mobilized.

DISTRIBUTION:

1. One sorbent boom will be carried on each engine and truck with a plastic trash bag.

DATE 6/16/78

2. Three replacements and/or spares will be retained in stations where Battalion Chiefs are quartered.

3. Replacements will be made from Maryland Port Administration (see Replacement Supply - page 3 of 3).

OPERATIONS:

1. Upon arrival at the scene, the Officer in Charge will report to Fire Communications as per item 1 [MOP 644-1].

2. When a single unit responds to a spill incident and additional sorbent booms are required, the Unit Officer will notify Fire Communications office to dispatch additional units as needed and specifically request that units respond with booms. He will also determine and notify Communications whether response should be EMERGENCY or NON-EMERGENCY.

3. Whenever three (3) or more units are at the scene of a spill incident and a box alarm has not been sounded, Communications office will dispatch the nearest Battalion Chief who will assume command at the scene.

4. If additional quantities of booms are still needed, the Officer in Charge will arrange for delivery through the Officer in Charge of Field Operations in accordance with [MOP 644-1].

5. Units that are not needed after they have delivered their sorbent booms shall be placed in service.

6. Clean-up and Disposal

   a. Oil-contaminated sorbent booms shall be placed in the plastic bag or in a suitable container such as a metal can.

   b. Booms can be disposed of in the same manner as the regular station trash is collected by Bureau of Utility Operations.

c. Sorbent booms that contain volatile flammable liquids and large quantities of oil-contaminated booms shall be disposed of by supervisor of the Bureau of Utility Operations crew that responded or by State or Federal Government clean-up crews or contractors.

d. When completing Spill Report (210-041), in area where it indicates "absorbed by sorbent material," show total footage of booms used.

REPLACEMENT SUPPLY OF SORBENT BOOMS:

- When sorbent boom is used, Unit Officer will notify the Battalion Chief by phone and request a replacement boom.

- When the Battalion Chief's supply is depleted, the Chief will notify Maryland Port Administration for replacements as follows:

Marine Foreman, Robert F. O'Conner
383-5764 or 383-5104 or
237-8339 - Voice Beeper

Chief of Debris and Oil, Marty Wallace
237-8582 - Voice Beeper
391-1192 - Home (24 hours)

By order,

THOMAS J. BURKE, Chief

MOP 600-7

Manual of Procedure BROADCAST

SECTION

EMERGENCY SERVICES

SUBJECT

DISPOSABLE SURGICAL MASKS

TAKE THE FOLLOWING ACTIONS IMMEDIATELY TO BRING YOUR MANUAL UP-TO-DATE:

PLACE THIS DOCUMENT IN NUMERICAL ORDER AFTER THE DIVIDER FOR SECTION 600 - EMERGENCY SERVICES.

In Section 644-3 across the top of the page, mark SEE BROADCAST 600-7.

Large amounts of dust are produced while spreading absorbent material at spill incidents. To safeguard members against the hazards of inhaling these dust particles, disposable surgical masks will be provided for respiratory protection.

Each first-line Engine and Truck Company will be issued six (6) masks, and Unit Officers may secure replacement masks when the need arises from their respective Battalion Chief.

A supply of masks will be distributed to each Battalion Chief's station from the Fire Department Storeroom.

Disposable surgical masks are not to be worn during emergency operations involving fire, smoke, or toxic gases. In these instances, self-contained breathing apparatus must be used.

By order,

THOMAS J. BURKE, Chief

DATE 3/14/77

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICE

SUBJECT

PREVENTION OF CONTAMINATION OF DOMESTIC WATER SUPPLY

Water from the Baltimore Harbor; fresh water streams in and around the City; static water supplies such as tanks, swimming pools, and other untreated water supplies, must be considered as polluted and under no circumstances shall water from these sources be interconnected with any piping system or any hose system that is connected to the domestic water supply.

Fireboats and pumpers at draft shall not be used to supply automatic sprinkler and standpipe systems.

Relays shall not be established where one source of water is the City water supply and the other is a fireboat or pumper at draft.

Hose lines being supplied by a fireboat or pumper at draft shall not be connected to any apparatus or appliance that is also connected to the City water supply.

Whenever a pumper has been used at draft, it shall be connected to a City water supply hydrant and shall be thoroughly flushed as soon as possible after such use.

Whenever it becomes necessary to provide emergency water supply for human consumption in buildings or ships, only new fire hose connected to a City water supply hydrant shall be used.

Manual of Procedure POLICY

SECTION: EMERGENCY SERVICE

SUBJECT: HARBOR PROTECTION, FIREBOATS

Fireboat No. 1	Mayor Thomas D'Alesandro, Jr.	Dundalk Marine Terminal 2700 Broening Highway
Fireboat No. 2	Mayor J. Harold Grady	2609 Leany Street Locust Point
Reserve Fireboat No. 1	P. W. Wilkinson	Dundalk Marine Terminal 2700 Broening Highway
Reserve Fireboat No. 2	August Emrich	Maintenance Bureau 1407 Key Highway

Assignment

All fireboats are under the jurisdiction of the Second Battalion who shall also be responsible for maintaining reserve fireboats in operating condition at all times.

Response

A. Fire Communications will dispatch Fireboats No. 1 or No. 2 to box alarms as per card of assignment, each filling in for the other in accordance with standard fill-in policy.

B. For fires reported aboard vessels in the stream; vessels in inaccessible areas to land units, Fire Communications will dispatch both fireboats as per the following:

The nearest fireboat, immediately, to the scene of the incident and the nearest battalion chief, engine and truck to the station of the remaining fireboat, to be transported immediately to the scene of the incident.

. The remaining fireboat will prepare to respond and stand by until the arrival of the land units.

. The land units will take with them all equipment from their apparatus necessary for safe and efficient shipboard operations, such as:

a. Air masks and spare air bottles

b. Manual and powered forcible entry tools

c. Any equipment necessary to supplement the equipment carried on the fireboat

- The pump operator will remain at the fireboat station and care for the apparatus and vehicles of the land units.

- After initial evaluation of the situation at the scene, the first-arriving unit will immediately notify Fire Communications of conditions and: (a) request any special equipment, (b) additional assistance necessary, (c) return unnecessary units.

- When additional assistance is needed, Fire Communications will notify the Officer in Charge of Field Operations who will coordinate operations. Any available fireboat will be utilized to transport the additional personnel and equipment of the land units to the scene.

- Fireboat commanders shall make provisions for having sufficient life safety devices aboard to accommodate the fireboat crew and all passengers.

Response When a Fireboat is Away From Station

When a fireboat is away from its station and an alarm of fire is received, Fire Communications will determine the fireboat's position and dispatch the nearest fireboat to the incident.

When a fireboat is away from station for other than fire or emergency service and a second alarm is received for an incident to which the other fireboat has responded, the fireboat shall return to station.

Transfers

Fireboat No. 1 or No. 2 will not be transferred; however, an activated reserve fireboat may be transferred by the Officer in Charge of Field Operations as conditions necessitate.

To Place a Reserve Fireboat in Service

A. A reserve fireboat will be placed in service at any time to take the place of either Fireboat No. 1 or No. 2 when the latter must be placed out of service for drydock, overhaul or routine maintenance.

B. On other occasions, the Officer in Charge of Field Operations will arrange for and coordinate activation of a reserve fireboat in accordance with MOP 613 - Activating Reserve Apparatus and MOP 613-1 - Recall of Off-Duty Members to Duty.

C. Under emergency conditions when Fireboats No. 1 and No. 2 are committed to an incident or incidents, the Officer in Charge of Field Operations will activate one or both reserve fireboats by utilizing the on-duty crews of land units, provided sufficient licensed fireboat personnel are available to properly operate the vessel(s).

Training

A. Two hour harbor training cruises beginning at 0800 hours will be conducted as follows, weather conditions permitting:

1. Fireboat No. 1 - The first day of each day shift.

   Fireboat No. 2 - The third day of each day shift.

2. The Captains of fireboats shall maintain an accurate record of training cruises.

3. Fireboats in reserve status will be utilized on alternate training cruises.

4. All fireboat personnel shall participate in training exercises with their assigned units.

B. Land Unit Participation

1. From time to time as required, land units will participate in training cruises and instructions. This shall be determined by Battalion Chief Fire Academy with the approval of the Chief of Fire Department and the scheduling of such participation will be issued on a general order.

2. The scheduling of land units to participate in fireboat training cruises shall not conflict with the existing training and inspections scheduled for the land units.

3. Land units will be placed out of service and report to the fireboat station assigned with their apparatus at 0745 hours.

