BASIC FIELD SAFETY

Unit 1 - Worker's Rights and Responsibilities

Unit 2 - Preparation for Field Activities

Unit 3 - Emergency First Aid for Field Activities

Unit 4 - Heat and Cold Stress

Unit 5 - Chemical Hazard Recognition

Unit 6 - Toxicology

Unit 7 - Health Hazards of Chemicals

Unit 8 - Evaluating Health Hazards and Toxicity Information

Unit 9 - Inspection and Sampling in Industrial Plants

Unit 10 - Hazards of Air Sampling

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UNIT 1

WORKER RIGHTS AND RESPONSIBILITIES

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Educational Objectives

o Determine the legal basis for job related and safety protection for Federal employees.

o Understand the responsibilities of the Agency to its employees.

o Identify the employees' responsibilities under the regulations.

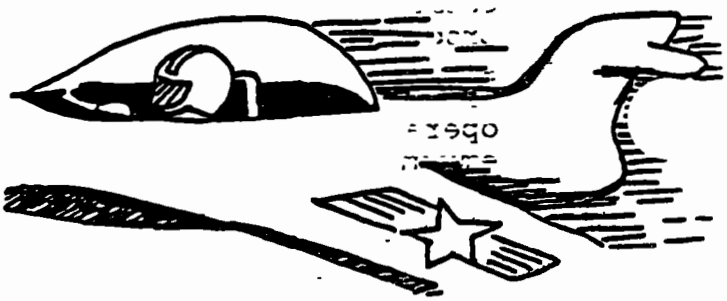
o Establish the rights of the employees under current regulations.

NOTES

Federal Safety and Health Legislation

The Federal Government employs approximately 2.8 million workers. Job descriptions run from clerical to test pilot. In FY 1981, almost 200,000 civilian employees were injured and approximately 300 were killed in job-related injury or accidents. Compensation and medical payment costs arising from injury and illness for Federal employees that year totalled $820 million dollars.

The Occupational Safety and Health Act was written to assure, so far as possible, for every working man and woman in the nation, safe and healthful working conditions. Specifically, Section 19 of the Act charges the head of each Federal Agency with the responsibility to "establish and maintain an effective and comprehensive occupational safety and health program which is consistent with the standards" set by OSHA for private sector employees.



Federal employee safety and health were further emphasized by Presidential Executive Order 12196 which defines the responsibilities of the agencies, and the role of the Secretary of Labor in developing, implementing, and evaluating such programs.

EPA Occupational Health and Safety Program

EPA has adopted an occupational health and safety program which includes compliance with the Executive Order, with OSHA Standards and with safety standards of other Federal agencies. The EPA program has specific requirements for safety and health training, respiratory protection and medical monitoring. The EPA program also spells out employee rights and responsibilities in detail.

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In addition to the general safety and health policy, EPA has adopted specific health and safety requirements for employees engaged in field activities. EPA Order 1440.2, adopted July 12, 1981, establishes policy, responsibilities, and mandatory requirements for occupational health and safety training and certification. The order also establishes guidelines for occupational medical monitoring of Agency employees engaged in field activities.

Field activities, ranging from the routine to the extremely hazardous, are a critical part of most EPA programs. Since protection cannot be engineered into field working situations, the protection of field personnel involves establishing safe operating procedures, proper use of appropriate personal protective clothing and equipment, and training employees in use of safe operating procedures and protective equipment.

Rights and Responsibilities

The EPA program defines the occupational health and safety rights that all EPA employees have. The program also specifies the general safety and health responsibilities of all employees and the specific responsibilities of supervisory personnel, including the Agency administrator.

Employee Rights

EPA employees are entitled to work under safe and healthful conditions, free of recognized hazards. EPA employees are not expected to take unusual risks or to expose themselves to serious hazards. If an EPA employee encounters serious hazards in carrying out assigned field activities, the activities should be carried out only with appropriate safety procedures and safety equipment.

NOTES

If it is necessary to postpone a scheduled activity until it can be done safely and without adverse health effects, the activity should be postponed. If a field employee decides it is necessary to postpone a scheduled activity for safety and health reasons, it will be important to inform the supervisor or team leader of the details which were the basis for the decision.

EPA employees are also entitled to have basic safety and health training for field activities, and training which is specific for the hazards to be encountered in assigned activities.

EPA employees are entitled to personal protective clothing and equipment, to training in selection and use of respiratory protective equipment, and to supervision and assistance in activities requiring protective equipment.

All employees are entitled to participate in the occupational medical monitoring program if they are routinely engaged in field activities which present the probability of exposure to hazardous or toxic substances, arduous or physically taxing activities, or work requiring the use of respiratory protective equipment.

EPA employees are entitled to report hazardous working conditions, without any adverse consequences, and they have the right to make the reports anonymously if they wish. Employees have a right to expect that hazardous conditions reported will be inspected promptly.

Employee Responsibilities

Employees are responsible for complying with the Agency's health and safety standards, rules, regulations, and orders which are applicable to their own actions and conduct.

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Employees are responsible for reporting accidents, injuries, and property damage of $100.00 or more.

EPA employees also have a responsibility to report unsafe and unhealthful working conditions so that they can be corrected, or so that safe operating procedures can be established for employee protection.

Employees who engage in field activities are responsible for having a baseline medical examination to confirm their physical fitness for the stress of the activities, and to provide a base to measure any adverse effects that activities may have.

Employees are responsible for giving their supervisor information when requested on the extent of their individual health and safety training, and the history of their participation in occupational medical monitoring.

Employees are responsible for notifying their supervisor of any hazardous work situations, making suggestions for corrective measures, and applying the knowledge, skills, and techniques acquired through training in a manner that will help assure their own health and safety and that of fellow workers.

Employees are responsible for using the safety equipment, personal protective equipment, and other health and safety devices provided.

Employees are responsible for following the safe operating procedures established, or other safety directions that the Agency deems necessary for their protection.

When an employee reports for work, the employee should be ready, willing, and able to perform assigned duties. For example, an employee who reported to

work without safety equipment would not be ready to perform assigned duties and could be placed on leave. In addition, the conduct and physical or mental condition of an employee must not create a situation in which the presence of the employee will constitute an immediate threat to the general public, fellow employees, or Government property.

All employees are expected to observe all rules, signs, and instructions relating to personal safety. Willful non-observance of certain safety regulations constitute grounds for disciplinary actions.

Some of the more serious safety violations include:

failure to report an accident involving injury to persons or damage to property or equipment

failure to use protective clothing or equipment when it is prescribed

endangering the safety of or causing injury to personnel or damaging property or equipment through negligence

negligent or careless work performance resulting in loss or danger of loss of life.

penalties prescribed for non-compliance can range from a written reprimand or suspension to more severe penalties if offenses are repeated.

Supervisors' Responsibilities

Supervisors are responsible for the health and safety of their employees, and for furnishing them a place of employment which is free from recognized hazards that are likely to cause death or serious harm.

Supervisors are responsible for complying with the Agency's occupational

health and safety standards, and complying with all rules, regulations, and orders issued by the Agency with respect to the occupational health and safety programs.

Supervisors are also responsible for enforcing correct work practices.

Supervisors are responsible for compliance with the Agency Order for employee training and certification, and occupational medical monitoring programs. To do so they must:

identify employees who require training and certification and occupational medical monitoring

assure that they receive it to comply with provisions of the Order

insure that these requirements are properly contained in position descriptions at job posting.

Administrator's Responsibilities

The Executive Order requires the EPA Administrator to establish and operate an occupational health and safety program in accordance with the Occupational Safety and Health Act of 1970, and with the basic program elements issued by the Secretary of Labor in 29 CFR 1960.

The EPA Administrator has designated, in the Agency, an Occupational Health and Safety Office to manage and administer the Agency's occupational health and safety programs.

EPA Occupational Health and Safety Program

One goal of the program is to assure prompt abatement of unsafe or unhealthful working conditions, or to develop abatement plans and interim steps to protect employees when

conditions cannot be promptly corrected.

Procedures have been established to assure that employees who file reports of unsafe or unhealthful working conditions or who participate in other occupational health and safety program activities, are not subject to restraint, interference, coercion, discrimination or reprisal. These procedures also are designed to assure the right to anonymity of those making the reports.

As part of the program, efforts have been made to assure response to employee reports of hazardous conditions and require inspections within relatively short time limits: 24 hours for imminent dangers, three working days for potentially serious conditions, and 20 working days for other conditions.

("Imminent danger" means any condition or practice within EPA organizations or workplaces or at a field site that could reasonably be expected to cause death or serious physical harm either immediately or before the danger could be eliminated through normal administrative procedures.)

The EPA Office of Occupational Health and Safety has an occupational health and safety management information system to provide sufficient data to identify unsafe and unhealthful working conditions, and to establish program priorities.

The Office of Occupational Health and Safety has been working to provide occupational health and safety training for management officials and all employees involved in field activities, including supervisors, occupational collateral duty health and safety personnel, occupation health and safety committee members, and employee

representatives.

Training and Certification Program

The objectives for training and certification are to assure that EPA employees are aware of the potential hazards they may encounter during the performance of field activities, and to provide knowledge and skills necessary to perform the work with the least possible risk to personal health and safety. Other objectives are to assure that Agency program goals are accomplished in as safe and healthful a manner as feasible, and to assure that EPA employees can safely disengage themselves from an actual hazardous situation which may occur during field activities.

Employees should not be allowed to engage in routine field activities until they have been trained and certified to a level commensurate with the degree of anticipated hazards.

The training order describes the requirements for three levels of health and safety training, the methods for certification, and annual refresher training.

Basic Level of Health and Safety Training

All employees are to be provided a minimum of 24 hours of health and safety training prior to becoming involved in normal, routine field activities. The training is to include, but not be limited to, classroom instruction.

Each person who will engage in field activities should, as part of the

basic level of training, also accompany an employee experienced in field activities and perform actual field tasks for a minimum of th~~irty six~~ hours within a period of three months after classroom instruction. twenty-four

Intermediate Level

Additional training is required for field employees who are expected to be required or allowed to participate in certain types of field activities. The intermediate level of training is required for all inexperienced employees who are to work in uncontrolled Hazardous Waste and Hazardous Spill Investigations. This level of training may later be required for employees engaged in other activities which are determined to present unique hazards requiring additional training.

The intermediate level is to include a minimum of eight hours of specified additional health and safety training, as well as supervised field experience. Each person who will engage in hazardous waste site or spill investigations should as part of the intermediate level of training, also accompany an experienced employee and perform actual field tasks for a minimum of three days within a period of three months after classroom instruction.

Advanced Level

An advanced level of training is required for all employees who manage monitoring, sampling, investigations, and cleanup operations at uncontrolled hazardous waste sites and spill sites. The training is to include eight hours of additional health and safety training and on-the-job training on topics such as management of restricted and safe zones, rules of handling the press and VIP's, and safe use of specialized

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Certification

Certification is based on employees satisfactorily completing these requirements and a multiple-choice examination based on the instructional material.

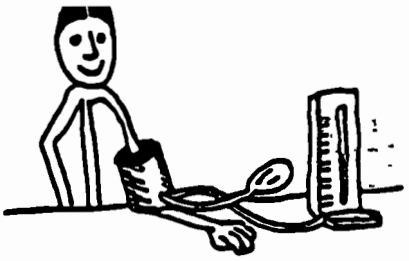
Certification may be based on evaluation of their previous training, education, and experience. Recommendations for this type of certification should be made by the Safety Designee at the Reporting Unit to the Director of the EPA Office of Occupational Health and Safety.

Certification of safety and health training will be issued by the Occupational Health and Safety Designee at the Reporting Unit in which an employee works.

Employees can be certified at the next higher level by completing only additional training required, if certification at the next lower level has been received within the previous one-year period.

Refresher Training

Employees at the Basic, Intermediate, and Advanced levels are required to complete a minimum of eight hours of refresher classroom instruction annually to maintain their certification. In addition to the classroom instruction, employees shall have demonstrated by having performed actual field tasks that they have sufficient practical experience to perform duties in a safe and healthful manner.



Physical Examination and Medical Monitoring Programs

There are two types of physical examinations that are part of the EPA occupational health and safety program.

One is required for everyone who will be expected or allowed to use a respirator. The other is recommended for everyone who may be exposed to toxic chemicals as part of one's field activities. Both types of examination can be included in a single comprehensive physical.

Use of respirators and protective clothing put additional stress on the body, and some people may not be able to handle this stress safely.

A health surveillance program can be very important to an EPA employee. A pre-placement medical exam may reveal an existing medical condition that may place you at a higher risk when working around certain hazardous substances. Specific tests given at different times may indicate exposure to hazardous substances and may help prevent further exposure problems or aid in treatment.

The objectives for occupational medical monitoring are to detect any adverse effects of occupational exposure on the employee's health, to initiate prompt corrective actions when indicated, to assure that employees assigned to arduous or physically-taxing jobs or jobs requiring unique skills, are able to perform those jobs without impairing their health and safety or the health and safety of others.

UNIT 2

PREPARATION FOR FIELD ACTIVITIES

Educational Objective

o The student should be able to define criteria for team member selection.

o The student should be able to complete a pre-site visit planning form.

o The student should be able to recognize potential hazard areas found on site.

o The student should be able to marshall on-site resources to assist Agency personnel.

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Operating in a known environment such as an office or factory, repeatedly on a regular basis, quickly familiarizes the individual with the hazards that can be expected. Field activities, on the other hand, present a wide variety of unknowns that must be anticipated and prepared for. EPA field crews can go a long way in preventing accidents and hazards by training themselves to devote pre-activity time to careful and thorough investigation of the up and coming activity. It is no product of luck that careful pre-planning and reduced accidents go hand-in-hand.

Planning for Field Activities

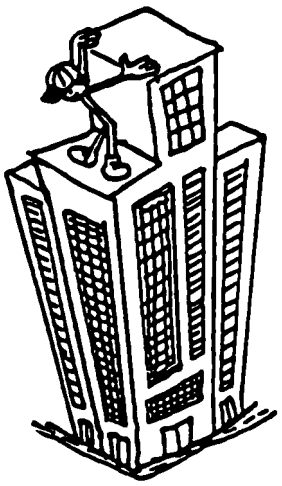
Planning for field activities should be done as a team effort. By drawing on the experience and training of the team members, a more comprehensive plan can be drawn up than can be done by a single individual.

Team Member Selection

Selecting the proper team members is an important first step. The first criterion for selection should be that members that have visited the site or similar sites before. Experienced individuals will be able to provide a wealth of valuable information rather than the guesswork that would guide a team that lacks actual experience.

The second criterion for selection is physical conditioning. Inquire whether potential team members have had experience in the expected site conditions in the past and if they have been recently acclimated to the expected work load or anticipated adverse weather conditions. Be wary of selecting someone who would "just like to get out of the office for awhile," if they are going to face heavy workloads or severe temperature extremes. Make sure all team members are physically fit. Get a

record of their past physical examination and interview them to discuss any limitations they may have. In many cases the fear of heights, or the fear of small, tight places or protective equipment may not show up on physical exams, and it could severely limit the effectiveness of crews during regular work routines as well as emergencies. Such conditions may also increase the likelihood of accidents.



Select an appropriate number of team members to accomplish the job safely. During heavy workloads or extreme weather conditions, anticipate that work will take longer and crew members will have to be relieved on a regular basis for rest and recuperation. When hazards are anticipated, never assign a crew member to work alone, even for a short period of time unless the worker has been provided with two-way communication.

Team Assessment of Potential Hazards

All discussion of up and coming activities should be done with all team members present. Arrange for an open forum type of discussion. Avoid telling crew members what they must do. The collective contributions of a carefully selected team are better than those of the most experienced individual.

Appoint one member to be responsible for summarizing in writing, the suggestions of crew members. The saying "What is the responsibility of all is the responsibility of none" provides little consolation to crew members who need something that has been forgotten.

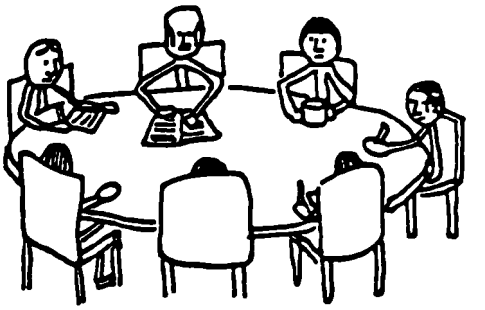
Organize the discussion along a prearranged format. This helps eliminate forgetting a crucial subject.

NOTES

If information is needed that cannot be provided by the crew members during the discussion, assign a member to get that information and relay it to the member responsible for writing the summary.

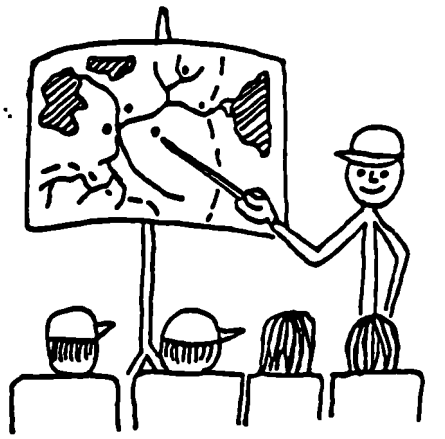
Discussion Format - Past Experience

Ask crew members to discuss their past experiences at the site or similar sites. If no selected crew members has had similar past experiences, ask other Agency personnel to sit in briefly to discuss their experiences. By setting the stage, crew members can make intelligent suggestions based on known facts.



Ask each crew member to briefly outline the field experiences they have had, as well as the training they have received. Such a discussion builds confidence in team members, reveals weaknesses in past experience and training, and points out inexperienced crew members who may need special assistance or training.

Site Evaluation



Secure a map, or photographs, of the site to be visited. Each member should become thoroughly familiar with the site, its relative location in regard to roads, shelters and emergency help centers such as treatment centers and hospitals. Crew members should not only know how to reach and leave the site, but also how to communicate that information to emergency squads.

Evaluation of existing or potential two-way communication is essential. In most cases, site communication is by telephone. Find exactly where the telephone is located at the site and verify it is working. Secure the telephone numbers of emergency help in the area. Assign a crew member to call

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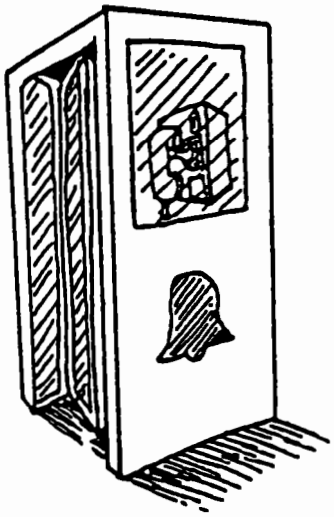


and verify the accuracy of the numbers. On sites where extreme hazards are anticipated, calls should be made to the local emergency centers, informing them of the exact time and date the crews will be operating at the site. This is particularly crucial at remote sites or at sites near small towns where volunteers operate the emergency equipment. Never assume a town has emergency equipment available. Over 50% of the towns in this country have no immediate emergency help available; call and verify.

On sites where telephone communication is not available, anticipate the use of two-way radios. Determine if there is a possibility that there may be interference with two-way signals from sources of interference such as transmission lines, hills or tall structures. When arriving on site, a check should be made with emergency help. If the radios depend on batteries, extra sets of fresh batteries should be brought.

Examine the site for natural physical hazards such as deep ponds, streams, marshes, cliffs, lack of ingress and egress, high winds, poor visibility, tidal changes, high seas or rough water, wave action, poor footing, prevailing winds and abrupt wind direction changes, abrupt changes in weather patterns, heavy snows, flash flooding, avalanches, mud slides, and ice storms.

Where adverse weather conditions are a possibility, it may be necessary to carry out some preliminary investigations about when past conditions at the anticipated time Agency personnel will be working at the site. Local residents, radio stations, and newspapers can often provide the needed information. If the site is to be visited within three days to a week, a long range weather forecast can be

gotten from the local TV, radio station, Coast Guard or the National Weather Bureau. Assign a crew member to complete this task and report this information to the team members.

Careful assimilation of both a physical and mental picture of the site is invaluable in proper preparation. Only by knowing all the facts can a comprehensive plan be put together with a minimum of omissions.

Assessing the Hazards

Once a crew is familiar with the physical layout of the site, a unit-by-unit assessment of the potential hazards should be undertaken. Hazards can be categorized into the following units:

Transportation
Atmospheric
Chemical
Fire and Explosion
Physical and Mechanical
Radiation
Biological
Weather Related
Drowning

Each of these units is covered in detail in a separate section of the Basic Field Activities Safety Training Course. Careful analysis of these sections will provide the team with information needed for the planning necessary to meet the hazards associated with each site. Figure 1 is an example of the information that should be compiled and recorded during the planning period. A copy of this summary along with pertinent medical records or information should be kept in a file and taken along for reference in the event of an emergency where the information might be needed. A second copy should be filed with a supervisor before leaving for the site. Such information is particularly important for visits to

sites where crews may be stranded or lost.

FIGURE 2-1

SAMPLE PLANNING GUIDELINE FOR FIELD ACTIVITIES

Project Title: _____

Location: _____

_____

_____

_____

EPA files exist and have been reviewed? _____ **Yes** _____ **No**

Names and Telephone Numbers for Contacting You:

Name	Position	Tel. Number

Crew Members:

Name	Med. Mont.	Training Received Field	Respiratory	Medical or Phy. Restrictions

Length of Proposed Activity: _____

Crew Lodging Arrangements: Motel/Hotel _____

Location: _____ **Telephone #** _____

Anticipated Hazards:

Driving distance _____ **Hauling test equipment** _____

Hauling chemicals _____ **Hauling supplies** _____

Noise _____ **Thermal hazards** _____

Flammable Hazards_____ Moving hazards_____

Weather:_____heat_____cold_____wind_____rain_____thunderstorms

Toxic Substances (List) MSDS

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Heights:_____

Vehicle(s) and Equipment

Motor vehicles:_____ sedan_____ van_____pickup

Mobile laboratory_____ Other (list)_____ _____

Vehicle safety check made:_____yes _____no

Vehicle appears okay_____ or needs (list)_____

_____

Watercraft

Boat will be used_____yes _____no

Boat safety check made_____yes _____no

Site access:

Identification_____

Permits_____

Visitors Agreement_____

Special problems_____

_____

Type of Communication needed_____

_____

_____

Figure 1 Cont'd.

Emergency and Rescue

Is first aid available in the area? _____Yes _____No Location:

_____Telephone No._____

Is ambulance available?_____on site_____on call Tel. #_____

Nearest hospital with emergency services. Location_____

_____Telephone No._____

Nearest poison control center. Location_____

_____Telephone No._____

Fire Department Telephone No._____

Portable extinguishers available. Location_____

Type_____

Heavy and special rescue services available___yes___no.

What_____

Emergency Signals and Communication

Fire Signal is_____

Evacuation signal is_____

Severe weather signal is_____

Toxic release signal is_____

Personal Protective Equipment/Clothing (Check if needed)

1. Eyes and Head

   Safety glasses_____Type_____

   Face shield_____Goggles_____

   Hard Hat_____Type_____

   Hearing protection_____Type_____

   Other_____

Figure 1 Cont'd.

x

2. Body, Hands, Feet

Coveralls _____ Type _____

Foul Weather gear _____

Full encapsulated gear _____

Safety footwear _____ Type _____

Boot/shoe covers _____

Gloves _____ Type _____

Other special equipment/clothing _____

_____

_____

3. Respiratory Protection

Respirator _____ Type _____

SCBA _____ Type _____

Emergency Escape Mask _____ Type _____

4. Special Health and Safety Equipment

Life belt _____

Safety line _____

Other (list) _____

_____

5. Miscellaneous

Extra clothing _____

Socks _____ Shoes _____ Boots _____

Coveralls _____ Outer clothing _____

Undergarments _____ Other (list) _____

_____

Water _____

Drinking _____

Figure 1 Cont'd.

Flushing_____

Other (list)_____

6. Miscellaneous Rope_____String_____Tape____

Matches_____Food_____Other_____

On-Site Evaluation

No matter how thorough and complete the pre-site briefing is, there will always be hazards not anticipated or covered. Before launching into a work routine, take time to aquaint the entire crew with the on-site hazards.

First tour the site. Look for hidden hazards such as broken railings or ladders, dangerous or unprotected machinery, low or heated pipes, discharges or outlets carrying dangerous materials, new construction, open trenches or unsafe scaffolding or any other hazards not discussed at the briefing.

Second, if there is a safety department or knowledgeable company employee, ask for a briefing of any known hazards that exist at the site. Request information as to evacuation routes and warning signals, medical staffing or other on-site emergency help, and the location and type of protective gear that is at the disposal of Agency personnel. Take a few moments to walk the crew through the emergency evacuation route. Physically locate and aquaint crew members with the on-site, available safety gear. Remember, no matter how much experience your crew members have had, they cannot possibly know and prepare for the on-site hazards as well as the people who work at the site every day.

Ask the company employee to alert the safety department, medical or emergency staff, and all those in the vicinity of where Agency personnel will be working of the exact time and location of EPA personnel. This is particularly important in confined space entry. Find out if company rules require special safety gear such as steel-toed shoes or respirators. Do not ignore company safety policy. It was undoubtedly imposed for good reason.

NOTES

Assign a crew member to keep a log of any unexpected hazards encountered during the work at the site and how these hazards were handled. Such records will go a long way in helping the next crew prepare for similar hazards and emergencies. List any extra gear that is recommended to take along that was not taken on this site visit.

When contemplating entry into a confined space or atmosphere, such as a manhole, in addition to crew monitoring, request information from company employees as to past hazards or events such as production discharges that might quickly and significantly change the degree of hazards associated with the confined space. Agency employees may not have enough time for evacuation of a toxic discharge catches them unaware in a confined area.

Whenever possible, always send Agency personnel in pairs. The "buddy system" has repeatedly been shown to save lives. When entering into a suspected hazardous environment, one team member should always remain behind with constant visual or voice communication with the second. Buddy teams must be taught to recognize danger and respond to it effectively using methods of rescue that have been taught rather than headlong rush into hazardous areas to save a fallen team member.

Where only one Agency person has been assigned to a site, have that employee request to be accompanied by an on-site company employee knowledgeable with the area to be inspected or sampled.

Remember, the buddy system is a safety precaution only. It is not a protective procedure. Never enter highly hazardous areas without thorough monitoring and protective gear. At its best, the buddy system speeds up rescue.

