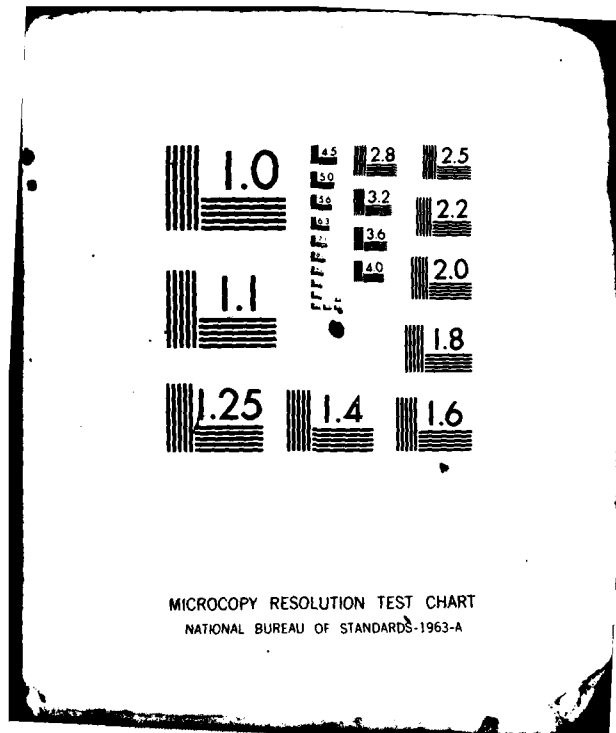


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**EMERGENCY MEDICAL TREATMENT NEEDS:
CHRONIC AND ACUTE EXPOSURE
TO HAZARDOUS MATERIALS**

FINAL REPORT

for

**Federal Emergency Management Agency
Washington, D.C. 20472**

Contract Number EMW-C-0750
Work Unit Number 2412D

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Rockville, Maryland 20850**

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GEOMET Report Number EHF-1004

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Final Report

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under

**Contract Number EMW-C-0750
Work Unit Number 2412D
James W. Kerr, Project Officer**

by

**David A. Hammond, M.Ed.
Horace S. Anderson, A.S.
Michael D. Koontz, M.S.**

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Rockville, Maryland 20850**

This report has been reviewed in the Federal Emergency Management Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Federal Emergency Management Agency.



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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A117490	
4. TITLE (and Subtitle) EMERGENCY MEDICAL TREATMENT NEEDS: CHRONIC AND ACUTE EXPOSURE TO HAZARDOUS MATERIALS		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER EHF-1004
7. AUTHOR(s) D.A. Hammond, H.S. Anderson, M.D. Koontz		8. CONTRACT OR GRANT NUMBER(s) EMW-C-0750
9. PERFORMING ORGANIZATION NAME AND ADDRESS GEOMET Technologies, Inc. 1801 Research Boulevard Rockville, Maryland 20850		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Work Unit 2412D
11. CONTROLLING OFFICE NAME AND ADDRESS Federal Emergency Management Agency Washington, D.C. 20472		12. REPORT DATE June 1982
		13. NUMBER OF PAGES 109
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) hazardous materials, medical management, chemical exposures, toxic effects, resource and referral center, signs and symptoms, training programs, needs assessment, feedback		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report identifies gaps in the ability of the medical community to recognize and treat problems resulting from exposure to hazardous materials. A summary of available guidance for medical management following chemical exposures is presented. The guidance focuses on prehospital and in-hospital care. The feasibility or utility is assessed for subclassifying chemicals by toxic effects or by chemical properties. The assessment relates to medical management. One study recommendation is for establishment of a resource and referral center to assimilate/review chemical toxicity data and medical management protocols. The protocols, oriented toward recognizing signs and (continued)		

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symptoms, should generally be chemical-specific. Other recommendations concern improved training programs, community needs assessments, and incident feedback.

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SUMMARY

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SUMMARY

STUDY PROBLEM AND OBJECTIVES

Hazardous materials are those chemicals or substances that are harmful to human health and to the environment. Society's dependence on chemical products is accompanied by increasing exposures to chemicals during their production, transportation, use, disposal, and accidental release. Effective emergency response plans for accidental chemical releases require containment and cleanup procedures, along with preparedness for initial and interim management of persons exposed to hazardous materials.

The central objective of this study was to identify any existing gaps in the ability of the overall medical community to recognize and treat health problems resulting from exposure to hazardous materials. The study had two major tasks: (1) to assess the utility of cataloging chemicals by major class and (2) to determine the availability of medical treatment guidance for chemical exposures. Study recommendations could range from finding better ways to disseminate known information to identifying chemical classes that require better treatment characterization.

STUDY METHODOLOGY

To assess the utility of cataloging chemicals by major class, two classes--ethers and metals--were selected from a system of 30 classes contained in a frequently referenced toxicology and industrial hygiene text. For chemicals in these two classes, toxic effects were obtained from the Registry of Toxic Effects of Chemical Substances (RTECS) maintained by the National Institute for Occupational Safety and Health (NIOSH). Matrices were constructed



summarizing compound-specific postings in terms of exposure route and toxic effects and/or system involvement.

To identify and assess existing aids for medical management, study staff contacted the following types of organizations:

- International groups such as the World Health Organization and the International Labor Organization
- National societies/associations concerned with chemical products, such as the Chemical Manufacturers Association and the American Chemical Society
- Organizations involved in the training of medical professionals, i.e., selected medical schools and medical associations/councils
- Federal Agencies concerned with the development, promulgation, or use of medical management aids as well as with medical training, such as the U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA), and Centers for Disease Control/NIOSH
- Local or regional (within state) providers/coordinators of medical care for chemical casualties, i.e., first responders and hospital emergency departments.

STUDY FINDINGS

Summary tables of toxic effects do not reflect substantial differences between the two classes chosen for study. Within classes, lines of demarcation between subgroups are even more difficult to follow. If a specific type of toxic effect is not noted in RTECS for a specific substance, the omission could mean either that the chemical does not produce the effect or that the chemical has not yet been adequately tested for the effect. The fact that toxic effects are not substantially different across major classes in the

aggregate serves as one justification for the current requirement to treat signs and symptoms and to ascertain route of exposure during the initial management of a chemical exposure victim.

A major expenditure of funds would be required to develop any system to subdivide major classes on the basis of chemical properties and to cross-index substances across classes or class subdivisions. Another problem is that the nature and action of a specific chemical may be altered by factors such as fire, rain, or interaction with other substances. Although chemically defined classes could be used as a framework for monitoring the availability of medical management guidance, it is preferable to assess guideline availability on a chemical-specific basis.

Only half the U.S. medical schools teach occupational health and only 30 percent require this subject in their curriculums. Thus, many medical students graduate without the knowledge and the skills needed to recognize and take appropriate action for work-related problems. Similarly, general nursing programs neither provide nor require specific training in occupational and environmental health. Training received by occupational health nurses is geared toward prevention and does not always prepare nurses to function as first responders at the scene of a hazardous materials incident. None of the paramedical training programs reviewed by the study staff provide specific training in identifying chemicals.

A number of aids were identified as having been used or promulgated for use in medical management. These aids are grouped by their mode of access--written materials, telephone advice, or computerized data bank. Eleven written-material aids are described. The aids have been prepared by or for Agencies



such as DOT, the U.S. Army, the EPA, NIOSH, the Occupational Safety and Health Administration, the American Lung Association of Western New York, the Association of American Railroads, and the National Fire Protection Association. Telephone advice is available from the Chemical Transportation Emergency Center (CHEMTREC); from Poison Control Centers; from Ecology and Environment, Incorporated; and from the Medical University of South Carolina. The major computerized data bank is the Chemical Information System, which is jointly supported by the National Institutes of Health and the EPA.

Major gaps apparent from the study findings are as follows:

- Gaps in Resource Materials
 - Lack of guidelines for many chemicals
 - No formal review of the adequacy of existing written guidelines
 - No careful evaluation of first responders' awareness of written resource materials
 - No system for ensuring that organizations requiring materials receive them
 - Insufficient awareness by emergency treatment facilities of sources and types of telephone medical advice
 - No careful evaluation of the quality of the materials on which telephone advice is based
- Gaps in Training Programs
 - Insufficient occupational health teaching in U.S. medical and nursing schools
 - Need to continue to alert paramedical personnel to the inherent dangers in responding to a chemical accident

- No standard publication or handbook that adequately meets all or most needs of paramedical personnel for handling chemical incidents
- Gaps in Incident Feedback
 - Insufficient information regarding the number of incidents in which specific chemical exposures are involved
 - No systematic attempt to relate the results of incident-specific medical management experience to resource material and training needs.

STUDY RECOMMENDATIONS

The major study recommendations are as follows:

- Expend greater effort toward assimilating toxicological and incident data for commonly used and transported chemicals
- Expand the development of protocols for prehospital basic and advanced life support following chemical exposure
- Establish a centralized resource and referral center to assimilate, evaluate, and disseminate medical treatment guidance for chemical exposures
- Include a Chemical Accident Scene Evaluation (CASE) module in paramedical training programs
- Develop a pocket-size handbook describing classical signs and symptoms usually present from chemical exposure
- Expand continuing education programs in the management of chemical accidents
- Increase the amount of occupational health teaching in medical and nursing school curriculums
- Assess chemical incident potential and medical response capability at community levels



- Conduct field drills that simulate various types of chemical incidents
- Establish a mechanism to report the medical management experience with chemical exposure victims.

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Section 1.0
INTRODUCTION



Section 1.0

INTRODUCTION

1.1 NATURE OF THE PROBLEM

The Federal Emergency Management Agency (FEMA) defines hazardous materials as "those chemicals or substances that are harmful to human health and the environment" (FEMA 1981a). Such substances are often used in industry, agriculture, medicine, research, and consumer goods. Hazardous materials can be broadly classified as physical, biological, or chemical agents.

Our society has become increasingly dependent on chemical products. A 1979 FEMA report to the President noted that more than a million chemicals have been created (FEMA 1979). In spite of the potential benefits that may result from the use of chemicals, they can create life-threatening emergencies. Our society's dependence on chemical products is accompanied by increasing exposures to chemicals during their production, transportation, use, disposal, and accidental release.

The disposal of hazardous materials can lead to chronic or long-term exposures in both urban and relatively isolated areas. The chemical contamination of Love Canal in New York was an example. In contrast, industrial accidents or spills during transportation typically result in acute or short-term exposures to small or large populations, depending on the incident. On November 10, 1979, a chlorine gas release resulting from a freight train derailment in Mississauga, Canada, led to the evacuation of nearly 250,000 residents of that Toronto suburb.



Effective emergency response plans for accidental chemical releases require containment and cleanup procedures along with preparedness for initial and interim management of exposed individuals. Fire department personnel, often first responders to such emergencies, may or may not have access to written guidelines or verbally transmitted instructions at the time they arrive at an incident scene. Professionals at emergency treatment facilities may also lack sufficient information. These individuals may be called for advice by the first responders or may themselves be involved in initial or secondary treatment stages.

1.2 STUDY OBJECTIVES AND REPORT ORGANIZATION

The central objective of the study was to "identify what gaps, if any, exist in the ability of the overall medical community to recognize and treat health problems resulting from exposure to hazardous materials" (FEMA 1981b). The scope of work comprised the following elements:

- Determine the utility of cataloging chemicals by major class
- Determine the availability of medical treatment guidance
- Identify gaps or problems in the chemical categorization or treatment guidance
- Make recommendations on the most effective ways to ameliorate identified gaps.

Study recommendations could range from finding better ways to disseminate known information to identifying chemical classes that require better treatment characterization.

The identification of existing gaps in the ability of the medical community to recognize and treat hazardous material exposures merely scratches the surface of a complex and important problem. Detailed assessments are needed of the effects and resultant costs (human and economic) of exposure, the appropriate mechanisms for providing better data on chemical production and exposures, and the adequacy of existing medical management aids. These tasks, however, are not within the scope of work for this contract.