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICE

SUBJECT

FIREBOAT OPERATIONS

1. Fireboats shall be operated in accordance with the U.S. Coast Guard Regulations insofar as they are applicable.

2. When marine units respond to alarms of fire or other emergencies where land units have likewise responded, the officer in charge of the marine units shall receive his orders from the officer in charge of the land units who will be in charge of operations. The officer in charge of marine units shall advise the commander of the land units the extent of the fire from the water side and the necessity of summoning additional fireboats should the situation warrant.

3. Monitor pipes on fireboats shall not be placed in service at fires unless so ordered by officer in charge of fire.

4. Handlines from fireboats must be shut down when monitor pipe is placed in service.

5. Upon leaving station for any purpose except alarms of fire, the officer in charge of the fireboat must notify the Fire Communications Office and respective Battalion Chief of his destination. Radio communication must be maintained.

6. In case of abnormal weather conditions or other emergency that may endanger a fireboat, the commanding officer of the fireboat shall notify the Battalion Chief of the existing conditions and request permission to move the boat to a more protected or safer location. The Battalion Chief or officer acting as such shall be responsible for the decision as to whether the boat is to be moved to prevent damage. In the event the Battalion Chief cannot be contacted, the officer in charge of the boat shall use his best judgement in the matter and be held responsible accordingly.

7. The relocating of fireboats while operating at the scene of a fire must have the approval of the officer in charge, unless under extreme emergency conditions which are endangering the safety of the boat.

8. Officers in charge of hose lines being supplied by fireboats will notify the boat as to length of line and type of nozzle or appliance being supplied.

Manual of Procedure DETAIL PROCEDURE

SECTION: EMERGENCY SERVICES

SUBJECT: CHLORINE LEAKS

INFORMATION:

There are three (3) Chlorine Safety Kits available for service at the Steadman Fire Station. These kits are assigned to Rescue Company No. 1 and are stored in the air bottle storage closet on the Lombard Street side of the apparatus floor.

The kits are marked as follows:

A - for use on 100 or 150 pound cylinders
B - for use on one ton containers
C - for use on tank cars of 16, 30 and 55 tons

Note: A carrying case containing paint scrapers, cloths, ammonia, and vaseline is also provided for use with the above kits to aid in protecting members and locating the source of chlorine leaks. This carrying case must accompany any Chlorine Safety Kit(s) to an incident.

GENERAL INSTRUCTIONS:

In the event of an emergency involving a chlorine leak, all three (3) of the above kits (unless only one type is specified) must be obtained from the Steadman Station and delivered to the location of the incident.

1. Fire Communications will immediately dispatch Rescue No. 1 and a first-alarm assignment to the scene and notify the Officer in Charge of Field Operations of the incident.

2. Rescue 1 will transport the appropriate kit(s) on the apparatus and respond to the incident.

   If Rescue No. 1 is out of service, the Officer in Charge of Field Operations will:

   a. Authorize the use of another unit in the Steadman Station (Airflex, Scuba Wagon, Pumper) to deliver the kit(s).

b. Make arrangements to have the kit(s) delivered to the incident in the event the above-mentioned units are unavailable.

3. Fire Communications will notify the Officer in Charge of the incident when Rescue No. 1 is available to respond to the scene.

4. Keys to the storage closet and Scuba Wagon will be maintained in High Pressure Pumping Station.

5. Members will wear complete protective clothing and self-contained breathing apparatus and make use of petroleum jelly to cover delicate and exposed areas of the body when making emergency repairs on chlorine containers.

6. The Officer in Charge of the incident will notify Fire Communications by radio giving all pertinent information concerning the leak, e.g., size of container, magnitude of leak, whether or not the leak has been contained, and size of area involved.

7. Fire Communications will inform Chemtrec (telephone number 800-424-9300, 24 hours a day) of any chlorine emergency that has been reported.

8. Chemtrec will contact the closest manufacturer of chlorine gas, and this company will send representatives to the scene if necessary.

9. Fire Communications will notify the Fire Department Safety Officer giving him all pertinent information concerning the incident.

Manual of Procedure DETAIL PROCEDURE

SECTION: EMERGENCY SERVICES

SUBJECT: HAZARDOUS MATERIALS TASK FORCE (HMTF)

Purpose:

To provide an attack force with specific guidelines for operations at incidents involving hazardous chemicals and/or materials.

Definition:

A Hazardous Materials Task Force (HMTF) consists of 2 Engines, 1 Truck, Chemical Unit and a Battalion Chief, manned with specially trained personnel, designed to respond as a single entity on all incidents involving hazardous chemicals and/or materials.

Scope:

Designated HMTF's are:

Task Force 1	Task Force 2
Engine 41	Engine 10
Engine 50	Engine 57
Truck 20	Truck 28
Chemical 1	Chemical 2
Battalion Chief 1	Battalion Chief 6

A Deputy Chief, Rescue 1, Airflex 1, and nearest in-service ambulance will respond with whatever task force is dispatched. During normal working hours, the Safety Officer shall be notified and at all other times if it has been established a serious incident. In those situations when all required units are not available from the same task force, Captain, Fire Communications will consider the most expedient dispatch from 1st or 6th Battalion, based on circumstances, to insure that the four required components necessary to complete HMTF are dispatched.

Typical responses would include, but not limited to:

- Chlorine or ammonia leaks
- Bulk petroleum storage facilities - incidents
- Radiological incidents
- Chemical spills and/or explosions
- Petroleum products transportation fires

SECTION	SUBJECT
EMERGENCY SERVICES	HAZARDOUS MATERIALS TASK FORCE (HMTF)

Responsibility:

It will be the responsibility of each member to exercise the appropriate control dictated by his rank in the implementation of this operation procedure.

Procedure:

A. General

Pre-Planning

Hazardous materials locations will be pre-planned by the local unit. (MOP 610)

Required forms will be updated on an annual basis and theoretical fire-fighting training periods will be conducted to familiarize the members with conditions and to discuss specific fire-fighting operations that may be encountered. Where necessary, due to the size or complexity of the facility, pre-planning tours will be coordinated through respective Battalion Chief. Deputy Chief to be notified of all pending tours. Copies of the pre-plans will be forwarded to all HMTF units who will maintain a separate book containing this information.

B. Dispatch, response, and arrival procedures on box or silent alarms

Upon receipt of a report of an incident involving hazardous materials, Fire Communications will transmit the closest fire alarm box to the incident. If the report of the incident is from an employee handling the hazardous materials and the information indicates the incident to be of a serious nature, Fire Communications will also dispatch the nearest HMTF.

If the information received on a reported incident is of a minor nature, Fire Communications may use their discretion and dispatch on a silent alarm those units deemed necessary.

If the task force is included in this assignment, no other units will be required besides the Deputy Chief, Rescue 1, Airflex 1, and the nearest in-service ambulance. During normal working hours, the Safety Officer shall be notified and at all other times if it has been established a serious incident. If the task force is not included in the assignment, they will also be dispatched.

1. Where the cause of the alarm is not known, the first-arriving units will size up the situation and give a complete report to the FCB. If it is determined that a hazardous chemical or material is involved, the officer in charge will determine if the nearest available HMTF should be dispatched.

2. Where the cause of the alarm has been reported to involve hazardous materials, the first-assigned engine company will respond directly to the scene of the incident with the remaining units going into hold positions a minimum of 6 blocks (2,000 feet) from the reported location of the incident. The officer of the first-assigned engine company upon arrival will determine if the remaining units on the assignment should continue to the scene from their hold positions. If the services of the units in the hold positions or the HMTF are required, he shall transmit to them any precautionary measures to take while responding.

C. Operating Procedure

- Until proper identification of the product or material has been made, it should be considered toxic and explosive.

- Members should ANTICIPATE and not delay in calling for assistance as a limited situation can quickly become a major problem if not handled expeditiously. If evacuation is deemed necessary, it should be started immediately, moving those closest to the problem first and working away from the incident.

- All protective clothing, including breathing apparatus, will be worn in handling these incidents. If initial dispatch indicated a hazardous chemical, air masks will be donned before entering the contaminated area.

- Upon arrival, the Deputy Chief will assume charge of the incident, assisted by the task force Battalion Chief. The officer in charge will designate the staging area and designate an officer in charge.

- Points to be considered in selecting a staging area would include wind direction and velocity, topography, and accessibility. First-aid equipment, stand-by manpower, and logistical support will be marshalled here.

- Subsequent arriving units will, in the absence of specific instructions, report to the staging area.

- Chief officers will be cognizant of available monitoring equipment (radiological, explosive meter, etc.) and utilize them to best advantage, as well as the available supportive resources; i.e., CHEMTREC, Hazardous Materials Guides, local technical assistance.