At its worst, it prevents the loss or injury of one instead of two people. Neither is acceptable if the accident could have been prevented at the start.

It is estimated that fire and rescue teams prepare and train for emergencies 40 hours for every hour they actually are involved in an emergency. There is no substitute for effective pre-planning. Never go out on even on a small detailed activity without devoting a block of time anticipating and planning for hazards and emergencies. The National Safety Council reports that most accidents occur around the home or within three miles of the home, a time when few people anticipate an accident and fewer prepare for it.

UNIT 3 EMERGENCY FIRST AID FOR FIELD ACTIVITIES

Educational Objectives

o The student should be able to list medical emergencies that are life-threatening and require immediate first aid.

o The student should be able to list the minimum first aid training a field crew should have.

o The student should be able to demonstrate the correct first aids techniques of cardiopulmonary resuscitation (CPR).

o The student should be able to define the first aid steps for stopped breathing.

o The student should be able to define the first aid steps for stopped circulation.

o The student should be able to define the first aid steps for excessive bleeding.

o The student should be able to define the first aid steps for traumatic injuries to head, neck or back.

o The student should be able to define the first aid steps for shock resulting from injuries.

o The student should be able to define the first aid steps for overexposure to heat or cold.

o The student should be able to define the first aid steps for thermal burns that are deep or extensive.

o The student should be able to define the first aid steps for inhalation of toxic gas.

o The student should be able to define the first aid steps for chemical contact that is concentrated or extensive.

NOTES

Introduction

Every person who engages in field activities should be able to recognize injuries and exposures which require immediate emergency action. Most injuries and illnesses are not life-threatening, but it is important to recognize those that are and be prepared to take emergency action to prevent serious consequences or death.

In many field activities, EPA personnel can receive injuries or chemical exposures which could cause serious illness or death unless immediate action is taken to control the emergency. If EPA personnel are remote from immediate medical emergency treatment, they will have to depend on the training and preparation of other members of their team.

Every EPA field team should have one or more members with recent training in first aid, chemical splash treatment, and cardiopulmonary resuscitation.

Every EPA employee engaged in field activities should carry a wallet card with important medical information such as blood type. allergies, medication being taken, and any physical condition which may cause a problem in regular activities or emergency situations. The crew leader should know about any medical conditions which may become a problem during field activities.

This unit will describe medical emergencies that may occur in field activities, describe the general course of action for any type of medical emergency, and review the procedures for treating such emergencies.

This unit does not take the place of a first aid course or hands-on training in first aid, chemical splash procedures or CPR. This unit does however, emphasize a different range of

emergencies than a basic Red Cross first aid course.

Serious and Life-Threatening Medical Emergencies

Medical emergencies may occur during field activities as a result of accidents, work stress, individual medical conditions, or exposure to toxic or corrosive chemicals. Nine different conditions are so serious that they are considered life-threatening. Three conditions in particular require immediate action because death will result in minutes if no effort is made to help the victim.

The three medical emergency conditions that require immediate action to prevent death are listed in the order of their seriousness:

1. Bleeding severely
2. Breathing stopped
3. Circulation stopped

Bleeding severely from traumatic injuries can lead to an irreversible state of shock in which death is inevitable.

Breathing can be stopped because of

- An obstructed airway
- Allergic reactions to insect stings
- Drowning
- An electrical shock
- Exposure to an oxygen-deficient atmosphere
- Exposure to a toxic gas with immediate paralytic effects

Circulation can be stopped because of

- Heart attack
- Electrical shock
- Paralysis from chemical exposure

NOTES

If a victim is unconscious, it is important to determine if he has stopped breathing, if the victim's heart has stopped beating and circulating blood throughout the body, or if the person is suffering from some other life-threatening emergency. Always check for an open airway, breathing and circulation.

Other medical emergencies which are extremely serious, or which can become life-threatening, include:

4. Traumatic injuries to the head, neck or back
5. Shock resulting from injuries
6. Overexposure to heat or cold
7. Thermal burns that are deep or extensive
8. Inhalation of toxic gas
9. Chemical contact that is concentrated or extensive

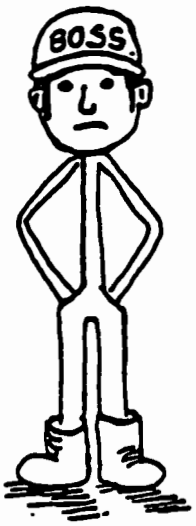
General Emergency Procedures

When a person is seriously injured or exposed to large amounts of hazardous chemicals, there are three activities that must be carried out quickly. These activities can be carried out by one person, but if several people are available it is much more effective if all three activities can be carried out at the same time:

1. Take charge of the situation

2. Give first aid

3. Summon assistance or prepare to transport the injured person



Taking Charge of the Emergency

Someone must take charge of the situation (with full recognition of his or her own limitations). The person who takes charge must direct others quickly and clearly on exactly what they should do.

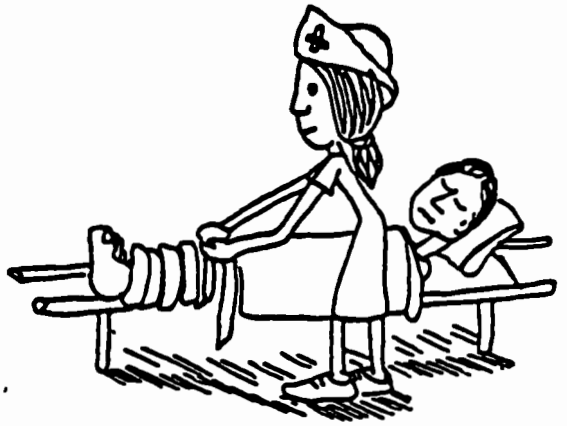
NOTES

The person who takes charge needs to stay calm and try to instill confidence in the injured person and others that the emergency can be controlled.

Some injuries or illnesses that have alarming symptoms are not dangerous to the victim. (Examples include: fainting, convulsions, epileptic seizures.)

The crew leader should be sure that the team has the first aid supplies necessary for the season and the activity. The crew leader should also see that the team has a first aid manual and directions for obtaining emergency medical assistance.

Giving First Aid



Someone must administer first aid to reduce the severity of any life-threatening medical emergency. This person should have recent first aid training and practice. If there is no one available with recent training, a crew member can carry out the most important steps guided by a first aid manual. Be sure that a good manual is available in a readily accessible location.

First aid is generally defined as the immediate and temporary care given the victim of an injury or sudden illness until medical assistance can be obtained. In this unit we use the term "first aid" to include any immediate and temporary care, including chemical splash treatment and cardiopulmonary resuscitation. The objectives of first aid are to:

- care for life-threatening conditions;
- minimize further injury and complications, such as infection; and

obtain medical assistance

Arranging for Transportation

Someone must arrange for medical assistance for further treatment of serious medical emergencies. Medical assistance can be obtained in some areas from paramedic teams from local hospitals or fire departments. In other areas, medical assistance can be obtained most readily by taking the injured person directly to a medical treatment facility such as a hospital.

Find out in advance how to call for medical assistance, and how to reach the emergency medical facility. Have a map and directions readily available, and make a practice run if your field activities are particularly hazardous.

If it is necessary to transport an injured person to a medical facility, it should be done so that it does not complicate the injury or subject the victim to unnecessary discomfort.

If it is necessary to transport an injured or ill person without the assistance of an ambulance team or specially-trained personnel, there are some important considerations before starting to move the person. If the medical emergency is one in which movement can cause further injury, be sure that the move is planned and carried out so that it does not do the injured person more harm than waiting for help to arrive.

If the medical emergency is one that requires uninterrupted treatment, such as cooling thermal or chemical burns, plan the movement so that the emergency treatment can be continued. If the medical emergency is the result of a chemical splash, be sure that preliminary washing has been thorough enough to minimize the injury and to prevent serious contamination of others.

Medical Emergency Supplies

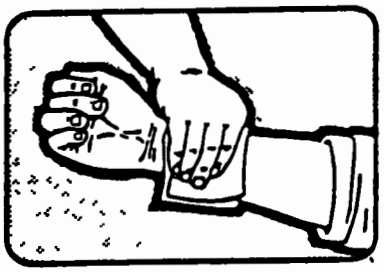
Every vehicle should be equipped with a first aid kit with supplies for emergencies which field personnel are likely to encounter. In cold or wet environments, the team should have blankets and supplies needed for treating cold stress, and in hot environments the team should have the water or replacement fluids needed for survival and for prevention and treatment of heat stress. If the team can be exposed to contact with hazardous chemicals, their vehicle should be equipped with a pressurized supply of potable water which can be used for flushing chemicals from the eyes and body in case of splash. The volume of the pressurized water supply should be at least eight gallons. (The water can also be used for washing skin areas which may be contaminated during field operations.)

Let's look at the first three life-threatening emergencies that can occur during field activities: severe bleeding, stopped breathing, and stopped circulation.

Emergency Treatment for Severe Bleeding

USE PRESSURE DIRECTLY OVER THE WOUND

Place a pad, clean handkerchief or other clean cloth directly over the wound and press firmly with one or both of your hands. Hold the pad firmly in place with a strong bandage, adhesive tape, necktie or strips of cloth. If a pad or bandage is not available, close the wound with your hand or fingers.



ELEVATE THE BLEEDING PART OF THE BODY

Unless bones are broken, raise the bleeding part higher than the rest

of the body. Keep the victim lying down.

USE OTHER METHODS TO STOP BLEEDING IF NECESSARY

If direct pressure and elevation do not stop the bleeding, try to close the artery to the bleeding area by applying pressure where the artery passes close to a bone and can be restricted. Use a tourniquet only if a victim is bleeding profusely and other methods have failed and the victim's life is in danger. A tourniquet must be tight to stop bleeding from an artery.

KEEP THE VICTIM WARM TO PREVENT SHOCK AND LOSS OF BODY HEAT

Use blankets, coats, or any covering available. If the victim is lying on the ground, use something under the victim to prevent loss of body heat.

GIVE FLUIDS IF POSSIBLE

Give the victim fluids if she, or he, is conscious, can swallow and does not have head or abdominal injuries. Do not give any fluids if she, or he, probably will require surgery and will receive professional help within less than one hour. Do not give the victim alcoholic drinks or any stimulants.

Emergency Treatment for Stopped Breathing

Abdominal Thrust

The second most serious medical emergency after severe bleeding is stopped breathing. If an injured person is not breathing for any reason, treatment given to other injuries will not help. If a person's breathing is stopped for more than just a few minutes the person will, in most cases, die or suffer brain damage from lack of oxygen.

In a serious emergency without

severe bleeding, the first priority is to determine if the victim is breathing.

1. Look to see if the victim's chest or abdomen is rising and falling regularly.

2. If there is no visual evidence of breathing, place your ear and the side of your face very close to the victim's nose and mouth to listen and feel for air being exhaled by the victim.

If there is no evidence that a victim is breathing, proceed with emergency treatment for stopped breathing as quickly as you can. No harm will result if the victim has not stopped breathing.

Let's go over some of the reasons why breathing may be stopped, and some special procedures that may be needed. Breathing can be stopped because of

- Obstructed airway
- Allergic reactions to insect stings
- Drowning
- Electrical shock
- Exposure to oxygen-deficient atmosphere
- Exposure to toxic gas with immediate paralytic effects

Performance Guidelines and Rationale

Complete Airway Obstruction-Conscious Victim

STEP 1

Activity

Rescuer asks "Can you speak?" (2-3 seconds) Victim may be using the "Universal Distress Signal" of choking: clutching the neck between thumb and index finger.

Critical Performance

Rescuer must identify complete airway obstruction by asking victim if she, or he, is able to speak.

Rationale

In the conscious victim it is essential to recognize the signs of an airway obstruction and take action immediately. If the victim is able to speak or cough effectively, do not interfere with his or her attempts to expel the foreign body.

STEP 2

Activity

Deliver four back blows. (3-5 seconds)

Critical Performance

With the heel of your hand, deliver 4 sharp blows rapidly and forcefully between the shoulder blades; support the victim's chest with the other hand on the breastbone.

Rationale

Continually check for success. This maneuver may have the effect of dislodging the foreign body before forcing it upward with the manual thrust maneuver.

STEP 3

Activity

Deliver four abdominal thrusts or chest thrusts. (4-5 seconds)

Critical Performance

ABDOMINAL THRUST: Stand behind the victim and wrap your arms around the victim's waist. Grasp; one fist with

your other hand and place thumb side of your fist in the midline between the waist and rib cage. Press fist into abdomen with quick inward and upward thrusts.

(Repeat back blows and manual thrusts until effective or until the victim becomes unconscious.)


Chest Thrust

CHEST THRUST: Stand behind victim and place your arms under victim's armpits to encircle the chest. Grasp one fist with other hand and place thumb side on the middle of the breastbone. Press with quick backward thrusts.

Rationale

The sequence of back blows and abdominal or chest thrusts is more effective than either maneuver used alone.

Each back blow and manual thrust should be delivered with the intent of relieving the obstruction.

Chest thrusts are more easily done than abdominal thrusts when the abdominal girth is large, as in gross obesity or in advanced pregnancy.

Note: Although the above sequence of back blows followed by manual thrusts is preferred, the reverse sequence of manual thrusts followed by back blows is acceptable.

Obstructed Airway - Choking Victim Who Becomes Unconscious

STEP 1

Activity

Position the victim and call out for help. Allow 4-10 seconds if face down and turning is required.

NOTES

Critical Performance

Turn if necessary, supporting head and neck. Call out "Help!"

Rationale

The victim must be properly positioned on his back in case CPR becomes necessary.

This initial call for help is to alert bystanders.

STEP 2

Activity

Open airway and attempt to ventilate. (3-5 seconds)

Critical Performance

Kneel properly. Use head tilt-chin lift or head tilt-neck lift. Attempt ventilation. Airway remains obstructed.

Rationale

Complete airway obstruction by a foreign body is assumed present, but at this point an attempt must be made to get some air into the lungs just in case the victim's fall has jarred the foreign body loose.

STEP 3

Activity

Activate EMS. (2 seconds)

Critical Performance

If unsuccessful and a second person is available, that person should activate the EMS.

NOTES

Rationale

Advanced life support capability may be required.

STEP 4

Activity

Give 4 back blows in rapid succession. (4-6 seconds)

Critical Performance

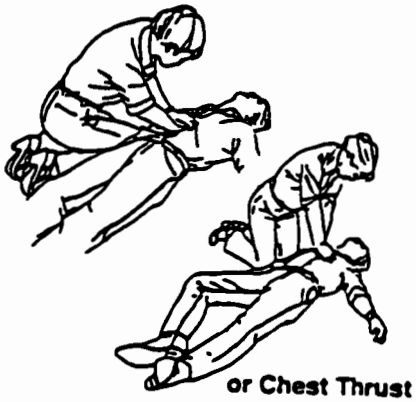
Roll victim toward you using your thigh for support. Give 4 forceful and rapidly delivered blows to back between shoulder blades with the heel of one hand; keep other hand on the victim's shoulder for support.

Rationale

Continually check for success. Each back blow or manual thrust should be delivered with the intent of relieving the obstruction.

STEP 5

Activity



Give 4 abdominal thrusts. (5-6 seconds or give 4 chest thrusts (5-6 seconds)

Critical Performance

ABDOMINAL THRUST: Position yourself with your knees close to victim's hips. Place heel of one hand in the midline between the waist and the ribcage and second on top. Press into abdomen with quick inward and upward thrusts. Never place hands on the xiphoid process or on the lower margins of the ribcage. Rescuer may use the aside or astride position.

CHEST THRUST: Same hand position

compression. Exert quick downward thrust.

Rationale

Kneeling at victim's side gives the rescuer greater mobility and access to the airway.

Chest thrusts are preferred in the presence of large abdominal girth (advanced pregnancy or obesity). Downward thrusts generate effective airway pressure.

STEP 6

Activity

Check for foreign body using finger sweep. (6-8 seconds)

Critical Performance

Turn head up, open mouth with jaw lift technique and sweep deeply into mouth along cheek with hooked finger.

Rationale

A dislodged foreign body may now be manually accessible if it has not been expelled. Dentures may need to be removed to improve finger sweep.

STEP 7

Activity

Reattempt to ventilate. (3-5 seconds)

Critical Performance

Reposition head using the head tilt-neck lift or head tilt-chin lift maneuver.

Rationale

By this time another attempt must be made to get some air into the lungs.

STEP 8

Activity

Repeat sequence until successful.

Critical Performance

Alternate the above maneuvers in rapid sequence:

* back blows
* manual thrusts
* finger sweep
* attempt to ventilate

Rational

Persistent attempts are rapidly made in sequence in order to relieve the obstruction.

As the victim becomes more deprived of oxygen, the muscles will relax and maneuvers that were previously ineffective may become effective.

<u>Obstructed Airway - Unconscious Victim</u>

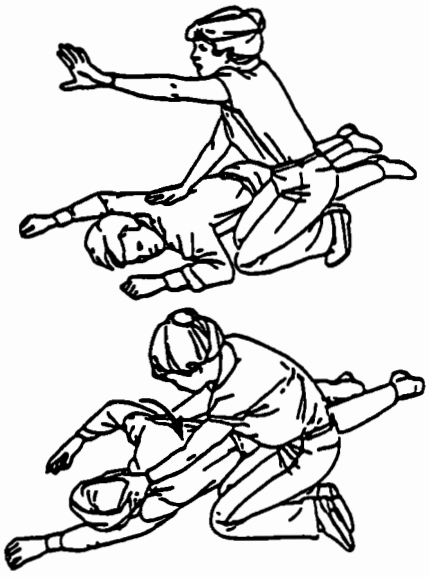
STEP 1

Activity

Establish unresponsiveness and call out for help. Allow 4-10 seconds if face down and turning is required.

Critical Performance

Tap, gently shake shoulder, shout "Are you OK?" Call out "Help!" Turn if necessary, supporting head and neck.



NOTES

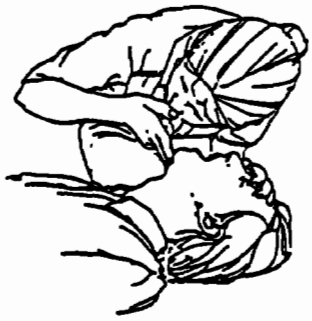
Rationale

This initial call for help is to alert bystanders.

STEP 2

Activity

Open airway. Establish breathlessness (look, listen and feel). (3-5 seconds)



Critical Performance

Kneel properly. Head tilt with one hand on forehead and neck lift or chin lift with other hand. Ear over mouth, observe chest. Adequate time.

Rationale

None

STEP 3

Activity

Attempt to ventilate (3-5 seconds) 2 breaths

Critical Performance

Attempt ventilation. Airway remains obstructed.

Rationale

Complete airway obstruction for a foreign body is assumed present, but at this point an attempt must be made to get some air into the lungs.

STEP 4

Activity

Reattempt ventilation (3-5 seconds)

NOTES

Critical Performance

Reposition head, airway remains obstructed.

Rationale

Improper head tilt is the most common cause of airway obstruction.

STEP 5

Activity

Activate the EMS

Critical Performance

If unsuccessful, and a second person is available, he should activate EMS system. Know your local EMS or rescue unit number.

Rationale

Advanced life support capability may be required.

STEP 6

Activity

Give 4 back blows in rapid succession. (4-6 seconds)

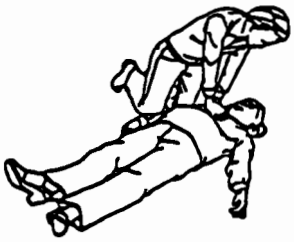
Critical Performance

Roll victim toward you using your thigh for support. Give 4 forceful rapidly delivered blows to back between shoulder blades.

Rationale

Each back blow or manual thrust should be delivered with the intent of relieving the obstruction.

NOTES



STEP 7

Activity

Give 4 abdominal thrusts (5-6 seconds) or Give 4 chest thrusts (5-6 seconds)

Critical Performance

ABDOMINAL THRUSTS: Position yourself with your knees close to victim's hips. Place heel of one hand in the midline between waist and rib cage and second hand on top. Press into abdomen with quick inward and upward thrusts. Never place hands on the xiphoid process or on the lower margins of the ribcage. Maneuver may be done astride victim.

CHEST THRUSTS: Same hand position as that for applying chest compression. Exert quick downward thrusts.

Rationale

Kneeling at victim's side gives the rescuer greater mobility and access to the airway.

Chest thrusts are preferred in the presence of large abdominal girth (advanced pregnancy or obesity). Downward thrusts generate effective airway pressure.

STEP 8

Activity

Check for foreign body using finger sweep. (6-8 seconds)

Critical Performance

Turn head up, open mouth with haw lift technique and sweep deeply into mouth along cheek with hooked finger.

Rationale

A dislodged foreign body may now be manually accessible if it has not been expelled.

Dentures may need to be removed to improve finger sweep.

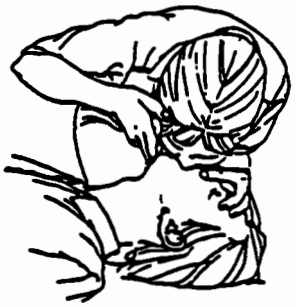
STEP 9

Activity

Reattempt to ventilate. (3-5 seconds)

Critical Performance

Reposition head using head tilt-chin lift or head tilt-neck lift. Airway remains obstructed.



Rationale

By this time another attempt must be made to get some air into the lungs.

STEP 10

Activity

Repeat sequence until successful.

Critical Performance

Alternate the above maneuvers in rapid sequence:

* back blows
* manual thrusts
* finger sweep
* attempt to ventilate

Rationale

Persistent attempts are rapidly made in sequence in order to relieve the obstruction.

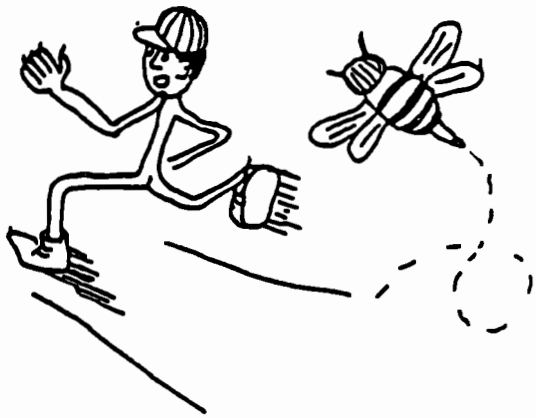
As the victim becomes more deprived of oxygen, the muscles will relax and

maneuvers that were previously ineffective may become effective.

Allergic Reactions to Insect Stings

In some individuals, an insect sting can cause an allergic reaction that is so severe that swelling can block the victim's airway and stop the individual from breathing. If such a reaction occurs, try to open the victim's airway by tipping his, or her, head back and keeping his, or her, tongue from blocking his, or her, throat.

An allergic reaction can be so severe that it causes anaphylactic shock which is life-threatening. Immediate first aid, medication and medical treatment will be needed.



If one of the crew members has had severe allergic reactions previously, she, or he, should have a special emergency kit for insect stings. Such a kit will contain a prescription medication such as adrenaline or an antihistamine. Emergency treatment consists of maintaining an open airway, removing the stinger (if the sting was from a honeybee), using the emergency kit, and seeking medical attention promptly.

If a person has a severe allergic reaction to an insect sting but no emergency kit is available, emergency treatment will be more difficult and less effective. In addition to maintaining an open airway and removing any honeybee stinger, you can try to reduce circulation of the insect venom. Get the victim to lie down and keep as calm as possible. If the sting is on an arm or leg, it may be possible to reduce the circulation of the insect venom by placing a construction between the sting and the body. The constriction is somewhat like a tourniquet, except that it must be placed immediately and it

NOTES

should not cut off the flow of blood in the arteries. Seek medical attention promptly.

Drowning

Trying to rescue someone who is in danger of drowning is difficult. In deep water, a drowning person may pull the rescuer under. In water below 70°F, the drowning person may not be able to hold on to a life preserver or rope.

If you must rescue a drowning person, use a boat, life preserver, spare tire, rope, long stick or other means than swimming out to the person. Begin mouth-to-mouth resuscitation as quickly as possible, even before the victim is completely out of the water.

If the victim is unconscious and a neck or back injury is suspected, try not to move or lift the victim until you can keep his, or her, head and back from twisting and possibly causing more severe injury. (See the section on head, neck and back injuries.)

Mouth-to-mouth resuscitation must usually be started within a few minutes after a victim has stopped breathing, to avoid serious brain injury from lack of oxygen. However, people who have been submerged in water colder than 70°F for periods as long as 30 minutes have been revived successfully without any brain damage. In cold-water drowning there is a body reflex that slows the heartbeat and reserves oxygen for the brain and the heart. Mouth-to-mouth resuscitation and cardiac compression must be started as soon as possible, and must be continued for several hours even though the victim may appear to be dead.

Electrical Shock

Electrical shock can stop breathing by paralyzing the respiratory system, and in some cases it can stop the heart or

cause it to beat irregularly and ineffectively. If the victim is in contact with a live electrical wire or circuit, rescue will be necessary before an effort can safely be made to restore breathing.

If a person has stopped breathing after being struck by lightning, you can give assistance immediately because the victim is not in contact with a source of electrical energy. However, as a precaution against lightning striking a second time in the same place, try to move the victim to a safer location before you begin resuscitation.

If a person has stopped breathing because he, or she, has touched a live wire or faulty electrical wiring or apparatus, you must first get the power turned off or get the person out of contact with the electrical wire. Do not touch the victim until the power is turned off or the victim is removed from contact with the source of electricity.

If circuit breakers are quickly accessible, turn off the individual circuit breaker or open the main electrical breaker. If circuit breakers are not accessible, get the power cut off or the victim removed from contact by the power company or the fire department.

Do not try to remove a person from an electrical circuit or a power line unless there is absolutely no other way to save the victim. Unless you have had special training for this type of rescue work, you are likely to receive an electrical shock and may also become a victim needing rescue. You must use a dry rope or a long dry stick which will prevent you from coming into electrical contact with the victim or the wire.

As soon as the victim is free of contact with the electrical current, begin mouth-to-mouth resuscitation. If

the victim's heart has stopped, cardiopulmonary resuscitation will be needed.

Exposure to Oxygen-Deficient or Toxic Atmospheres

If a person has stopped breathing in any unventilated space which may contain an oxygen-deficient atmosphere or a high concentration of toxic gas, the first step is to rescue the person.

Do not enter an unventilated confined space or a space containing a high concentration of toxic gas without using self-contained breathing apparatus or air-supplied breathing apparatus.