Section 2.0 of this report outlines the methods used to investigate schemes for classifying or cataloging chemicals and methods used to determine the current availability of medical treatment guidance. Section 3.0 presents findings concerning the utility of chemical classification schemes, the current training requirements for medical professionals with regard to hazardous materials, and the written or verbal medical guidance for managing chemical casualties. Gaps highlighted at the end of Section 3.0 are based on study findings. Section 4.0 summarizes the recommendations for ameliorating the identified gaps. Sample pages from written medical guidance materials are provided in the Appendix.



Section 2.0
STUDY METHODOLOGY

Section 2.0

STUDY METHODOLOGY

2.1 INVESTIGATION OF THE FEASIBILITY OF CLASSIFYING CHEMICALS

Numerous techniques have been developed and used to classify chemicals and hazardous materials. Some classification schemes have considered chemical compound type, degree of hazard, and known acute or chronic toxicity. The intent of this investigation was to assess whether a classification scheme useful in identifying adverse health effects could be applied to a readily available, unbiased listing of chemicals in order to correlate medical guidelines with chemical classification groups.

The starting point for the assessment was a system of 30 classes contained in a frequently referenced toxicology and industrial hygiene text (Patty 1963). The classes taken from this text are listed in Table 1. More detailed subclassifications by chemistry have been developed, for example, by the International Union of Pure and Applied Chemists (IUPAC) and by Aldrich Chemical Company; but further refinement was not considered necessary for the investigation. An assessment of the utility of detailed classification by chemistry is presented in Section 3.1.

The other input to the assessment was the Registry of Toxic Effects of Chemical Substances (RTECS) of the National Institute for Occupational Safety and Health (NIOSH). This data bank was accessed by remote terminal to obtain a listing of chemical substances with toxic effects under one or more of the categories listed in Table 2. Over 13,000 postings (representing a duplicated count of chemical substances) were obtained. An example of the format in which the information was received appears in Figure 1. The



**Table 1. Chemical Classes Listed in
Industrial Hygiene and Toxicology (Patty 1963)**

Metals

Phosphorus, selenium, and tellurium

Halogens and nonmetals, boron and silicon

Inorganic compounds of oxygen, nitrogen, and carbon

Fluorine-containing organic compounds

Organic sulfur compounds

Organic phosphates

Cyanides and nitriles

Aliphatic nitro, nitrate, and nitrite compounds

Aromatic nitro and amino compounds

N-nitrosamines

Alkaline materials

Aliphatic hydrocarbons

Alicyclic hydrocarbons

Aromatic hydrocarbons

Halogenated aliphatic hydrocarbons

Halogenated cyclic hydrocarbons

Aliphatic and alicyclic amines

Phenols and phenolic compounds

Glycols and derivatives

Aliphatic acids

Organic acid anhydrides

Epoxy compounds

Aldehydes and acetals

Ketones

Esters

Alcohols

Ethers

Polymers

Heterocyclic compounds

Table 2. Categories Used in the RTECS Data Bank

Allergenic	Liver
Autonomic nervous system	Musculoskeletal
Behavioral symptoms	Mutation (human)
Blood	Nasal
Blood pressure	Neoplastic
Cardiovascular	Peripheral nervous system
Carcinogenic	Psychotropic
Central nervous system	Pulmonary system
Coma	Red blood cell
Convulsions	Reproductive
Endocrine system	Skin--mild
Equivocal tumorigenic agent	Skin--moderate
Eye--mild	Skin--severe
Eye--moderate	Systemic
Eye--severe	Teratogenic
Gastrointestinal tract	Toxic effects unspecified
Glandular	Tumor
Immune system	Tumor-related
Irritant	Urogenital system
Kidney	White blood cell



-
- 1 N1 - ACETAMIDE,
N-(2-(m-BUTOXYPHENOXY)ETHYL)-N-METHYL-2-(PYRROLIDINYL)-,
HYDROCHLORIDE
 - 2 N1 - ACETAMIDE, 2-(BUTYLAMINO)-N-METHYL-N-(2-(o-TOLYLOXY)ETHYL)-,
HYDROCHLORIDE
 - 3 N1 - ACETAMIDE,
N-(2-(o-CHLOROPHENOXY)ETHYL)-N-METHYL-2-(PYRROLIDINYL)-,
HYDROCHLORIDE
 - 4 N1 - ACETAMIDE, 2-(DIETHYLAMINO)-N-(DIPHENYLMETHYL)-, HYDROCHLORIDE
 - 5 N1 - ACETAMIDE, N-(2-MESITYLOXYETHYL)-N-METHYL-2-(MORPHOLINO)-,
HYDROCHLORIDE
 - 6 N1 - ACETANILIDE, 4'-BUTOXY-2-(DIETHYLAMINO)-, HYDROCHLORIDE
 - 7 N1 - ACETANILIDE, 2'-CHLORO-2-(DIETHYLAMINO)-, HYDROCHLORIDE
 - 8 N1 - ACETANILIDE, 2'-CHLORO-2-(2-(DIMETHYLAMINO)ETHYLTHIO)-,
HYDROCHLORIDE
 - 9 N1 - ACETANILIDE, 4'-CHLORO-2-(METHYL(2-(PYRROLIDINYL)ETHYL)AMINO)-,
DIHYDROCHLORIDE
 - 10 N1 - ACETANILIDE, 2',6'-DICHLORO-2-(DIPROPYLAMINO)-, HYDROCHLORIDE
 - 11 N1 - ACETANILIDE, 2-(DIETHYLAMINO)-2'-PROPOXY-, HYDROCHLORIDE
 - 12 N1 - ACETANILIDE, 4'-(2-HYDROXYETHYLSULFONYL)-
RN - 27375-52-6
 - 13 N1 - ACETIC ACID, 2-(sec-BUTYL)-4,6-DINITROPHENYL ESTER
RN - 2813-95-8
 - 14 N1 - ACETIC ACID, 2-CHLORO-5-NITROPHENYL ESTER
RN - 64846-47-5
 - 15 N1 - ACETIC ACID, ISOBUTYL ESTER
RN - 110-19-0
 - 16 N1 - ACETIC ACID, THIOCYANATO-, BICYCLO(2.2.1)HEPT-5-EN-2-YLMETHYL
ESTER,
RN - 63906-51-4

Figure 1. Sample Postings from RTECS Under Category
"Moderate Eye Irritation"

example is a partial listing of those compounds reported to cause moderate eye irritation.

On the basis of the listing cited above, two chemical classes--ethers and metals--were chosen to test the feasibility of subclassification on the basis of readily available toxic effects information. The major criteria for selection of the test classes of compounds were as follows:

- Ease with which listed substances could be placed within the chemical classes (i.e., how easily the substances fit chemically into the classification scheme)
- Extent of variability in toxic action across members of a class, with a wide range of toxic effects within a class being preferred
- Sufficient numbers of individual substances within a class to allow an adequate evaluation of the utility of a chemical classification scheme toward medical management.

From the toxic effects posted in RTECS, matrices were constructed for matching compound-specific effects with exposure routes. Exposure routes were classified as cutaneous, inhalation, ingestion, or other. Toxic effects and/or system involvement were noted under the following headings:

- Eye irritation
 - Mild
 - Moderate
 - Severe
- Skin irritation
 - Mild
 - Moderate
 - Severe
- Pulmonary involvement



- Gastrointestinal involvement
- Neurologic involvement
 - Behavioral symptoms
 - Central nervous system symptoms
- Cardiac involvement
- Reproductive involvement
 - Developmental
 - Fertility
 - Embryotoxicity
- Carcinogenic agent
- Equivocal tumorigenic agent
- Neoplastic agent.

Information was reviewed for approximately 600 chemicals classified as ethers and 1,800 chemicals classified as metals. Matrices displaying toxic effects associated with specific chemicals were constructed for each class. Patterns of effects within and across classes were examined. Section 3.1 presents the results of this exercise.

2.2 IDENTIFICATION OF EXISTING AIDS FOR MEDICAL MANAGEMENT

Aids to guide the medical management of chemical casualties are in continuing stages of development and refinement in both the public and private sectors. Training and certification programs are also updated in response to changing circumstances that medical professionals encounter in their practices. Thus, the intent of this investigation was threefold:

- To uncover major new developments in medical management aids or new directions in medical training philosophies with regard to chemical exposures

- To assess the utility of existing aids and the level of preparedness that training provides toward chemical casualty management
- To pinpoint specific gaps and problem areas viewed by those who have developed medical management aids, who have trained medical professionals, or who have been involved in various aspects of chemical casualty management.

To accomplish these objectives, study staff specifically sought input from the following types of organizations:

- International groups such as the World Health Organization and the International Labor Organization
- National societies/associations concerned with chemical products, such as the Chemical Manufacturers Association and the American Chemical Society
- Organizations involved in the training of medical professionals, i.e., selected medical schools and medical associations/councils
- Federal Agencies concerned with the development, promulgation, or use of medical management aids as well as with medical training, such as the U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA), and Centers for Disease Control/NIOSH
- Local or regional (within state) providers/coordinators of medical care for chemical casualties, i.e., first responders and hospital emergency departments.

The specific nature of the query varied, depending on the responding entity. International groups and national organizations concerned with chemical products were asked about new or existing developments in medical



management aids. Federal Agencies were also asked primarily about aid developments, but in some cases their representatives had insights concerning utility of the aids and/or training needs. Medical schools and associations primarily addressed the issues of current training requirements and practices. Local providers/coordinators were best equipped to discuss the utility of aids and training toward actual situations that they had encountered.

In many cases, one of the staff members knew one or more representatives of a responding organization. These acquaintances were useful in providing their insights or in pinpointing the most appropriate contact within the organization.

In other cases, several phone calls were typically required before the most knowledgeable individual was reached. Most of the information supporting the study's findings and recommendations was either on hand at the outset of the study, obtained by means of a telephone conversation, or received subsequent to a conversation. Several meetings were held with individuals in the Washington, D.C., area who had a particularly keen insight into problem areas associated with the day-to-day management of chemical casualties or with the response to hazardous material incidents. The findings from this portion of the investigation are reported in Section 3.2.

Section 3.0
STUDY FINDINGS



Section 3.0
STUDY FINDINGS

3.1 UTILITY OF A CHEMICAL CLASSIFICATION SCHEME

Several alternate methods exist for classifying major chemical hazardous materials, such as by physical state, by use, by chemical nature, or by toxic effects. The usefulness of correlating a toxic classification with a chemical nature classification was explored. This approach does not appear feasible or cost-effective toward improving the management of chemical exposure victims, as discussed below.

3.1.1 Feasibility of Subclassification by Toxic Effects

As noted in Section 2.1, postings were obtained from the RTECS registry for all chemicals in two major classes--ethers and metals--in order to assess the feasibility of subclassification by toxic effects. Tables 3 and 4 show tabulations of toxic effects of specific types posted in RTECS for the two classes. The toxic effects are summarized in relation to the route of exposure for which the effects were investigated.

The tables do not reflect any substantial differences between classes with respect to types of toxic effects noted. Within classes, lines of demarcation between subgroups are even more difficult to draw. For ethers, the nature and severity of toxic effects often vary with the chain length of specific chemicals. Other general toxicity characteristics, however, are not so evident.