- Chief officers will closely monitor casualties in case the Natural Disaster Plan should be implemented.

- Use of hose streams for flushing, cooling, or absorption should be considered and stretched where indicated.

- FIRES IN FLAMMABLE GASES SHOULD NOT BE EXTINGUISHED UNLESS THE FLOW OF GAS CAN BE STOPPED.

Communications will be maintained at all times between operating task force and Fire Communications Bureau.

As wind direction and velocity are extremely important in relation to chemical spills or leaks, the following format will be used by Fire Communications Bureau when giving wind conditions:

"wind from north to south at 12 MPH," or
"wind from east to west at 6 MPH," etc.

The above information will be obtained from Weather Bureau, Baltimore Washington International Airport:

PHONE: 962-2177 (24-hour number)
787-7257

This information will be transmitted:

1. At time of dispatch.
2. When command post is established.
3. When requested by fireground commander.

The Captain Fire Communications will insure that when obtaining weather information, the actual readings at time of request are recorded. The fireground commander will be apprised of any changes that might affect fireground operations.

If type of material is known, all pertinent information; such as, fire, explosion, and/or health hazards known about the material or incident will be transmitted:

1. At time of dispatch.
2. Via radio, after the response of the Battalion Chief has been verified.
3. When requested by the fireground commander.

MOP 632 - 1 ✓

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICES

SUBJECT

PENN CENTRAL - ELECTRIFIED TERRITORY

In the event of a fire or other incident on or adjacent to the Electrified Territory of the Penn Central Railroad, no major fire operations shall be conducted within two hundred (200) feet of this territory when there is a possibility of a stream or spray contacting charged electrical wires.

Personnel will not approach charged electrical system closer than;

1. Eight (8) feet of 132,000 volt Transmission lines.

2. Three (3) feet of 11,000 volt Catenary lines.

3. Three (3) feet of 6,600 volt Signal power lines.

If absolutely necessary, members will operate fog streams only near charged electric wires or equipment but in no case shall members approach such charged electrical equipment nearer than twenty (20) feet when operating such streams. Hose lines will be operated so that water from the lines does not run, drip, or splash on charged electrical equipment.

If the officer in charge deems it necessary to have the electric power shut off in a respective zone, he will advise Fire Communications Office.

Fire Communications will notify:

Power Director - - Penn Central Railroad - - - - 685-4827

Although a call to the Power Director will result in the de-energizing of a portion of the system, stopping electric locomotives, it will not stop diesel locomotives traveling on the system. Therefore notify the Power Director to notify the Movement Director to stop all movement.

When deemed necessary to de-energize the system, operations shall not take place unless the system has been properly grounded by a qualified electrician (Class A Employee) of the railroad. The officer in charge shall personally see that the ground stick is properly applied. No member of the Fire Department will attempt to make any ground or other connections.

All electric equipment shall be considered energized and shall be treated as such until a qualified employee of the company is on the scene and made the proper grounding connections.

Members must not touch any dangling wires or foreign objects hanging from damaged wires, attachments, or supports nor attempt to move them by any means.

Caution shall be taken not to come in contact with or use water directly on tracks, guy lines, or catenary poles, serious injury could occur.

When the emergency no longer exists, the officer in charge at the scene must make every effort to authorize restoration of the electrical system and/or movement of all trains as quickly as possible.

Manual of Procedure DETAIL PROCEDURE

SECTION: EMERGENCY SERVICES

SUBJECT: ACCIDENTS - DERAILMENTS RAILROAD RIGHT-OF-WAY

INCIDENTS - RAILROAD PROPERTY RIGHT-OF-WAY:

The Officer in Charge of Unit or Units that respond to an incident along a railroad right-of-way will immediately advise Fire Communications of:

- The correct name of the railroad involved.
- Location of incident.
- Nature and extent of the incident.

Should the incident be of a serious nature and the emergency operations must be conducted on or across the railroad tracks, the Commanding Officer will notify Fire Communications to have train movement stopped.

Fire Communications will notify the railroad involved by calling one of the following numbers:

- Baltimore and Ohio - 237-3433, Chief Train Dispatcher
- Canton - 342-4458, Train Master
- Western Maryland - 237-3938, Yardmaster
- Penn Central - 685-4827, Power Director

When the incident involves the Penn Central Railroad, emergency operations must be performed in accordance with [MOP 632-1] "Penn Central Electrified Territory." Until it has been absolutely ascertained that train movement has been stopped, men will be stationed at opposite ends of the incident to alert fire personnel of on-coming trains (using portable radios, if necessary). DANGER: DUE TO THE HIGH SPEED OF SOME TRAINS, (UP TO 140 M.P.H.), IT MAY BE NECESSARY TO REQUEST THAT ADDITIONAL UNITS BE DISPATCHED A MINIMUM OF THREE MILES TO EITHER SIDE OF THE INCIDENT IN ORDER TO RADIO AN ADEQUATE WARNING OF ON-COMING TRAINS TO THE UNITS WORKING AT THE INCIDENT.

The Fire Department is not equipped with apparatus or tools to lift heavy railroad equipment; i.e., freight cars, locomotives, heavy machinery, etc. Therefore, the Officer in Charge shall advise Fire Communications to request proper heavy equipment from railroad involved.

When the accident or derailment involves freight and/or tank cars transporting explosives, hazardous chemicals, flammable liquids, or gases and there is spillage of chemicals, oils, or noxious materials, [MOP 644-1] "Spill Procedure" must be initiated.

Hose lines must be placed under rails between ties to prevent hose from being run over by passing trains while performing fire-fighting operations.

INCIDENTS - ACCIDENTS INSIDE OF TUNNELS:

The Officer in Charge of Unit or Units that respond to an incident, accident or other emergency inside a railroad tunnel will follow the same procedure for reporting the incident as stated in "Incidents Along a Railroad Right-of-Way."

Should the incident be a fire in a railroad car, the Officer in Charge will notify railroad that the car is in the tunnel. The railroad will bring the car out of the tunnel, if possible, for fire-fighting operations. However, when fire-fighting and/or rescue operations must be performed inside the tunnel, the Officer in Charge will ensure that all train traffic has been stopped and all safety precautions have been taken to protect fire and civilian personnel.

Manual of Procedure POLICY

SECTION
EMERGENCY SERVICE

SUBJECT
OIL, CHEMICAL AND NOXIOUS MATERIAL SPILL INCIDENTS

When a spill of oil, chemical, or noxious material results in pollution of a waterway, a violation of Federal and State Law occurs. A spill, which occurs in any section of the City of Baltimore and enters either the sanitary or storm sewer system, will eventually flow to a stream or tidal waters. Under the terms of the 1972 amendment of the Federal Water Pollution Control Act, practically any waterway is under Federal jurisdiction.

Failure to report a spill is a violation of the law. Responsibility for reporting a discharge or spill rests primarily with the individual who caused it, or who owns or controls the property, equipment, or vehicle on which or from which the emmission of oil, chemical or noxious material occurs. The Maryland Water Resoures Law, Article 96A, Sec. 29a-1 requires, " Any person discharging or permitting the discharge of oil, or any person, actively or passively participating in the discharge or spilling of oil into the waters of the State whether from a land-based installation, including vehicles in transit, or from any vessel, ship or boat of any kind, shall not knowingly fail to report the incident immediately to the appropriate Federal authority and to the Administration and shall not knowingly fail to remain available until clearance to leave is given by appropriate officials ".

Responsibility for the prompt control, containment and removal of any spilled oil rests with the person or persons responsible for the illegal discharge. In case of emergency, actions, which judgement dictates will best control or rectify the conditions constituting the emergency, are permitted.

In response to an incident involving a spill or discharge of oil, chemical or noxious material, the Baltimore City Fire Department will make every effort to prevent the spillage from flowing into storm water drains, sanitary sewers, streams, rivers, harbors or any waterway. When a spill or discharge endangers life or property, the Fire Department shall take whatever action is deemed necessary, to control and eliminate the life, fire and explosion hazard. The Commanding Officer at the scene shall use all available means to restore the hazardous condition to normal safety.

Manual of Procedure DETAIL PROCEDURE

SECTION: EMERGENCY SERVICE

SUBJECT: OIL, CHEMICAL AND NOXIOUS MATERIAL SPILL INCIDENTS

1. The Commanding Officer of unit or units that respond, shall size-up the incident and immediately report to Fire Communications Office the following:

   a. The location of the incident.

   b. The general conditions at the scene.

   c. The type and quantity of material spilled.

   d. Additional Fire Department units, equipment and manpower needed.

   e. Material, equipment and/or manpower needed from agencies outside the Fire Department.