Be sure there is one other person equipped with such breathing apparatus to assist or stand by to help.

Move the victim to fresh air as quickly as possible without becoming a victim and complicating the rescue problem.

Control the source of poisonous gas, if possible.

Procedures for Restoring Breathing

The first step in restoring breathing is to be sure that there is a clear and open passageway for air to reach the lungs. Often the head slumps forward and the tongue blocks the passage of air. The passageway for air through the nose and mouth to the lungs is referred to as the "airway."

1. Lay the victim on his, or her, back on a firm surface such as the floor or ground.

2. Quickly clear the mouth and airway of foreign material with your fingers or a clean cloth wrapped around your fingers.

3. If there does not appear to be any neck injury, gently tilt the victim's head backward by pressure of one hand on the person's forehead, and by lifting the victim's neck upward with your other hand. This will keep the victim's tongue from falling back and blocking the airway.

The second step in restoring breathing is to force air into the lungs by some means of artificial breathing or artificial respiration. The most effective emergency method is to use your exhaled breath, which contains an adequate amount of oxygen for the person who is not breathing. There are less effective methods in which air is forced out of the lungs by pressure on the rib cage, and air is drawn into the lungs by lifting the victim's arms to lift the rib cage. Use of exhaled breath is usually referred to as "mouth-to-mouth resuscitation" even though the method may have to be modified to force the air into the victim through the nose or throat.

Since restoring breathing is vital, start as soon as you possibly can. Do not wait for help and do not pay attention to less important injuries. Continue resuscitation until the victim begins breathing, or someone else takes over, or medical personnel direct you to stop.

Mouth-to-Mouth Resuscitation

With the victim's airway open and the head tilted backward, you are going to force your breath into the victim. If your mouth can cover the victim's mouth, you will have to pinch the person's nose shut to force air into the person's lungs. If you have to force air in through the person's nose you will have to seal the person's mouth with your hand. If the victim breathes through an opening or stoma in the throat, you may need to seal both the

nose and mouth so you can force air into the lungs through the opening in the throat.

The initial step before you begin resuscitation is to inflate the victim's lungs fully and give a lot of oxygen quickly.

Blow your breath into the victim until you see the chest rise and repeat these breaths four times as rapidly as you can without allowing the victim's lungs to deflate fully.

Maintain the head tilt and again check the victim for breathing for approximately five seconds.

For continuing resuscitation, blow your breath into the victim until you see her, or his, chest rise and then remove your mouth and let the victim exhale while you take another deep breath. As soon as you hear the victim breathe out, replace your mouth over his, or her, mouth or nose and repeat the procedure.

Repeat this procedure of giving one breath and allowing the victim to exhale about once every five seconds or about 12 times per minute.

Try to breathe at a normal rate so that you do not overbreathe or hyperventilate and become light-headed or lose consciousness.

Hyperventilation can cause unconsciousness. Hyperventilation causes decreased blood flow to the brain by decreasing the carbon dioxide concentration in the blood. A decreased blood flow to the brain can also be caused by an increased concentration of oxygen.

Emergency Treatment for Stopped Circulation

The third most serious medical emergency is loss of blood circulation. Blood circulation can be stopped because of a heart attack, cardiac arrest or fibrillation resulting from electrical shock, or cardiac paralysis from exposure to high concentrations of a toxic gas such as hydrogen sulfide. If blood circulation stops, breathing will usually stop too.

If the victim has no apparent pulse, his, or her, heart may have stopped or it may be beating so irregularly that it is not circulating blood effectively.

Cardiopulmonary Resuscitation (CPR)

Cardiopulmonary resuscitation (CPR) is a basic life-support technique used in a medical crisis when the victim is not breathing and it is possible that her, or his, heart has stopped beating.

The technique involves:

1. opening and clearing the victim's airway (by tilting the head backward)

2. providing oxygen to the blood (by mouth-to-mouth resuscitation)

3. and restoring blood circulation (by external cardiac compression)

The first two steps can be done effectively with the instructions in this unit. However, restoring circulation cannot be learned effectively on the spot. Cardiac compression should be learned and practiced in a classroom with qualified instructors. A course in CPR is strongly recommended for every person working in field activities.

Cardiac compression should not be applied when the heart is beating normally, and it should not be continued when the heart begins to beat again.

Information provided in this unit is not designed to take the place of a complete course of instruction and practice under the direction of a qualified instructor. All training programs should adhere to the standards in JAMA "Supplement on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC), 18 February 1974, Vol. 227, Number 7.

Introduction to CPR Techniques

Sudden death or cardiac arrest (the sudden, unexpected stopping of breathing and circulation) may occur as the first and only indication of heart disease or heart attack. It may also occur in individuals with known heart disease and especially during heart attack. Within seconds after cardiac arrest occurs, the victim loses consciousness and breathing stops. **If CPR is started promptly,** the person has a good chance of surviving.

Cardiopulmonary Resuscitation (CPR) is a basic, life-saving technique for sudden cardiac or respiratory arrest pioneered by the American Heart Association. CPR involves a combination of mouth-to-mouth breathing or other ventilation techniques and chest compression. This technique provides basic emergency life support until more advanced life support can be added. More important, it keeps oxygenated blood flowing to the brain and other vital organs until appropriate medical treatment can restore normal heart action.

Cardiopulmonary Resuscitation is based on three basic rescue skills, the "ABC's of CPR."

Airway

The most important action for successful resuscitation is immediate opening of the airway. In opening the airway, it is important to remember that the back of the tongue is the most common cause of airway obstruction in the unconscious victim. Since the tongue is attached to the lower jaw, moving the lower jaw forward lifts the tongue from the back of the throat and opens the airway.

Airway

Breathing

When breathing stops, the body has only the oxygen remaining in the lungs and bloodstream. It has no oxygen reserve. Therefore, when breathing stops, cardiac arrest and death quickly follow. Rescue breathing by mouth-to-mouth resuscitation is the quickest, most effective way to get oxygen into the victim's lungs. There is more than enough oxygen in the air you exhale to supply the victim's needs. Rescue breathing must be performed until the victim can breathe on her, or his, own or until training professionals take over. **Remember:** If the victim's heart is beating, you must (1) maintain an open airway and (2) breathe for the victim at a rate of 12 times per minute (once every 5 seconds). If the victim's heart is not beating, you will have to perform CPR (mouth-to-mouth resuscitation PLUS chest compression).

Breathing

Circulation

The third skill of CPR is chest compression which replaces the circulation (heartbeat) of the victim. This procedure results in the flow of blood from the heart to the lungs, brain, and other major organs. Remember, never perform chest compression on a victim unless mouth-to-mouth breathing accompanies the attempt.

Performance Guidelines and Rationale

Single Rescuer CPR

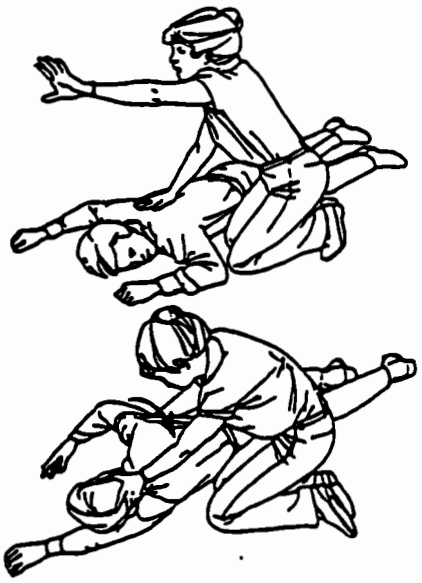
STEP 1

Activity

Establish unresponsiveness and call out for help. Position the victim (4-10 seconds)

Critical Performance

Tap, gently shake shoulders and shout: "Are you OK?" Call out "help." Turn if necessary, supporting head and neck. Take adequate time.



Rationale

One concern about teaching people CPR is the risk of unnecessary resuscitation and possible damage from unnecessarily resuscitating sleepers, fainters, etc. A call for help will summon nearby bystanders.

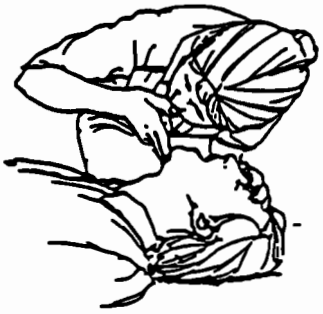
Frequently the victim will be face down. Effective CPR can only be provided with the victim flat on the back. The head cannot be above the level of the heart or CPR is ineffective.

Accurate diagnosis is important. Four to 10 seconds gives time to do that.

STEP 2

Activity

Establish breathlessness (look, listen, feel). (3-5 seconds)



Critical Performance

Kneel beside victim's shoulder; upper hand on forehead, lower hand either under neck or lifting chin. The chin lift uses the lower hand to lift the chin while the neck lift uses the

lower hand to support the neck. The chin should be lifted so that the teeth are nearly brought together. Avoid completely closing the mouth. Turn your head toward the victim's foot with your ear directly over and close to victim's mouth. Listen and feel for evidence of breathing. Look for respiratory effort (rise and fall of the chest).

Rationale

The airway must be opened to establish breathlessness. Many victims may be making efforts at respiration that are ineffective because of obstruction by the tongue.

Hearing and feeling are the only true ways of determining the presence of breathing. If there is chest movement but you cannot feel or hear air, the airway is still obstructed.

STEP 3

Activity

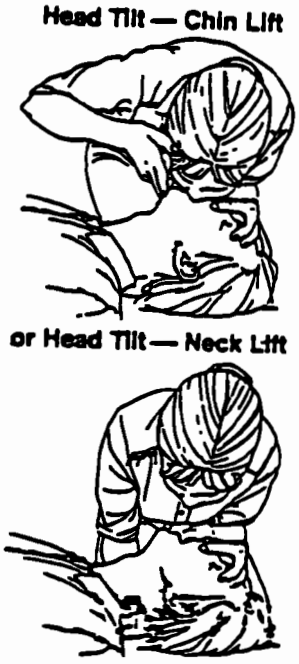
~~Four~~ Two ventilations (3-5 seconds).

Critical Performance

Pinch off nostrils with thumb and forefinger of upper hand while maintaining pressure on victim's forehead to keep the head tilted.

Open your mouth widely, take a deep breath and make tight seal. Breathe into victim's mouth four times with complete refilling of your lungs after each breath. Watch victim's chest rise.

Ventilations must be given in rapid succession. These are "building breaths"--that is, the victim's lungs should not fully deflate after each breath.



Rationale

When you are beginning rescue breathing, it is important to get as much oxygen as possible to the victim. If your rescue breathing is effective, you will:

* feel air going in as you blow
* feel the resistance of the victim's lungs
* feel your own lungs emptying
* see the rise and fall of the victim's chest and belly.

STEP 4

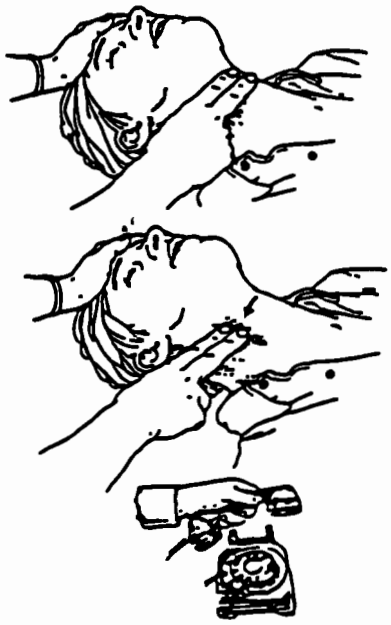
Activity

Establish pulselessness (5-10 seconds).

Activate the EMS System

Critical Performance

Place 2-3 fingers on voice box just below chin. Slide fingers into groove between voice box and muscle, on side next to rescuer. Other hand maintains head tilt.



Palpate the carotid pulse.

Know your local EMS or rescue unit telephone number. Send second rescuer to call.

Rationale

This activity should take 5 to 10 seconds because it takes time to find the right place, and the pulse itself may be slow or very weak and rapid. The victim's condition must be properly assessed.

Notification of the EMS system at this time allows the caller to give complete information about the victim's condition.

STEP 5

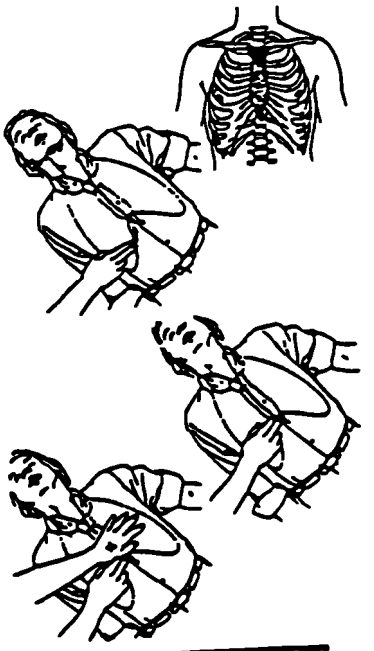
Activity

Begin first cycle: 15 compressions and 2 ventilations (54-66 seconds).

Critical Performance

To begin first cycle:

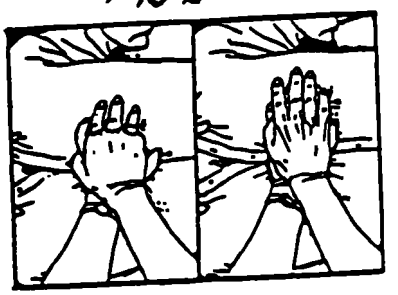
Move to victim's chest. Run fingers up lower margin of the rib cage and locate sternal notch with middle finger. With index finger on sternum, place heel of hand closest to head on sternum next to, but not covering, index finger. Place second hand on top of first.



Position body:

Weight is transmitted vertically, elbows should be straight and locked, shoulders over hands.

Say mnemonic at proper rate and ration. (Count aloud to establish rhythm; "one-and-two-and-three-and-four-and"...)



Compress smoothly and evenly, keeping fingers off victim's ribs. The rescuer must apply enough force to depress the sternum 1 1/2-2 inches, at a rate of 80 compressions per minute.

Ventilate properly:

After every 15 compressions, deliver 2 rescue breaths.

Rationale

Precise hand placement is essential to avoid serious injury.

50% of compression is downward to empty the heart, 50% of compression/relaxation is upward to fill the heart. With each compression, you

want to squeeze the heart or increase pressure within the chest so that blood moves to the vital organs.

Adequate oxygenation must be maintained.

STEP 6

Activity

At the end of 4 cycles, check for return of pulse and breathing.

Critical Performance

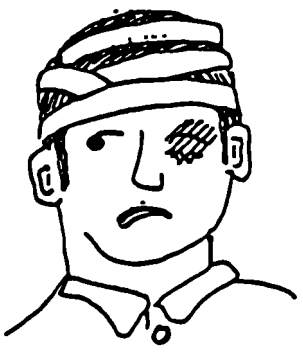
Check pulse and breathing. If no pulse, resume CPR. If there is a pulse but no breathing, apply rescue breathing.

Rationale

To establish whether there is a spontaneous return of pulse or breathing.

Now that we have discussed the three most serious medical emergencies that might occur during field activities, let's discuss six other medical emergencies that could be very serious or life-threatening.

Traumatic injuries to the head, neck or back
Shock resulting from injuries
Overexposure to heat or cold
Thermal burns that are deep or extensive
Inhalation of toxic gas
Chemical contact that is concentrated or extensive



Emergency Treatment for Head, Neck and Back Injuries

Head Injury

Any time a person is found unconscious, assume that a head injury

is possible and treat the victim accordingly.

Maintain an open airway so that the person will be able to breathe. Keep the person lying down, quiet and comfortably warm. Do not move the person any more than may be necessary to maintain an open airway.

Neck Injury

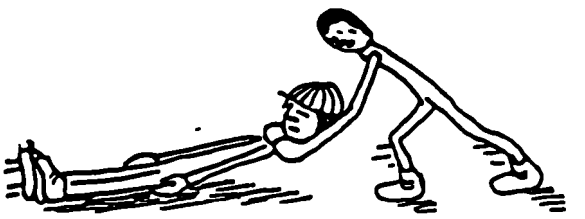
If a person has a neck injury, it is particularly important to prevent the head from moving in any direction and damaging the spinal cord. If the person is having difficulty breathing, tilt the head back slightly and very gently to maintain an open airway.

Back Injury

Maintain an open airway so that the person will be able to breathe. Keep the person lying down, quiet and comfortably warm. Do not move the person any more than may be necessary to maintain an open airway.

Moving Persons with Head, Neck or Back Injuries

If it is necessary to move someone who has possible head, neck or back injuries, it is important to keep the head from moving in a different direction, sideways, backward or forward. It is important to keep the back from bending in any direction. Do not let the victim's neck or back twist or bend.



If it is necessary to rescue a person with a neck or back injury, or to move the victim in an emergency, take special steps to keep the head in line with the body and to keep the body from bending or twisting. If an injured person has to be dragged to safety, pull the person in the direction of the length of the body by the armpits or by

the legs.

In some cases, a board can be used to immobilize an injured person's neck or back. The board should be tied to the person's body around the forehead, under the armpits and around the hips or lower abdomen.

To prevent neck injuries a towel or newspaper can be rolled into a collar about four inches wide and used to immobilize the victim's head. The collar is wrapped around the injured person's neck and tied in place gently but firmly (to hold it in place without constricting the person's throat or putting too much pressure on the person's neck.)

If it is necessary to transport someone with a neck or back injury to a hospital, keep the person lying down and try to keep the person's head and body in their normal position. The person's neck and back can be pillowed with some soft objects such as folded sweaters, shirts or newspapers.

Emergency Treatment for Heat and Cold Stress

See Heat and Cold Stress Unit.

Emergency Treatment for Thermal Burns

Thermal burns can be life-threatening if they are deep, extensive or located on critical areas of the body. Burns on the hands, feet, face and genital areas are especially dangerous.

This section is limited to a discussion of emergency treatment for severe thermal burns. (Burns that cause blistering are classified as second-degree burns, and burns that char or burn through the skin are classified as third-degree burns.)

Any thermal burn from hot chemicals should be recognized and treated not only as a thermal burn, but also as a chemical exposure that may require additional treatment for effects of the chemical on the skin and in the body. Chemical burns will be discussed in a later section of this unit.

The objectives of emergency first aid for serious burns are to:

Prevent further injury and promote healing.

Prevent and treat shock.

Prevent contamination.

Preventing Further Injury

Thermal burns can cause further injury if a person runs with clothing on fire, or if no action is taken to cool hot or burning clothing and the burned skin.

Thermal burns will be serious if a person's clothing catches fire, and they can be fatal if the person runs (as some are likely to do). It is vital to stop a person from running if her, or his, clothing is on fire, and to get her, or him, to drop to the floor or ground so that the flames will not burn as rapidly and so that the person's face is not in the path of smoke and flames. As soon as the person is horizontal, try to snuff out the flames and cool smoldering clothing. Roll the person, use a fire blanket, use water, or even use a fire extinguisher. Then treat the person for the thermal burns and for shock.

Burns on the face, nose or mouth may be accompanied by burns within the airway that will keep the person from breathing. Be sure a person with such burns is breathing. Maintain an open airway and give mouth-to-mouth resuscitation if necessary.

Usually the first emergency measure in case of serious thermal burns is to stop further burn injury by cooling the burned area. Thermal burns will continue to get worse as long as hot, smoldering or melted clothing is in contact with the skin, and as long as the skin is much hotter than normal. Hot wet clothing should be removed immediately. If you try to remove burned clothing from the victim, be careful not to remove any of his skin that may be sticking to the clothing.

Use of ice or ice water is not recommended to cool third degree burns because it may intensify the shock reaction. Use of water is not recommended where the skin is broken because the water may increase the danger of infection.

Preventing and Treating Shock from Burns

Shock can complicate every type of burn. A person with "burn shock" may die unless she, or he, receives immediate first aid. In "burn shock" there is a massive loss of fluid from the burned areas. There may not be enough blood volume left to keep the brain, heart, and other organs functioning normally.

Have victim lie down. Place victim's head and chest a little lower than the rest of the body. Elevate the legs slightly if possible.

If the victim is conscious and can swallow, give the person plenty of non-alcoholic liquids to drink (water, tea, coffee, dilute salt solution).

All thermal burns that destroy the skin (third degree burns) and all thermal burns that cause blistering on large or critical areas should be seen by a medical facility as soon as possible.

Preventing Contamination

Place the cleanest available cloth material over all burned body areas to exclude air and prevent contamination. A covering for burns should be dry. Clean newspaper can be substituted if no clean cloth is available.

Emergency Treatment for Shock Resulting from Injuries

Any serious traumatic injury can also cause shock which can be life-threatening. Shock depresses normal body functions by causing the blood to pool in the body core so that insufficient oxygen reaches the brain and other vital organs.

Shock can result as a side effect of all serious injuries, from traumatic loss of blood or other body fluids, and from too little oxygen reaching the lungs. Shock should be expected in any serious medical emergency during field activities. First aid for any life-threatening emergency should always include prompt treatment for shock.

Signs and symptoms of shock can include:

Restlessness, anxiety, unusual thirst, weakness, unresponsiveness

Eyes that look dull and sunken, pupils widely dilated

Skin cool and clammy, or pale or bluish

Breathing rapid, shallow, irregular

Pulse rapid and weak

To treat or prevent shock:

Keep the victim lying down.

Keep the airway open.

Raise the victim's feet if you can safely do so.

Keep the victim warm enough to prevent loss of body heat.

Give fluids only if the victim does not have head or abdominal injuries, and if it will be more than one hour before the victim can reach a hospital. Do not give alcoholic beverages or stimulants.

Try to reassure the victim and keep him calm.

Emergency Treatment for Inhalation of Toxic Gas

The first step in emergency treatment for inhalation of toxic gas is to get the exposed person out of the toxic atmosphere exposure, without exposing anyone else and multiplying the problem. Unless the toxic gas exposure was the result of a sudden localized leak or a passing cloud of gas (a transient exposure), rescue will require two people equipped and trained to use self-contained breathing apparatus. (In some very unusual atmospheres that might exist within a chemical plant, fully-encapsulating suits may also be required for safe rescue. See the unit on Industrial Plant Hazards for detailed information on hydrogen cyanide.)

Death or serious injury may be prevented by removing the exposed person from the exposure area and by providing mouth-to-mouth resuscitation. If there is an antidote for the chemical exposure, it should be available if there has been adequate preparation.

Once a person exposed to a toxic gas or vapor has been removed from the exposure, it is safe to administer mouth-to-mouth resuscitation. There

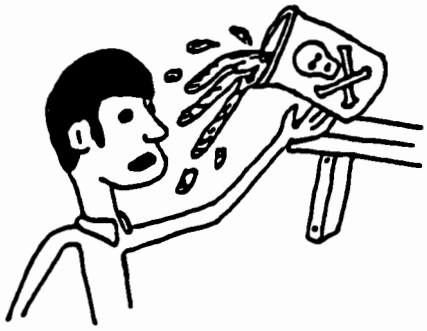
will be very little gas or vapor in the respiratory system of the exposed person and what there is will be exhaled gradually (in dilute concentrations) only after the rescuer has forced air into the victim and taken his mouth away from the victim's mouth.

Inhalation of a few breaths of concentrated toxic gases or vapors of some chemicals is likely to be followed by almost instantaneous collapse and cessation of breathing (examples are hydrogen sulfide and hydrogen cyanide). However, even if breathing stops because of such an exposure, the heart will usually continue beating for some time. Therefore, immediate mouth-to-mouth resuscitation and emergency medical treatment are very effective in preventing death.

If a person exposed to a toxic gas or vapor is not breathing, give mouth-to-mouth resuscitation (or some other form of artificial respiration) until normal breathing resumes or until a resuscitator is available. (If a toxic liquid has been splashed on the victim's face, wash it off quickly before you begin mouth-to-mouth resuscitation.)

Continuing emergency treatment of a person exposed to a toxic gas or vapor should include treatment for shock and keeping the exposed person as quiet as possible. Do not give the exposed person any alcoholic beverage.

Emergency Treatment for Chemical Contact by Splashes



Chemicals in contact with the eyes and skin can cause serious or life-threatening emergencies that must be treated quickly. One drop of corrosive chemical in an eye can cause permanent blindness and splashes or corrosive chemicals on the skin can cause permanent tissue destruction. Some chemicals splashed on a large portion of

the body can cause death if they are not washed off quickly.

Washing splashed chemicals from the eyes and body is the most important emergency treatment. It takes precedence over seeking medical assistance.

If chemicals come in contact with the eyes or body, flush the chemicals off as quickly and as thoroughly as possible. Use copious amounts of potable water and wash for at least 15 minutes. Splashes of hot, concentrated or corrosive chemicals will usually require washing for a longer period, up to several hours.

In case of chemical splashes in the eyes or on more than a small area of the skin, emergency treatment by flushing with water should always be followed by medical examination. Make sure that the medical facility knows as much as possible about the chemicals splashed or contacted, particularly if the chemical may have been absorbed so that further diagnosis and treatment are needed. (There have been deaths as the result of material absorbed from massive splashes with chromates and nitrates.)

Emergency Treatment for Chemical Splashes in the Eyes

The most important emergency measure, if chemicals are splashed in the eyes, is immediate washing of the eyes with large quantities of potable water. To wash the eyes and exposed surfaces effectively, hold the eyelids open and try to get the injured person to roll his eyes while you are irrigating with water. The eyes and the inside of the eyelids should be washed for at least 15 minutes before any effort is made to go to a medical facility for follow-up treatment.

Immediate washing with water is essential, and only a few seconds delay can result in some permanent damage. Washing the eyes thoroughly is more important than reaching a medical facility, and washing should not be delayed for any reason. A victim should be transported for medical attention only after a thorough washing.

Chemical burns to the eyes may be aggravated by soft or extended-wear contact lenses which can accumulate some chemicals. Hard contact lenses may complicate effective irrigation of the eyes, even though they may not aggravate a chemical injury.

Eyes should not be irrigated with any neutralizing agents as an emergency treatment. Any neutralizing solution is less effective than plain water, because of the physiological characteristics of the eye. Any acid in a neutralizing solution will tend to react with the protein in the cornea to form an insoluble barrier which will prevent washing out of any alkaline solution trapped under the barrier. Medical tests have shown that washing with potable water is the most effective emergency treatment available in field situations.