Table 3. Matrix of Toxic Effects Following Exposure to
Approximately 600 Chemicals Classified as Ethers

Toxic Effects and/or System Involvement	Route of Exposure*			
	Cutaneous	Inhalation	Ingestion	Other
EYE IRRITATION				
Mild	28	0	0	0
Moderate	20	1	1	0
Severe	27	0	0	0
SKIN IRRITATION				
Mild	74	0	0	0
Moderate	20	0	0	0
Severe	11	0	0	0
PULMONARY INVOLVEMENT	0	7	2	3
GASTROINTESTINAL INVOLVEMENT	0	1	8	2
GENITOURINARY INVOLVEMENT	0	0	1	0
NEUROLOGIC INVOLVEMENT				
Behavioral Symptoms	0	5	13	8
CNS Symptoms	0	2	0	2
CARDIAC INVOLVEMENT	0	0	0	0
REPRODUCTIVE INVOLVEMENT				
Developmental	0	0	0	0
Fertility	0	1	1	0
Embryotoxicity	0	3	3	0
CARCINOGENIC AGENT	0	1	7	4
EQUIVOCAL TUMORIGENIC AGENT	3	2	4	8
NEOPLASTIC AGENT	2	1	2	7

* Data within each cell represent the number of ethers identified as capable of causing a specific toxic effect when exposure occurs by the specific route considered. Exposure by any single route may produce multiple toxic effects that involve more than one body system.

Table 4. Matrix of Toxic Effects Following Exposure to
Approximately 1,800 Chemicals Classified as Metals

Toxic Effects and/or System Involvement	Route of Exposure*			
	Cutaneous	Inhalation	Ingestion	Other
EYE IRRITATION				
Mild	12	0	0	0
Moderate	15	0	1	0
Severe	36	0	0	0
SKIN IRRITATION				
Mild	27	0	0	0
Moderate	18	0	0	0
Severe	18	0	0	0
PULMONARY INVOLVEMENT	0	33	3	51
GASTROINTESTINAL INVOLVEMENT	0	9	33	40
GENITOURINARY INVOLVEMENT	0	6	0	0
NEUROLOGIC INVOLVEMENT				
Behavioral Symptoms	0	6	24	108
CNS Symptoms	0	6	6	16
CARDIAC INVOLVEMENT	0	7	3	0
REPRODUCTIVE INVOLVEMENT				
Developmental	0	4	33	33
Fertility	0	6	12	36
Embryotoxicity	0	3	13	17
CARCINOGENIC AGENT	0	15	14	37
EQUIVOCAL TUMORIGENIC AGENT	0	21	39	165
NEOPLASTIC AGENT	0	6	6	81

* Data within each cell represent the number of metals identified as capable of causing a specific toxic effect when exposure occurs by the specific route considered. Exposure by any single route may produce multiple toxic effects that involve more than one body system.



The summaries in Tables 3 and 4 support what one might expect by intuition for any major chemical class. For example, where the route of exposure is cutaneous, eye/skin irritation is the primary effect noted. Pulmonary and gastrointestinal involvement are associated with inhalation and ingestion routes, respectively. While effects are noted in RTECS, the numbers of testing occasions are not. Therefore, the fact that a specific type of toxic effect is not noted in RTECS for a specific substance could mean either that the chemical does not produce that effect or that it has not yet been adequately tested for that effect.

The information gap cited above, coupled with the lack of any consistent patterns in the RTECS data, casts considerable doubt on the feasibility of subclassification through readily accessible, computerized data banks. A thorough examination of toxic effects must proceed in a painstaking, chemical-by-chemical fashion based on all available inputs. Many new substances can be classified immediately in regard to acute toxic effects, even when the material is altered by other physical and chemical forces. It is the chronic effect that is very difficult to define.

The apparent fact illustrated by Tables 3 and 4--namely that toxic effects are not substantially different among major classes in the aggregate--serves as one justification for the current requirement of treating signs and symptoms and ascertaining route of exposure during initial management of a chemical exposure victim. This approach would hold whether or not the identity of the chemical(s) involved is known to the responder. In situations where the identity of the chemical is known, selected guidelines are available.

These are discussed in Section 3.2.3. In general, provision of basic life-support measures combined with minimal response and transport times would appear to optimize exposure outcomes associated with the first-responder component of the emergency medical care system.

3.1.2 Application of Major Classes or Subclasses Defined by Chemical Properties

Difficulty arises in choosing a chemical classification system that will adequately represent member substances, yet allow use by nonchemists. Classification at general levels, such as by Patty's 30 classes, admittedly has self-defined limitations. That is, the wide range of both chemical properties and toxic actions within such classes does not allow for the development of class-specific medical guidelines or protocols.

A more detailed subdivision could be gained, for example, by applying the parent moiety system devised by IUPAC. The inherent limitation of the IUPAC system is that each individual compound must be evaluated for its chemical properties, placed manually into the chemical classification scheme, cross-indexed into other classes as necessary, and ultimately structured into a computerized data storage system.

After a sufficient number of substances (i.e., thousands) were entered into the data system, a process of data correlation and manipulation might identify similar trends in toxic actions among chemicals of a given class. Retrieval of chemical data would need to cover not only chemicals within a class, but be sophisticated enough to search and extract related data in other classes. It must be emphasized, however, that this approach is not presently in existence, according to the Chemical Abstract



Service of the American Chemical Society. A major expenditure of funds would be required to conduct a preliminary setup and evaluation of the system.

Another problem with using chemical properties to define classes for development of class-specific guidelines is that the nature and action of a particular chemical may be altered by factors such as fire, rain, or interaction with other substances. Nevertheless, chemically defined classes might still serve some general purpose; for example, they could be used as a framework for monitoring the availability of medical management guidance. However, the consensus among study staff and interviewees is that a chemical-specific assessment of medical guideline availability is more appropriate. Further details concerning this notion appear in Section 3.3.

3.2 AVAILABLE GUIDANCE FOR MEDICAL MANAGEMENT OF CHEMICAL EXPOSURES

3.2.1 Overview of Medical Management

Medical management of chemical exposures consists of three stages--prehospital, hospital, and posthospital (followup) care. This study focuses on medical management guidelines for first aid (prehospital) response and for in-hospital care following chemical exposure.

The term prehospital simply refers to that level of care provided to victims of an injury or illness before they arrive at a medical facility or are placed under the care of a physician. Personnel performing this function may range from highly trained emergency medical technicians to first responders with little or no training.

The successful management of the prehospital phase is dependent upon the following elements:

- Existence of an organized response plan coordinated with local health care facilities
- State of preparedness to deal with a variety of illnesses and/or injury situations
- Capability for stabilization of the victim before and during transportation
- Ability to communicate with the receiving or the coordinating health care facility.

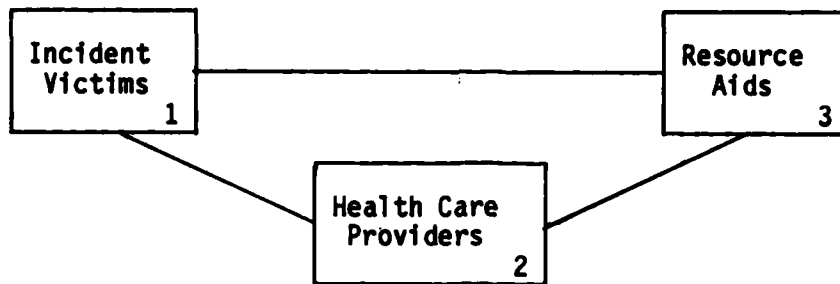
The hospital care phase is meant to describe and include those actions and personnel who provide definitive care to the emergency patient. This would include all those health care professionals from emergency room physicians and nurses to the various supporting activities.

In-hospital care of patients exposed to hazardous materials is often guided by a sound exposure history and a thorough clinical evaluation. The precise identity of the offending or injurious chemical may prove extremely valuable. However, in most cases, the physician approaches the condition from symptom recognition, physical examination, and laboratory findings.

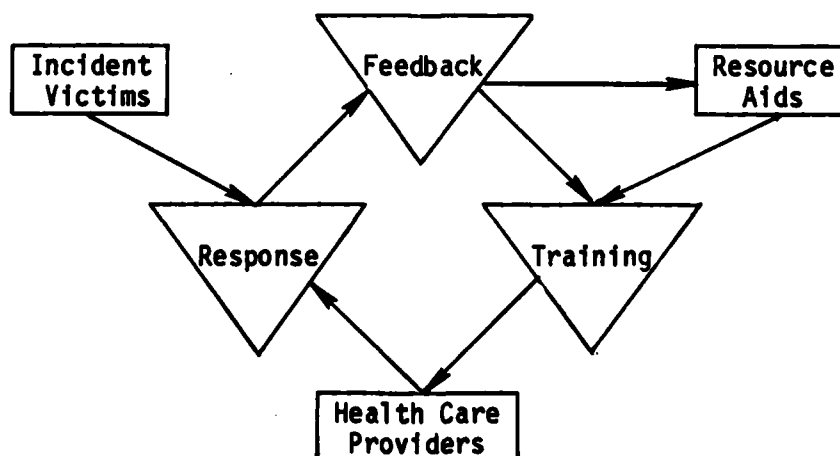
As a routine requirement, followup care, to the extent possible and necessary, should be conducted on those people treated as a result of chemical exposure. To the best of the staff's knowledge, no standard requirements or procedures currently exist for tracking those personnel exposed to hazardous materials. However, such tracking can be very important, especially for those substances that can exhibit latent effects.



To adequately understand and analyze the ability of the medical community to respond effectively to a chemical incident, it is necessary to identify the inputs to the treatment process:



Block 1 represents the victims of the chemical incident or emergency. Block 2 represents the health care providers, from first responder to clinical specialists, who provide medical care subsequent to an incident. Block 3 represents an unknown quantity and quality of resource aids for providing guidance in dealing with such an incident. These three elements are involved to some extent when a chemical exposure occurs, but their characteristics can vary from incident to incident. Variations in medical management capabilities are often a function of the interactions between the three blocks:



The critical interactions are response to the incident, feedback obtained from incident response, and training of the health care providers. Section 3.2.2 describes current training requirements for medical community members with regard to management of chemical exposures. Section 3.2.3 discusses resource aids that are intended to provide guidance for medical management of such exposures.

3.2.2 Specific Training Requirements for the Medical Community

3.2.2.1 Physicians

The curriculum in occupational health is often the vehicle for covering chemical hazards associated with industry and commerce. A survey (Levy 1980) of the 112 U.S. medical schools was performed to determine the content and format of occupational health teaching during the 1977-1978 academic year. Only 46, or 50 percent, of the 92 responding institutions indicated that they specifically taught occupational health; only 28, or 30 percent, of the 92 respondents indicated that it was a required part of the curriculum, usually taught in the preclinical years. Given the current status of curriculums in occupational health, many medical students graduate today without the knowledge and skills needed to recognize and take appropriate action for work-related medical problems.

During this study, staff were told of several instances where an occupational history that pinpointed a chemical incident would have greatly aided both the clinician and the patient.



3.2.2.2 Nurses

Results of a survey (Task Force on Environmental Cancer and Heart and Lung Disease 1979) of nursing education programs, conducted to identify specific training requirements relative to occupational health nursing, indicated that general nursing programs neither provide nor require specific training in occupational and environmental health. Specialty areas within the nursing field, however, do provide specific training. One such area is occupational health nursing, for which board certification may be obtained by nurses who meet education and experience standards established by the American Board of Occupational Health Nurses. A relatively small number of nurses choose to specialize in this field. The broad objective of the occupational health nurse is to protect the health of the employee in the occupational environment. The nurses are concerned with, and receive specific training in, health and safety education of the work force, accident prevention, and medical surveillance programs for occupational hazards in the workplace. The American Association of Occupational Health Nurses provides educational opportunities, conferences, and workshops to help these nurses meet certification and continuing-education requirements.

The training received by this group of nurses is geared toward prevention and does not always prepare nurses to function as first responders at the scene of a hazardous material incident.

3.2.2.3 Paramedical Personnel

In the event of an injury, accident, or sudden illness, there is rarely a physician, nurse, or trained Emergency Medical Technician (EMT) at hand. Even though there may be other responders on the scene (friends, bystanders, police, firefighters, etc.) who have had some training, they are limited in their ability to maintain patients until professional help is available. This limitation is due in large part to three factors:

- Insufficient knowledge to accurately assess the situation
- Insufficient equipment or supplies to adequately provide basic life support
- Insufficient means for properly transporting the patient to a treatment facility.