2. The Commanding Officer at the scene of spill incident will make every effort to prevent discharge from flowing into storm water drains, sanitary sewers, streams, rivers, and harbors, by diverting flow to a safe catchment area, by diking, or by utilizing sorbant material to contain the liquid for later disposal, unless there is imminent life, fire or explosion threat.

   The Highway Maintenance Division of the Department of Public Works has available for emergency response a vehicle with sand and special chemicals.

   The Water Resources Administration of the Maryland State Department of Natural Resources has available for emergency response, a vehicle and crew to assist in containment and clean-up of spillage.

   Regardless of the quantity of material involved in the spill, Fire Communications Office must notify the following:

   United States Coast Guard (Group Officer of the Day) 789-8050

   Maryland Water Resources Administration
   Office hours- Annapolis -1-267-5551
   After office hours, holidays, weekends - Annapolis -1-267-5181

SECTION	SUBJECT
EMERGENCY SERVICE	OIL, CHEMICAL AND NOXIOUS MATERIAL SPILL INCIDENTS

If there is any spillage, that can enter any storm water drain, sanitary sewer, stream, river, harbor or waterway, Fire Communications Office will immediately notify:

The Officer in charge of Field Operations (day or night).....63086 or 63088

The Officer in charge of Field Operations will coordinate Fire Department Operations and insure that the following are notified:

a. The Fire Prevention Bureau, 0800 to 1600 Weekdays.....65753
1600 to 0800 Nights, Weekends and Holidays - Duty Officer as per posted list.

b. Department of Public Works, Highway Maintenance Division.....63179

c. Department of Housing and Community Development.....63184

d. The United States Coast Guard (Group Officer of the Day)....789-8050

e. Maryland Water Resources Administration - Office hours-
Annapolis -1-267-5551
After office hours, holidays, weekends -
Annapolis -1-267-5181

f. Assistant City Solicitor, Mr. Richard M. Hartman
Day.....63948
After 1630 hours.....879-1190 or 661-7020

g. The Baltimore Police Department.....Direct line

When spill is on the public highway or operations in any respect impede the normal flow of traffic, notify the Department of Transit and Traffic.....Direct line

In case of a chemical spill notify:

The Environmental Protection Agency, Philadelphia, Pa.....215-597-9898
and the Water Resources Administration (as listed in e. above)

If hazard of spilled product is unknown, ascertain up to date information from.....CHEMTREC.....800-424-9300
Officer in charge of incident will attempt to secure any and all information that might be of assistance to Chemtrec in identifying the product.

3. If there is the possibility that a large spill will enter the waters of Baltimore Harbor, the following action shall be implemented:

    1. The Officer in charge of Field Operations upon obtaining information from Officer in charge at scene or from other agencies, will dispatch a Battalion Chief to investigate the harbor area where the spill will most likely appear.

    2. The Battalion Chief will:

        a. Notify Fire Communications of conditions in the harbor.

        b. Call for units and equipment needed to contain and control the spill.

        c. Coordinate Fire Department operations at the harbor site.

    3. The Fire Communications Office will:

        a. Notify the Officer in Charge of Field Operations of all information received.

        b. Comply with Battalion Chief's orders for Fire Department units.

        c. Notify the United States Coast Guard (Group, Officer of the Day) of the situation in the harbor.....789-8050

        d. Notify the Maryland Port Administration as per posted list.

4. When volatile flammable liquids are involved, every precaution must be taken to prevent ignition:

        a. Eliminate all possible sources of ignition.

        b. Utilize explosimeter to monitor build-up of dangerous concentrations of vapors.

        c. Cover exposed surface of flammable liquid with Mechanical, Chemical or High Expansion foam until proper disposal can be accomplished.

        d. Care should be taken to approach the scene from the upwind side.

        e. Set up safety zone and evacuate unnecessary personnel and citizens.

SECTION	SUBJECT
EMERGENCY SERVICE	OIL, CHEMICAL AND NOXIOUS MATERIAL SPILL INCIDENTS

5. If leakage is from an above ground or underground tank, ascertain owner of tank or company responsible for filling the tank and have the product pumped out to minimize amount of discharge. The Commanding Officer at the scene will advise Fire Communications to notify company involved.

6. If spill involves military chemicals or biological material and military response is required, notify Fire Communications, who will call Fort George G. Meade at any of the following numbers:

0800 to 1630 hours.....677-6910
677-2975
677-4129

1630 to 0800 hours.....677-4805
677-4827

7. Fire Department personnel shall make no statements concerning the incident to anyone who is not a member of the City Government, unless a legal advisor from the Law Department is present.

8. Reports shall be forwarded as per current procedure through normal channels.

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICE

SUBJECT

REPORT OF SPILL INCIDENT
FORM 28-2100-0041

1. Report of Spill Incident (form 28-2100-0041) [MOP 644-2-1] will be completed in triplicate and forwarded in lieu of Fire Report (form 28-2100-0042) when incident involves a spill only, without fire or combustion of any kind.

2. Fire Report will be forwarded when fire or combustion results from a spill; and if there is a residue of oil remaining after the fire (re. MOP 644-1, Oil, Chemical and Noxious Material Spill Incidents), Report of Spill Incident will be forwarded with the Fire Report.

3. If more than two (2) persons are involved in a spill incident, check appropriate box and use the reverse side of (form 28-2100-0041) for the names and information concerning the additional persons.

4. Report of Spill Incident will be completed by Officer in Charge of incident in the same manner that Fire Reports are completed and forwarded through normal channels.

5. Distribution:

   a. Forward original and one copy to Headquarters.

      1. Original copy retained in Headquarters in the same manner as Fire Reports.

      2. One copy will be forwarded to the Law Department through the office of the Safety Officer.

   b. One copy to be retained in unit file.

DATE 10/2/75

SECTION

EMERGENCY SERVICES

SUBJECT

REPORT OF SPILL INCIDENT
FORM 210 - 041

BALTIMORE CITY FIRE DEPARTMENT — REPORT OF SPILL INCIDENT

Date: (mo day yr)	Box:	Time:	2nd.: hrs.	3rd.: hrs.	4th.: hrs.	5th.: hrs.	6th.: hrs.
Sub. 3 calls							Recall: hrs.

Location

Owner	Owner's Address	Zip Code

Person(s) involved in Spill Incident

Name	Name:
Address: Zip Code:	Address: Zip Code:
Company or Firm:	Company or Firm:
Address: Zip Code:	Address: Zip Code:
Vehicle License Number:	Vehicle License Number:

If Additional Persons are involved in Spill Incident, check here ☐ and use reverse side.

Type of Substance (Check)

- ☐ Gasoline
- ☐ Kerosene
- ☐ Jet Fuel
- ☐ Diesel Oil
- ☐ Waste Oil
- ☐ Other _____
- ☐ No. 2 Fuel Oil
- ☐ No. 4 Fuel Oil
- ☐ No. 5 Fuel Oil
- ☐ No. 6 Fuel Oil
- ☐ Bunker C Oil

How spill occurred (Check)

- ☐ Vehicular Accident
- ☐ Personal Error
- ☐ Vandalism
- ☐ Mechanical Failure
- ☐ Other _____

Extent of Spill (Check)

- ☐ Contained on Land
- ☐ Entered Storm Sewer
- ☐ Entered Sanitary Sewer
- ☐ Entered Surface Water

(Name of body of water) _____

Amount of spill _____

Fire Department Response

Engine _____

Trucks _____ Chemical _____ Hi-Ex. _____ Fire Boat _____

Other Units _____ BC _____ DC _____ Chief ☐ F.P.B. _____ F.I.B. _____

Other Agency Response

- ☐ United States Coast Guard
- ☐ Environmental Protection Agency
- ☐ Maryland Water Resources Administration
- ☐ Maryland Port Administration
- ☐ Department of Law

Department of Public Works:
☐ Sewers ☐ Highways ☐ Sanitation

Department of Housing and Community Development
☐ Building Inspector ☐ Mechanical Inspector

Fire Department Operations

- ☐ Absorbed in surface — No action taken
- ☐ Evaporated — No action taken
- ☐ Surface skimming
- ☐ Contained by baffle or barrier
- ☐ Diverted to safe location
- ☐ Dispersed by flushing — Extreme Hazard — Danger to life and property
- ☐ Foam blanket maintained on spill
  - Type used: ☐ Hi-Ex ☐ Mechanical ☐ Chemical — Amount used: _____
- ☐ Absorbed by sorbent material — _____
- ☐ Explosimeter used:
  - Initial reading _____
  - Maximum reading _____
  - Final reading _____

Remarks: _____

Officer in charge: Unit:

Forwarded:	Forwarded:	Approved:
Battalion Chief Number _____	Deputy Chief Number _____	Chief of Fire Department

Form 210-041

Original form is 8 1/2" x 11", white in color.