Emergency Treatment for Chemical Splashes on the Skin

The most important emergency measure in case chemicals are splashed on the skin is immediate washing with large quantities of potable water. To keep chemicals splashed on clothing from being washed through the cloth or onto the skin, remove splashed clothing and wash the chemicals from skin with large quantities of water. Speed and thorough washing are important to reduce the extent of injury.

If the chemical has splashed on the victim's face or been inhaled, it will

be important to see that there is an open airway so the victim can breathe.

Remove all contaminated clothing and shoes, and all clothing that may accumulate contaminated wash water. In case of a splash on the body, it will usually be necessary to remove all clothing.

Physical removal of splashed chemicals may be speeded up by use of a wash cloth or by use of a detergent. In no case, however, should any attempt be made to neutralize splashed chemicals.

Since washing chemicals off of a person will dilute and spread the chemicals, rescuers should recognize the potential spread of contamination to themselves and the immediate environment. If gloves and protective clothing are available within a few seconds, so there is very little delay in emergency washing, the rescuers may want to wear the protection to reduce their contact with splashed chemicals. After the victim has been washed, the rescuers will have to wash themselves to prevent any injury from the chemical which has been washed off the victim.

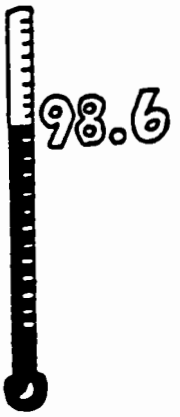
The cold water from a hose or safety shower will reduce chemical activity and burning during the initial 15 minute flushing. For prolonged washing it will be desirable to find a source of water in which the temperature can be adjusted to prevent traumatic shock.

If the area of chemical contact is extensive or the period of washing has to be prolonged, you will have to treat the victim for shock. If the splashed person is conscious and can swallow, give him plenty of non-alcoholic liquids to drink.

UNIT 4 HEAT AND COLD STRESS

EDUCATIONAL OBJECTIVES	NOTES
o The student should be able to recognize the causes of heat stress.	
o The student should be able to identify the symptoms of heat stroke.	
o The student should be able to identify the symptoms of heat exhaustion.	
o The student should be able to identify the symptoms of heat cramps.	
o The student should be able to identify the symptoms of sunburn.	
o The student should be able to list the ways heat stress can be prevented.	
o The student should be able to summarize the medical treatments for various degrees of heat stress.	
o The student should be able to identify the causes of cold stress.	
o The student should be able to identify the symptoms of Hypothermia.	
o The student should be able to identify the symptoms of frostbite.	
o The student should be able to identify the symptoms of frostnip.	
o The student should be able to list the ways cold stress can be prevented.	
o The student should be able to summarize the medical treatments for various degrees of cold stress.	

Field crews often experience a variety of problems and discomforts. By careful training and preparedness many of these problems can be circumvented or prevented. In the case of adverse weather conditions, personnel must rely on careful preparation before going out in the field. Early recognition of signs of weather related health problems and a well organized and rehearsed emergency treatment program are needed.



Heat Stress

Warm blooded animals such as the human being maintain a very precise body temperature. A slight deviation from the normal 98.6 internal temperature can dramatically alter the behavior of the body and its functions. As external temperatures are increased, heat due to metabolism, increase internal temperature, and the body responds by working to reduce the unwanted heat. The result is increased heat rate, body temperature, respiration and perspiration or heat stress. This additional burden on the body functions can result in a variety of adverse health effects ranging from cramps to collapse and even death.

CAUSES

Heat stress is caused by external heat sources such as high ambient air temperature and direct sunlight or internal sources such as heavy work or protective gear such as encapsulated suits or SCBA units.

EXTERNAL HEAT SOURCES

Advanced planning and preparation will lessen the chance of adverse health effects from high temperature. Work which requires long hours in the sun should be scheduled if possible in a time of the year when temperatures are moderate. If the work

must be done during the hot season daily scheduling should be arranged so a most of the strenuous work or work in direct sunlight, can be accomplished in the cooler morning or evening hours.

NOTES

If possible, investigate ambient air temperatures before scheduling work. At some industrial sites, heat generating processes may shut down during certain times of the day.

Other external factors such as high humidity and altitudes may increase the effects of heat on the body.

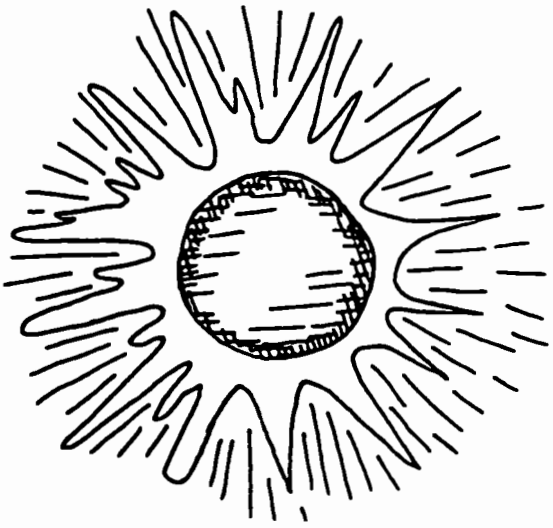
INTERNAL HEAT SOURCES

Many factors may affect the amount of heat generated by the body. Human factors such as inadequate acclimatization, fatigue, physical condition, the effects of alcohol consumption, cardiac and respiratory conditions and some medications all can cause increased body stress under high temperatures. Before Agency personnel are assigned work requiring exposure to some form of heat stress, a Preliminary Medical Monitoring program should be conducted. Any indication of systemic diseases or other physical problems should be carefully considered before the employee is assigned to a team working in high stress areas.

PRELIMINARY ASSESSMENT

The following factors should be considered before committing Agency personnel to an area of potential high heat stress.

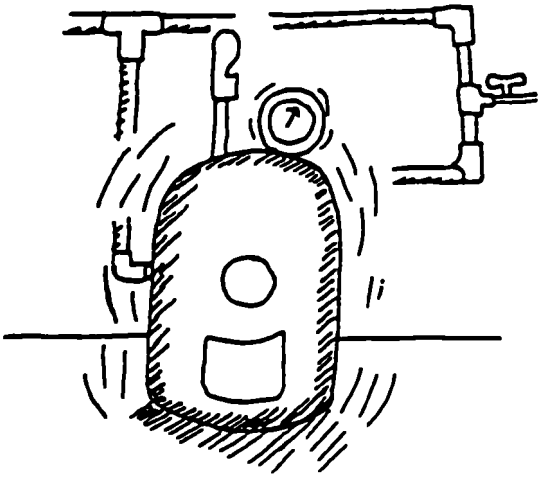
- o Normal ambient air temperatures for the time Agency personnel will be at the site.
- o Forecast winds and humidity
- o Human factors such as medical problems, accumulation and physical condition of the crew.
- o Exposure to direct sunlight
- o Proximity of additional heat sources such as vats, stacks, or pipes.



o Required use of heat retaining equipment such as encapsulating suits, respiratory gear, outer wear such as rain gear or disposable suits

o Overall work load such as lifting and climbing

o Amount of prior acclimatization the crew members have had.



EMERGENCY INFORMATION

Once a site has been scheduled advanced preparations should be made in the event of an emergency problem. The following steps should be taken.

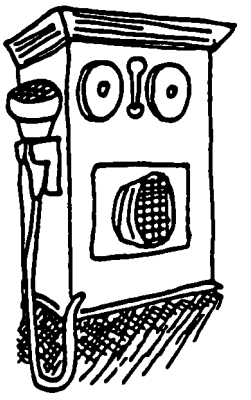
o Locate your exact position on a map. Or in an industrial site. Be sure you can give adequate directions to ambulance or emergency crews.

o Determine the exact location of the nearest emergency treatment center. In case an emergency vehicle is not available, be sure you know how to find the emergency center.

o Find the phone numbers of any emergency center, emergency crew and ambulance.

o Locate a source of water for emergency cooling or a room that is air conditioned.

o Make sure at least one member of the crew is well versed in emergency first-aid for heat stress victims.



ON-SITE WORK SCHEDULES

Plan to arrive early in the morning while it is relatively cool. Lifting and hauling should be done immediately.

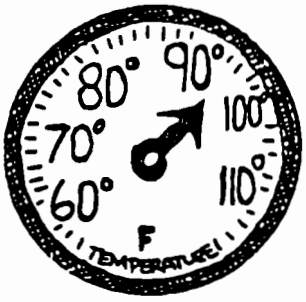
If work is to be done during the heat of the day in the hottest months of the year, be sure to include time for adequate rest periods. Rest gives the body an opportunity to rid itself of accumulated heat, slows production of internal body heat, and provides greater blood flow to the skin for cooling.

If respiratory equipment or

encapsulating suits will be worn without cooling vests when ambient temperatures are expected to be over 90 degrees F, schedule work periods of only 15 to 20 minutes at a time. Factors such as the exact type of suit worn, provision of cooling devices, amount of direct sun, and the amount of physical activity involved will affect the maximum working time at any ambient air temperature.

NOTES

EQUIPMENT AND SUPPLIES



Careful planning in bringing the right equipment and supplies can not only reduce workloads thus generation of internal body heat, but can also protect against or prevent the exposure that lends to heat stress.

The following equipment and supplies should be considered when heat stress is a possibility:

o A reliable air thermometer for continuous surveillance of ambient air temperatures.

o An oral fever thermometer for surveillance of internal body heat.

o Block and tackle for hoisting heavy equipment.

o A large beach type umbrella or tarpaulin to protect personnel from direct sunlight.

o Protective heat shields, insulating or reflective materials for intense heat areas.

o Electric fans, blowers or other ventilating equipment.

o Large insulated containers of cool liquids both for drinking and cooling.

o Towels, blankets, sponges, and a plastic basin for emergency cooling procedures.

o First aid kit

o Emergency communication equipment for use between ground crews and those at locations such as smoke stacks or pits.

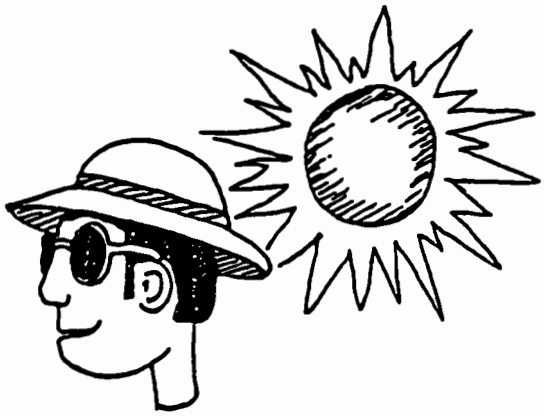
o Body replacement fluids containing salts or other electrolytes that are lost during perspiration, 2-3

NOTES

gallons per day per individual of a solution of Gatorade, ERG, Squincher, or salt water made up of 1 teaspoon per 5 quarts of water are required.

CLOTHING

Clothing worn by personnel should be selected to reduce heat load. In general clothing should be selected to reduce heat load. In general clothing should be light in color absorbent and reflective. In direct sunlight special precautions should be taken to cover the head and wear shatter proof sun glasses. When ambient temperatures are below 100 degrees F, clothing should be loose-fitting, porous and preferably made of cotton rather than synthetics or wool. If ambient temperatures exceed 100 degrees F, loose fitting clothing covering all exposed skin areas should be worn.



PREPARATIONS FOR EMERGENCY TREATMENT

The possible effects of heat stress should be taken as seriously as any other life-threatening hazard. Field crews should be trained to quickly recognize the symptoms and react accordingly. Heat stress victims should be tended to as quickly as possible. If help is more than 10 minutes away crew members should administer first aid.

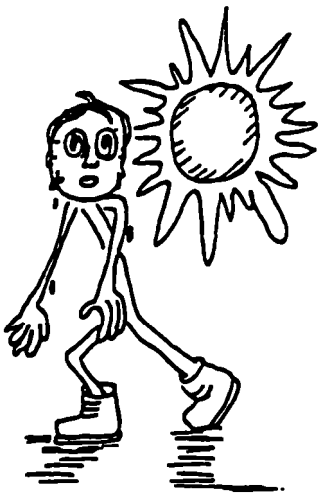
Vital information such as location and phone number of emergency help, description on crew location and pertinent medical information of crew members should be located in a centrally kept place such as a crew vehicle.

Evacuation plans should be discussed with the entire crew and, if possible, practiced before work begins. Stretchers, harnesses, or block and tackle should not only be brought to the site but made readily available to crews that might need them.

ON-GOING EVALUATION

NOTES

Ambient conditions are subject to change during a working day. Conditions such as temperature, humidity and wind should be recorded before work begins and throughout the day at regular predetermined intervals. Two members should be assigned this task with one acting as a back-up in case the first forgets or is pre-occupied. As monitored conditions change increase vigilance for signs of heat stress will be necessary.



In situations where it is necessary to be on the site for more than one day a careful evaluation of the need for supplies to be replenished and for new equipment, due to changing conditions, assessed. Remember what is the responsibility of everyone quickly becomes the responsibility on no one. Assign the task of equipment and supply evaluation to one responsible member of the crew.

If possible two crew members should be given the responsibility of visually monitoring crew members for signs of heat stress. When one of the responsible members is in doubt, consultation with the other observing member should be held. Visual checks should be made and recorded at predetermined intervals. Crews should be reminded of the necessity to replace lost body fluids on a regular basis. It if recommended that under heat stress, personnel should drink every 15 minutes to one hour depending on the heat load. Under extreme heat conditions, oral temperatures should be taken and recorded at breaks to detect the onset of heat stress problems.

<u>Recognizing the Symptoms of Heat Stress</u>

Heat stress manifests itself in four disorders. From the most sever to the least:

- Heat Stroke
- Heat Exhaustion
- Heat Cramps
- Sunburn

Heat stroke (sometimes called sun stroke) is the most serious of the heat stress disorders. In its most serious form it is lethal. It results from excessively high body temperature which in turn disturbs or interferes with, the body's own heat regulating system.

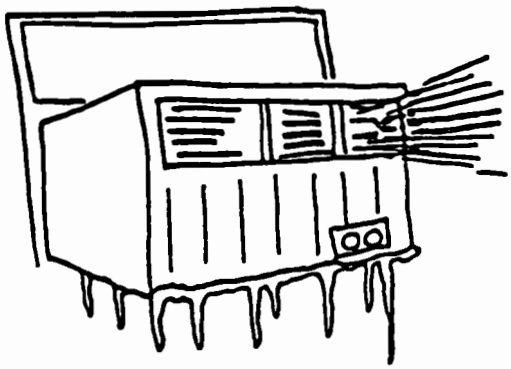
Normally, the body sweats producing moisture for skin evaporation. As most individuals know from standing wet in a breeze, evaporation is an effective cooling process. During heat stroke this perspiration evaporation cooling process is interrupted with a resultant quick rise in internal body temperature.

Continuous exposure to high temperatures for as little as three hours can produce heat stroke. RAPID COOLING IS URGENT TO PREVENT DEATH.

Symptoms of heat stroke:
Any or all of these symptoms may be present:

- o Body temperature is extremely high, often 106 degrees and above.
- o Skin is red, hot and dry. Sweating is absent.
- o Pulse is rapid and strong.
- o Possible convulsion or collapse
- o Possible delerium, disorientation or unconsciousness.

If the person's body temperature is elevated to 104 degrees F or above (orally) but sweating is occurring, the person is probably in a stage just before heat stroke. The person should be treated for heat stroke.



<u>Emergency Response to Heat Stroke</u>

In the advent of heat stroke, action must be taken immediately if the life is to be saved.

- o Call for emergency help
- o <u>COOL THE PERSON RAPIDLY</u>. Remove the person from the heat stress area. to an air-conditioned room , vehicle, or as

a minimum to a shaded area. Remove the person's clothing and begin to bathe the body continuously with water, chilled if possible. Fans or air currents such as a hand fanning will assist in the cooling-evaporation process. If possible submerse the body completely in chilled water and message continuously. Apply cold packs if available.

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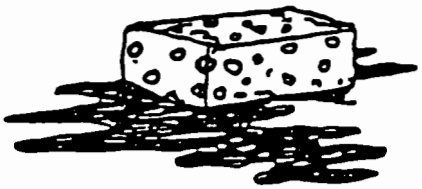
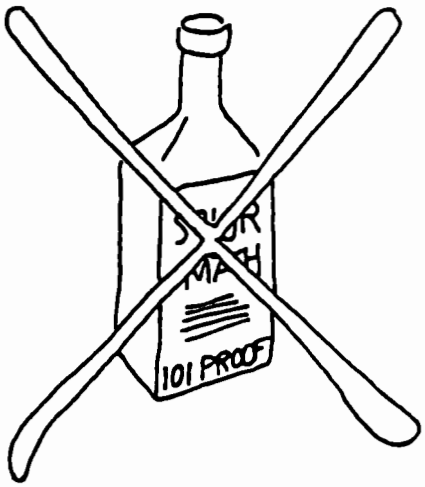


In the event the victim is in a position such as on a smoke stack where it is difficult to immerse them in water, remove the clothing and use a sponge and basin to bathe the body until help arrives. Monitor the victims body temperature. When the back of the hand held against the victims check indicates normal skin temperature, or when the internal body temperature reads 101 degrees F or below, discontinue the cooling process. Wrap the person in a blanket to prevent shock. If the person is conscious, let the person sip liquids. Do not give alcoholic beverages or stimulants such as coffee or tea.



If the person's body temperature begin to rise again, repeat the cooling process.

Prevention of Heat Stroke

The likelihood of heat stroke can be lessened by protecting your body from radiant heat, breaking the work day into short work-rest periods, and drinking enough fluids to replace those lost by sweating.

HEAT EXHAUSTION

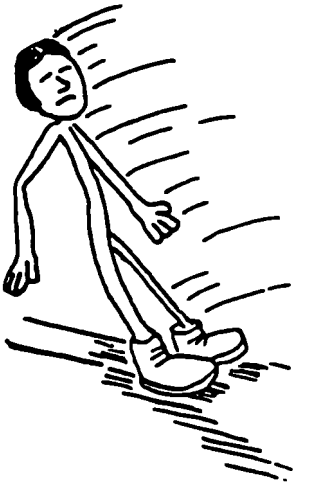
Heat exhaustion is also known as heat prostration or heat collapse. Although heat exhaustion is considered less severe then heat stroke, it is recognized that failure to quickly treat heat exhaustion can lead to heat stroke.

Heat exhaustion is the result of cardiac insufficiency stemming from

failure of the circulatory system to compensate for increased blood flow demands imposed by a need to cool the body and from dehydration caused by profuse sweating.

NOTES

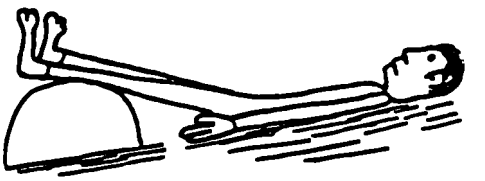
If recognized and treated immediately, heat exhaustion usually results in no permanent damage.



Symptoms of Heat Exhaustion

o Body temperature is normal or slightly elevated or reduced.
o Skin is clammy and pale, moist profuse sweating.
o Pulse may be weak with low blood pressure.
o The person is tired and weak.
o The person may complain of dizziness, giddines, fainting is possible.
o Possible muscle cramps
o Possible nausea or vomiting
o The mental state is generally rational

Emergency treatment of heat exhaustion: Early recognition of heat exhaustion is necessary if heat stroke is to be prevented.



o Move the victim into shade, or a air-conditioned room or vehicle.
o Have the person lie down.
o Elevate the feet 8"-12"
o Loosen tight fitting clothing
o If the victim is conscious, have the person sip a glass of elecholyte replacement solution such as Gatorade, ERG or Squicher. Repeat every 15 minutes for 1 hour. Stop fluids if vomiting occurs.

If the symptoms persist or return summon medical help immediately.

Prevention of heat exhaustion

To prevent heat exhaustion, schedule frequent rest periods. Replace lost body fluids by drinking electrolyte liquids every 15 minutes to one hour.

Heat Cramps

NOTES

Agency personnel working prolonged hours where profuse sweating takes place experience painful muscle pains and spasms known as heat cramps. Although not life-treating, the resultant painful cramps may hinder work or cause a potential hazardous situations such as when working at heights.

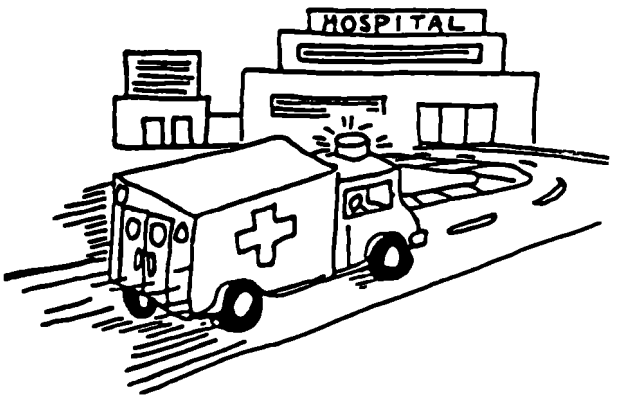
Heat cramps are caused by the loss of salts (electrolytes) due to sweating over a long period of time. Simple replacement of lost fluids with water without electrolyte may be insufficient to prevent heat cramps.

Symptoms of Heat Cramps

- o Painful muscle cramps and spasms
- o Heavy sweating, vomiting, and/or convulsions.
- o Normal, or near normal, pulse and blood pressure
- o Rational behavior

Emergency Treatment for Heat Cramps

- o Quiet rest in a cool shaded area.
- o Gentle massage of affected area.
- o If the person is not vomiting, give electrolyte fluids every 15 minutes for on hour.



Medical Treatment of Heat Cramps

If the heat cramps are not relieved by giving fluids and the symptoms persist, the victims should be transported to the nearest medical facility. Persistant symptoms may be symptomatic of heat exhaustion or the beginning of heat stroke.

Prevention of Heat Cramps

- o Salt food more heavily than normal
- o Drink electrolyte solutions
- o Eat salty food during heavy sweat producing activities. (Salt tablets are no longer recommended for general use.)

If you are on a low sodium diet or are taking diuretics, consult your physician in advance of field activities about replacement of salts. Be sure to explain any such problems to your crew leader.

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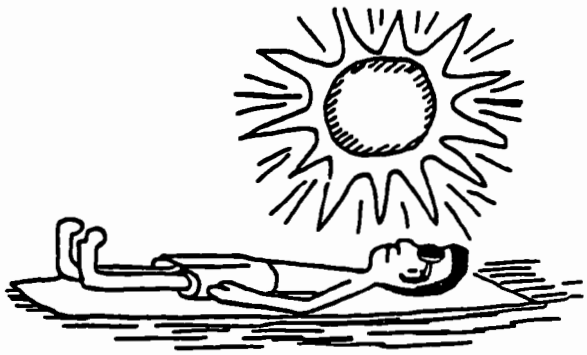

SUNBURN

Sunburn is the least serious of the four heat disorders although by far the most common. It can result in painful, red, swollen or blistered skin that may result in the inability to continue work. Advanced cases may require medical treatment and should be viewed as a precurser to more serious heat disorders.

Sunburn is usually a first-degree burn of the epidermis or first layer of skin. The affects of a sunburn may not be noticed or felt for many hours after exposure.

Symptoms of Sunburn

o Skin redness
o Pain
o Swelling
oIn severe cases, blisters, nausea, vomiting, chills

Emergency Treatment of Sunburn

o Put cold water on the burned area as quickly as possible.
o Severe burns should be submerged in cold water or soaked with wet cloths.
o Elevate burned limbs
o Do not break blister that would increase the chance of infection.

Medical Treatment of Sunburn

o Seek medical help if pain, chills, and vomiting persist.

Prevention of Sunburn

The first line of defense against sunburn is to cover exposed parts such

as the head, arms and legs. Those individuals whose job requires a great deal of exposure to the sun should take steps to gradually expose the skin to the sun for 20 minute intervals per day, extending the time as the skin builds it own natural protection in; the form of a tan. If this is not possible or as a safe-guard for overexposure, sun lotions and sun shields should be used.

NOTES

Lotion and ointments come in various degrees of protection. Those Agency personnel with fair skin or being exposed for the first time should use maximum protection. The level of protection should be gradually reduced as the skin tans.

Heavy sweating can reduce the protection levels of ointments and lotion in time. Personnel experience heavy perspiration should reapply protection approximately every hour.

It should be remembered that the ultraviolet rays of the sun which cause sunburns, can penatrate thin layers of cloud. Sunburn protection should be worn on days that are lightly overcast.

CCLD STRESS

EPA personnel are often required to perform field work in cold weather. Such conditions can lead to severe health problems ranging from skin injury to loss of fingers and toes, from frost-bite and even death due to hypothermia. It is imperative for EPA employees' health and safety that adequate planning and preparation be undertaken prior to exposure to cold weather conditions.

Causes of Cold Stress

The human body functions normally within a very narrow range of internal body temperatures. Although the body is capable of compensating for loss of body

heat for short period of time, a drop of only 5 degrees of internal body temperature usually results in disruption of normal activities. To prevent this sudden loss of body heat, Agency personnel should recognize the ways in which heat can be lost.

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BODY HEAT LOSS

- o Radiation
- o Conduction
- o Convection
- o Evaporation

RADIATION

Radiation is the loss of heat through the radiation of heat from the body. Exposed skin areas because of the heat can lose as much as 25% of the body's heat. Prevention of this type of heat loss is primarily by insulation, in the form of adequate clothing, such as hats, gloves, thermal underwear.

CONDUCTION

Conduction is the loss of heat when it is transferred to other objects; ladders, metal surfaces, wet clothing, snow, ice, or water all resulting in the quick loss of heat. Care should be taken to wear waterproof gloves and clothes when near wet surfaces. Gloves should always be left on during contact with highly conductive materials. Clothes that are wet should be dried or changed immediately.

CONVECTION

The loss of heat due to the movement of air currents is dramatic. Winds can result in body heat loss with unbelievable speed. In many areas weather forecasts include the estimated effect of winds on the body with what is called the wind chill index. The wind chill index allows you to estimate the equivalent temperature based on the thermometer reading and the wind speed (see Figure 4-1). By determining the wind chill judgements can be made about

scheduling field activities and the amount and type of clothes to be taken. To prevent loss of heat due to convection wind proof gear such as rubber, vinyl or poplin should be worn.