It is essential that the EMT/paramedic arriving at an accident scene be able to assess the degree of first aid already provided and to assume responsibility immediately for the patient. In the event of a chemical accident, the EMT must also be cognizant enough to prevent further exposure to the patient, himself or herself, and other bystanders.

All of the paramedical training courses reinforce the objectives of assessing any situation or accident so as to preclude the rescuer from becoming a victim. There is no specific coverage, however, of the many types of spills or chemical accidents that can occur. None of the paramedical training programs reviewed by the study staff provide specific training in identifying chemicals. Many programs mention that paramedical personnel should be aware of the presence and sources of toxic fumes.



Treatment protocols stress the rendering of basic life-support measures based on signs and symptoms. The programs also stress the importance of establishing communication with a physician at a base hospital. The hospital physician can usually direct medical management when the paramedic at the scene provides information.

3.2.3 Aids Identified and Their Applicability as Resources in the Medical Management of Chemical Exposures

Aids that have been used or promulgated for use in medical management can be grouped according to their mode of access--written materials, telephone advice, or computerized data bank. Sample pages from approved written guidelines appear in the Appendix. For an unbiased presentation, the first chemical, guideline, or page containing multiple chemicals and guidelines was chosen. Staff members have identified numerous aids, which are described in this report. Yet, it is likely that medical management resources exist that were not covered during the project search.

3.2.3.1 Written Materials

Hazardous Materials Emergency Response Guidebook (U.S. Department of Transportation, 1980)

This guidebook was developed for use by first responders such as firefighters, police, and other emergency services personnel. The booklet describes initial actions that can be taken to protect the public and the emergency personnel who respond to incidents involving hazardous materials. It was primarily designed for use at a hazardous material incident occurring on a highway or a railroad. With certain limitations, however, the guidebook can be used in handling incidents occurring elsewhere.

More than 2,000 chemicals commonly involved in interstate transportation are listed both alphabetically and numerically by identification number in this publication. Each chemical is also assigned an emergency response guide number that coincides with one of the specific guides within the book. The guide identifies the most significant potential hazards and recommends initial actions to be taken for each chemical incident. Each emergency response guide lists health hazards normally caused by exposure and states the basic life-support measures that the first responder should immediately initiate. Selection of the appropriate emergency response guide is made by identifying a hazardous material through its identification number, shipping name, or placard displayed on the transport vehicle.

Many materials represent similar types of hazards and require similar initial emergency response actions. Thus, the 50 emergency response guides included in this publication provide the general guidance needed to initially manage exposures to the more than 2,000 chemicals listed.

The DOT guidebook is available free of charge for use by first responders; however, some study participants indicated that first responders, particularly in nonmetropolitan areas, are not aware of the guidebook's existence.

Chemical Hazard Response Information System (CHRIS)
(U.S. Department of Transportation, 1978)

This system is designed to provide information needed for decision-making by responsible U.S. Coast Guard personnel when emergencies occur during the transport of hazardous chemicals by water. CHRIS consists of four handbooks or manuals, a hazard assessment computer system (HACS), and technical



support personnel located at Coast Guard headquarters. The handbooks or manuals are interrelated; each is an integral part of the total system. The HACS is a computerized version of one of the manuals, the Hazard Assessment Handbook. Its format permits trained specialists at the headquarters level to obtain detailed hazard evaluations quickly when requested by coordinators at the scene of a chemical incident.

The major component of CHRIS is the Hazardous Chemical Data Manual, which lists physical and biological data on more than 1,000 chemicals. Health hazards information provided in this manual includes symptoms of exposure and recommended treatment. These symptoms and treatments are presented on a chemical-specific basis.

Like the previously described guidebook, CHRIS contains only basic life-support measures related to presenting signs and symptoms. Even though chemical composition may vary greatly, first-responder treatment guidelines from these sources are often similar across large numbers of substances. This similarity results from the fact that first-responder treatment focuses on basic life support to enable subsequent hospital-based care that is more definitive.

Medical Management of Hazardous Material Injuries

This document was developed by Lt. Col. Stutz, Ph.D., U.S. Army, Surgeon General's office. The project was funded through a cooperative agreement with FEMA's Fire Administration (Mr. Jim Smalley, Project Officer). The document is presently under review within the Army Surgeon General's office, with a final version expected in the summer of 1982.

The document is an enhancement of DOT's Hazardous Materials Emergency Response Guidebook. It contains 78 protocols that segregate basic and advanced life-support measures. The Guidebook is geared toward chemicals for which prehospital care would be required following exposure. The treatment to be rendered by first responders is based on signs and symptoms, but specific antidotes are noted where they exist.

This document was prepared on the basis of an extensive review of toxicity information; sources such as CHEMTREC, OHM-TADS, CHRIS, and POISINDEX; and information obtained from chemical company medical departments. Distribution of the document is not known at this time. It is intended to be published privately in order to enable rapid distribution following its final approval.

Chemical Emergency Action Manual (American Lung Association of Western New York, 1981)

This manual was prepared to aid occupational health personnel, emergency medical technicians, fire and police personnel, rescue personnel, and emergency room personnel. The manual is intended to provide a continuum of preferred medical treatment following exposure to any of 35 selected chemicals.

The format of the manual is a series of "chemical/substance cards" that present information emphasizing six major areas of concern. These areas can be briefly summarized as follows:

- Immediate hazards--The first section on each card highlights those hazards that affect rescue workers, firefighters, and people exposed to the particular chemical that could cause serious harm. This section provides early warning guidance necessary to protect life and property.



- In case of accident--This section provides additional actions that should be taken to ensure safety in each of three major problem areas--spill or leak, fire, or exposure. The data will provide the personnel on the scene with the information necessary to limit the amount of damage done by the accident.
- Signs/symptoms--This section presents information in lay terms to aid in identifying possible accident victims.
- Special instructions--This section lists any special medical procedures established for use in a particular area or plant.
- Medical instructions--This section provides detailed instructions regarding the treatment of a possible chemical accident victim. It is divided into areas defined by type of exposure the victim encountered.
- Use of "Hazardous Materials Classification" diamond--In the upper right-hand corner of each chemical/substance card is a diamond-shaped diagram that indicates the hazards and their severity under emergency conditions.

A revised and expanded edition of this manual, currently in press, contains an additional 24 chemicals or substances of concern, including radiation and major groupings of pesticides. The revision also provides a suggested outline for a toxic emergency training program.

Occupational Health Guidelines for Chemical Hazards (National Institute for Occupational Safety and Health/Occupational Safety and Health Administration)

These guidelines resulted from a joint 1974 NIOSH/OSHA project known as the Standards Completion Program. The document is intended primarily for industrial hygienists and medical surveillance personnel who are responsible for initiating and maintaining an occupational health program. It can also be used, for example, by other types of personnel for obtaining summary information about specific chemical substances found at the worksite.

Guidelines exist for nearly 400 chemicals that have Federal occupational safety and health regulations. Each guideline includes data on chemical names and synonyms, permissible exposure limits, chemical and physical properties, and signs and symptoms of overexposure. Respiratory and personal protective equipment use, control measures, and procedures for emergency treatment and conditions are also discussed. The information for the guidelines was assembled from recognized textbooks in industrial hygiene, medicine, toxicology, and analytical chemistry; from articles in technical journals; and from personal communications with representatives of industry and labor.

Approximately 100 chemicals that have OSHA regulations but no occupational health guidelines as yet are listed in the table of contents and marked with an asterisk. Guidelines for these substances are to be issued as supplements at a later date.

Pocket Guide to Chemical Hazards (National Institute for Occupational Safety and Health/Occupational Safety and Health Administration, 1978)

This pocket guide presents information taken from the NIOSH/OSHA Occupational Health Guidelines. The information was assembled through the joint efforts of NIOSH and the U.S. Department of Labor. The guide presents key information and data in an abbreviated tabular format for 380 federally regulated chemical hazards found in the work environment. The guide serves as a quick reference source of information relating to industrial hygiene and medical surveillance practices for use by employees, employers, occupational health professionals, and others. Elements presented in the guide include chemical names and synonyms, permissible exposure limits, chemical and physical



properties, signs and symptoms of overexposure, environmental and medical monitoring procedures, recommendations on the use of respiratory and personal protective equipment, and procedures for emergency treatment.

The industrial hygiene and medical surveillance practices recommended in this guide and the preceding guidelines will certainly assist in initiating and maintaining effective occupational health programs to protect workers in the workplace. The guide could help the first responder to select and initiate basic life-support measures based on signs and symptoms. Target organs most likely to be affected by exposure to a specific chemical are also identified.

Hazardous Chemicals Data (National Fire Protection Association, 1975)

This text, which has undergone a series of revisions, was originally prepared by the National Fire Protection Association Committee on Hazardous Chemicals and Explosives in cooperation with the American Chemical Society. Information is presented on chemicals used and shipped commercially that have significant health hazard/reactivity ratings, that present unusual storage or firefighting problems, or that can become hazardous when contaminated or mixed with other chemicals. Not all substances meeting these criteria are included in the 1975 edition, which covers approximately 500 chemical names. The schedule of the committee at that time called for the addition of approximately 20 chemicals per year.

The format for most chemicals includes descriptions of physical properties, fire and explosion hazards, life hazards, personal protection measures, firefighting phases, usual shipping containers, storage recommendations, and selected remarks. Life hazards sometimes refer to specific types

of toxic effects on organs/systems or to general signs and symptoms of exposure. Initial treatment recommendations listed for a few of the chemicals are general in nature.

For a number of the chemicals in this publication, the above types of information are excluded. Instead, the reader is referred to an appendix listing properties and firefighting phases of common flammable chemicals.

Chemical Supplement to the International Medical Guide for Ships

This supplement, obtained in undated draft form, was prepared as a result of work on the carriage of dangerous goods. The work was preformed by a subcommittee of the Inter-Governmental Maritime Consultative Organization. The supplement was designed to provide guidance to international seafarers in the management of chemical accidents and poisonings.

The format covers seven topic areas:

- General toxic hazards
- Emergency treatment
- Chemical tables
- Index of chemical tables
- List of medicines
- Alphabetical index of chemicals
- Numerical index of chemicals.

Guidelines for the management of chemical exposure, including both first-aid management and interim management in an isolated environment, are included in the chemical tables.



To the best of the study staff's knowledge, this supplement, with minor revisions, has not only cleared the International Labor Organization and World Health Organization panels, but has additionally been approved by the United States as a working guide for seafarers in handling chemical accidents.

Pesticide Protection Training Package (U.S. Environmental Protection Agency, 1977)

This training package results from a 3-year pilot training project conducted by the University of Miami School of Medicine under a grant from the EPA. The project was headed by John E. Davies, M.D., M.P.H., Chairman of the Department of Epidemiology and Public Health. Dr. Davies is recognized as an international authority on pesticide toxicology and prevention treatment of pesticide exposures.

This training package is a comprehensive educational tool that uses cassette tapes, slides, and concise printed training materials. The package also enables trained personnel to train others who may have contact with field workers or persons exposed to pesticides. It stresses recognition, prevention, and treatment of pesticide poisoning. The training would prove valuable for physicians, nurses, rescue workers, ambulance drivers, employers of farm workers, or anyone who might have contact with agricultural workers or plant employees working with pesticides.

The University of Miami offers to conduct onsite training programs in the diagnosis, management, and prevention of pesticide illness and poisoning for health care personnel.

Emergency Handling of Hazardous Materials in Surface Transportation (Association of American Railroads, 1981)

This text was prepared by the association's Bureau of Explosives staff as an aid to emergency response involving hazardous materials. Specific emergency response information is provided for each hazardous material regulated by DOT and listed in Table 49 of the Code of Federal Regulations. For substances designated as hazardous by EPA, guidelines for emergency environmental damage mitigation are also provided.