11/ 5/73

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICES

SUBJECT

SPILL INCIDENTS - ABSORBENT MATERIAL

Absorbent Material for use at oil spill incidents is supplied to the Fire Department by the Maryland Water Resources Administration.

This material will not absorb water, and while it will absorb all petroleum products, it works best with the heavier oils.

Purpose

The primary reasons for supplying absorbent material to Fire Department Units is as follows:

1. To provide immediate complete control of small oil spills.
2. To provide immediate initial control measures to contain large oil spills in accordance with [MOP 644 - 1], until clean up forces of the responsibile party, the State or Federal Governments can be mobilized.

Distribution

1. A total of five bags of absorbent material will be maintained at each fire station under the jurisdiction of the captain in charge of quarters.
2. From this total, two (2) bags may be carried on each engine and truck if sufficient storage space is available.
3. A reserve supply will be maintained at the Supply Bureau.

Operations

1. The unit officer will have all available absorbent material placed on the apparatus before responding from quarters on either a silent or box alarm to a spill incident, automobile accident, flushing operation, or when the dispatcher's response instructions indicate it may be needed.
2. Upon arrival at the scene, the officer in charge will report to Fire Communication Office as per item 1 [MOP 644-1].
3. When a single unit responds to a spill incident and additional absorbent material is needed, the unit officer will notify Fire Communications Office to dispatch additional units as needed and specifically request that units respond with sorbent materials.

4. Whenever three (3) or more Fire Department Units are at the scene of a spill incident and a box alarm has not been sounded, Fire Communications Office will dispatch the nearest Battalion Chief, who will assume command at the scene.

5. If additional quantites of absorbent material are still needed, the officer in charge will arrange for delivery through the Officer in Charge of Field Operations in accordance with [MOP 644-1].

6. Units that are not needed after they have delivered their supply of absorbent material, shall be placed in service.

7. Clean up and Disposal:

   a. Small quantities of oil contaminated absorbent shall be cleaned up and placed in a suitable container such as the empty bags which originally contained the material.
   b. Small quantities of absorbent material can be disposed in the same manner as the regular station trash is collected by the Bureau of Utility Operations.
   c. Absorbent material that contains volatile flammable liquids and large quantities of oil contaminated material shall be disposed of by supervisor of the Bureau of Utilities Operations crew that responded or by State or Federal Government clean up crews or contractors.

Maintenance of Supply of Absorbent Material

1. When absorbent material is used, unit officer will notify the supply officer by phone and request sufficient quantity to maintain the five (5) bag supply at the station.

2. The Supply Officer will schedule delivery of needed quantities as soon as practicable after request is received from the unit officer.

3. The Supply Officer will notify the Deputy Chief Staff Services on form 210-033 thru normal channels when the reserve supply at the storeroom is depleted to fifty bags.

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICE

SUBJECT

SPILL INCIDENTS - SEALING COMPOUND

One (1) pound packs of Mac-Seal sealing compound is issued by the Fire Department and is to be carried on the apparatus of all Engine and Truck Companies.

PURPOSE:

This sealing compound is to be used to seal small leaks or ruptures in gasoline and/or fuel oil tanks to control the flow from a leak and to minimize the amount of product spilled.

LIMITATIONS:

This product is intended as a temporary measure only and is not to be used for permanent repair under any circumstances. Product will not retain large leaks and may not control leaks under pressure.

INSTRUCTIONS:

Officer in charge will insure that all provisions of MOP 644-1 are complied with and that necessary reports, including Fire Prevention Code violations are forwarded.

The unit's supply of Mac-Seal sealing compound will be replenished by requisition from the Supply Bureau.

Manual of Procedure DETAIL PROCEDURE

SECTION

EMERGENCY SERVICES

SUBJECT

POLYCHLORINATED BIPHENYLS (PCB'S)

PCB's or askarels are fire-resistant, chlorinated hydrocarbon insulating fluids which are used in capacitors and transformers. PCB's are insoluble in water. They are also non-biodegradable and cumulative.

PCB's have been used in three broad types of applications for the past 40 years as follows:

(1) "Open-ended" applications; for example, in paints, specialty inks, paper coatings, plastics, etc.

(2) "Nominally closed" applications; for example, as the working fluid in hydraulic or heat-transfer systems.

(3) "Closed electrical system" applications, specifically as the insulating fluid in transformers and capacitors.

Askarel-filled transformers and capacitors present less fire hazard than oil-filled transformers. As a result, askarels have replaced mineral oils in more than 90% of the power and industrial capacitors today and are used in transformers located in buildings without enclosed electrical vaults.

The environmental effects of askarels are under in-depth study by governmental and other agencies. Traces of askarels are being found in the environment and in fish and bird life. The long term genetic and ecological effects are not yet completely understood. For these reasons, care should be taken to contain askarels and minimize their entry into the environment.

Askarel wastes should never be disposed of down drains or sewers.

Emergency Handling of PCB's:

Most equipment is under the control of the Baltimore Gas and Electric Company, but some equipment is privately and city owned. Unit commanders during fire prevention and/or pre-fire planning inspections will

check transformers and capacitors that are privately and city owned to see that they are properly marked. This information is on the equipment tag located on the unit itself.

In response to an incident involving a PCB spill, the Baltimore City Fire Department will make every effort to prevent the spillage from flowing into storm water drains, sanitary sewers, streams, rivers, harbors or any waterway. When a spill or discharge endangers life or property, the Fire Department shall take whatever action is deemed necessary to control and eliminate the life, fire and explosion hazard. The commanding officer at the scene shall use all available means to protect the public, pending the arrival of a representative of Maryland Water Resources Administration who will take charge of removal of spilled PCB's.

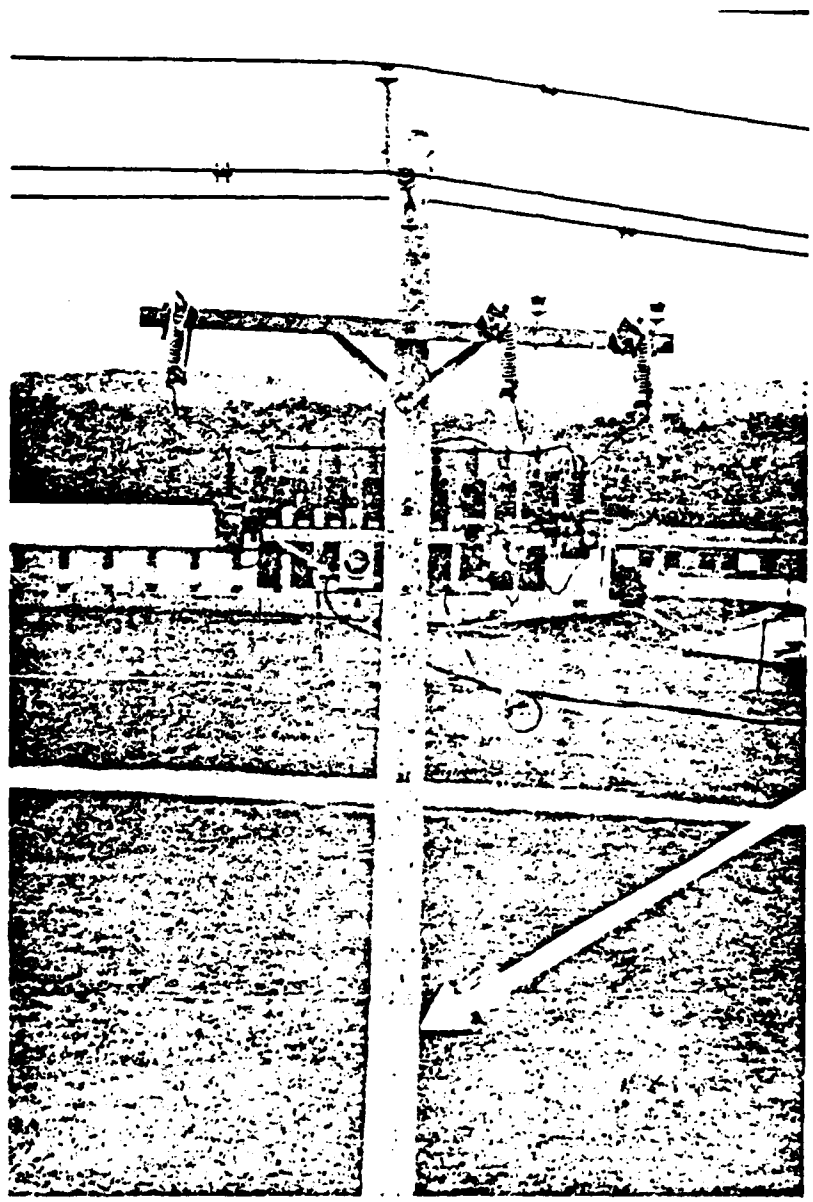
Operating procedures should be to avoid physical contact with any askarels. The use of porous gloves (such as leather) that can absorb and retain askarels should be avoided. Resistant gloves of rubber (neoprene, polyethylene) should be used if contact is unavoidable. Self-contained breathing apparatus must be worn to avoid askarel vapors. The gases produced when askarel is decomposed by high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride and small percentages of other gases.