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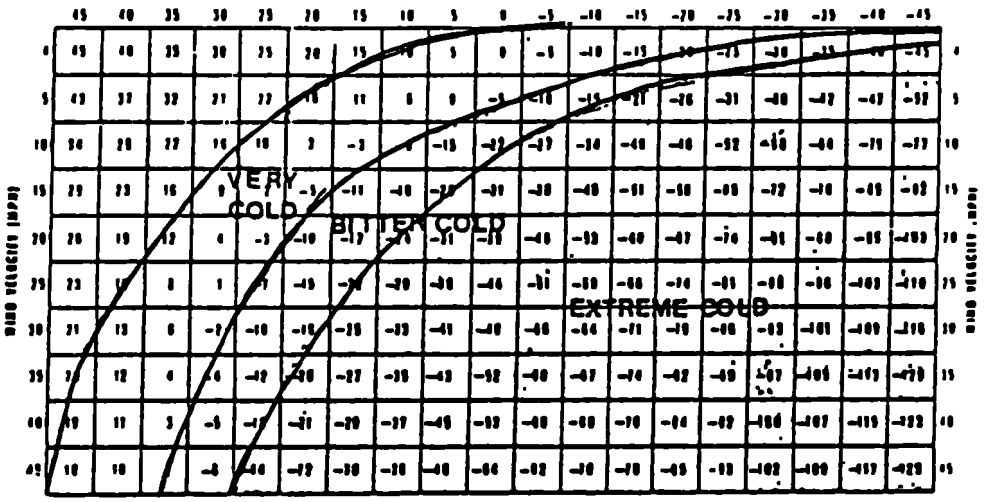
FIGURE 4-1

WIND CHILL EQUIVALENT TEMPERATURE TABLE



EVAPORATION

Evaporation is a very effective natural cooling process. Moisture for evaporation can come from external sources such as rain or snow or internal sources such as perspiration. External sources can be prevented by waterproof gear. The same waterproof gear can also minimize heat loss due to evaporation of sweat.

Evaporation of sweat can also be reduced by wearing highly absorbent clothing next to the skin.

HUMAN FACTORS CONTRIBUTING TO COLD STRESS

Before Agency personnel are assigned to field activities with the possibility of cold stress, an analysis of their general physical condition should be carried out to ascertained the following factors that can contribute to cold stress.

- o Cardiac or respiratory conditions
- o Fatigue or lack of acclimatization

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- o Inadequate sleep, food, or water
- o Dehydration

PRELIMINARY ASSESSMENT

Although little can be done about the weather, advance planning and preparations can spell the difference between worker hardships and reasonably comfortable working conditions.

Crew chief is responsible for scheduling and should access weather conditions carefully during the period Agency personnel will be at the site. The possibility of high winds, low temperatures, snow, or rain must be carefully weighed before a site is scheduled.

On-site conditions such as the openness of the work area, availability of warm shelter, warm food and drinks and drinking water must all be considered against predicted weather conditions.

Availability of Crew Members

If continuous Agency activity is required consideration should be given to assigning enough crew members to allow alternate personnel to continue the activity while others warm themselves.

Carbon monoxide poisoning and asphyxziation are always a danger when vehicles or heaters are used. Care should be taken to ensure adequate ventilation where these alternate heating sources are used.

PREPARATION AND PLANNING FOR COLD WEATHER WORK

A great deal of unfavorable working conditions can be avoided by careful and thoughtful planning. Check weather conditions before scheduling outdoor work in highly exposed areas. Plan to rotate crews regularly. Determine the availability of shelter and food.

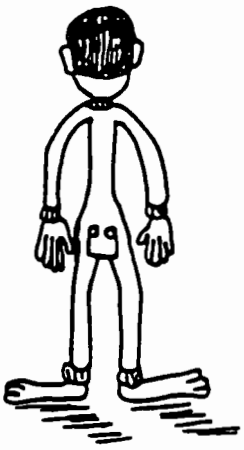
NOTES

Prepare a checklist of required clothing, supplies, and equipment needed for anticipated conditions. Arrange for temporary shelter if none exists at the site. Arrange and discuss emergency plans for treatment and evacuation if necessary. Prepare for a change of scheduling if prevailing weather conditions change during scheduled activities. Carry a portable radio or monitoring equipment to keep informed of predicted or changing weather conditions. Locate communications equipment such as two way radios or telephones. Schedule activities to make maximum use of the warmer daylight hours, including equipment retrevial and egress from the site. Make allowances in scheduling for the extra time and added fatigue heavy clothing adds. Assign two members of a team to monitor weather on a regular basis and to evaluate the physical condition of team members. Prepare supplies, equipment, clothing, blankets, and food for the worst possible scenerio of being stranded at the site.

SELECTION OF CLOTHING FOR COLD WEATHER WORK

The proper selection of clothing is the best possible defense against cold stress. Clothing should be selected keeping three factors in mind:

- o Insulation Value
- o Absorption ability
- o Wind resistance



Studies have shown that multiple layers of clothing have more insulating volume than single thick layers of equal thickness. Each layer traps air between it and the next layer to provide an effective insulation layer. Multiple layers also have the advantage of being removable one at a time as weather conditions or work may load dictate. Inner layers should be porous as in insulating underwear. Outer layers would be non-porous, wind and water proof. Intermediate layers should be of

good insulating properties such as found in wool.

NOTES

In determining protective clothing, be sure to give special consideration to the head, hands, and feet, the three areas of the body most commonly injured by cold.

Heat loss from the head is much greater than the ratio of surface area exposed to the rest of the body. As much as 25% of the entire body heat loss may come from the head alone. Head covering should be well lined and loose fitting with a means of protecting the ears. Since EPA personnel often are in areas exposed to high winds, some means of securing the protection to the head should be considered. Hard hats are often inadequate for heat loss protection. Insulating head protection should be selected to accommodate hard hats if requires.

Protection for hands and feet should be selected with the same properties in mind as head protection. Well insulated but loosely fitting materials should be selected. Fur lined mittens with water resistant covering are the best, although gloves may be required for dexerity. Fur lined or insulated boots in a size larger than normally warn during warmer weather will allow for air space insulation and multiple layers of socks. Boots should be of water proof material such as rubber or leather, treated with water proofing. In some instances steel toed boots will be required. Soles should be designed for sure footing on slippery surfaces or in snow. Always carry extra pairs of socks and gloves. Wet gloves or socks quickly lose their insulation value and can materially add to body heat loss. Wet socks or gloves should be changed immediately.

SYMPTOMS OF COLD STRESS DISORDERS

Hypothermia

Hypothermia is the progressive

NOTES

lowering of body temperatures with accompanying rapid and progressive mental and physical collapse. Hypothermia is the most serious of the cold stress disorders and is responsible for the largest percentage of cold stress fatalities.

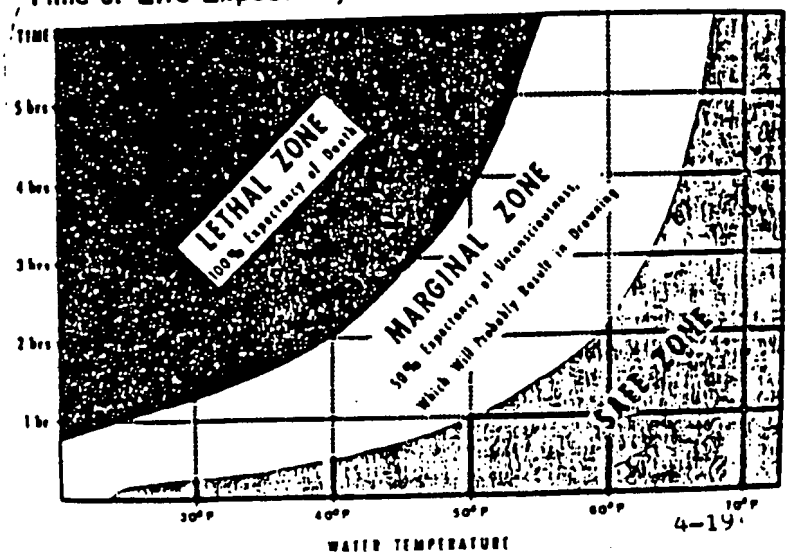
A number of factors can induce or speed up the onset of hypothermia. Extended exposure to cold with aggravating circumstances such as moisture, winds, fatigue, hunger, and inadequate clothing or shelter, and heavy perspiration with rapid cooling all play a role in hypothermia.

Hypothermia usually occurs between the temperatures of 30 - 50 degrees F, temperatures that most people believe are not dangerous. Crew members should be alert for symptoms of hypothermia, especially when temperatures are dropping rapidly or when they are exposed to rain, snow, or ice.

Hypothermia is extremely rapid when the body is submerged in cold water. Even moderately cold water at 65 degrees F and below quickly robs the body of vital heat. Unconsciousness and death may occur as rapidly as thirty minutes after submersion in water temperatures of 32 degrees F. Crew members that have been totally submerged in cold water should be treated as extreme emergency cases. Table 4-1 gives the comparison between exposure to water temperatures and unconsciousness.

Table 4-1

Time of Life Expectancy in Water With No Exposure Suit



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In the early stages of hypotermia the body begins to lose heat faster than it can produced it and it makes efforts to stay warm by shivering. When the body can no longer generate heat fast enough to overcome heat loss and when energy reserves are exhausted, a second stage begins. The body temperature begins to drop. This affects the ability of the brain to make rational judgements and may result in loss of muscular control of consciousness, as Table 4-2 shows.

TABLE 4-2

EFFECTS OF LOSS BODY TEMPERATURES

Internal Body Temperature	Symptons
95 degress F and above	Person is conscious and alert, but may have shivering that becomes uncontrollable as temperature nears 95 degress F. Respiration increases at first.
90 to 95 degress F	Person is conscious but disoriented and apathethic. Shivering is present, diminishes as temperature drops. Below 93 degress F, respiratory rate gradually deminishes and pupils begin to dilate.
86 to 90 degress F	Person is semi-conscious. Shivering is replaced by muscualr rigidity. Pupils are fully dilated at 86 degress F.
80 to 86 degress F	The person is unconscious and respiration is diminished.
80 degress F and below	Respiration is barely detectable or nondetectable. Death usually follows.

EMERGENCY TREATMENT

Hypothermia should be considered a major medical emergency. All but the very mild cases should be treated by qualified medical personnel at a medical facility. The following onsite treatment is for very mild cases or when waiting for medical help to arrive.

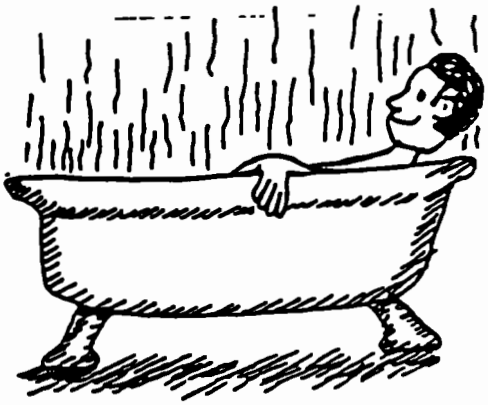
NOTES

Mild Cases

Move victim to shelter and warmth as soon as possible. Wet clothing should be removed; it drains body heat. Replace with warm dry clothing. Provide beverages.

Severe Cases

While waiting for medical treatment remember that in more severe cases of hypothermia the body has lost a great deal of internal body heat. Heavy clothes or blankets are only of value in keeping heat in. In the case of hypothermia it is necessary to get external heat to the body. Clothing only prevents this external heat from reaching the body. Therefore strip the victim of his clothes. If possible submerge the victims body in a bath of 105 to 110 degrees F water. Remain with the patient if there is loss of mental or physical ability or if the patient is unconscious. If a bath is not possible, warm towels should be wrapped around the body particularly around the head, neck, sides, and groin. Keep the towels warm. Do not use hot water. If available use electric blankets, hot water bottles or heating pads.



Once the victim has been warmed, wrap in blankets or sleeping bags with an external source of heat if possible. Although sleeping bags or blankets provide no heat themselves, they do prevent any further heat loss.

In remote locations with no other heat source available lives have been saved by body to body contact with the victim being sandwiched between two others.

Victims of hypothermia should be checked for signs of frostbite.

Frostbite

Frostbite is the second most severe manifestion of cold stress. Frostbite is the freezing of some part of the body

as a result of exposure to very low

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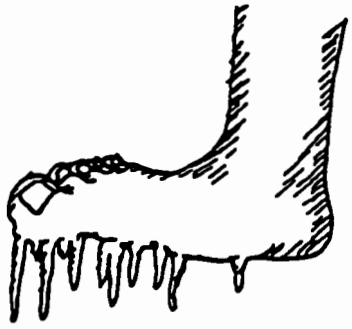
temperatures. Frostbite most likely will affect hands, feet, ears, and exposed parts of the face. As long as circulation remains good frostbite will not occur. The chances of frostbite occurring increase in strong wind conditions.



There are three stages of frostbite, classified according to the amount of skin damage. Severity can range from frostnip, which only damages the surface skin, to superficial frostbite, which involves the skin and the tissues immediately beneath it, to deep frostbite, a much more serious injury with damage that may effect deeper tissue and even bone, often requiring amputation.

Symptoms of Frostbite

Skin first turns red and later becomes pale or waxy white. There may be tingling stinging, or coldness followed by numbness; or the frostbite may be unnoticed by the person.

Superficial Frostbite

The skin in affected areas turns white or gray-white with a waxy appearance. The skin is firm to the touch moving easily across the softer tissue beneath. There is usually little or no feeling in the area.

Deep Frostbite

Tissue is pale, cold and solid to the touch. All sensation is lost. Blisters and swelling follow thawing of parts.

Emergency Treatment

Frostnip is easily reversed in the field by the application of body heat. Placing the hands under the armpits or in other warm parts of the body will reverse frostnip. The heat of respiration can also help the hands. Do not rub or massage affected areas; apply heat.

NOTES

Superficial frostbite can be reversed by application of body heat or external heat

Deep Frostbite

The most effective method of minimizing damage due to severe frostbite is by immediate application of external heat. Remove the victim to warm shelter. Remove gloves boots, socks, and other clothing that will prevent heat from reaching the affected area warm extremities in a carefully controlled bath of warm water between 104 and 107 degrees F until color and feeling return to the area. If warm water is not available, warm packs or towels between 100 and 112 degrees F, or heating pads will suffice. Radiant heat such as that from a stove, fireplace or heater, should be used with great caution, as burns may result before feeling is restored. Never use snow to thaw frostbite. Never rub or massage frozen or damaged areas, as this increases the likelihood of tissue damage.

Keep frostbitten areas elevated. Do not allow victims to walk on frostbitten feet. Have the victim move or exercise toes or fingers as soon as possible.

PREVENTION OF FROSTBITE

Treatment of frostbite is a painful experience that may result in amputation of the affected part. If is far easier to take the necessary steps to prevent frostbite. Insist that crews prepare adequately for frostbite with warm clothing, shelter, and team surveillance.

UNIT 5

CHEMICAL HAZARD RECOGNITION

NOTES

Educational Objectives

o The student should be able to accurately define the chemical terms needed to recognize potential hazards.

o The student should be able to differentiate between hazardous waste, and hazardous materials.

o The student should be able to recognize a material as a hazardous material or hazardous waste.

o The student should be able to evaluate the effects of chemical and physical properties.

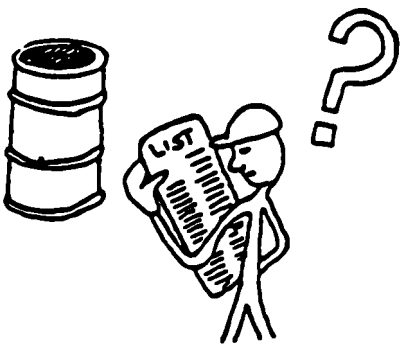
o The student should be able to determine chemical compatibility.

o The student should be proficient in the use of health and hazard data resources.

CHEMICAL HAZARD RECOGNITION

Definitions

Many very important regulations have been passed in recent years, regarding hazardous materials and hazardous wastes. In response to these regulations, a great many informational resources have been developed to assist those affected by the regulations. These resources can be very helpful to those who are involved in protecting the health and safety of all those coming in contact with these hazardous substances if time and effort are spent collecting and learning to use these diverse and sometimes very comprehensive aids. In order to use informational resources to recognize chemical hazards, it is necessary to understand terms (or "jargon").



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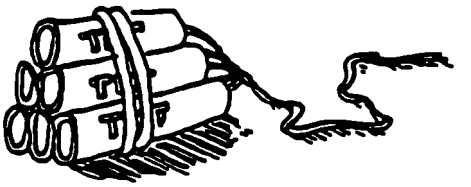
DEPARTMENT OF TRANSPORTATION

One of the earliest efforts to organize the handling of hazardous materials was instituted by the Department of Transportation (DOT) in the 49 CFR 172.102 Hazardous Material Tables. This comprehensive guide is still one of the most frequently used sources of information pertaining to hazardous materials available. Many other guides such as the Emergency Response Guide (ERG), the Coast Guard's Chemical Hazard Response Information System (CHRIS), and the National Fire Prevention Association's Fire Protection Guide on Hazardous Materials utilize definitions formulated by DOT. The following are the most important definitions:

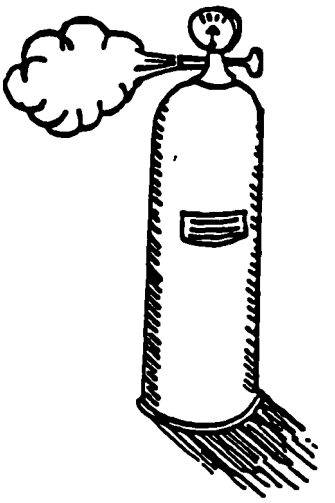


Explosive A - Materials that have a mass explosion hazard such as TNT.

Explosive B - Materials that have a fire hazard such as solid rocket fuels.

Explosive C - Materials that have only a relatively small hazard as compared to explosives A and B. Examples are common fireworks.

Poison A - Poisonous gases or liquids that are extremely dangerous even in very small amounts, such as hydrogen cyanide.



Flammable Gas - A compressed gas is considered flammable when either a mixture of 13% or less (by volume) with air forms a flammable mixture or the flammable range with air is wider than 12% regardless of the lower limit. Methane, Propane, and Acetylene are examples.

Nonflammable Gas - Those gases that will not burn in any concentration of air or oxygen. A number of these gases, however, will support combustion. Examples are anhydrous ammonia and oxygen.

Flammable Liquid - Any liquid with a flash point below 100 degrees C. Examples are benzene, toluene, xylene, acrylonitrile.

Combustible Liquid - Any liquid that has a flash point above 100 degrees C and below 200 degrees C. Examples are fuel oil, and creosote.

Flammable Solid - Any solid material that is prone to cause fires through friction or contact with water, or spontaneous combustion and when ignited, burn vigorously. Examples are calcium carbide, magnesium metal, potassium metal, sodium metal.

Oxidizers - A substance such as chlorate, permanganate, inorganic peroxide, or a nitrate that yields oxygen readily to stimulate the combustion of organic material. Examples are calcium hypochlorite (HTH), hydrogen peroxide, and ammonium nitrate.

Organic Peroxides - An organic compound which contains the bivalent -O-O- structure and which may be considered a derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by an organic radical.

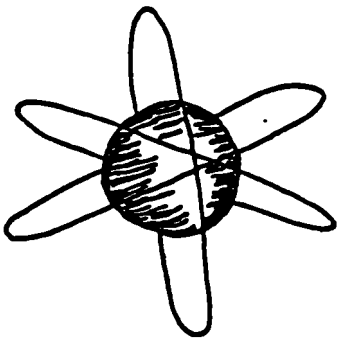
Poison B - Those substances, liquid or solid, other than Class A poisons or irritating substances, that have been considered toxic to humans or are presumed to be toxic to because they fall into any one of the following categories when tested on laboratory animals: (1) oral toxicity, (2) inhalation toxicity, (3) skin absorption toxicity. Examples are tetraethyl lead, and potassium cyanide.

Irritant Materials - A liquid or solid substance which upon contact with fire or when exposed to air gives off dangerous or intensely irritating fumes.

Examples are brombenzyl cyanide, chloracetophenone, and tear gas.

Infectious Substance/Etiologic Agent

- A viable microorganism or its toxin, which causes or may cause human disease and is limited to those agents listed in 49 CFR 72.3 (c). Examples are Polio virus, enterotoxin, or CSorynebacterium diphtheriae bacteria. Such agents may be found in body parts, excreta, sewage, diagnostic specimens, or biological products.



Radioactive Substances - Those products which emit various types of radiation that consists of particles or photons of energy, such as neutrons, gamma rays, or x-rays. Examples are cesium, barium, and uranium.

Corrosive Liquids - A liquid that causes visible destruction or irreversible alterations in human skin or tissue at the site of contact or in the case of leak age from its container, a liquid that has a severe corrosion rate on steel. Examples are hydrochloric acid, sulfuric acid, and hydrofluoric acid.

Corrosive Solid - A solid that causes visible destruction or irreversible alternations in human skin tissue at the site of contact. Examples are potassium hydroxide, soda lime, and sodium hydroxide.

ORM-A - Items that are anesthetic, irritant, or noxious. Examples are carbon tetrachloride, chloroform, 1,1,1 trichloroethane, and trichlorethylene.

ORM-B - Items which can damage vehicles through aluminum corrosion. Examples are metallic-mercury, and calcium oxide.

ORM-C - Catch all category. An example is asbestos.

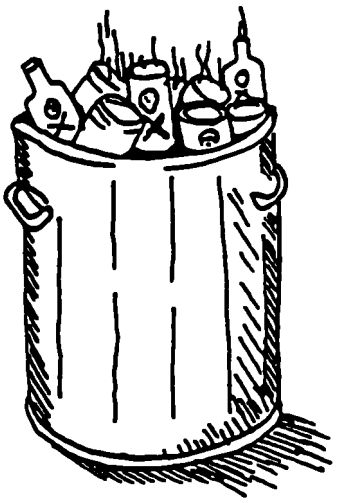
ORM-E - Hazardous waste category.

NOTES

Usually a mixture of substances that demonstrate one or more of the characteristics of ignitability, reactivity, corrosivity, EP toxicity. The container or shipping name usually contains the abbreviation NOS (not otherwise specified.)

The recognition of hazardous materials, wastes, or substances can be further aided by the use of lists formulated by specific acts, regulations or agencies.

THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)



Under RCRA a waste is defined as hazardous if it basically meets any of the following criteria:

A. 1. If it exhibits ignitability, corrosivity, reactivity, and/or extraction procedure toxicity.

2. If it is waste from a nonspecific source, or discarded commercial products, off-specification products, container residues, or spill residues.

3. If it is a mixture of solid waste and a hazardous waste, and exhibits one of more of the following: ignitability, corrosivity, reactivity, or extraction procedure toxicity.

Since there are further criteria for classifying wastes as hazardous, students should refer to 40 CFR Part 261, subpart A for further details.

B. EPA Hazardous Characteristics

Definitions

1. Ignitability (I) - A solid waste is considered ignitable if a representative sample of the waste has any of the following properties:

a. It is a liquid other than an aqueous solution containing less than 24% alcohol by volume and has a flashpoint less than 60 degrees C

b. It is not a liquid and is capable under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard

c. It is an ignitable compressed gas

d. It is an oxidizer

2. Corrosivity (C) - A solid waste is considered corrosive if a representative sample of the waste has either of the following properties:

a. It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5 as determined by a pH meter or other EPA approved method

b. It is a liquid and corrodes steel at a rate of 6.35 mm per year at a test temperature of 130 degrees F.

3. Reactivity (R) - A solid waste is considered reactive if a representative sample of the waste has any of the following properties:

a. It is normally unstable and readily undergoes violent change without detonating

b. It reacts violently with water

c. It forms potentially explosive mixtures with water

d. It generates toxic gases, vapors, or fumes when mixed with

water in sufficient quantity to be dangerous to human or environmental health

e. It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2.5 and 12.5 can generate gases, vapors, or fumes which present a danger to public or environmental health

f. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement

g. It is readily capable of detonation or explosive decomposition or reaction at STP

4. EP Toxicity (E) - A solid waste is considered EP toxic if using the test methods set forth in Appendix II of Part 261, the extract from a representative sample of the waste contains any of the contaminants listed in table 1 at a concentration equal to or greater than the value given in the table.

TABLE 5-1

Maximum concentration of contaminants for characteristic of EP Toxicity

EPA hazardous waste number	Contaminant	Maximum concentration (milligrams per liter)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin (1,2,3,4,10-10-hexa-chloro-1,7-epoxy -4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,6-dimeth-ano-naphthalene.	0.02
D013	Lindane (1,2,3,4,5,6-hexa-chlor-ocyclohexane, gamma isomer.	0.4
D014	Methoxychlor (1,1,1-Trichloro-2,2-bis (p-methoxy-phenyl ethane).	
D015	Texaphene (C10H10Cl2 Technical chlorinated camphene 67-69% chlorine).	0.5
D016	2,4D,(2,4-Dichlorophenoxyaceticacid).	10.0
D017	2,4,5-TP, Silvex (2,4,5-Trichlo-rophenoxypropionic acid).	1.0

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5. Acute Hazardous Waste (H) - A hazardous waste is considered acute if it (1) exhibits characteristics (ignitability, corrosivity, reactivity, EP toxicity), (2) has been found to be fatal to humans in low doses. If human data are unavailable the following animal toxicity will be considered an oral LD_{50} (rat) of less than 50 mg/kg, an inhalation LC_{50} (rabbit) of less than 200 mg/kg. It is also considered acutely hazardous if it is otherwise capable of causing or significantly contributing to an increase in serious irreversible or incapacitating reversible illness, or (3) it contains any of the toxic constituents listed in Appendix A, Figure 5.

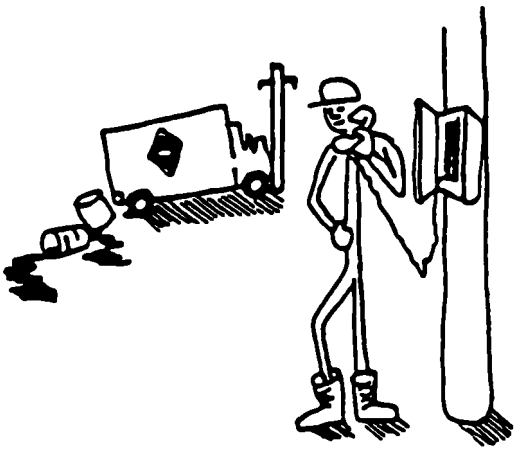
6. Toxic Waste (T) - A waste is considered toxic if it contains any constituent listed in Appendix A, Figure 4, using the test methods listed in 40 CFR or meets the criteria which classify it as capable of posing a substantial present or potential hazard to human or environmental health when improperly treated, stored, transported, disposed of, or otherwise managed.