Specific information for each substance includes physical properties, containment/extinguishing procedures and precautions in the event or absence of fire, personnel protection methods, and evacuation criteria and procedures. Also covered are environmental considerations, such as containment, neutralization, and absorption in case of land, air, or water spills. Advice on personnel protection is mostly preventive in nature; some general treatment advice is given for selected substances.

Hazardous Materials Intelligence Report (World Information Systems)

World Information Systems publishes this international weekly newsletter on hazardous materials and hazardous wastes. It provides current information about hazardous waste problems and discusses actions being taken or recommended to correct the problems. The newsletter also reports on regulations pertaining to hazardous waste handling, cites incidents of exposure to hazardous materials or chemicals, and discusses injuries and illnesses directly related to exposure. Thus, it provides--although to a limited extent--part of the feedback recognized in the introduction to this section.



3.2.3.2 Telephone Advice

Chemical Transportation Emergency Center (CHEMTREC)

CHEMTREC is a public service provided by the Chemical Manufacturers Association in Washington, D.C. CHEMTREC operates 24 hours a day, 7 days a week, to receive direct-dial toll-free calls from any point in the continental United States through a wide area telephone service (WATS) number, 800-424-9300.

By design, CHEMTREC deals only with chemical transportation emergencies. The center's staff members provide immediate advice to those at the scene of emergencies, promptly contact the shipper of the involved chemical for more detailed assistance, and provide appropriate followup. To preclude speculation about a reported emergency, the communicators who receive the calls at CHEMTREC are strictly instructed to provide only information prepared by technical experts and to notify the shipper of the chemical immediately after the emergency. After receiving all known facts related to the emergency, the shipper will take appropriate action, e.g., to provide information by telephone or to dispatch a response team to the scene of the emergency. Identification of the product and its shipper is normally accomplished by checking the shipping papers carried by the truck driver or onboard the train.

Treatment protocols provided by CHEMTREC communicators are very basic, and additional followup advice from the shipper is sometimes delayed due to its being relayed through dispatcher to the scene of the emergency. CHEMTREC may also be used as a referral service during interim care, placing

the emergency room physician in contact with a physician in the medical department of a chemical company.

Poison Control Centers

These centers are designed to provide advice, primarily by telephone, on the management of poisoning emergencies. There are regional centers as well as area and local hospital centers. A regional center responds to requests for advice received directly from the public and from area and local hospitals. Poison Control Centers can provide information on chemical composition, appearance, toxicity of common poisonous materials, symptoms of exposure, and recommended emergency procedures following exposure.

The majority of calls to poison control centers relate to poisonings in children under the age of 5 years. Usually the poisonous substance is known, and the management advice given is that recommended by POISINDEX, Chemical Hazards of the Workplace, or other state-of-the-art reference materials.

Ecology and Environment, Incorporated

This company, located in Buffalo, New York, has significant experience in working with hazardous materials, both at waste sites and in response to spills. The company operates a system of clinics that provide physical examinations to employees who deal with hazardous materials. The company also maintains a 24-hour emergency hotline to its corporate toxicologist and health and safety committee. A compendium of incidents developed by the company serves as an information base for providing medical assistance. Telephone advice may range from suggested tests for pinpointing the nature of a chemical exposure to treatment recommendations when the exposure is well defined. Hospitals may subscribe to the service or be charged on a per-call basis.



Medical University of South Carolina

This resource, which provides 24-hour medical advice regarding pesticide poisonings, may be accessed by a toll-free number, 800-845-7633. Those providing medical management in pesticide poisonings might be referred to this resource through CHEMTREC or through poison control centers. The POISINDEX system references the University for selected substances. If the chemical agent is known and a thorough history is available for the patient, the communicator at the University will provide a management scheme to an attending physician. Liability insurance is carried for this activity.

3.2.3.3 Computerized Information

Chemical Information System (CIS)

This system, under development since 1971, is supported jointly by the National Institutes of Health and EPA in collaboration with the National Bureau of Standards, the Food and Drug Administration, NIOSH, and the United Kingdom's Department of Industry. A recent article in Science (Milne et al. 1982) describes the structure and uses of CIS, which consists of disk-stored data bases and various computer programs for interactive search.

The active system, resident on computers in the private sectors, operates on a cost-recovery basis through annual subscription fees. CIS is currently used, for example, by EPA's emergency response teams, who carry portable computer terminals to chemical spill sites. The system is currently most useful as an aid in identifying materials involved and in controlling a

spill. The system can also retrieve toxicity data from RTECS. An agreement has been reached with the U.S. Coast Guard to add CHRIS to this system.

Chemical Industry Scheme for Assistance in Freight Emergencies
(CHEMSAFE)

This scheme, launched in 1974 by the Chemical Industries Association of the United Kingdom in collaboration with Central Government, was described in its developmental stages in the Journal of Hazardous Materials (Cumberland and Hebden 1975). The scheme was designed to facilitate identification of products, their hazards, and advice for their safe treatment in an emergency.

Information sought by the system for specific chemicals included code marks, chemical names, concentrations and forms, types of packaging, brief descriptions of the nature of hazards, spillage action, extinguishing media, first aid, transportation routes, references, and accident reports. At the time the article was prepared, questionnaires were being distributed to chemical companies to acquire needed information for subsequent integration into a filing system amenable to computer searching. The project was recently discontinued, however, due to lack of funding.

3.3 SUMMARY OF MAJOR GAPS

Because a limited number of individuals were contacted during this investigation, the assessment of gaps in medical management capabilities for chemical exposures must be based on an anecdotal, rather than a totally comprehensive, information base. However, several of the individuals contacted are among the most knowledgeable in the country with respect to hazardous



materials response and associated medical management problems. From staff discussions with these individuals, coupled with review of resource materials cited in Section 3.2, a number of gaps in preparedness are readily apparent. These gaps primarily fall in the following areas:

- Adequacy of existing resource materials
- Awareness and dissemination of resource materials
- Adequacy of existing training programs
- Adequacy of feedback from incidents to update resource materials and training programs.

3.3.1 Resource Materials

Collectively, the written materials that now exist provide some form of medical guidance for several thousand chemicals. But for many chemicals, no guidelines exist. To date, chemicals have been selected based largely on the specific needs perceived by such Agencies as DOT, NIOSH, and the U.S. Coast Guard. Obviously, the number of available guidelines will not change by orders of magnitude in the near future. Consequently, the first apparent gap is the lack of medical guidelines for many chemicals.

Prepared guidelines are probably not needed for all chemicals in existence. Many substances are produced in small quantities, rarely transported, or infrequently used; the probability of their involvement in an incident is essentially zero. In contrast, no guidelines may exist for a number of chemicals previously involved in incidents or with high incident potential. Several such instances have been cited in issues of the Hazardous Materials Intelligence Report. No formal assessment has been made of need versus

existence of guidelines for specific chemicals. As noted in Section 3.1, this assessment needs to be performed on a chemical-by-chemical basis, rather than by chemical classes or subclasses.

Those written materials that do exist are used mostly during the prehospital phase of medical management. What is not known, however, is the extent to which these guidelines are helpful. Do they provide advice beyond that which is strictly common sense? If so, is the advice accurate? Do different documents provide identical advice for the same substance? A second gap is that there has been no formal review of the adequacy of existing written guidelines. This gap includes lack of assessment of the degree of overlap and consistency among guidelines that exist, in addition to their relative strengths and weaknesses.

Even if guidelines are adequate, the issue of their dissemination remains. The awareness of available resource materials varies among localities. If the likelihood of a hazardous materials incident is extremely low, then lack of awareness might not be a cause for concern. In general, however, the extent to which first responders are aware of written-resource materials has not been carefully evaluated. Furthermore, there is no system to ensure that organizations requiring these materials receive them.

Mechanisms for providing telephone advice would appear to be most useful during the in-hospital phase of medical management. However, there are variations in the extent to which telephone advice is sought. Not all emergency treatment facilities are aware of the sources that provide telephone medical advice and the types of information provided. Moreover, the quality of the materials on which telephone advice is based has not been carefully evaluated.



3.3.2 Training Programs

The majority of physician and nurse training programs in the United States do not include any occupational or environmental health training within the curriculums. This deficit does not apply in such specialties as occupational and preventive medicine. Rather, the deficit affects the general practitioner and the emergency room physician who provide the majority of hands-on care in the event of a chemical incident.

There is a distinct gap in the amount of occupational health teaching in medical and nursing schools in the United States. The existence of this gap is evidenced by the lack of occupational histories in many cases of work- or chemical-related accidents/problems. The lack of an appropriate history becomes more likely with increased length of time between occurrence and contact with the medical care system.

The majority of paramedical training programs provide a good solid base of knowledge and skill for rendering basic and advanced life support. Information on assessing signs and symptoms and providing life-support measures is abundant and technically very sound.

There does, however, appear to be a need to continue to alert paramedical personnel to the inherent dangers in responding to a chemical accident. Documented cases show that rescuers have become victims simply because they did not adequately assess the environment before initiating their rescue response.

In assessing the situation, paramedical personnel must be generally aware of the substances within the environment and their relative properties. Thus, reference documents for first responders should state the expected

signs and symptoms, as well as the protective items to be worn when caring for the chemical exposure victim. At present, no standard publication or handbook adequately meets all or most needs of paramedical personnel who handle chemical incidents. That is, no publication lists a sufficiently broad number of chemicals, the signs and symptoms for specific exposure routes of each chemical, and the immediate life-support measures to be taken.

3.3.3 Feedback from Incidents

Two important feedback items are needed after an incident involving chemical exposure: nature of the substances involved and appropriateness of the medical care rendered. At present, insufficient information is available regarding the number of chemical exposure incidents. Such information would help identify the chemicals that require medical guidelines on the basis of a relatively high likelihood of involvement in an incident. Similarly, chemicals frequently involved in such incidents would provide valuable case studies for training purposes.

Often, the appropriateness of the medical care rendered is known to the network of providers involved in a specific incident, but the results of that learning experience help only a handful of individuals. Isolated cases have been used to illustrate appropriate or inappropriate management for specific chemical incidents. Yet, no systematic attempt has been made to relate the results of incident-specific medical management experience to resource material and training needs.



Section 4.0
STUDY RECOMMENDATIONS

Section 4.0

STUDY RECOMMENDATIONS

4.1 CENTRALIZED ASSIMILATION AND REVIEW OF CHEMICAL TOXICITY DATA AND MEDICAL MANAGEMENT PROTOCOLS

The Nation lacks adequate, sound instructional and reference materials that relate known chemical toxicity levels to medical treatment steps. To a great degree, the inadequacy can be attributed to a deficit of appropriate toxicological data for a great many chemicals. The problem is aggravated by a scarcity of knowledge concerning the multiple toxic effects that may result from chemical interactions.

Since enactment of the Toxic Substances Control Act (TCA) in 1976, the chemical industry has become highly regulated. The criterion for regulation used in TSCA is whether a substance presents "an unreasonable risk of injury to health or the environment." The regulatory mechanism adopted in TSCA is the control of a substance in commerce. The basic TSCA philosophy is as follows:

- Regulate the manufacturing and processing of chemicals
- Control new chemical products
- Collect research data on chemicals.

A solid base of information must be compiled regarding the known toxic effects of commonly used or transported chemicals. From this point, accurate medical protocols can be developed and expanded. These protocols must be oriented toward sign and symptom recognition; the protocols should be guided by a chemical-specific, rather than a chemical-class, perspective.



Study recommendations for this area are as follows:

- Direct greater effort toward assimilating toxicological and incident data for commonly used and transported chemicals. The data will then convey health hazard potential as well as experience.
- Expand the development of protocols for prehospital basic and advanced life support for chemical exposure. This activity would be a follow-on to Lt. Col. Stutz's project entitled Medical Management of Hazardous Material Injuries.
- Establish a centralized resource and referral center that assimilates, evaluates, and disseminates medical treatment guidance following chemical exposure. The recommended scope of such a resource center is as follows:
 - To serve as a central coordination mechanism for medical guidance in chemical and hazardous material accidents
 - To provide information and/or materials that assist in accident management and to support formal and continuing education training programs.