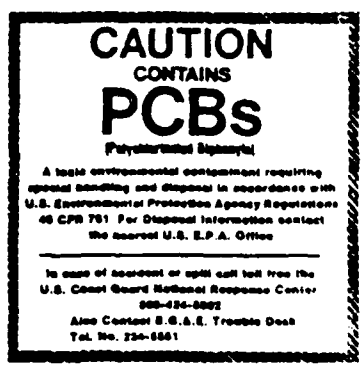
In case of spillage on clothing or contamination of equipment, the items should be removed and bagged for proper cleaning. If the appliance is owned by the Baltimore Gas and Electric Company, they will make arrangements to pick up and clean the items.

If the appliance is privately or city owned, the contaminated items should be removed and bagged and forwarded to the contractor who will clean up the PCB spill. This information can be obtained from the Water Resources Representative on the scene. A listing of all items contaminated will be forwarded to the Chief of Fire Department.

A member with an open cut or abrasion that has been exposed to askarel vapors should report to the Department Infirmary for treatment immediately. Eyes that have been exposed to liquid askarel should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician.

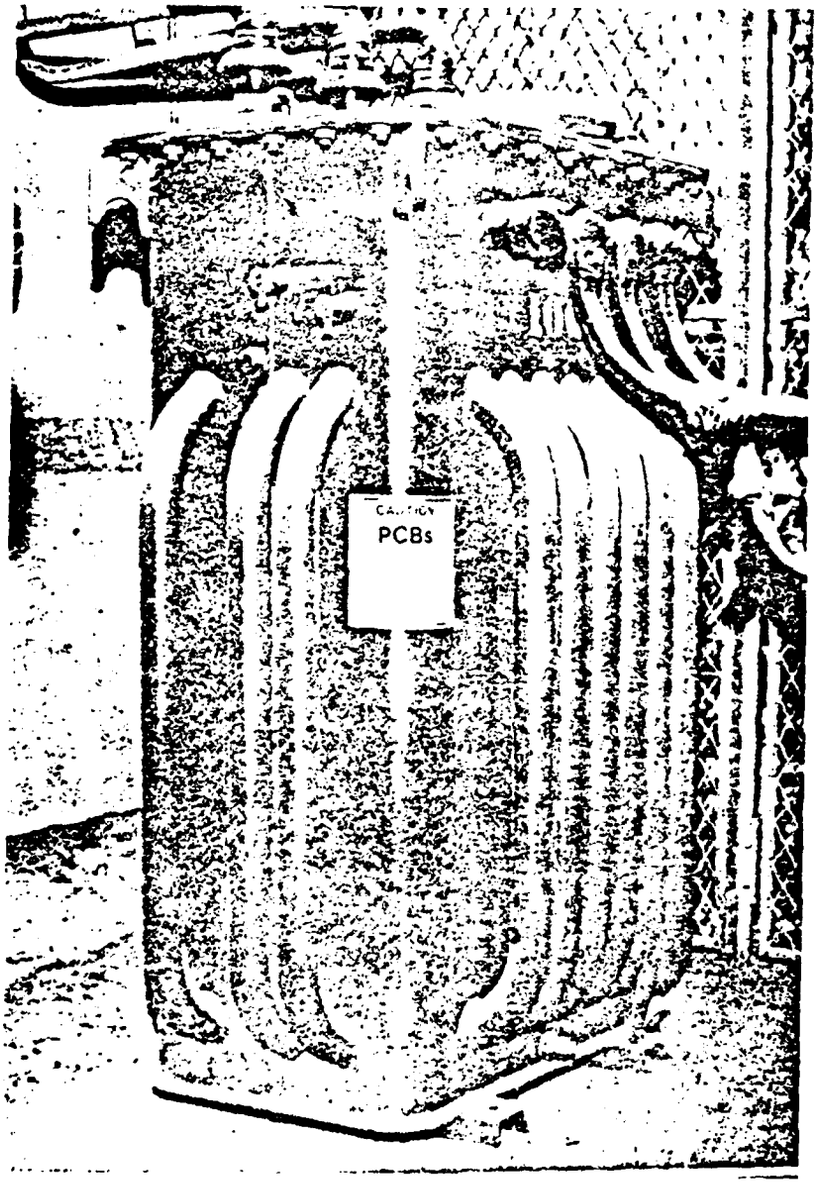
SECTION	SUBJECT
EMERGENCY SERVICES	CAPACITORS





9 FEET ABOVE GROUND

SECTION	SUBJECT
EMERGENCY SERVICES	TRANSFORMERS



SECTION	SUBJECT
EMERGENCY SERVICES	WARNING IDENTIFICATION

CAUTION

CONTAINS

PCBs

(Polychlorinated Biphenyls)

A toxic environmental contaminant requiring special handling and disposal in accordance with U.S. Environmental Protection Agency Regulations 40 CFR 761 For Disposal Information contact the nearest U.S. E.P.A. Office

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In case of accident or spill call toll free the U.S. Coast Guard National Response Center.
800-424-8802
Also Contact B.G.&.E. Trouble Desk
Tel. No. 234-5551

HAZARDOUS SUBSTANCE SPILL REPORT

I. REPORTER

A. _____, _____
(Agency)
can be contacted for further information at _____
(Phone)

_____.
(Location)

II. LOCATION OF INCIDENT

A. Structure

Building or Company Name _____

Address _____

City _____ County _____

B. Roadway

Highway or Street Name _____

Nearest Intersection _____

C. Off-Shore

Nearest identifying landmarks (Beach name, pier, nearby road, street, etc.) _____

_____

III. TYPE OF INCIDENT

A. Oil Spill

Substance _____ Quantity _____

_____Ship _____ Oilfield _____Pipeline _____ Railroad

Name of ship, etc. _____

B. Radiological Incident

1. Nature of Incident:

a. Loss of control _____

b. Lost source _____

c. Radiation producing device _____
d. Exposure _____
e. Transportation accident _____
f. Nuclear weapon _____

2. Radioactive material involved _____ amount _____?

C. Other Hazardous Material

Substance _____ Quantity _____

Generic Names _____

_____ Solid _____ Liquid _____ Gas

IV. CAUSE OF INCIDENT

Describe _____

_____

_____

V. INJURIES

Injured _____ (number) To which hospital were injured taken? _____

_____

Are injured persons contaminated? Yes ___ No ___ Nos. _____

Were injured persons exposed? Yes ___ No ___ Nos. _____. If yes, was the hospital and ambulance crew so advised? _____

Dead _____ Were dead contaminated? _____

VI. PERSONNEL AND EQUIPMENT

What emergency personnel and equipment are at the scene?

_____

_____

Type of additional assistance requested? _____

_____

VII. ADDITIONAL INFORMATION AND COMMENTS

_____

_____

_____

RESPONSE CHECKLIST

	YES	NO	NA
1. Have the proper authorities been notified?			
CHEMTREC (800) 424-9300	___	___	___
COUNTY/CITY			
Sheriff (or Police Dept.)	___	___	___
County Health Department	___	___	___
Fire Department	___	___	___
Hospitals	___	___	___
Public Works	___	___	___
Water Department	___	___	___
Water Resources	___	___	___
Fish and Game	___	___	___
Air Pollution District	___	___	___
STATE			
Bureau of Disaster Preparedness	___	___	___
Department of Health	___	___	___
2. Have adequate safety precautions been taken in the polluted area?	___	___	___
3. Have you identified the pollutant?	___	___	___
4. If unidentifiable, do you know who to contact for proper identification?	___	___	___
5. Are adequate communications available?	___	___	___

EMERGENCY RESOURCES

1. Collection Agents	Location	Telephone No.

A. Absorbents

Absorbent felt paper
Bark
Copolymer PVC/PVA
Cotton waste
Peat
Polypropylene fiber
Polyurethane foam
Rayon floss
Rock wool sheets
Rope
Sawdust
Sisal string
Straw
Waste paper

B. Congealing Agents

Nylon Agglutinants
Plastic film
Plastic foam

C. Gelling Agents

Molten wax
Soap

D. Liquids ie

Chlorine repair kit

2. Supplies

A. Signs

B. Rope

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4. Bay County Natural Disaster Operations Plan. Panama City/Youngstown, FL. 1981.