C. Hazardous Waste List - For specific Hazardous Wastes List see Appendix A, Figure 1.

CERCLA (SUPERFUND)

A. Scope/Purpose - CERCLA, enacted December 11, 1980, established broad federal authority to deal with releases or threats of releases of hazardous substances from vessels and facilities. The Act specifies an initial list of 696 hazardous substances.

The Act requires the person in charge of a vessel or facility to notify the National Response Center immediately when there is a release of a designated hazardous substance in an amount equal to or greater than the reportable quantity for that substance. The main purpose of the notification requirements is to alert governmental officials of a release of hazardous substances that may require rapid response to protect public and environmental health.



Appendix A, Figure 2, fulfills the requirement of Section 306(a) of CERCLA that all "hazardous substances," as defined in CERCLA, shall be listed as hazardous materials under the Hazardous Materials Transportation Act.

The CERCLA List also includes substances listed in the Federal Water Pollution Control Act, the Solid Waste Disposal Act and the Clean Air Act.

CLEAN WATER ACT (1977)

A. Scope/Purpose - The Clean Water Act (formerly the Federal Water Pollution Control Act) (1972/1977) set forth comprehensive revisions of previously existing water pollution control laws. Major provisions of the Act, as amended in 1972 were:

1. Standards for direct discharges into waters.

2. Standards for discharges into publicly owned treatment works.

3. Provisions for responding to, preventing, and penalizing spills of oil and hazardous substances.

Regarding spills of oil and hazardous substances, EPA designated a list of hazardous substances and defined what constitutes a harmful discharge of both oil and each hazardous substance.

The following are chemicals listed by EPA under Section 307(a) of the Clean Water Act. This list includes any toxic pollutant or combination of pollutants which has been determined hazardous due to the following criteria:

1. Toxicity of the pollutant

2. Resistance of the pollutant

3. Degradability of the pollutant

4. Its present or potential toxic effects on aquatic organisms

Each toxic pollutant listed is subject to effluent limitations resulting from the application of the best available technology economically achievable. If determined by EPA, effluent standards (which may include a prohibition) establishing requirements

for a toxic pollutant can be promulgated.

B. Toxic Pollutants List - For specific Toxic Pollutants List see Appendix A, Figure 3.

CHEMICALS LISTED BY EPA UNDER SECTION 112 OF THE CLEAN AIR ACT

a. Benzene

b. Mercury

c. Radionuclides

d. Vinyl chloride

CHEMICAL TERMINOLOGY

Physical Properties

The successful use of health and safety rescue guides, in addition to understanding definitions, requires knowledge of the chemistry of the material. Chemicals by nature of their intended use, react in a variety of ways and demonstrate a wide degree of physical characteristics, many of which must be understood if they are to be handled in a safe manner. One of the most used information sources, the Material Safety Data Sheet (MSDS) relies heavily on DOT definitions and the physical properties of chemicals to diagnose potential hazards.

1. Density/Specific Gravity

The density of a substance is usually defined as mass per unit volume or in somewhat less accurate but simpler terms, the weight of a given substance divided by the volume of the container it is being measured in. The density of 1000 gms of water in a 1000 cm^3 container is 1000 gms/1000 cm^3 or 1 gm per cm^3.

The significance of densities can be noted when investigating or sampling

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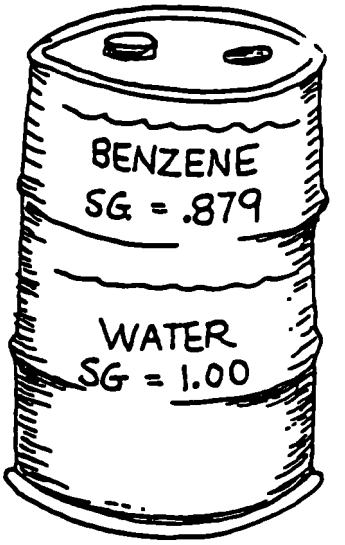
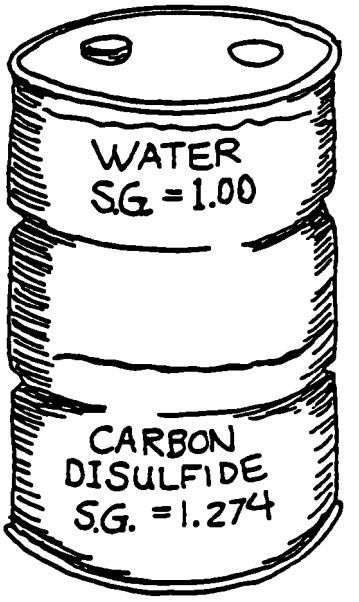
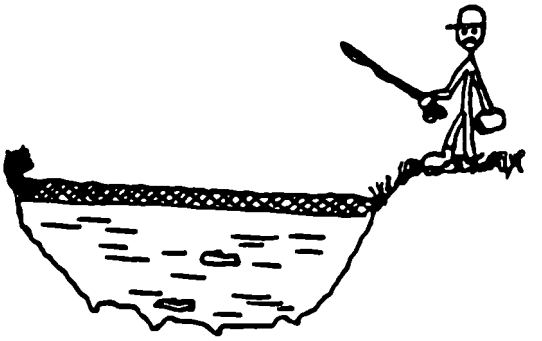
a drum or tank with an open top. If the drum has been open to the accumulation of rain water and the substance in the drum is Benzene with a density of 0.879 gm per cm^3, then the Benzene is lighter or has less density than water and will float on top. A sample taken from the top will most likely include the Benzene. Since Benzene is highly flammable and very volatile, and to some extent toxic, personnel working near the container must be constantly on guard for explosion, fire, or asphyxia.



If in the above example the substance were Carbon disulfide with a density of 1.274 gm/cm^3, it would be heavier than water and would sink to the bottom of the container below the water layer. A sampling device such as the Coliwasa would be needed to take a true representative sample of the container. Little or no danger from fire, explosion, or toxic fumes would be present.



In sampling streams, sewers, or ponds, if the density of the substance is greater than 1.00 gm per cm^3, then it will be found on the bottom of the water layer. If the density is less than 1.00 gm per cm^3, then it will be found on top. Table 5-2 is a list of some common liquids and solids and their densities.



Densities of some common liquids and solids

Substance	Density (g/cm^3 at 20°C)	Density (lb/ft^3 at 68°F)
Acetone	0.792	48.42
Aluminum	2.70	168.48
Benzene	0.879	54.85
Carbon disulfide	1.274	79.50
Chloroform	1.489	92.91
Diethyl ether	0.730	45.55
Ethyl alcohol	0.791	49.36
Gasoline	0.66-0.69	41.0-43.0
Kerosene	0.82	51.17
Lead	11.34	707.62
Mercury	13.6	848.64
Silver	10.5	655.20
Sulfur	2.07	129.17
Turpentine	0.87	54.29
Water (4°C)	1.00	62.40

Vapor Density

In most cases, liquids or solid density is compared to water. In the case of vapors, density is compared to air at standard atmospheric pressure and density, or if a direct comparison of existing conditions, of the ambient air. If the gas being measured is heavier than air, it will have a tendency to settle to the lowest physical point before eventually dispersing.

If, on the other hand the gas being measured is lighter than the ambient air, it will rise and quickly disperse.

Gases with densities greater than air create three hazards. First, if the vapor displaces enough air to reduce the atmospheric concentration of oxygen below 16% (21% is normal) asphyxia (death by suffocation) may result. Second, if the vapor is toxic, then inhalation dangers are present. Third, if the gas is explosive, explosive concentrations may accumulate in depressions, ditches, wet wells sewers, etc., where they are often overlooked or out of normal scrutiny. Table 3-2 is a

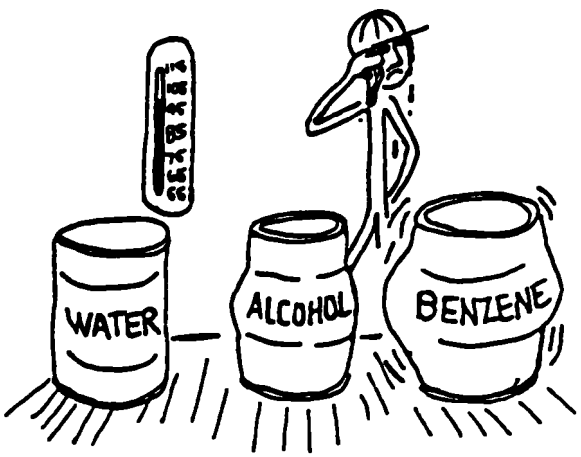
list of common gases that have been compared to air = 1. Normal density of air at Standard Pressure and Temperature (STP) is .0012 gm per cm^3.

Vapor densities of some common gases

Gas	Density (g/1 at 0°C)	Vapor Density (air = 1)
Acetylene	1.16	0.899
Ammonia	0.76	0.589
Carbon dioxide	1.96	1.52
Carbon monoxide	1.25	0.969
Chloride	3.17	2.46
Fluorine	1.70	1.32
Hydrogen	1.09	0.07
Hydrogen chloride	1.63	1.26
Hydrogen cyanide	1.21	0.938
Hydrogen sulfide	1.52	1.18
Methane	0.714	0.553
Nitrogen	1.25	0.969
Oxygen	1.43	1.11
Ozone	2.14	1.66
Propane	1.96	1.52
Sulfur dioxide	2.86	2.22

Vapor Pressure

Vapor pressure is defined as the pressure exerted by a vapor against the sides of a closed container. The vapor pressure of a substance is dependent on temperature and is specific to that liquid. As temperature rises, the vapor pressure exerted on a closed container increases, increasing the danger of rupture. If the container is open, the vapor pressure is relieved by rapid vaporization. There is a direct relationship between the lower boiling point of a lower density liquid and the greater vapor pressure it will exert on the container at a given temperature. In somewhat simpler terms, the higher the evaporation rate of a substance, the greater the chances of a build-up of pressure inside a heated container.



Values for vapor pressure are most often given as millimeters of mercury (mm Hg) at a specific temperature. Table 5-4 gives the vapor pressure of some common liquids.

Vapor pressures of some common liquids

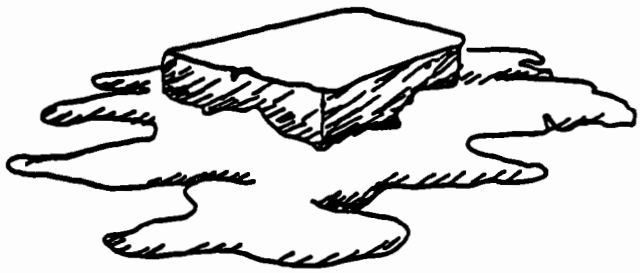
Temperature (°C)	Water (mm of Hg)	Ethyl Alcohol (mm of Hg)	Benzene (mm of Hg)
-10	2.1	5.6	15
0	4.6	12.2	27
10	9.2	23.6	45
20	17.5	43.9	74
30	31.8	78.8	118
50	92.5	222.2	271
75	289.1	666.1	643
100	760.0	1,693.3	1,360

Boiling Point

The boiling point is the temperature at which a liquid changes to a vapor. A major consideration with toxic substances is how they enter the body. With high-boiling-point liquids, the most common method of entry is by body contact. With low-boiling-point liquids, generally it is by inhalation.

Melting Point

The temperature at which a solid changes to a liquid is the melting point. This temperature is also the freezing point.



A substance often exhibits marked differences in properties depending on the phase it is in. Liquids may be explosive or highly reactive, while solids may be relatively inert. Personnel dealing with substances that may exhibit a phase change should be aware of the dangers.

Solubility

Solubility is defined as the ability of a solid, liquid, or gas to dissolve in a solvent. An insoluble substance can be physically mixed or blended in a solvent for a short time, but is unchanged when it finally separates. The solubility of a substance is independent of its density or specific gravity, but can be closely

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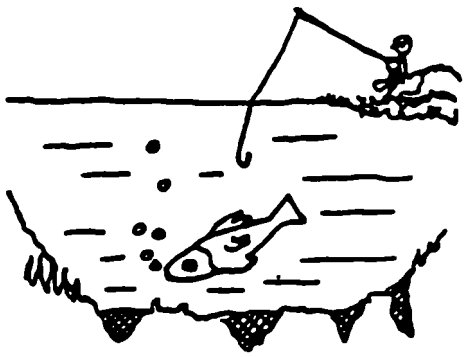
related to vapor pressure and boiling point.



Solubility

Solubility is of particular importance when determining the ability of a substance to disperse or migrate from one area to another, and to the ability to locate, sample, or recover hazardous materials. Insoluble liquids for example, can be located in a stratified layer in a container or on the top or bottom of a lagoon. Soluble materials, on the other hand, are virtually impossible to locate, sample, or recover once they have mixed with a solvent.

Although solubilities vary greatly, water is commonly referred to as the universal solvent since nearly every substance, at least to some degree, is soluble in it. Solubility is measured in parts per million (ppm) 1 ppm = .0001 %, approximately 1 mg/l.

Solubilities are often influenced by external factors such as pH. Insoluble heavy metal precipitates often become quite soluble in water when the pH is lowered. In some cases, pH can be lowered by subsoil conditions.

Flashpoint

The definition of flashpoint is the minimum liquid temperature at which a spark or flame causes an instantaneous flash in the vapor space above the liquid.

The relative flammability of a substance is based on its flashpoint. An accepted relationship between the two is:

High flammability - Flashpoint less than 100 degrees F.

Moderate flammability - Flashpoint

greater than 100 degrees F but less than 200 degrees F.

Relatively inflammable - Flashpoint greater than 200 degrees F.

Table 5-6 relates the physical properties to the combustion of Butyl alcohol and Xylene.

TABLE 3-4

Physical properties related to the combustion of Butyl Alcohol and Xylene

Liquid	Boiling Point (°F)	Flash Point (°F)	Fire Point (°F)	Autoignition Temperature (°F)	Lower Expl. Limit (%)	Upper Expl. Limit (%)
Butyl alcohol	244	114	122	650	1.7	18.0
Xylene	280	77	111.2	924	1.1	7.0

Table 5-7 is a list of the names of general compounds and families that exhibit the characteristics of flammability.

TABLE 5-7

Flammable Compounds and Elements

Flammable Liquids	Flammable Solids
Aldehydes	Phosphorus
Ketones	Magnesium dust
Amines	Zirconium dust
Ethers	Titanium dust
Aliphatic hydrocarbons	Aluminum dust
Aromatic hydrocarbons	Zinc dust
Nitroaliphatics	Flour
Water-Reactive Flammable Solids	**Pyrophoric Liquids**
Potassium	Organometallic compounds
Sodium	Dimethyl zinc
Lithium	Tributyl aluminum

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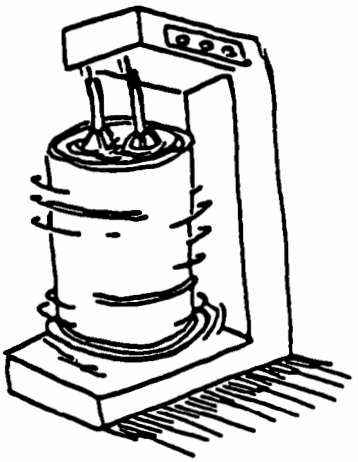
Chemical Compatibility

The term chemical compatibility, at least on the surface, appears to have a relatively straight forward definition. If two chemicals in contact with each other do not react in any way, they are said to be compatible. It should be remembered however, that the speed of a chemical reaction is dependent on factors such as temperature, concentration, and physical state. Chemicals which appear to be compatible may in fact simply be slow in reacting.



In the normal routine of Agency personnel in field work, some mixing of chemicals is inevitable. It is critical for personnel working with a variety of chemicals to know the compatibility of these chemicals. The result of mixing of incompatible chemicals could range from the formation of highly toxic gas to violent fire or explosion. Table 5-8 illustrates some of the results of mixing incompatible chemicals.

TABLE 5-8

Hazards due to chemical reactions (incompatibilities)

- Generation of heat - e.g., acid and water
- Fire - e.g., hydrogen sulfide and calcium hypochlorite
- Explosion - e.g., picric acid and sodium hydroxide
- Toxic gas or vapor production - e.g., sulfuric acid and plastic
- Flammable gas or vapor production - e.g., acid and metal
- Formation of a substance with a greater toxicity than the reactants - e.g., chlorine and ammonia
- Formation of shock- or friction-sensitive compounds
- Pressurization of closed vessels - fire extinguisher
- Solubilization of toxic substances - e.g., hydrochloric acid and chromium
- Dispersal of toxic dusts and mists
- Violent polymerization - e.g., ammonia and acrylonitrile

Understanding chemical compatibility must not be left to chance. A wide variety of resources has been developed to assist field

personnel in this task. Table 5-9 and the J. T. Baker Chemical Company Compatibility some of the possible incompatible combinations.

TABLE 5-9
Non-compatible chemicals

DO NOT CONTACT

Alkali metals, such as calcium, potassium, and sodium with water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.

Acetic acid with chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides and permanganates.

Acetone with concentrated sulfuric and nitric acid mixtures.

Acetylene with copper (tubing), flourine, bromine, chlorine, iodine, silver, mercury, or other compounds.

Ammonia, anhydrous with mercury, halogens, calcium hypochlorite or hydrogen flouride.

Ammonium nitrate with acids, metal powders, flammable fluids, chlorates, nitrates, sulphur and finely divided organics or other combustibles.

Bromine with ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine or finely divided metals.

Chlorates with ammonium salts, acids, metal powders, sulfur, carbon, finely divided organics or other combustibles.

Chromic acid with acetic acid, napthalene, camphor, alcohol, glycerine, turpentine, and other flammable liquids.

Chlorine with ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbides, turpentine, and finely divided powered metals.

Hydrogen peroxide with copper, chromium, iron, most metals or their respective salts, flammable fluids, and other combustible materials, aniline, and nitro-methane.

Hydrogen sulfide with nitric acid, or oxidizing gases.

Table 5-9 Cont'd.

Aniline with nitric acid, hydrogen peroxide or other strong oxidizing agents.

Iodine with acetylene or ammonia.

Mercury with acetylene, fulminic acid, or hydrogen.

Nitric acid with acetic, chromic and hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable fluids or gases, and substances that readily become nitrated.

Oxygen wil oils, grease, hydrogen, flammable, liquids, solids and gases.

Oxalic aicd with silver or mercury.

Perchloris acid with acetice anhydride, bismuth and its alloys, alcholol, paper, wood and other organic materials.

Hydrocarbons, generally, withl fluorine, chlorine, bromine, chromic acid or solium peroxide.

Phosphorus perntoxide with water.

Potassium permangante with glycerine, ethylene glycol, benzaldehyde, or sulfuric acid.

Sodium peroxide **with any oxidizable substances, for instance: methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene lyol, ethyl acetate, furfural, and so on.**

Sulfuric acid **with chlorates, perchlorates, permanganates and water.**

In the case of unknown chemicals, chemical analysis by a laboratory is the only way to determine with some degree of certainty, possible incompatibility. Care should be exercised not to assume the results of a specific test are sufficient to determine compatibility for an entire site.

Response personnel who must determine compatibilities should refer to "A Method for Determining the Compatibility of Hazardous Wastes (EPA 600/2-80-076)," published by EPA's Office of Research and Development.

Field personnel may at times find

it is impossible to ascertain laboratory compatibility tests. In the absence of such tests, as a minimum safeguard, simple field tests should be performed. The following tests represent a minimum field testing for compatibility.

Water Reactivity and Solubility

Purpose - This method is designed as a qualitative test for the reactivity and solubility of unknown liquid wastes with water.

Summary - A small volume of liquid waste is mixed with water and observed for miscibility, rise in temperature, precipitation, and gas formation.

Sampling Procedure - The sample should be collected and tightly sealed from atmospheric reaction. Tests should be performed as soon as possible.

Apparatus

Test tube

Liquid thermometer

10 ml disposable pipets

Glass stirring rods

Procedure

o Pipet 10 ml of water into test tube. The test tube should be clamped securely to a stand at a 45 degree angle to prevent splattering in the event of a violent reaction.

o The temperature of the test solution and water should be nearly equal.

o Insert a thermometer and record the temperature.

NOTES

o Slowly add 10 mls of test sample to the test tube. The liquid should drain slowly down the inside of the test tube any addition should be stopped if an immediate reaction occurs.

o Mix the sample with a glass stirring rod.

o Observe mixture for incompatibility signs such as liquid/liquid phase separation, gas or solids formation, color or temperature changes.

Conclusion - Gases involved may be toxic or explosive. Temperature rise is an indication or exothermic rise is an indication of exothermic activity that might lead to spontaneous fire or explosion. Color change or phase separation is indicative of chemical incompatibility that may have deleterious effects.

pH

Purpose - To determine the hydrogen ion concentration pH of a solution.

Apparatus - Small test tube or beaker and pH range testing paper.

Sample Collection - Perform test immediately.

Procedure

o Approximately 10 mls of sample is placed in a small beaker or test tube.

o The indicator strip of pH paper (hydrion paper) is either immersed in the sample or a drip of sample is placed on the test strip.

o The color developed on the test strip is compared to the color chart supplied with the test package.

Conclusion - Solution below pH 2.0 and above pH 12.5 should be handled with care as acids and bases.

Compatibility of Liquid Waste/Liquid Waste

Purpose - This test is designed to determine the compatibility of liquids of unknown composition at ambient temperatures.

Sample Handling - Samples should be collected in closed containers prior to testing.

Apparatus

Small glass beaker

10 ml disposable pipets

Liquid thermometer

Glass stirring rods

Procedure - Pipet 1 ml of the first unknown waste into a beaker. Place thermometer in the liquid. Record temperature. Add 1 ml aliquots of the other waste to be tested, stirring after each addition. Note any rise in temperature, gas bubbles, or precipitation of solids as each aliquot is added.

Conclusion - Gases evolved may be toxic or explosive. Temperature rise is an indication of exothermic activity that might result in spontaneous fire or explosion. Solid precipitation indicates chemical incompatibility that may be deleterious effects.

Information Resources

In approaching any chemical hazard, the single greatest danger is the unknown. Safety precautions, protective gear, and advanced planning all become a matter of trial and error, or just plain

luck if careful analysis of the hazardous substance is not undertaken.

As the result of public and regulatory pressure for increased knowledge of the hazards of chemical compounds, an abundance of informational resources has been developed. EPA field personnel should be aware of the various resources available, what information can be ascertained from them, and the format used by each. The uniqueness of the format of many of these resources requires prior exposure and practice to utilize them to their fullest advantage in the shortest possible time. The following list represents some of the data sources currently available.

CHRIS: Chemical Hazard Response Information System, developed by the U.S. Coast Guard. Access through the National Response Center, telephone 800/424-8802.

"Dangerous Properties of Industrial Materials," fourth edition (1975), edited by N. Irving Sax, Van Nostrand Reinhold, Co., 135 W. 50th St., New York, NY 10020.

"Condensed Chemical Dictionary," Gessner G. Hawley, Van Nostrand Reinhold Co., 135 W. 50th St., New York, NY 10020 (10th edition, 1981).
"The Merck Index," ninth edition (1976), Merck and Co., Inc., Rahway, NJ 07065.

"NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards," U.S. Government Printing Office, Washington, DC 20402.

"Fire Prevention Guide on Hazardous Materials," National Fire Protection Association (NFPA), Quincy, MA 02269.

1984 Emergency Response Guidebook: Guidebook for Hazardous Materials Incidents, 1984, U.S. Department of Transportation, Materials Transportation Bureau, DMT-11, Washington, DC 20036.

"NIOSH/OSHA Pocket Guide to Chemical Hazards," U.S. Government Printing Office, Washington, DC 20402.

Farm Chemicals Handbook, (1984), Richard T. Meister, editorial director, Meister Publishing Co., 37841 Euclid Avenue, Willoughby, OH 44094.

Materials Safety Data Sheets (MSDS): Department of Labor Standardized Material Safety Data Sheets (MSDS).

"Documentation of the Threshold Limit Values (TLV)," fourth edition (1980), ACGIH Publications Office, 6500 Glenway Avenue, Building D-5, Cincinnati, OH 45221.

Registry of Toxic Effects of Chemical Substances, 1980 edition, two volumes, Richard J. Lewis, Sr., and Roger L. Tatken, editors, U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Cincinnati, OH 45226.

Emergency Handling of Hazardous Materials in Surface Transportation, 1981, Bureau of Explosives, Association of American Railroads, 1920 L Street, NW, Washington, DC 20036.

HMIS: Hazardous Materials Information System, developed by the Department of Defense, Defense Logistics Agency, Defense General Supply Center, Richmond, VA 23297.

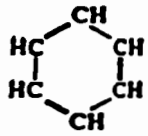
Chemical Hazard Warning Systems

There have been many attempts to expedite or summarize vital information found in the various data sources. Two systems that have gained wide recognition and acceptance are the system of hazardous material placarding and marking of large tanks and trucks, devised by the Department of Transportation (DOT) and the labeling system found on smaller tanks and containers, devised by the National Fire Protection Association (NFPA).

DOT HAZARD EVALUATION SYSTEM

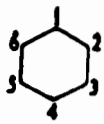
The DOT's Hazardous Materials Transportation Administration is responsible for the safe transportation of over 1,400 chemicals. The system is based on a series of regulations summarized in the Code of Federal Regulations 40 CFR. These regulations spell out in definitive language the proper shipping names, warning labels and placards that must be present to ship a hazardous material or hazardous waste on the public highways. These warning devices can prove extremely valuable in Agency personnel work. A summary of these requirements is found in the Hazardous Material Tables 49 CFR 172.101 (see Table 5-10 for an example).

benzene C_6H_6. Thirteenth in order of high-volume chemicals produced in U.S. (1975).



I

II



III

IV

Structure: I. Complete ring showing all elements.
II. Standard ring showing double bonds only.
III. Simple ring without double bonds, with numerals indicating position of carbon atoms to which substituent atoms or groups may be attached (2 = ortho, 3 = meta, 4 = para).
IV. Generalized structure, with enclosed circle suggesting the resonance of this compound.

These structures are also referred to as the benzene nucleus.