4.2 STRENGTHENING OF TRAINING PROGRAMS

During the course of researching management of past chemical incidents, there is sufficient documented evidence to illustrate that the most well-intended and medically skilled first responder often finds his or her life-support efforts negated by the situation. Even more disturbing are cases where the rescuer fails to assess the chemical accident accurately and becomes a victim.

Although it is unlikely that the first responder will ever have all the necessary data to assess a chemical accident/injury totally, those personnel who respond must be completely aware of the hazards involved and the avenues available to obtain support, including personal protection.

Members of the study staff have compiled recommendations for training needs. The recommendations have been divided into two distinct, yet related, health care components: prehospital care and in-hospital care. For this study, all first responders--fire, rescue, law enforcement, or volunteer personnel--are considered within the prehospital scenario. The in-hospital scenario comprises physicians, nurses, and clinical support disciplines.

The recommendations are as follows:

- Prehospital care

- Encourage the U.S. Department of Transportation to actively foster state emergency medical technician programs that include a Chemical Accident Scene Evaluation (CASE) module in their training programs.
- Develop a pocket-size handbook describing classical signs and symptoms usually present from chemical exposure. Such a handbook could also include sources of assistance within a specific area or region.
- Encourage the National Registry of Emergency Medical Technicians (NREMT) to support and ultimately approve more continuing education courses in the management of chemical accidents.

- In-hospital care

- Continue efforts to increase the amount of occupational health teaching in medical and nursing school curriculums relative to work- and industry-related medical programs.
- Encourage professional associations and societies involved in continuing education programs for physicians and nurses to promote more offerings in the chemical accident area.



4.3 ENCOURAGEMENT OF A COMMUNITY NEEDS ASSESSMENT

Communities and municipalities often are not totally aware of the potential for a chemical accident. Neither medical nor paramedical personnel may know the identity of chemical manufacturers, their locations, or their routes of transportation for hazardous substances.

While identifying the sources and the potential for accidents, a community must assess its ability to handle an incident. What resources are available? What is their location? Are special hazardous response capabilities available?

The ability of the medical community to respond to a chemical accident is but one element of a total needs assessment for any community. A more comprehensive plan for assessing total needs is provided in the publication entitled Hazardous Materials Management System--A Guide for Local Emergency Managers (Lee and Roe 1981).

Recommendations regarding community needs assessment are as follows:

- Encourage states and local municipalities to assess, to the extent possible, the types and uses of various chemicals, so that they can identify the potential for incidents.
- Make accurate assessments within these areas or regions to determine the response capability to a chemical incident. This assessment should also ensure that sources of additional information/support are well documented.
- Conduct field drills simulating various types of chemical incidents. Valuable experience can be gained by reviewing the past management of chemical incidents.

4.4 IMPROVEMENT OF INCIDENT FEEDBACK

Systems are in place for reporting hazardous materials incidents in the U.S. Department of Transportation and the U.S. Environmental Protection Agency. However, both systems suffer to some degree from incomplete reporting. Neither system provides feedback concerning the medical management experience with exposure victims. Because accurate feedback is essential to improving resource materials, information dissemination procedures, and training programs, some mechanism needs to be established for reporting the medical management experience with exposure victims.

Such a mechanism need not identify patients, thereby avoiding confidentiality problems. Relevant items would include number of exposed victims, nature of the substances and exposure routes involved, written or verbal resources consulted for medical management, and degree of satisfaction with the sources consulted. The general outcome of the exposure victims, as well as the extent of exposure by first responders, could also be noted. An Agency such as the National Center for Health Statistics should be consulted in developing the details of such a reporting mechanism.



Section 5.0

REFERENCES

Section 5.0

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Appendix

**SAMPLE INFORMATION FROM SELECTED
WRITTEN-MATERIAL RESOURCES**

SAMPLE GUIDE FROM HAZARDOUS MATERIALS
EMERGENCY RESPONSE GUIDEBOOK



POTENTIAL HAZARDS **Guide 11**

FIRE OR EXPLOSION

Will burn. May be ignited by heat, sparks and flames.
May ignite combustibles (wood, paper, oil, etc.).
Container may explode in heat of fire.
Reaction with fuels may be violent.
Runoff to sewer may create fire or explosion hazard.

HEALTH HAZARDS

May be fatal if inhaled, swallowed or absorbed through skin.
Contact may cause burns to skin and eyes.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

EMERGENCY ACTION

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.
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.
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.
Keep combustibles (wood, paper, oil, etc.) away from spilled material.
Do not touch spilled material.
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 or eyes with running water for at least 15 minutes.
Remove and isolate contaminated clothing and shoes.
Keep victim quiet and maintain normal body temperature.



SAMPLE HAZARDOUS CHEMICAL DATA SHEET
FROM CHRIS



AAD

ACETALDEHYDE

Customer Reviews Acute aldehyde Irritant	Waterly liquid Colorless Sharp, fruity odor
Flammable, irritating vapor to produce. Boiling point is 20.2°C.	
Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Shut off ignition sources and call for assistance. Stay upwind and use water spray to "knock down" vapor. Stop discharge if possible. Isolate and contain discharged material. Heavily treat health and pollution control agencies.	
Fire extinguish	FLAMMABLE. Flammable above vapor and very weak. Vapor may explode if ignited by an external flame. Wear goggles and self-contained breathing apparatus. Contain fire from safe distance or personal exposure. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Vapor may be toxic when in fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause asthma, vomiting, 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 Will burn skin and eyes. Irritated 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	HAZARDOUS TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water bodies. Heavily treat health and wildlife officials. Heavily exposure of nearby water streams.
1. RESPONSE TO DISCHARGE (See Response Summary Worksheet, CG 404-6) Irritant warning—high flammability Disperse and flush	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Acetaldehyde Ethanal Ethyl aldehyde 3.2 Coast Guard Classification: Flammable Aldehyde 3.3 Chemical Formula: CH ₃ CHO 3.4 MSDS/Chemical Hazards Worksheet Designation: 3.1/1009	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (see shipping): Liquid 4.2 Odor: Colorless 4.3 Odor: Penetrating, fruity; sharp pungent
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Rubber gloves, eye goggles, and other equipment to prevent any contact with body. Organic catalyst or air pump as required. 5.2 Symptoms Following Exposure: Breathing vapors will be irritating and may cause nausea, vomiting, headache, and unconsciousness. Contact with eyes may cause burns. Skin contact from clothing wet with the chemical causes burns or severe irritation. 5.3 Treatment for Exposure: INHALATION: remove victim to fresh air; if breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen call a physician at once. SKIN: wash with soap and water. EYES: flush with water. 5.4 Toxicity by Inhalation (Threshold Limit Values): 100 ppm 5.5 Short-Term Inhalation Limits: 50 ppm for 60 min 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 Classification: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high concentrations. 5.9 Liquid or Solid Irritant Classification: Minimum hazard. If spilled on clothing and allowed to remain, may cause staining and reddening of the skin. 5.10 Oral Threshold: 0.21 ppm	

6. FIRE HAZARDS 6.1 Flash Point: -38°F C.C.; -50°F O.C. 6.2 Flammable Limits in Air: 4%—44% 6.3 Fire Extinguishing Agents: Dry chemical, alcohol foam, carbon dioxide 6.4 Fire Extinguishing Agents that to be used: Water may be ineffective 6.5 Special Hazards of Combustion Products: Products emitting vapor when heated 6.6 Behavior in Fire: Vapors are heavier than air and may travel a considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 365°F 6.8 Chemical Hazard: Class I, Group C 6.9 Burning Rate: 3.3 mm/min.	7. WASTE POLLUTION 7.1 Aquatic Toxicity: 33 ppm/96 hr/freshwater/TL ₅₀ /fresh water 70 ppm/96 hr/saltwater/TL ₅₀ /salt water 7.2 Waterborne Toxicity: Data not available 7.3 Biological Oxygen Demand (BOD): 93—127%, 5 days 7.4 Pond Oxygen Concentration Potential: None
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 Bases: Not pertinent 7.5 Polymerization: May occur. Avoid heat, dust, strong oxidizing or reducing substances, strong acids and bases 7.6 Inhibitors of Polymerization: None	8. SELECTED MANUFACTURERS 1. Colson Corp. Colson Chemical Co. Division 245 Park Ave. New York, N. Y. 10017 2. Eastman Kodak Co. Eastman Chemical Co. Division Longview, Texas 75601 3. Union Carbide Corp. Chemicals & Plastics Division 270 Park Ave. New York, N. Y. 10017
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Worksheet, CG 404-6) A-B-C-E-L-M-N-Z	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 10°C and 1 atm: Liquid 12.2 Molecular Weight: 44.05 12.3 Boiling Point at 1 atm: cd. 7°F = 20.4°C = 293.6°K 12.4 Freezing Point: -119°F = -123°C = 150°K 12.5 Critical Temperature: 370°F = 188°C = 461°K 12.6 Critical Pressure: 130 atm = 56 atm = 5.7 MN/m ² 12.7 Specific Gravity: 0.789 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid-Vapor Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: 1.5 12.11 Ratio of Specific Heats of Vapor (Gaseous): 1.182 12.12 Latent Heat of Vaporization: 243 Btu/lb = 136 cal/g = 5.69 × 10 ³ J/kg 12.13 Heat of Combustion: -10,600 Btu/lb = -5000 cal/g = -265.4 × 10 ³ J/kg 12.14 Heat of Solidification: Not pertinent 12.15 Heat of Solidification: Not pertinent 12.16 Heat of Polymerization: Not pertinent
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAB Hazard Rating for Bulk Water Transportation: Category Rating Fire 4 Health 3 Vapor Irritant 3 Liquid or Solid Irritant 1 Poison 2 Water Pollution 2 Hazardous Toxicity 2 Aquatic Toxicity 3 Acute Effort 2 Reactivity 2 Other Chemicals 2 Water 0 Self-Reaction 1 12.3 NFPA Hazard Classifications: Category Classification Health Hazard (Blue) 2 Flammability (Red) 4 Reactivity (Yellow) 2	NOTES

REVISED 1978

SAMPLE CHEMICAL/SUBSTANCE CARD
FROM CHEMICAL EMERGENCY ACTION MANUAL

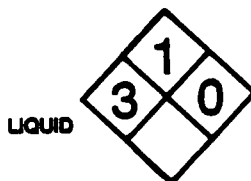


ANHYDROUS AMMONIA

(Ammonia hydrates)



Colorless gas or liquid with extremely pungent odor.



IMMEDIATE HAZARDS

RESCUER'S PROTECTION

Wear self-contained breathing apparatus (including full face mask) and full body suit with boots of rubber, neoprene or plasticized PVC. Also gloves of same material. Do not touch liquid and stay away from ends of tanks.

FIRE

Can catch fire, if high concentrations exposed to open flame. Vapor - Air mixture can explode. Flammable limits in air 16.0 - 25.0 volume %. Emits toxic fumes when exposed to heat. Ammonia gas is lighter than air.

EXPOSURE

Vapor extremely irritating to eyes and respiratory tract. Liquid causes severe burns.

IN CASE OF ACCIDENT

SPILLS OR LEAKS	FIRE	EXPOSURE
Use water spray to absorb ammonia from gas leaks, but DO NOT PUT WATER ON LIQUID AMMONIA OR ON LEAKING TANKS.	Small fire: dry chemical or carbon dioxide. Large fire: water spray or fog.	Evacuate if necessary; Fire: 1,500 feet minimum in all directions. Non-fire: 400 feet minimum in all directions. 600 feet on all sides of area endangered by vapor cloud.

IMPORTANT: See back of this card for medical instructions.