5. California Department of Transportation, Maintenance Department. Hazardous Substances Spill Procedure Manual. September, 1979.

6. California Highway Patrol. Explosives Routes and Stopping Places. HPH 84.3, August 1973.

7. California Highway Patrol. Hazardous Materials Transportation. November, 1979.

8. Chemical Marketing Reporter. 1980-81 OPD Chemical Buyers Directory. Schnell Publishing Company. 1980.

9. City of Baltimore Emergency and Major Disaster Assistance Plan. Office of the Mayor.

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11. Department of Transportation, Materials Transportation Bureau. Student Performance Manual To Accompany Handling Hazardous Materials Transportation Emergencies.

12. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau. 1980 Emergency Response Guidebook. Report No. DOT-P-5800.2. Washington, D.C.: Government Printing Office.

13. Department of Transportation, United States Coast Guard, Chemical Hazards Response Information System, A Condensed Guide to Chemical Hazards, January 1974.

    This manual is Volume I of four volumes that provide timely information essential for proper decision-making by responsible Coast Guard personnel and others during emergencies involving the water transport of

hazardous chemicals. It also provides certain basic non-emergency related information to support Coast Guard efforts to achieve improved levels of safety in the bulk shipment of hazardous chemicals.

14. Department of Transportation, United States Coast Guard. CHRIS Hazard Assessment Handbook Volume 3. Report No. CG-446-3. January 1974.

15. Department of Transportation, United States Coast Guard. CHRIS Hazardous Chemical Data, Volume 2. Report No. CG-446-2. January 1974.

16. Department of Transportation, United States Coast Guard, Chemical Hazards Response Information System, Response Methods Handbook. Volume 4, December 1978.

This manual is Volume IV of our volumes that provide timely decision-making information for use by Coast Guard personnel and others involved in responding to and mitigating the effects of hazardous material discharges. It can be properly used only in conjunction with the other manuals of the CHRIS system.

17. Department of Transportation, United States Coast Guard, Office of Research and Development, Chemical Hazards Response Information System for Multimodal Accidents (CHRISMA), Final Report. April, 1975.

This report examines the need for improved technical and other information for meeting emergencies connected with the transportation of hazardous materials, particularly actual or potential discharges of mode. The Chemical Hazards Response Information System (CHRIS), under development by the U.S. Coast Guard to furnish in-depth guidance during emergencies involving waterborne transport, was seen as a likely prototype for other modes as well. A reevaluation of CHRIS has been conducted to determine the desirability of enlarging its scope to include all modes of transportation. It is agreed that an expanded system would be beneficial in reducing losses to life, property and environment. This information system would be a decentralized organization providing response guidance on request to local emergency services personnel, a computerized hazard assessment system operated at Headquarters, and three reference manuals furnished to all response organizations.

18. Emergency Plan No. 1. Nashville, TN.

19. Encyclopedia of Explosives and Related Items, Volume 1. Picatinny Arsenal. Dover, N.J. 1960.

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21. Enviromental Protection Agency. Illinois Central Gulf Train Derailment: Claxton, Kentucky. August 1980. EPA Report No. 430/9-80-012.

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This report contains suggested procedures for control of hazardous material spills using improvised treatment processes. This manual includes: notification procedures on inventory of information sources; methods for spill identification and assessment; a thought guide for determining the best method of handling a spill; suggested treatment schemes for 303 designated hazardous chemicals; a limiting factor system design approach, and design construction, and operation steps for each of the five treatment processes applicable to improvised systems.

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30. National Transportation Safety Board. Highway Accident Report: Accidental Mixing of Incompatible Chemicals, Followed by Multiple Fatalities, During a Bulk Delivery, Berwick, Maine. April 2, 1971. NTSB Report No. NTSB-HAR-71-7. Adopted August 26, 1971.

31. National Transportation Safety Board. Highway Accident Report: Liquefied Oxygen Tank Explosion followed by Fires in Brooklyn, N.Y. May 30, 1970. Report No. NTSB-HAR-71-6.

32. National Transportation Safety Board. Highway Accident Report: Multiple-Vehicle Collision Followed by Propylene Cargo-Tank Explosion, New Jersey Turnpike, Exit 8. September 21, 1972. Report No. NTSB-HAR-73-4. Adopted October 17, 1973.

33. National Transportation Safety Board. Highway Accident Report: Multiple-Vehicle Collisions under Fog Conditions, Followed by Fires, New Jersey Turnpike, North of Gate 2. November 29, 1969. NTSB Report No. NTSB-HAR-71-3. Adopted January 20, 1971.

34. National Transportation Safety Board. Highway Accident Report: Propane Tractor Semitrailer Overturn and Fire, May, 1973.

35. National Transportation Safety Board. Highway Accident Report: Surtigas, S.A., Tank-Semitrailer Overturn, Explosion and Fire Near Eagle Pass, TX, April 29, 1975. Report No. NTSB-HAR-76-4.

36. National Transportation Safety Board. Highway Accident Report: Truck-Automobile Collision Involving Spilled Methyl Bromide on U.S. 90 near Gretna, Florida. August 8, 1971. NTSB Report No. NTSB-HAR-72-3. Adopted June 1, 1972.

37. National Transportation Safety Board. Highway Accident Report: Transfer Co., of Texas, Tractor-Semitrailer (Tank) Collision with Bridge Column and Sudden Dispersal of Anhydrous Ammonia Cargo, I-610 at S.W. Freeway, May 11, 1976. Report No. NTSB-HAR-77-1.

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GLOSSARY

ABSORBENT - (1) Any substance exhibiting the property of absorption. (e.g., substances capable of soaking up a particular HM(s))

ACOUSTIC EMISSION - Rapid release of energy through transient elastic waves, characteristic of structures under stress. (e.g., the characteristic sound waves produced by a structure under stress and which vary with change in stress or appearance of a crack).

AMPULES - Hermetically sealed small bulbous glass vessels used to hold chemicals/solutions.

BERM - A narrow shelf, path or ledge typically at the top or bottom of a slope. (e.g., along side a rail bed or highway).

BILL OF LADING - One type of shipping paper which lists goods shipped and other required identifying information.

BLEVE - The combination of a weakened structure and the buildup of intergal vapor pressure resulting in container rupture or instantaneous release and ignition of the vapor usually with violent effects. An acronym for boiling liquid expanding vapor explosion.

CARBOY - A glass, metal or plastic bottle or rectangular container of about 5 to 15 gallons capacity for liquids.

CARGO TANK - Any tank permanently attached to or forming a part of any motor vehicle or any bulk liquid or compressed gas packaging not permanently attached to any motor vehicle which by reason of its size, construction or attachment to a motor vehicle, is loaded or unloaded without being removed from the motor vehicle and is used for transporting the commodity(ies).

CHEMTREC - Abbreviation of Chemical Transportation Emergency Center. A division of the Manufacturers Chemical Association established as an emergency information source for transportaiton accidents involving hazardous materials (e.g., flammable, toxic or explosives).

COMMODITY FLOW - The quantity routing patterns for transportation of an article(s) of commerce (e.g., hazardous materials shipments and routes).

COMMODITY INCOMPATIBILITY - The situation whereby a chemical(s) is (are) capable of interacting with each other to create a hazard or unsafe condition and thus must be handled, packaged, stored and shipped with certain prescribed precautions.

COMMUNICATIONS COORDINATION CENTER - A central facility (mobile or fixed) which functions in the case to interlink and coordinate the different sources of information and communications at and away from the accident scene.

COMPRESSED GAS - Any material or mixture that, when enclosed in a container, has an absolute pressure exceeding 40 psi at 70°F or regardless of the pressure at 70°F, has an absolute pressure exceeding 140 psi. at 130°F; or any flammable material having a vapor pressure exceeding 40 psi absolute at 100°F.

CONSIST - Makeup or composition by classes, types, or grades and arrangement of rail cars in a train.

CONTAINER STRUCTURAL INTEGRITY - The existing condition of the container's structural components with respect to its original design and its capability to safely retain its contents as intended.