Properties: Colorless to light-yellow, mobile, nonpolar liquid of highly refractive nature; aromatic odor; vapors burn with smoky flame; b.p. 80.1°C; m.p. 5.5°C; sp. gr. 0.8790 (20/4°C); wt/gal 7.32 lb; refractive index (n 20/D) 1.50110; flash point (closed cup) 12°F; surface tension 29 dynes/cm. Autoignition temp. 1044°F. Miscible with alcohol, ether, acetone, carbon tetrachloride, carbon disulfide, acetic acid; slightly soluble in water.

Derivation: (a) Hydrodealkylation of toluene or of pyrolysis gasoline (q.v.); (b) transalkylation of toluene by disproportionation reaction; (c) catalytic reforming of petroleum; (d) fractional distillation of coal tar.

Grades: Crude; straw color; motor; industrial pure (2°C); nitration (1°C); thiophene-free; 99 mole %; 99.94 mole %; nanograde.

Containers: Drums; tank cars; barges.

Hazard: Flammable, dangerous fire risk. Explosive limits in air, 1.5 to 8% by volume. Toxic by ingestion, inhalation, and skin absorption. Tolerance, 25 ppm in air. Safety data sheet available from Manufacturing Chemists Assn., Washington, D.C.

Uses: Ethylbenzene (for styrene monomer); dodecylbenzene (for detergents); cyclohexane (for nylon); phenol; nitrobenzene (for aniline); maleic anhydride; dodecylbenzene; chlorobenzene; diphenyl; benzene hexachloride; benzene-sulfonic acid; solvent; antiknock gasoline.

Shipping regulations: (Rail) Red label. (Air) Flammable Liquid label.

See also aromatic.

Condensed Chemical Dictionary, Gessner Hawley

Chemical Name and Formula	Synonyms	Permissible Exposure Limit	IDLH Level	Physical Description	Chemical and Physical Properties		Incompatibilities	Measurement Method and Set (See Table 1)
Benzene C_6H_6	Benzol, Cyclohexatriene; Coal Tar Naphtha, Phenyl Hydride	1 ppm 5 ppm ceil (as of 3/11/78)	2000 ppm	Colorless liquid with an aromatic odor	MW 78 BP: 176 F Sol: 0 18% FLP. 12 F	VP: 75 mm MP. 42 F UEL: 7 1% LEL: 1 3%	Strong oxidizers; chlorine, bromine with iron	Char; CS, GC, U

Personal Protection and Sanitation (See Table 2)	Respirator Selection: Upper Limit	Respirator Selection: Devices Permitted (See Table 3)	Health Hazards: Route	Health Hazards: Symptoms (See Table 4)	Health Hazards: First Aid (See Table 5)		Target Organs
Clothing: Repeat protong Goggles: Reason prob Wash: Soap wash promptly Change: N.A. Remover: Any wol immed (flamm)	10 ppm: SA/SCBA 50 ppm: SAF/SCBAF 1000 ppm: SA PD,PP,CF 2000 ppm: SAF,PD PP,CF Escape GMS/SCBA		Inh Abs Ing Con	Irrit eyes, nose, resp sys; giddy; head, nau, staggered gait, fig, anor, less, derm; bone marrow depres; abdom pain	Eye Skin Breath Swallow	Irr immed Soap wash promptly Art resp NO VOMIT	Blood, CNS, skin, bone marrow, eyes resp sys

NIOSH/OSHA Pocket Guide to Chemical Hazards

1069. Benzene. Benzol; cyclohexatriene. C_6H_6; mol wt 78.11. C 92.25%, H 7.75%. Discovered by Faraday in compressed oil gas in 1825. Obtained in the coking of coal and in the production of illuminating gas from coal. Purification by washing with water: Brit. pat. 863,711 (1961 to Schloven-Chemie and H. Koppers GmbH), *C.A.* 55, 16971f (1961). Lab prepn by diazotization of aniline, followed by reduction of the diazonium salt in NaOH soln using stannous chloride: Gattermann-Wieland, *Praxis des organischen Chemikers* (de Gruyter, Berlin, 40th ed., 1961) p 247. Production of pure benzene: French, *Ind. Chemist* 39, 9-12 (1963). Toxicity: E. Browning, *Toxicity and Metabolism of Industrial Solvents* (Elsevier, New York, 1965) pp 3-65.

Clear, colorless, highly flammable liquid: characteristic odor. d_4^{20} 0.8787. bp 80.1°. Solidif +5.5°. n_D^{20} 1.50108: Thorne *et al.*, *Ind. Eng. Chem. Anal. Ed.* 17, 481 (1945). Flash pt 10-12°. Sol in 1430 parts water; miscible with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone, oils. *Keep in well-closed containers in a cool place and away from fire.* LD_{50} orally in rats (young adults): 3.8 ml/kg. Kimura *et al.*, *Toxicol. Appl. Pharmacol.* 19, 699 (1971).

Sodium deriv, C_6H_5Na, *phenyl sodium.* Prepn: Schlosser, *Angew. Chem.* 76, 267 (1964). Solid mass, dec by water, acids, alkalies. Sol in liquid ammonia, tetrahydrofuran.

Human Toxicity: Acute (from ingestion or inhalation): Irritation of mucous membranes, restlessness, convulsions, excitement, depression. Death may follow from respiratory failure. *Chronic:* bone marrow depression and aplasia; rarely, leukemia. Harmful amts may be absorbed through skin.

USE: Manuf of medicinal chemicals, dyes and many other organic compounds, artificial leather, linoleum, oil cloth, airplane dopes, varnishes, lacquers; as solvent for waxes, resins, oils, etc.

THERAP CAT (VET): Destroys screwworm larvae in wounds.

The Merck Index

BENZENE. Syns: *benzol, phenyl hydride, coal naphtha.* Clear colorless liquid. C_6H_6, mw: 78.11, mp: 5.51°, bp: 80.093°-80.094°, flash p: 12°F (CC), d: 0.8794 @ 20°, autoign. temp.: 1044°F, lel: 1.3%, uel: 7.1%, vap. press: 100 mm @ 26.1°, vap. d: 2.77, ulc: 95-100.

THR = Poisoning occurs most commonly through inhal of the vapor, though benzene can penetrate the skin, and poison in that way. Locally, benzene has a comparatively strong irr effect, producing erythema and burning, and, in more severe cases, edema and even blistering. Exposure to high conc of the vapor (3000 ppm or higher) may result from failure of equipment or spillage. Such exposure, while rare in industry, may result in acute poisoning, characterized by the narcotic action of benzene on the CNS. The anesthetic action of benzene is similar to that of other anesthetic gases, consisting of a preliminary stage of excitation followed by depression and, if exposure is continued, death through respiratory failure. The chronic, rather than the acute form, of benzene poisoning is important in industry. It is a recog leukemogen. [*14, 3, 1, 102*] There is no specific blood picture occurring in cases of chronic benzol poisoning. The bone marrow may be hypoplastic, normal, or hyperplastic, the changes reflected in the peripheral blood. Anemia, leucopenia, macrocytosis, reticulocytosis, thromocytopenia, high color index, and prolonged bleeding time may be present. Cases of myeloid leukemia have been reported. For the supervision of the worker, repeated blood examinations are necessary, including hemoglobin determinations, white and red cell counts and differential smears. Where a worker shows a progressive drop in either red or white cells, or where the white count remains below 5,000 per cu mm or the red count below 4.0 million per cu mm, on two successive monthly examinations, he should be immediately removed from exposure. Following absorption of benzene, elimination is chiefly through the lungs, when fresh air is breathed. The portion that is absorbed is oxidized, and the oxidation products are combined with sulfuric and glycuronic acids and eliminated in the urine. This may be used as a diagnostic sign. Benzene has a definite cumulative action, and exposure to relatively high conc is not serious from the point of view of causing damage to the blood-forming system, provided the exposure is not repeated. On the other hand, daily exposure to conc of 100 ppm or less will usually cause damage if continued over a protracted period of time. In acute poisoning, the worker becomes confused and dizzy, complains of tightening of the leg muscles and of pressure over the forehead, then passes into a stage of excitement. If allowed to remain in exposure, he quickly becomes stupefied and lapses into coma. In non-fatal cases, recovery is usually complete and no permanent disability occurs. In chronic poisoning the onset is slow, with the symptoms vague; fatigue, headache, dizziness, nausea and loss of appetite, loss of weight and weakness are common complaints in early cases. Later, pallor, nosebleeds, bleeding gums, menorrhagia, petechiae and purpura may develop. There is great individual variation in the signs and symptoms of chronic benzene poisoning. Benzene is a common air contaminant.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials, such as BrF_3, Cl_2, CrO_3, O_2NClO_4, O_2, O_3, perchlorates, ($AlCl_3$ + $FClO_4$), (H_2SO_4 + permanganates), K_2O_2, ($AgClO_4$ + acetic acid), Na_2O_2. [*19*]

Spont Heating: No.

Explosion Hazard: Mod, when its vapors are exposed to flame. Use with adequate ventilation.

Disaster Hazard: Dangerous, highly flam.

To Fight Fire: Foam, CO_2, dry chemical.

☆☆C BENZENE - Skin

C_6H_6

25 ppm (Approximately 80 mg/m^3)

Benzene as an acute posion produces narcotic effects comparable to those of toluene. Chronic intoxicatior by benzene is by far the most serious disease caused by the common hydrocarbon solvents. Its action is primarily on the bone marrow resulting in numerous blood changes and, in serious cases, aplastic anemia, with a frequently fatal outcome. It is unique among the hydrocarbons as a myelotoxicant, according to Gerarde(1). Elkins(2) stated that more than 140 fatal cases of benzene poisoning had been recorded prior to 1959. Vigliani and Saita(3) listed 26 deaths from chronic benzene poisoning in two provinces in Italy between 1960 and 1963. Eleven of these cases were diagnosed as leukemia, which frequently develops several years after cessation of exposure to benzene.

Many of the deaths from benzene have resulted from exposures of the order of 200 ppm or more. Bowditch and Elkins(4) estimated that of eleven fatal cases, three resulted from concentrations in excess of 200 ppm, four from concentrations between 100 and 200 ppm, and three from concentrations judged to be below 100 ppm (but not measured). Greenburg et al.(5) described nine cases, with one death, in the rotogravure printing industry. Of 48 air analyses, 20 showed less than 100 ppm, and 15 more than 200 ppm. Savilahti(6) found that 107 of 147 workers in a shoe factory revealed blood abnormalities. The source of the benzene was cement, and concentrations were reported to have ranged from 318 to 470 ppm (these seem high for shoe cementing operations). One death occurred.

Winslow(7), however, reported blood changes in workers where concentrations of benzene vapor below 100 ppm were found. Heimann and Ford(8) found one death and three cases with blood changes where air analysis for benzene showed a concentration of 105 ppm. Wilson(9) reported three fatal cases in a plant where the average concentration of benzene vapor was 100 ppm. Hardy and Elkins(10) recorded one death and several cases of blood changes in a plant where repeated air analyses indicated benzene vapor concentrations of about 60 ppm.

Blaney(11) found little evidence of benzene intoxication in a group of 90 workers regularly exposed to benzene for about 13 years. Concentrations were generally low, but urinary phenol measurements indicated some exposures of the order of 25 ppm(12). Pagnotto et al.(13) found rubber spreaders exposed to benzene vapor concentrations ranging for the most part between 6 and 25 ppm. A limited number of blood studies showed some abnormalities but no apparent correlation with exposure. So far as is known, none of this group developed serious blood dyscrasias.

A TLV of 25 ppm is believed low enough to prevent serious blood changes, but this limit should be considered a ceiling and exposure to higher concentrations not permitted.

Other recommendations: Cook (1945) 50 ppm; Smyth (1956) 35 ppm; Elkins (1959) 25 ppm; ANSI (1969) 10 ppm; U.S.S.R. (1967) 6 ppm; Czechoslovakia (1969) 16 ppm.

References:

1. Gerarde, H.W.: Toxicology and Biochemistry of Aromatic Hydrocarbons, Elsevier Publishing Co., New York (1960).
2. Elkins, H.B.: Chemistry of Industrial Toxicology, p. 103, Wiley & Sons, New York (1959).
3. Vigliani, E.C., Saita, G.: New Eng. J. of Med. 271, 872 (1964).
4. Bowditch, M., Elkins, H.B.: J. Ind. Hyg. & Tox. 21, 321 (1939).
5. Greenburg, L., Mayers, M.R., Goldwater, L., Smith, A.R.: J. Ind. Hyg. & Tox. 21, 395 (1939).
6. Savilahti, M.: Arch. Gewerbepath. u. Gewerbehyg. 15, 147 (1956).
7. Winslow, C.E.A.: J. Ind. Hyg. 9, 69 (1927).
8. Heimann, H., Ford, C.B.: N.Y. Ind. Hyg. Bull. p. 224 (Nov. 1940).
9. Wilson, R.H.: J. Lab. Clin. Med. 27, 1517 (1942).
10. Hardy, H.L., Elkins, H.B.: J. Ind. Hyg. & Tox. 30, 196 (1948).
11. Blaney, L.: Ind. Med. & Surg. 19, 227 (1950).
12. Walkley, J.E., Pagnotto, L.D., Elkins, H.B.: Am. Ind. Hyg. Assn. J. 22, 362 (1961)
13. P[illegible]otto, L.D., Elkins, H.B., Brugsch, H.G., Walkley, J.E.: Am. Ind. Hyg. Assn. J. 22, 417 (1961).

BNZ	BENZENE

Common Synonyms	
Benzol Benzole	Watery liquid Colorless Gasoline-like odor Floats on water. Flammable. Irritating vapor is produced. Freezing point is 42° F

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

Fire	**FLAMMABLE.** Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	**CALL FOR MEDICAL AID** **VAPOR** Irritating to eyes, nose and throat. If inhaled, will cause 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** Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
Water Pollution	**HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS** May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG-446-4)

Issue warning. Isolate hazard.
Restrict access.

2. LABEL

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Benzol, Benzole
3.2 **Coast Guard Compatibility Classification:** Aromatic hydrocarbon
3.3 **Chemical Formula:** C_6H_6
3.4 **IMCO/United Nations Numerical Designation:** 3.2/1114

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Aromatic, rather pleasant aromatic odor, characteristic odor

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Hydrocarbon vapor canister, supplied air or a hose mask, hydrocarbon insoluble rubber or plastic gloves, chemical goggles or face splash shield, hydrocarbon insoluble apron such as neoprene
5.2 **Symptoms Following Exposure:** Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death
5.3 **Treatment for Exposure:** SKIN: flush with water followed by soap and water, remove contaminated clothing and wash skin. EYES: flush with plenty of water and irritation subsides. INHALATION: remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen.
5.4 **Toxicity by Inhalation (Threshold Limit Value):** 25 ppm
5.5 **Short-Term Inhalation Limits:** 75 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 3. LD_{50} 50 to 500 mg/kg
5.7 **Late Toxicity:** Leukemia
5.8 **Vapor (Gas) Irritant Characteristics:** If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 4.68 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 12°F C.C.
6.2 **Flammable Limits in Air:** 1.3% – 7.9%
6.3 **Fire Extinguishing Agents:** Dry chemical, foam, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
6.7 **Ignition Temperature:** 1097°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 6.0 mm/min

7. CHEMICAL REACTIVITY

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

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 5 ppm/6 hr/minnow/lethal/distilled water; 20 ppm/24 hr/sunfish/TLm/tap water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 1.2 lb/lb, 10 days
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Commonwealth Oil Refining Co. Inc.
   Commonwealth Petrochemicals Co.
   Penuelas, Puerto Rico 00724
2. Phillips Petroleum Co.
   Phillips Puerto Rico Core, Inc.
   Banco Popular Center
   Hato Rey, P. R. 00936
3. Shell Chemical Co.
   Petrochemicals Div.
   P. O. Box 2463
   Houston, Texas 77001

10. SHIPPING INFORMATION

10.1 **Grades or Purity:**

Industrial pure	99+%
Thiophene-free	99+%
Nitration	99+%
Industrial 90%	85+%
Reagent	99+%

10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Pressure vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG-446-3)

A-T U-V-W

12. HAZARD CLASSIFICATIONS

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

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

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** 78.11
13.3 **Boiling Point at 1 atm:** 176°F = 80.1°C = 353.3°K
13.4 **Freezing Point:** 42.0°F = 5.5°C = 278.7°K
13.5 **Critical Temperature:** 552.0°F = 288.9°C = 562.1°K
13.6 **Critical Pressure:** 710 psia = 48.3 atm = 4.89 MN/m²
13.7 **Specific Gravity:** 0.879 at 20°C (liquid)
13.8 **Liquid Surface Tension:** 28.9 dynes/cm = 0.0289 N/m at 20°C
13.9 **Liquid-Water Interfacial Tension:** 35.0 dynes/cm = 0.035 N/m at 20°C
13.10 **Vapor (Gas) Specific Gravity:** 2.7
13.11 **Ratio of Specific Heats of Vapor (Gas):** 1.061
13.12 **Latent Heat of Vaporization:** 169 Btu/lb = 94.1 cal/g = 3.94 × 10⁵ J/kg
13.13 **Heat of Combustion:** −17,440 Btu/lb = −9698 cal/g = −406.0 × 10³ J/kg
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 3 and 6)

NOTES

REVISED 1978

TABLE OF PLACARDS AND APPLICABLE RESPONSE GUIDE PAGES

USE ONLY IF MATERIALS CANNOT BE SPECIFICALLY IDENTIFIED THROUGH SHIPPING PAPERS OR MARKINGS.

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INTERNATIONAL SHIPPING ONLY

Guide 37

Guide 41

TABLE OF PLACARDS AND APPLICABLE RESPONSE GUIDE PAGES

USE <u>ONLY</u> IF MATERIALS CANNOT BE SPECIFICALLY IDENTIFIED THROUGH SHIPPING PAPERS OR MARKINGS.

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Guide 46

Guide 46

Guide 16

Guide 19

Guide 15

Guide 26

Guide 26

TABLE 5-10

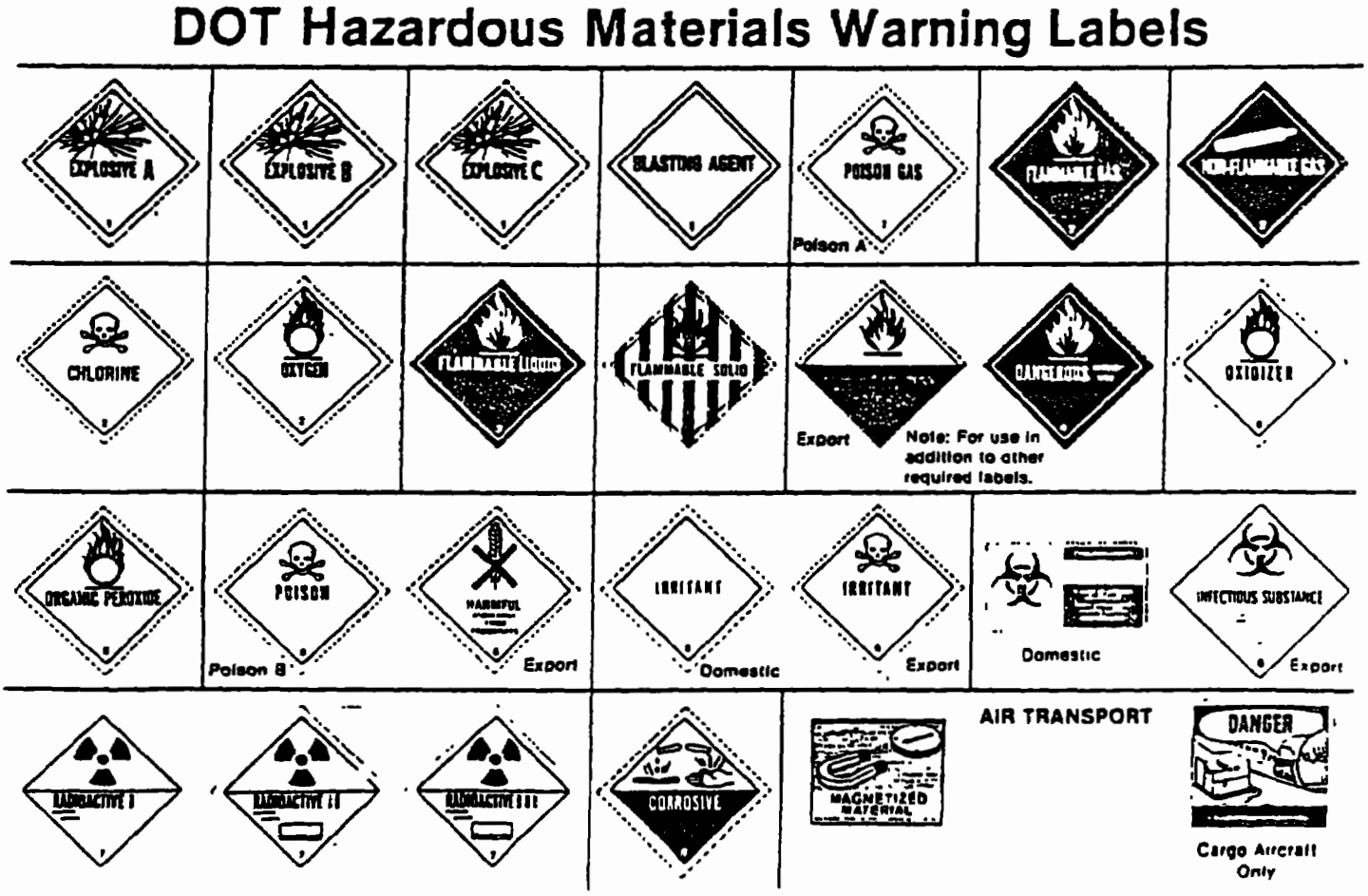
Hazardous materials table

(1)	(2) Hazardous materials descriptions and proper shipping names	(3) Hazard class	(3A) Identification number	(4) Label(s) required (if not excepted)	(5) Packaging (a) Exceptions	(5) Packaging (b) Specific requirements	(6) Maximum net quantity in one package (a) Passenger carrying aircraft or railcar	(6) Maximum net quantity in one package (b) Cargo only aircraft	(7) Water shipments (a) Cargo vessel	(7) Water shipments (b) Passenger vessel	(7) Water shipments (c) Other requirements
	Flame retardant compound liquid	Corrosive material	NA1760	Corrosive	173.244	173.291	1 quart	10 gallons	1.5	1.5	
+	Flammable gas n.o.s. *See* Compressed gas, n.o.s.										
	Flammable liquid, corrosive, n.o.s.	Flammable liquid	UN2924	Flammable liquid and Corrosive	173.118	173.119	1 quart	1 quart	1.5	1	
	Flammable liquid, n.o.s.	Flammable liquid	UN1993	Flammable liquid	173.118	173.119	1 quart	10 gallons	1.5	1	
	Flammable liquid, poisonous, n.o.s.	Flammable liquid	UN1992	Flammable liquid and Poison	173.118	173.119	1 quart	10 gallons	1.5	1	
	Flammable solid, corrosive, n.o.s.	Flammable solid	UN2925	Flammable solid and Corrosive	173.153	173.154	25 pounds	25 pounds	1	1	
	Flammable solid, n.o.s.	Flammable solid	UN1325	Flammable solid	173.153	173.154	25 pounds	25 pounds	1.5	1.5	
	Flammable solid, poisonous, n.o.s.	Flammable solid	UN2926	Flammable solid and Poison	173.153	173.154	25 pounds	25 pounds	1.5	1	
	Flare. See Fireworks, common										
	Flare, airplane. See Fireworks, special										
	Flash cartridge. See Fireworks, special or Low explosives										
	Flash marker. See Fireworks, common or special										
	Flash powder. See Fireworks, special or Low explosives										
	Flax. See Fibers										
	Flexible linear shaped charge, metal clad	Class C explosive		Explosive C	None	173.104	50 pounds	200 pounds	1.5	1.5	
	Flowers of sulfur. See Sulfur										
	Flue dust, poisonous	Poison B	NA2811	Poison	173.304	173.345	50 pounds	200 pounds	1.5	1.5	
	Fluoboric acid	Corrosive material	UN1775	Corrosive	173.244	173.245	1 quart	1 gallon	1.5	1.5	
	Fluoric acid. *See* Hydrofluoric acid										
	Fluorine	Nonflammable gas	UN1045	Poison and Oxidizer	None	173.307	Forbidden	Forbidden	1	5	Store in well ventilated space away from org in materials
	Fluorophosphoric acid, anhydrous. *See* Monofluorophosphoric acid, anhydrous										
	Fluorosilicic acid. *See* Hydrofluorosilicic acid										
	Fluorosulfonic acid or Fluosulfonic acid	Corrosive material	UN1777	Corrosive	None	173.274	Forbidden	1 gallon	1	5	Keep dry
	Forbidden explosives. See 173.53	Forbidden									
	Forbidden materials. See 173.21	Forbidden									
	Formaldehyde solutions (*flash point more than 141 deg F.; in containers of 110 gallons or less*) (*RQ-1000/454*)	ORM-A	UN2209	None	173.505	173.510	10 gallons	55 gallons	1.5	4	
	Formaldehyde solutions (*flash point not more than 141 deg F.; in containers over 110 gallons*) (*RQ-1000/454*)	Combustible liquid	UN1198	None	173.118a	None	10 gallons	55 gallons	1.5	1.5	
	Formaldehyde solutions (*flash point not more than 141 deg F., in containers of 110 gallons or less*) (*RQ-1000/454*)	ORM A	UN1198	None	173.505	173.510	10 gallons	55 gallons	1.5	4	
	Formaldehyde solutions (*flash point more than 141 deg F., in containers over 110 gallons*) (*RQ-1000/454*)	Combustible liquid	UN2209	None	173.118a	None	10 gallons	55 gallons	1.5	1.5	
	Formalin. *See* Formaldehyde solutions										
	Formic acid (*RQ-5000/2270*)	Corrosive material	UN1779	Corrosive	173.244	173.245 173.249	1 quart	5 gallons	1.5	1.5	Glass carboys in hampers not permitted under deck
	Formic acid solutions (*RQ-5000/2270*)	Corrosive material	NA1779	Corrosive	173.244	173.245 173.249	1 quart	5 gallons	1.5	1.5	
	Fuel, aviation, turbine engine	Flammable liquid	UN1863	Flammable liquid	173.118	173.119	1 quart	10 gallons	1.5	1	
	Fuel, aviation, turbine engine	Combustible liquid	UN1863	None	173.118a	None	No limit	No limit	1.5	1.5	
	Fuel oil	Combustible liquid	NA1993	None	173.118a	None	No limit	No limit	1.5	1.5	
	Fuel oil, Diesel. *See* Fuel oil										
	Fuel oil, No. 1, 2, 4, 5 or 6	Combustible liquid	NA1993	None	173.118a	None	No limit	No limit	1.5	1.5	
	Fulminate of mercury (dry)	Forbidden									
	Fulminate of mercury, wet. See Initiating explosive										
	Fulminating gold	Forbidden									
	Fulminating mercury	Forbidden									
	Fulminating platinum	Forbidden									
	Fulminating silver	Forbidden									
	Fulminic acid	Forbidden									
	Fumaric acid (*RQ-5000/2270*)	ORM E	NA9126	None	None	173.510	No limit	No limit	1.5	1.5	

DOT Marking and Labeling

Under DOT regulations, containers up to 110 gallons must have one of the 1,400 proper shipping names listed in the Hazardous Material Tables. In addition, there must also be a 4" x 4" diamond shaped label that contains a warning of the hazards present (see Figure 5-1).