Information, suggestions and recommendations contained herein are based on data available at the time of drafting and is subject to revision as additional data is received. The Association MAKES NO WARRANTY (Expressed or implied) WITH RESPECT TO THE COMPLETENESS OR CONTINUING ACCURACY OF THE INFORMATION CONTAINED HEREIN AND DISCLAIMS ALL LIABILITY FOR RELIANCE THEREON. The obtaining of current data is the responsibility of the user.



AMMONIA, ANHYDROUS

SIGNS/SYMPTOMS

Eye and respiratory tract irritation - may lead to delayed pulmonary edema; skin burn (frostbite) with liquid contact.

SPECIAL INSTRUCTIONS

MEDICAL INSTRUCTIONS

PLANT SITE	TRANSPORTATION	EMERGENCY ROOM
SKIN		
- Wash with water immediately - Remove clothing - Shower thoroughly at least 15 minutes	Cover affected areas with sterile wet dressings	Treat as a burn
EYES		
- Flush eyes with water for 15 minutes - Hold eyelids open while washing	Continue eye irrigation	- Continue eye irrigation (mediflow lens if available) - Notify ophthalmologist if needed
INGESTION • Rare		
- Treat as alkali ingestion - DO NOT induce vomiting	- Treat as alkali ingestion - DO NOT induce vomiting	- Treat as alkali ingestion - DO NOT induce vomiting
INHALATION		
- Remove from contaminated area - Give oxygen	- Continue O2 by 40% venturi mask - Monitor vital signs	- Arterial Blood Gas - Chest x-ray - Observe for delayed pulmonary edema*

*When there is a possibility of delayed pulmonary edema, the exposed person should be kept under observation for 24 hrs. (This warning not left alone but not necessarily implemented.)

SAMPLE GUIDELINE
FROM OCCUPATIONAL HEALTH GUIDELINES
FOR CHEMICAL HAZARDS



Occupational Health Guideline for Acetaldehyde

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_3CHO
- Synonyms: Ethanal; acetic aldehyde
- Appearance and odor: Colorless liquid or gas with a penetrating fruity odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acetaldehyde is 200 parts of acetaldehyde per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 360 milligrams of acetaldehyde per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has recommended for acetaldehyde a Threshold Limit Value of 100 ppm.

HEALTH HAZARD INFORMATION

• Routes of exposure

Acetaldehyde can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It may also affect the body if it is swallowed.

• Effects of overexposure

1. Short-term Exposure: Acetaldehyde vapors may cause irritation of the eyes, nose, and throat. Inhalation of high concentrations of acetaldehyde vapor may cause drowsiness, dizziness, and unconsciousness. The liquid splashed in the eyes may cause irritation and burning. Swallowing acetaldehyde may cause drowsiness, dizziness, unconsciousness, kidney damage, and

severe breathing difficulties which may be delayed in onset.

2. Long-term Exposure: Repeated or prolonged exposure to acetaldehyde may cause an irritation of the eyes and skin. An allergic skin rash may also result from repeated exposure.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to acetaldehyde.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to acetaldehyde at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from acetaldehyde exposure.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of acetaldehyde might cause exacerbation of symptoms due to its irritant properties.

—Liver disease: Although acetaldehyde is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Acetaldehyde ingestion has caused albuminuria in humans. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Skin disease: Acetaldehyde can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

• Summary of toxicology

Acetaldehyde vapor is an irritant of the eyes and mucous membranes and at high concentrations causes narcosis and delayed pulmonary edema. In rats the LC50 for 30 minutes was approximately 20,000 ppm; the animals developed pronounced excitement followed by an anesthesia-like state; the principal autopsy finding was pulmonary edema. Symptoms of narcosis occur in humans at very high exposure levels or by parenteral injection; the irritant effects of the vapor at lower concentrations, such as cough and a burning sensation in the nose, throat, and eyes, usually prevent sufficient exposure to cause narcosis. Human volunteers exposed for 15 minutes to 200 ppm had red eyes due to transient conjunctivitis, while at 50 ppm a majority had mild eye irritation. The liquid splashed in the eyes causes a burning sensation, lacrimation, and blurred vision. The liquid on the skin for a prolonged period causes erythema and burns; repeated contact may result in dermatitis, due either to primary irritation or to sensitization. Ingestion produces central nervous system depression, sometimes with pulmonary edema and albuminuria.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 44.05
2. Boiling point (760 mm Hg): 20.4 C (68.7 F)
3. Specific gravity (water = 1): 0.78
4. Vapor density (air = 1 at boiling point of acetaldehyde): 1.52
5. Melting point: -123.5 C (-190.3 F)
6. Vapor pressure at 20 C (68 F): 750 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): 49.1

• Reactivity

1. Conditions contributing to instability: Prolonged contact with air may cause formation of peroxides that may explode and burst container.

2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with acids, bases, alcohols, ammonia and amines, phenols, ketones, hydrogen cyanide and hydrogen sulfide may cause violent reactions with liberation of much heat and bursting of containers.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving acetaldehyde.

4. Special precautions: Liquid acetaldehyde will attack some forms of plastics, rubbers, and coatings.

• Flammability

1. Flash point: -37.8 C (-36 F) (closed cup)
2. Autoignition temperature: 175 C (347 F)
3. Flammable limits in air, % by volume: Lower: 4; Upper: 60
4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

• Warning properties

1. Odor Threshold: The AIHA *Hygienic Guide* reports an odor threshold of 2.3 ppm, May reports 0.031 ppm, and Stern reports 0.066 ppm.

2. Eye Irritation Level: Grant states that "irritation of the human eye is detectable at a concentration of 50 ppm in air and becomes excessive for chronic industrial exposure above 200 ppm. Higher concentration and extended exposure may injure the corneal epithelium, causing persistent lacrimation, photophobia, and foreign body sensation."

3. Evaluation of Warning Properties: Since the odor threshold for acetaldehyde is such a small fraction of the permissible exposure limit, odor is not considered a good warning of excessive exposures. Because of its irritant effects, however, acetaldehyde is judged to have adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of acetaldehyde. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

An analytical method for acetaldehyde is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for

operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid acetaldehyde.

- Clothing wet with liquid acetaldehyde should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of acetaldehyde from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the acetaldehyde, the person performing the operation should be informed of acetaldehyde's hazardous properties.

- Any clothing which becomes wet with liquid acetaldehyde should be removed immediately and not reworn until the acetaldehyde is removed from the clothing.

- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid acetaldehyde contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to liquid acetaldehyde, an eye-wash facility should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes wet with liquid acetaldehyde should be promptly washed or showered to remove any acetaldehyde.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to acetaldehyde may occur and control methods which may be effective in each case:

Operation

Production of intermediates during synthesis of acetic acid, acetic anhydride, aldol compounds.

Use during manufacture of synthetic resins; synthesis of intermediates in production of pesticides and pharmaceuticals; synthesis of rubber processing chemicals

Use in coating operations in the manufacture of mirrors

Use as hardening agent in photography and in manufacture of gelatin, glue, casein products

Use as preservative in food products and leather

Controls

Process enclosure; local exhaust ventilation; personal protective equipment

Process enclosure; local exhaust ventilation; personal protective equipment

Process enclosure; local exhaust ventilation; personal protective equipment

Process enclosure; local exhaust ventilation; personal protective equipment

Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If liquid acetaldehyde gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If liquid acetaldehyde gets on the skin, flush the contaminated skin with water. If acetaldehyde soaks through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of acetaldehyde, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When acetaldehyde has been swallowed, and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an uncon-

scious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

- If acetaldehyde is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak to disperse gas.
3. If in gaseous form, stop flow of gas.
4. If in the liquid form, for small quantities absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper in a location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Acetaldehyde should not be allowed to enter a confined space such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of acetaldehyde vapors are permitted.

- Waste disposal method:

Liquid acetaldehyde may be disposed of by atomizing in a suitable combustion chamber.

REFERENCES

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SAMPLE CHEMICAL LISTING
FROM POCKET GUIDE TO CHEMICAL HAZARDS



Chemical Name and Formula	Synonyms	Permissible Exposure Limit	IDLH Level	Physical Description	Chemical and Physical Properties	Incompatibilities	Measurement Method and Set (See Table 1)
Acetaldehyde <chem>CH3CHO</chem>	Ethanal; Acetic aldehyde	200 ppm (360 mg/m ³)	10,000 ppm	Colorless liquid or gas with a penetrating, fruity odor	MW: 44 BP: 69 F Sol: Miscible F.P.: -36 F	VP: 750 mm MP: -193 F UEL: 60% LEL: 4%	Strong oxidizers, acids, bases, alcohol, ammonia, amines, phenols, ketones, HCN, hydrogen sulfide
Acetic acid <chem>CH3COOH</chem>	Glacial acetic acid; Methane carboxylic acid; Ethanoic acid; Vinegar acid	10 ppm (25 mg/m ³)	1000 ppm	Colorless liquid or solid with a strong vinegar-like odor	MW: 60 BP: 244 F Sol: Miscible F.P.: 104 F	VP: 11 mm MP: 62 F UEL: 16% LEL: 5.4%	Strong oxidizers, chromic acid, sodium peroxide, nitric acid, strong caustics
Acetic anhydride <chem>(CH3CO)2O</chem>	Ethanoic anhydride; Acetic acid anhydride; Acetyl oxide	5 ppm (20 mg/m ³)	1000 ppm	Colorless liquid with a characteristic sharp odor	MW: 102 BP: 284 F Sol: 12% F.P.: 120 F	VP: 4 mm MP: -99 F UEL: 10.3% LEL: 2.9%	Water, alcohols, strong oxidizers, chromic acid, amines, strong caustics
Acetone <chem>CH3COCH3</chem>	2-Propanone; Dimethyl ketone; Ketone propane	1000 ppm (2400 mg/m ³)	20,000 ppm	Colorless liquid with a fragrant, mint-like odor	MW: 58 BP: 133 F Sol: Miscible F.P.: 1.4 F	VP(77 F): 266 mm MP: -169 F UEL: 12.8% LEL: 2.6%	Oxidizing material, acids
Acetonitrile <chem>CH3CN</chem>	Methylenecyanide	40 ppm (70 mg/m ³)	4000 ppm	Colorless liquid with an ether-like odor	MW: 41 BP: 179 F Sol: Miscible F.P.: 42 F	VP: 73 mm MP: -50 F UEL: 16% LEL: 4.4%	Strong oxidizers

Personal Protection and Sanitation (See Table 2)	Respirator Selection		Health Hazards			
	Upper Limit	Devices Permitted (See Table 3)	Route	Symptoms (See Table 4)	First Aid (See Table 5)	Target Organs
Clothing: Repeat prolonged Goggles: Any poss Wash: Promptly upon wet Change: N.A. Remove: Any wet immed (flammm) Provide: Eyewash	1,000 ppm: CCROVF 5,000 ppm: GMOVc 10,000 ppm: GMOVfb/SAF/SCBAF Escape: GMOV/SCBA		Inh Ing	Eye, nose, throat irrit; conj; cough; CNS depres; eye, skin burns; derm; delayed pulm edem	Eye: Irr immed Skin: Water, flush promptly Breath: Art resp Swallow: Water, vomit	Resp sys, lungs, skin, kidneys
Clothing: >50% AP/10-49% RP Goggles: Any poss Wash: Contam >50% imm/ 10-49% pro Change: N.A. Remove: Contam >50% imm/ 10-49% pro Provide: >5% eyewash >50% drench	500 ppm: CCROVF/GMOV/SAF/SCBAF 1000 ppm: SAF,PD,PP,CF Escape: GMOV/SCBA		Inh	Conj lac; irrit nose, throat; phar edema, chronic bron; burns eyes, skin; skin sens; dent erosion; black skin, hyperkeratosis	Eye: Irr immed Skin: Water flush immed Breath: Art resp Swallow: Water, NO VOMIT	Resp sys, skin, eyes, teeth
Clothing: Reason prob Goggles: Any poss Wash: Immed upon contam Change: N.A. Remove: Immed contam non-imperv Provide: Eyewash, quick drench	250 ppm: CCROVF/GMOV/SAF/SCBAF 1000 ppm: SAF,PD,PP,CF Escape: GMOV/SCBA		Inh Ing Con	Conj lac, corn edema, opac, photophobia, nas phar irrit, cough, dysp bron; skin burns, vesic, derm	Eye: Irr immed Skin: Water flush immed Breath: Art resp Swallow: Water, NO VOMIT	Resp sys, lungs, eyes, skin
Clothing: Repeat prolonged Goggles: Reason prob Wash: Promptly upon wet Change: N.A. Remove: Any wet immed (flammm)	5,000 ppm: GMOVc 20,000 ppm: GMOVfb/SAF/SCBAF Escape: GMOV/SCBA		Inh Ing Con	Irr eyes, nose, throat; head, dizz; derm	Eye: Irr immed Skin: Soap wash immed Breath: Art resp Swallow: Water, vomit	Resp sys, skin
Clothing: Repeat prolonged Goggles: Reason prob Wash: Immed upon contam Change: N.A. Remove: Any wet immed (flammm) Provide: Quick drench	400 ppm: CCROVF/SA/SCBA 1000 ppm: CCROVF 2000 ppm: GMOV/SAF/SCBAF 4000 ppm: SA,PD,PP,CF Escape: GMOV/SCBA		Inh Ing Abs Con	Asphy; nau, vomit; chest pain, weak, stupor, convuls; eye irrit	Eye: Irr immed Skin: Water flush immed Breath: Art resp Swallow: Water, vomit USE AMYL NITRITE PEARLS	Kidneys, liver, CVS, CNS, lungs, skin, eyes