CORROSIVE MATERIAL - A solid that causes visible destruction or irreverable alterations in human skin tissue at the site of contact, or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

CYLINDER - Pressure vessel designed for pressures higher than 40 psia and having a circular cross section. It does not include a portable tank, multi-unit tank car tank, cargo tank or tank car.

DENT - (1) A depression or hollow made by a blow or by pressure. (e.g., on a container surface)

DIKE - (1) A bank usually of earth construction used to control or confine water or other fluid. (2) A barrier preventing passage, especially of something undesirable.

DISPATCHER - One who controls the movement of vehicles/persons. (e.g., trains, trucks, fire, police)

EXPLOSIVE - Any chemical coumpound, mixture or device, the primary or common purpose of which is to function by explosion. (i.e., with substantially instanteneous release of gas and heat).

FLAMMABLE - Capable of being easily ignited and of burning rapidly. See 49 CFR, Part 173 for precise types of flammable liquids and gases.

FLAMMABLE GAS - Any gas that will ignite easily and burn rapidly. See 49CFR, Part 173 for a more precise definition.

FLAMMABLE LIQUID - Any liquid that will ignite easily and burn rapidly. See 49CFR, Part 173 for precise definition of various types.

FLATCAR - A railroad freight car without permanent raised sides, ends, or covering.

GAS CHROMATOGRAPHY-MASS SPECTROMETRY - This is a combination of two chemical instrumental techniques. The gas chromatography involves seperation and identifying the components of a mixture by volatizing the sample into a carrier gas stream and passing it through a bed of special packing and comparing the times for thew various components to be released from the packing.

GEL - A colloid in which the disperse phase has combined with the continous phase to produce a viscous, jelly-like product.

GOUGE - A groove or cavity scooped out.

GRAVITY FLOW - The movement of material without using a driving force like a pump or pressure (i.e., used during product transfer).

HACS - Computerized portion of USCG Chemical Hazards Response Information System (CHRIS). Abbreviation for Hazards Assessment Computer System.

THERMITE GRENADE - A grenade using a mixture of aluminum powder and iron oxide that when ignited evolves a great deal of heat and is used in welding and in incendiary bombs.

INFARED RADIOMETRY - Absorption of radiation in the infared spectrum (0.78 - 300 microns). Can be used to assess temperature remotely

IRRITATING MATERIAL - Substances which give off dangerous or intensely irritating fumes when exposed to air or upon contact with fire.

LEAK, CONTINOUS - A steady continous loss of substance through an opening.

LEAK, INSTANTANEOUS - A sudden, abrupt loss of substance through an opening.

LONGITUDINAL AXIS OF CAR - The lengthwise axis of a car.

LOWER EXPLOSIVE LIMIT (LEL) - The lower limit for the range of concentration of a flammable gas or vapor (% by volume in air) in which explosion can occur upon ignition in a confined area.

MASS SPECTROMETRY - A method of chemical analysis in which ions are passed in a vacuum first through an accelerating electric field and then through a strong magnetic field. This has the effect of seperating the ions according to their mass, as they traverse the magnetic field at different velocities (electromagnetic separation).

NATIONAL MOTOR FREIGHT CLASSIFICATION NUMBER - The specific number assigned to commodities being transported over the road.

NATIONAL RESPONSE CENTER - The Coast Guard operated response center that provides telephonic assistance during emergencies and accidents.

NONDESTRUCTIVE MATERIAL - A material that cannot be broken apart or destroyed.

NONFLAMMABLE GAS - A gas that is not easily ignited and does not burn rapidly if ignited.

OFF-LOAD - To remove cargo from its container.

ON-SCENE COORDINATOR - The authority at the scene of an accident who directs emergency handling and cleanup operations.

OXIDIZER - A substance that spontaneously releases oxygen at room temperature or upon heating (i.e., nitrogen tetroxide). Can react vigorously with organic and combustible materials.

PIT - A hollow or indentation on the surface of a substance.

PLACARD - Inverted, color-coded flat square placed on vessels transporting hazardous materials. Must be located on all four sides of the vessel, and can be used to aid material identification.

POISON A - A gas or liquid so toxic that an extremely low percentage of the gas or its vapor formed by the liquid is dangerous to life.

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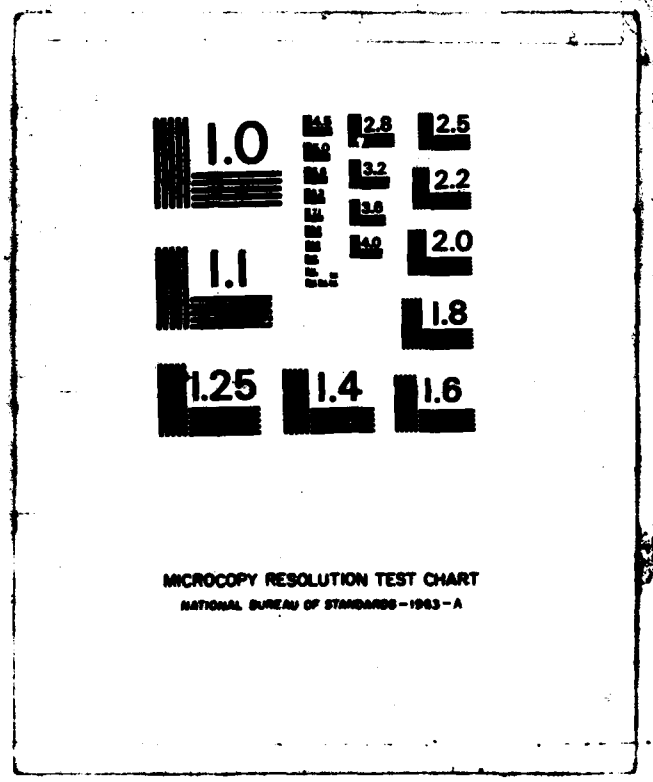
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MICROCOPY RESOLUTION TEST CHART
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POISONOUS GAS - A toxic or irritant gas or volatile liquid that is harmful to living tissues when applied in relatively small doses.

POLYMERIZATION - A chemical reaction, usually carried out with a catalyst, heat or light, and often under high pressure, in which a large number of relatively simple molecules combine to form a chain-like macro-molecule.

PORTABLE TANK - Any packaging (except a cylinder having a 1000-pound or less water capacity) over 110 U.S. gallons capacity and designed primarily to be loaded into or on or temporarily attached to a transport vehicle or ship, and equipped with skids, mounting, or accessories to facilitate handling of the tank by mechanical means.

PRESSURE FLOW - The steady movement of a material by applying a driving force using a pump or flow of gas or liquid.

RADIOACTIVE MATERIAL - A material which spontaneously emmits alpha or beta rays and sometimes also gamma rays by the disintegration of the nuclei of atoms.

RAIL CAR TRUCK - The structure supporting and attaching the wheels to the body of a rail car or tank car.

REMOTE SENSING - To detect a material property such as temperature or pressure from a distant location.

RERAIL - To realign and put back in place a rail car that had been derailed.

SELF CONTAINED BREATHING APPARATUS - A breathing apparatus with air supply that keeps the individual completely independent of the surrounding atmosphere.

SOLVENT - A substance capable of dissolving another substance (solute) to form a uniformly dispersed mixture (solution) at the molecular or ionic size level. Solvents are either polar (high dielectric constant) or non-polar (low dielectric constant).

SOLUBILITY - The ability or tendency of one substance to blend uniformly with another, e.g., solid in liquid, liquid in liquid, gas in liquid, gas in gas.

SORBENT - A substance that takes up and holds by either adsorption or absorption.

SYNTHESIS - Creation of a substance which either duplicates a natural product or is a unique material not found in nature, by means of one or more chemical reactions, or (for elements) by a nuclear change.

THRESHOLD LIMIT VALUES (TLV) - The upper values of a toxicant concentration to which an average healthy person may be repeatedly exposed to on day after day without suffering adverse effects.

TOXIC - Relating to, or caused by poison or toxin.

UNIFORM CLASSIFICATION NUMBER - The specific number assigned to commodities being transported by rail.

VAPOR DISPERSION - The movement of vapor clouds in air due to turbulence, gravity spreading and mixing.

VAPOR SUPPRESSION - The process of retaining vapors or preventing them from escaping from a liquid surface.

VENT AND BURN - To release a substance from its container and allow it to burn.

VOLATILE - A substance that will readily vaporize at a low temperature.

WAYBILL - A document prepared by the carrier of a shipment of goods that contains details of the shipment, route, and charges.