Acetonitrile



SAMPLE DATA
FROM HAZARDOUS CHEMICALS DATA 1975



HAZARDOUS CHEMICALS DATA

NOTE: This publication presents data on certain hazardous chemicals and omission of a chemical does not signify that it is nonhazardous.

ACETALDEHYDE CH_3CHO

DESCRIPTION: Colorless liquid at temperatures below 69° F. but rapidly volatilizes at this temperature; suffocating, fruity odor.



FIRE AND EXPLOSION HAZARDS: Reactive and flammable liquid which rapidly volatilizes at 69° F. Vapor forms explosive mixtures with air over a wide range. Flammable limits, 4% and 60%. Flash point, minus 36° F. Ignition temperature, 365° F. Liquid is lighter than water (specific gravity, 0.8). Vapors are heavier than air (vapor density, 1.5), and may travel a considerable distance to a source of ignition and flash back. Very reactive and can be oxidized or reduced readily. Combines with halogens and amines, and forms a great number of condensation products with alcohols, ketones, acid anhydrides, phenols and similar compounds. Hydrogen cyanide, hydrogen sulfide and anhydrous ammonia react with acetaldehyde readily. Acetaldehyde oxidizes readily in air to unstable peroxides that may explode spontaneously. Easily undergoes polymerization which is accompanied by evolution of heat. All of these reactions can be violent. Vapor oxidizes readily with air and may form highly explosive and unstable peroxides. Acetaldehyde is soluble in water.

LIFE HAZARD: Eye, skin and respiratory irritant. Capable of producing serious eye burns. Prolonged inhalation may have a narcotic effect, resulting in drowsiness.

PERSONAL PROTECTION: Wear self-contained breathing apparatus; wear goggles if eye protection not provided.

FIRE FIGHTING PHASES: In advanced or massive fires, fire fighting should be done from a safe distance or from a protected location. Use dry chemical, "alcohol" foam, or carbon dioxide. Water may be ineffective (see Explanatory), but water should be used to keep fire-exposed containers cool. If a leak or spill has not ignited, use water spray to disperse the vapors. If it is necessary to stop a leak, use water spray to protect men attempting to do so. Water spray may be used to flush spills away from exposures and to dilute spills to nonflammable mixtures.



USUAL SHIPPING CONTAINERS: One-quart glass pressure bottles, 5- to 55-gallon metal drums, insulated tank cars and insulated tank trucks, tank barges.

STORAGE: Protect against physical damage. Store bulk quantities outside in detached tanks provided with refrigeration and inert gas blanket, such as nitrogen, in void space above liquid level. Smaller container storage should be in a detached noncombustible building, provided with cooling facilities, adequate ventilation and free of sources of ignition; no alkaline materials (such as caustics, ammonia, amines), halogens, alcohols, ketones, acid anhydrides, phenols, nor oxidizing materials, permitted in storage room. Inside storage should be in a standard flammable liquids storage room or cabinet. Isolate from other storage.

REMARKS: Electrical installations in Class I hazardous locations, as defined in Article 500 of the National Electrical Code, should be in accordance with Article 501 of the Code. If explosionproof electrical equipment is necessary, it shall be suitable for use in Group C. See Flammable and Combustible Liquids Code (NFPA No. 30), National Electrical Code (NFPA No. 70), Static Electricity (NFPA No. 77), Lightning Protection Code (NFPA No. 78), Fire-Hazard Properties of Flammable Liquids, Gases and Volatile Solids (NFPA No. 325M), and Chemical Safety Data Sheet SD-43 (Manufacturing Chemists' Association, Inc.).

ACETIC ACID (Glacial) CH_3COOH

DESCRIPTION: A clear, colorless liquid with strong pungent odor of vinegar.



FIRE AND EXPLOSION HAZARDS: Gives off flammable vapor above its flash point, 109° F. Vapor forms explosive mixtures with air. Dangerous in contact with chromic acid, sodium peroxide, nitric acid, or other oxidizing materials. Soluble in water.

LIFE HAZARD: May produce severe acid burns to skin and eyes. Prolonged breathing of concentrated vapor may be harmful. Glacial acetic acid contracts upon freezing (specific gravity of liquid at 62.1° F is 1.05 and of the solid at 62° F is 1.27).

PERSONAL PROTECTION: Wear self-contained breathing apparatus; wear goggles if eye protection not provided.

SAMPLE CHEMICAL TABLE
FROM CHEMICAL SUPPLEMENT
TO THE INTERNATIONAL MEDICAL GUIDE
FOR SHIPS



TABLE 100
ARSENIC AND COMPOUNDS

General Information

These chemicals are very toxic, and may cause death. Arsine gas is produced if these chemicals are in contact with acids (Table 605).

SIGNS AND SYMPTOMS*

Skin Contact

There is irritation of the skin with redness. In severe cases blisters may form. These chemicals may be absorbed through the intact skin causing general symptoms of poisoning, similar to those produced by inhalation or ingestion. This is particularly true of arsenic tribromide and arsenic trichloride.

Eye Contact

Severe irritation with pain and redness of the eyes may occur.

Inhalation

There may be a dry mouth, difficulty in breathing and a persistent cough. In more severe cases, there may be a blue discoloration of the skin with shortness of breath. Pulmonary oedema and convulsions can occur.

Ingestion

There may be abdominal pain with vomiting. In more severe cases convulsions can occur. Symptoms similar to those of inhalation may occur.

TREATMENT*

Skin Contact

Emergency Treatment:
see page 24

If general symptoms occur
give dimercaprol as for
ingestion below.

Eye Contact

Emergency Treatment:
see page 25

Inhalation

Emergency Treatment:
see page 26
Pulmonary oedema:
see page 8
Convulsions: see page 12

Ingestion

Emergency Treatment:
see page 30
Convulsions: see page 8
Give dimercaprol 200 mg
intramuscularly every six
hours for the first day,
every eight hours on the
second day, and then twice
a day for three days.

RADIO FOR MEDICAL ADVICE

* Note by the Secretariat:

The appropriate references to the Supplement and the IMGS will be included later.

SAMPLE PAGE FROM EMERGENCY HANDLING
OF HAZARDOUS MATERIALS IN SURFACE TRANSPORTATION



**ACCUMULATOR, PRESSURIZED
NONFLAMMABLE GAS**

4904825
NA1956

Accumulators, pressurized are devices containing a nonflammable gas under pressure.

If material involved in fire

Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty.)

Cool all affected containers with flooding quantities of water

Apply water from as far a distance as possible

Personnel protection

Avoid breathing vapors

Wear protective gloves and goggles

Do not handle broken packages without protective equipment

**ACETAL
FLAMMABLE LIQUID**

4908103
UN1088

Acetal is a clear colorless liquid with a pleasant odor. It has a flash point of -5 deg. F. 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 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

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

**ACETALDEHYDE
FLAMMABLE LIQUID,
POLYMERIZABLE**

4907210
UN1088

ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)

Acetaldehyde is a clear colorless liquid with a pungent choking odor. It is used to make other chemicals. It has a flash point of -36 deg. F. and a boiling point of 69 deg. F. It is flammable over a wide vapor-air concentration range. Its vapors are irritating to the mucous membranes and especially the eyes. It is easily oxidized by air to form unstable peroxides which may explode. If it becomes contaminated, it may either react with the contaminant or polymerize, both with the evolution of heat. It is lighter than water and soluble in water. Its vapors are heavier than air.

It weighs 6.5 pounds per gallon.

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

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), 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

Neutralize with sodium bisulfate (nahs04)

Environmental considerations—water spill

Add sodium bisulfate

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

**ACETALDEHYDE AMMONIA
ORM-A**

4941103
UN1841

ENVIRONMENTALLY HAZARDOUS SUBSTANCE (RQ-1000/454)

Acetaldehyde ammonia is a white crystalline solid. It is used to make other chemicals, vulcanize rubber, and for other uses. It is soluble in water. It will burn though it may take some effort to ignite. It can cause illness by inhalation, skin absorption and/or ingestion.

If material involved in fire

Extinguish fire using agent suitable for type of surrounding fire (Material itself does not burn or burns with difficulty.)

If material not involved in fire

Keep material out of water sources and sewers

Build dikes to contain flow as necessary

Personnel protection

Keep upwind

Wear boots, protective gloves, and goggles

Avoid breathing vapors or dusts

Wash away any material which may have contacted the body with copious amounts of water or soap and water

Environmental considerations—land spill

Dig a pit, pond, lagoon, holding area to contain liquid or solid material

Cover solids with a plastic sheet to prevent dissolving in rain or fire fighting water

Environmental considerations—water spill

Neutralize with dilute acid or removable strong acid

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

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EMERGENCY MEDICAL TREATMENT NEEDS:
CHRONIC AND ACUTE EXPOSURE
TO HAZARDOUS MATERIALS

June 1982
Unclassified
109 pages

GEOMET Technologies, Inc.
Rockville, Maryland 20850

Work Unit No. 2412D
Contract No. EMW-C-0750

This report identifies gaps in the ability of the medical community to recognize and treat problems resulting from exposure to hazardous materials. A summary of available guidance for medical management following chemical exposures is presented. The guidance focuses on prehospital and in-hospital care. The feasibility or utility is assessed for subclassifying chemicals by toxic effects or by chemical properties. The assessment relates to medical management.

One study recommendation is for establishment of a resource and referral center to assimilate/review chemical toxicity data and medical management protocols. The protocols, oriented toward recognizing signs and symptoms, should generally be chemical-specific. Other recommendations concern improved training programs, community needs assessments, and incident feedback.

EMERGENCY MEDICAL TREATMENT NEEDS:
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GEOMET Technologies, Inc.
Rockville, Maryland 20850

Work Unit No. 2412D
Contract No. EMW-C-0750

This report identifies gaps in the ability of the medical community to recognize and treat problems resulting from exposure to hazardous materials. A summary of available guidance for medical management following chemical exposures is presented. The guidance focuses on prehospital and in-hospital care. The feasibility or utility is assessed for subclassifying chemicals by toxic effects or by chemical properties. The assessment relates to medical management.

One study recommendation is for establishment of a resource and referral center to assimilate/review chemical toxicity data and medical management protocols. The protocols, oriented toward recognizing signs and symptoms, should generally be chemical-specific. Other recommendations concern improved training programs, community needs assessments, and incident feedback.

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