FIGURE 5-1



EXAMPLE 5-1

ID No.	Guide No.	Name of Material
1058	12	LIQUIFIED NONFLAMMABLE GAS charged with NITROGEN, CARBON DIOXIDE or AIR
1060	17	METHYL ACETYLENE, mixed with 15% to 20% PROPADIENE, stabilized
1061	19	METHYLAMINE, anhydrous
1061	19	MONOMETHYLAMINE, anhydrous
1062	55	METHYL BROMIDE
1063	18	METHYL CHLORIDE
1064	18	METHYL MERCAPTAN
1065	12	NEON, compressed
1066	12	NITROGEN, compressed
1067	20	NITROGEN DIOXIDE
1067	20	NITROGEN TETROXIDE
1069	16	NITROSYL CHLORIDE
1070	14	NITROUS OXIDE
1071	22	OIL GAS
1072	14	OXYGEN, compressed
1073	23	OXYGEN, cryogenic liquid
1075	22	LIQUIFIED PETROLEUM GAS
1075	22	LPG, liquified petroleum gas
1075	22	PETROLEUM GAS, liquified
1076	13	PHOSGENE
1077	22	PROPYLENE
1078	12	REFRIGERANT GASES, n.o.s.
1079	16	SULFUR DIOXIDE
1080	12	SULFUR HEXAFLUORIDE
1081	17	TETRAFLUOROETHYLENE, inhibited
1082	17	TRIFLUOROCHLORO-ETHYLENE
1083	19	TRIMETHYLAMINE, anhydrous
1085	60	VINYL BROMIDE
1086	17	MONOCHLOROETHYLENE
1086	17	VINYL CHLORIDE
1087	17	VINYL METHYL ETHER, inhibited
1088	26	ACETAL
1089	26	ACETALDEHYDE
1090	26	ACETONE
1091	26	ACETONE OIL
1092	30	ACROLEIN, inhibited
1093	30	ACRYLONITRILE, inhibited
1095	26	ALCOHOL, denatured
1096	26	ALCOHOL, industrial
1098	28	ALLYL ALCOHOL
1099	29	ALLYL BROMIDE
1100	28	ALLYL CHLORIDE
1101	37	DIETHYLALUMINUM CHLORIDE
1102	37	ALUMINUM TRIETHYL
1103	37	ALUMINUM TRIMETHYL
1104	26	AMYL ACETATE
1105	26	AMYL ALCOHOL
1106	29	AMYL AMINE
1107	26	AMYL CHLORIDE
1108	26	AMYLENE
1109	26	AMYL FORMATE
1110	26	AMYL METHYL KETONE
1110	26	METHYLAMYL KETONE
1111	28	AMYL MERCAPTAN
1112	26	AMYL NITRATE
1113	26	AMYL NITRITE
1114	27	BENZENE
1114	27	BENZOL
1115	26	BENZINE
1118	27	BRAKE FLUID, HYDRAULIC
1120	26	BUTANOL
1120	26	BUTYL ALCOHOL
1123	26	BUTYL ACETATE
1125	29	BUTYLAMINE

MATERIALS IN BOLD ORANGE may require isolation or evacuation from spill areas. Find the material by name in the tables immediately following the Guide pages.

Guide 26 POTENTIAL HAZARDS

FIRE OR EXPLOSION

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

HEALTH HAZARDS

Vapors may cause dizziness or suffocation.
Contact may irritate or burn skin and eyes.
Fire may produce irritating or 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.
Isolate for 1/2 mile in all directions if tank or tankcar is involved in fire.
FOR EMERGENCY ASSISTANCE CALL CHEMTREC (800) 424-9300.
Also, in case of water pollution, call local authorities.

FIRE

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

SPILL OR LEAK

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

FIRST AID

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

UNIT 6

TOXICOLOGY

Educational Objectives

o The student should know the basic approaches to toxicity testing.

o The student should be able to illustrate a typical dose-response curve for toxicological data.

o The student should be able to define "LD^{50} and interpret such data.

o The student should realize the difference between LD^{50} and LC^{50}.

o The student should be able to distinguish between acute and chronic exposures.

o The student should be aware of some of the shortcomings of LD^{50} data.

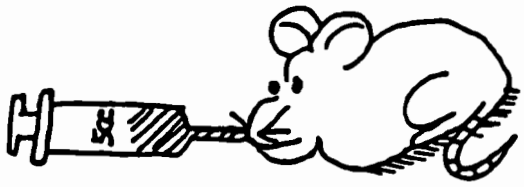
o The student should be familiar with factors which influence toxicity.

o The student should know different ways in which two different chemicals can affect each other's toxicity when present in the body together.

o Students should know the difference in effects caused by carcinogens, mutagens, and teratogens.

NOTES

Introduction



Toxicology is the science of poisons. If is the study of how chemical and physical agents interact with biologic systems to produce some negative response in affected organisms. Responses are measured and evaluated according to the amount of substance administered (DOSE) and the route of exposure.

Essentially all substances are poisons. The difference between a substance being toxic, non-toxic, or beneficial is determined by the dose. Toxicity is a measure of a substance's capacity to produce injury in living organisms.

It is important that response personnel become aware of toxicological data and how they are obtained. Route of entry and target organs of chemicals in the body determine how personnel should be protected in addition to maximum exposure limits. By knowing and understanding the fundamentals of toxicology, employees will be better able to determine the hazards they are faced with at the work site. Employees should ask themselves the following questions prior to entering any worksite:

- What toxic agents are present?
- How will they enter the body?
- How will they affect the body?
- How toxic are they?

Toxicity Tests

In order to gain imformation on the human toxicity of substances, controlled laboratory tests are run on animal species which, hopefully, can be correlated to human responses. The design of toxicity tests involves

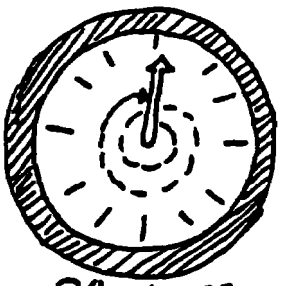
selection of :

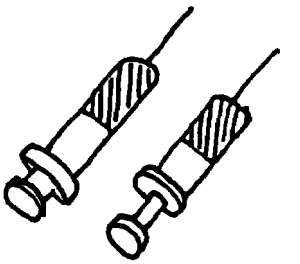
- A test organism (which can range from cellular material to higher order plants and animals.)

- A biological endpoint (observable or measurable response) which can range form subtle physiological or behavioral changes to death.

- A test period (exposure time)

- A dose or series of doses



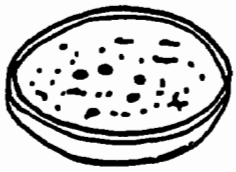


Test Organisms

Test organisms obviously vary significantly in physiology from humans. The proper selection of test animals requires a knowledge of which species most closely resembles humans with respect to the chemical of interest. The goal of animal toxicity tests is to predict chemical effects on humans. Thus, the fate of a chemical in humans, as well as its fate in various animal species, must be known in order to choose the best suited test species for a particular chemical.

In addition, the endpoint of choice plays a role in determining test species. If, for instance, the carcinogenicity of a chemical is being tested, the test orgamism of choice will be one with a short life span. It would be impossible economically to study carcinogenic effects in an organism whose life span is twenty years. Valuable research time would be lost, essentially wasting 20 years worth of human lives waiting for results from a single study. Man cannot afford to wait this long to determine if chemicals he is being exposed to are carcinogenic or not. Expenses would be prohibitive also.

Mutagenic effects can also be measured and extrapolated into possible carcinogenic effects. In this case species with extremely short life spans can be used to measure genetic effects.



Once a test species has been chosen, individual organisms are used which show as little variation among themselves as possible. Organisms are chosen of equal age, sex, and strain.

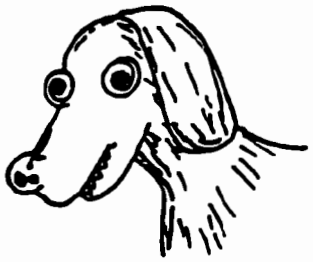
They must be healthy prior to testing so that harmful responses can be judged objectively. Controls are always used in toxicity tests. These organisms are treated exactly like test organisms with the exception that the dose administered does not contain the chemical being tested. At the end of the testing period, controls and test organisms are compared to see if controls remained healthy throughout the testing. If so, all detramental effects observed in the test animals are attributed to the chemical tested. There will be variation in response among tested organisms. Given identical doses, the majority of organisms will have a particular response, but a few will have little or no reaction and a few will have an extreme reaction.

Another consideration when choosing a test orgaism is population size. It is imperative that a large population size be used for toxicity tests in order to ensure statistically sound data. Financially, this limits the species of choice (rabbits chosen over dogs, for example) to smaller, easy to care for ones.

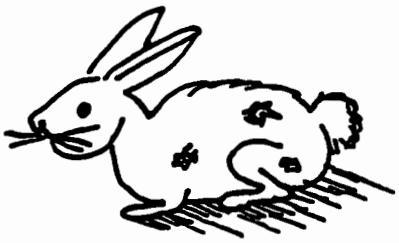
BIOLOGICAL ENDPOINT

The most common endpoint of choice in toxicity testing is death. One reason for this choice is its objectiveness. Many other endpoints, such as dermatitis or liver damage, leave room for judgement error. In addition, the chosen endpoint must be a

reproducible reponse. That is, in test after test, the same endpoint should be obtainable in response to the same dose(s).



Test data are plotted on a dose-response curve. If is from this curve that the dose (generally measured in milligrams (mg) of test substance per kilogram (Kg) of body weight of the test organism) which killed a certain percentage of test organisms is calculated. This calculated amount is called the lethal dose. The majority of toxicity tests (sometimes called bioassays) are designed to calculate the exact dose which kills 50% of the test organisms. This is called the median lethal dose, or LD^{50} and is a relative measure of toxicity. For example, if substance B has an LD^{50} =1000 mg/Kg, and substance A has an LD^{50} = 500 mg/Kg, given equal doses, substance A is more toxic than substance B (Figure 1). Other lethal doses (LD^{20} and LD^{80}, for example) are sometimes used in addition to the LD^{50} to judge the toxicity of chemicals at different doses. As seen in Figure 2, some chemicals (D) are very toxic at low doses and then, as the dose increases, toxicity increases only slowly. The opposite can also occur, where a chemical has a low toxicity at low doses, but as the dose increases slightly, toxicity increases greatly (C).



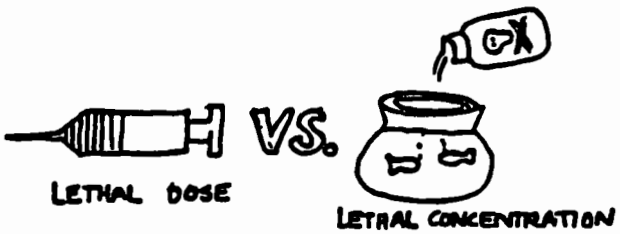
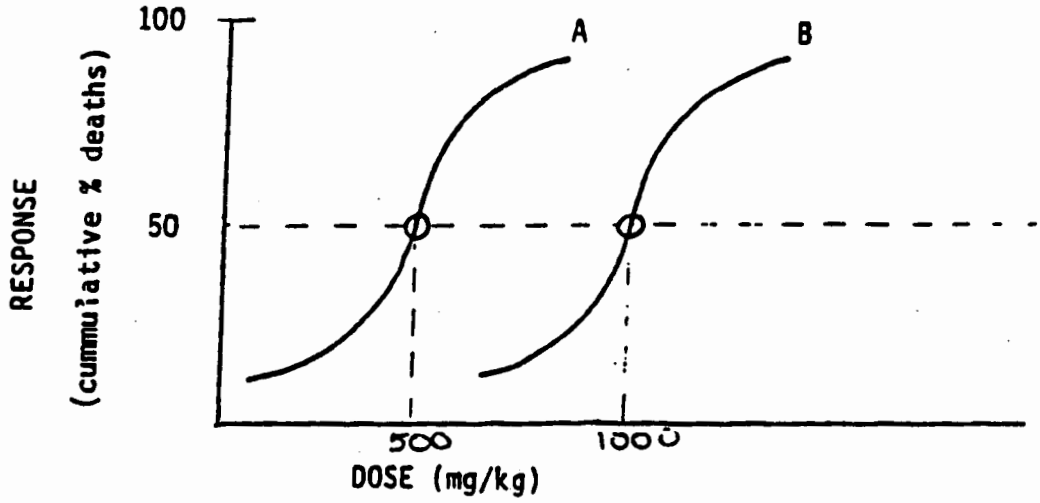
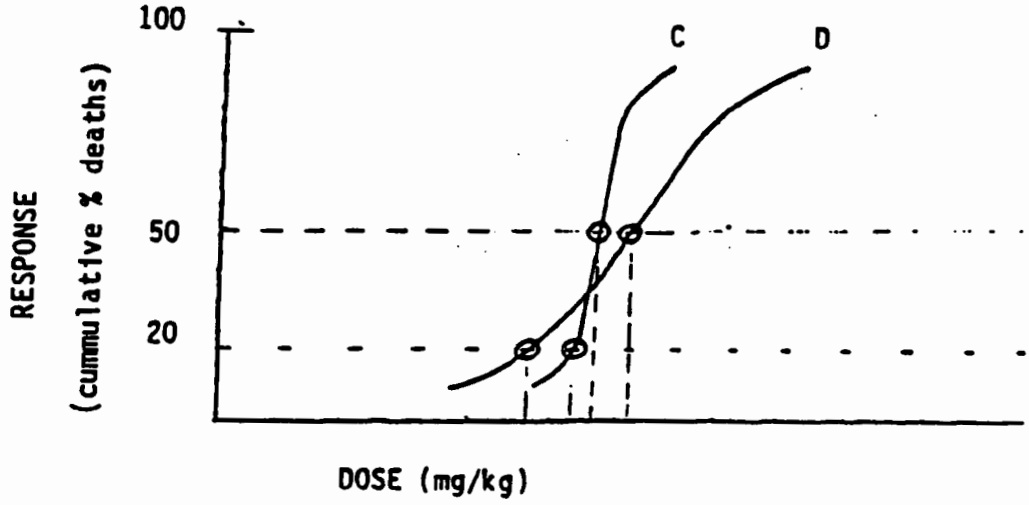


FIGURE 1



This illustration indicates that compound A is more toxic than B- that is, A gives the same response (50% deaths) as B at a lower dose.

FIGURE 2



From this illustration, compound C could be assumed to be more toxic than compound D, based on LD_{50}. This could be misleading because at lower doses the situation is reversed: at LD_{20}, D is more toxic than C.

When chemicals are dosed into the organism's environment rather than into the organism itself - as with airborne contaminants (for inhalation testing), or aquatic toxicity testing (where the test chemical is dosed into the water column), measurement of relative toxicity is based on median lethal concentration, or LC^{50}.

Terms often encounterred when evaluating toxicity data include:

Median Lethal dose (LD^{50}): A calculated dose of a chemical which is expected to kill 50% of an entire defined experimental population.

Median Lethal Concentration (LC^{50}): A calculated concentration of a substance in air, water, or feed, exposure to which, for a specified period of time, is expected to kill 50% of an entire defined experimental population.

Lethal dose low (LD^{lo}): The lowest dose, other than LD^{50}, of a substance introduced by any route which has been reported to cause death in the species of interest.

Toxic dose low (TD^{lo}): The lowest dose of substance introduced by any route over a given period of time which is reported to produce any toxic effect in humans or carcinogenic, neoplastigenic, or teratogenic effects in animals or humans.

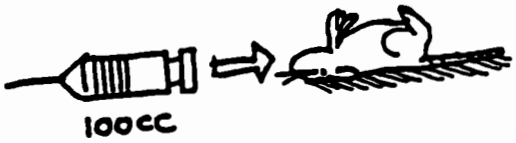
Toxic Concentration low (TC^{lo}): The lowest concentration of a substance in air, water, or feed to which humans or animals have been exposed for a given time period which produced any toxic effect in humans or carcinogenic, neoplastigenic, or teratogenic effects in animals or humans.

EXPOSURE TIME

Toxic effects are produced by acute or chronic exposure to chemicals:

o Acute exposure - a single exposure or multiple exposure occuring within a short time (24 hours or less). Usually it is a large single dose.

o Chronic exposure - several small doses over a longer period of time (usually months to years).



Exposures may also be of an intermediate length, termed subacute, subchronic, or short term exposure:

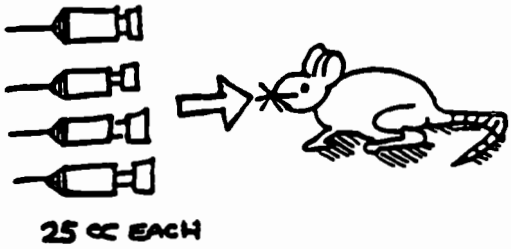
o Subacute exposure - exposure usually lasts 3 to 5 days.

o Short term exposure - exposure(s) usually lasts one to two weeks.

o Subchronic exposure - exposure(s) generally lasts three months.

DOSE - DOSES

The frequency of administration of a chemical also adds to characterization of its exposure. Generally speaking, fractionating the dose reduces the effect. Where a single large dose of a substance produces a given severe effect, halving the dose and administering it in two equal, separate doses may produce less than half of the original effect. In addition , dividing the original dose into ten doses may cause no ill effects at all. This decrease in additive effects occurs when metabolism or excretion takes place between successive doses of the toxic agent, or when the injury produced is partially or fully reversed between administrations of the agent.



When chronic effects occur, it is a sign that the agent accumulates in the body (absorption exceeds metabolism and

of excretion) or that effects caused by the agent are irreversible. Accumulation can also be a result of the frequency of dosing - there many not be time enough for recovery between doses.

DOSE-RESPONSE RELATIONSHIP

The most fundamental concept in toxicology is the dose-response relationship. This relationship is based on assumptions:

o The effect (response) is a result of the known toxicant administered.

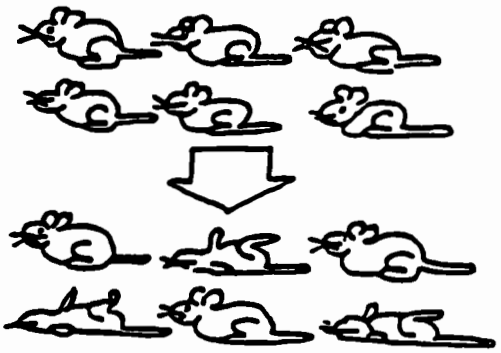
o The response is, indeed, related to the dose through this reasoning:

1. The response is a function of the concentration of toxicant at a specific site,

2. the concentration of toxicant at this specific site is a function of the dose administered, and

3. therefore, response and dose are causally related.

It is this correlation between the degree of a chosen response of the test organism's biologic system and the amount of toxic substance delivered that forms the basic dose-response relationship. When plotted graphically, this relationshup forms the classic sigmoid curve time and time again (as seen in Figures 1 and 2) which is indicative of toxicity test results.



As stated previously, the median lethal dose (LD^{50}) is the most frequently used endpoint in toxicity testing. This relative toxicity is measured for virtually every new chemical which is manufactured. Mice or rats are the most frequently used test animals for such testing.

The concept of LD^{50}'s is not without its shortcomings. The great majority of LD^{50} data are calculated based on acute bioassays. Chronic toxicity cannot be extrapolated from these data because nothing is known with reqard to distribution, bioaccumulation, metabolism, or excretion of the chemical in the body. For example, polychlorinated biphenyls (PCBs) were found to be relatively non-toxic in acute toxicity tests, but time has proved PCBs to be highly toxic after chronic exposure. This lack of chronic toxicity testing has taken it toll on human health in the past.

Another shortcoming of LD^{50} data is that there is often little information to go on for choosing a test species that mimics human exposure. Each chemical affects the body differently and thus it is difficult to pick a species which is affected similarly and with the same sensitivity as humans. For example, nearly all chemicals known to be carcinogenic in man are also carcinogenic in animals. One exception, however, is arsenic, which, although a human carcinogen, is not carcinogenic to animal species.

In addition, as seen if Figure 2, the LD^{50} is a single dat point and does not indicate the exact shape of the dose-response curve. The interval between a non-toxic dose and a lethal dose is not defined without further testing. It would be easy to get the wrong impression about the toxicity of a chemical from such data.

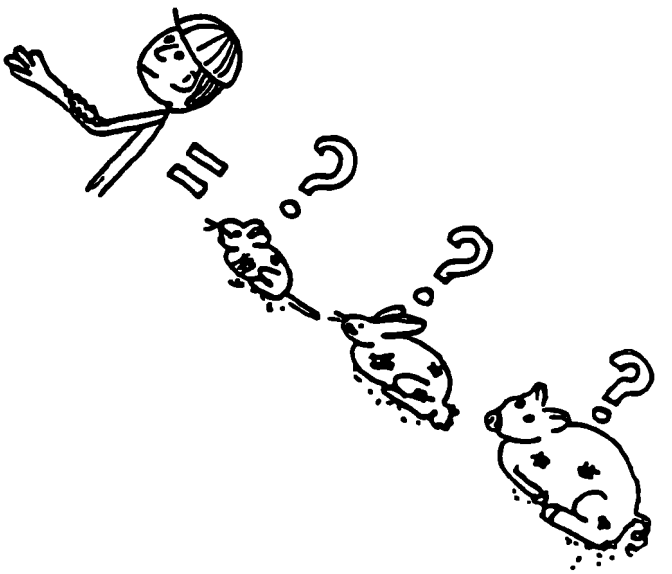


TABLE 1

TOXICITY RATING CHART

Probable Oral Lethal Dose for Humans

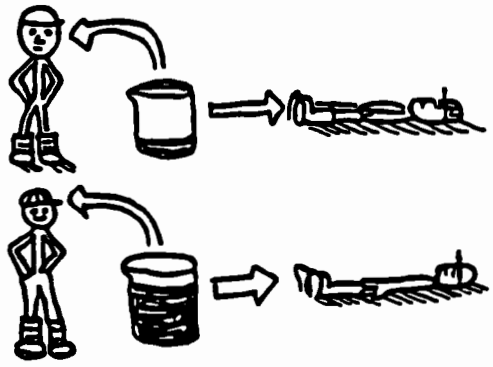
Toxicity Rating or Class	Dose	For Average Adult
1. Practically nontoxic	>15 g/kg	More than 1 quart
2. Slighty toxic	5-15 g/kg	Between pint & quart
3. Moderately toxic	0.5-5 g/kg	Between ounce & pint
4. Very toxic	50-500 mg/kg	Between teaspoonful & ounce
5. Extremely toxic	5-50 mg/kg	Between 7 drops & teaspoonful
6. Supertoxic	<5 mg/kg	A taste (less than 7 drops)

Source : Toxicology: The Basic Science of Poisons, p. 12, second ed., Doull, Klaassen & Amdur (eds.), 1980.

RELATIVE INDEX OF TOXICITY

When trying to interpret animal toxicity data as they apply to humans, it is necessary to use a conversion factor. To do this, LD^{50}'s (mg/kg) from animal studies are multiplied by 70 kg (the average weight of man) to give a rough estimate of human toxicity. This conversion is used assuming that humans have sensitivity to that of the test species to the chemical tested.

All toxicity test data, (i.e., LD^{50}), yield information pertaining to the relative toxicity of tested substances. Some chemicals are capable of producing death in microgram quanitities while others are essentially harmless in gram quantities. Toxicologists often classify chemicals based on computed LD^{50}'s. categorizing chemical toxicities, makes it clearer when the toxicologist answers the question, "How toxic is this chemical?" An example of such a classification scheme is given in Table 1.



The LD^{50} of various chemicals can vary widely depending on their relative toxicities, as seen in Table 2.

TABLE 2

Approximate Acute LD^{50} of a selected variety of chemical agents (for test animals).

Agent	LD^{50} mg/kg	Toxicity Class*
ethyl alcohol	10,000	Slightly toxic
sodium choloride	4,000	Slightly toxic
ferrous sulfate	1,500	Moderately toxic
morphine sulfate	900	Moderately toxic
phenobarbitol sodium	150	Moderately toxic
DDT	100	Very toxic
Picrotoxin	5	Extremely toxic
Strychnine sulfate	2	Extremely toxic
nicotine	1	Extremely toxic
D-tubocurarine	0.5	Extremely toxic
Hemicholinium-3	0.2	Supertoxic
Tetrodotoxin	0.10	Supertoxic
Dioxin (TCDD)	0.001	Supertoxic
Botalinus toxin	o.00001	Supertoxic

* There has been no conversion here from animal data to potential human toxicity. This column is used here to illustrate how toxicity classes (Table) are related to actual LD^{50} data for various chemicals.

Source: Toxicology: The Basic Science of Poisons, second ed, Doull, Klaassen & Amdur (eds.), 1980.

FACTORS INFLUENCING TOXICITY

Many factors affect the dose-response relationship and should be considered not only when designing toxicity test but also when interpreting toxicity data in specific situations. Some of these factors attribute to differences in the absorption, distribution, metabolism or excretion of toxic substances. These factors can be divided into the following categories:

o factors related to the toxic substance

UNIT 10

HAZARDS OF AIR SAMPLING

Educational Objectives

o The student should know what safety details should be discussed with work crews before traveling to the site.

o The student should be able to list the necessary precautions to follow before using a ladder.

o The student should be able to recognize safety procedures to protect workers below a working platform.

o The student should be able to describe safety precautions to prevent crew members from falling from heights.

o The student should be able to define precautions and procedures for erection of scaffolding.

o The student should be able to list procedures and precautions for hoisting equipment and supplies, and personnel.

o The student should be able to recognize safety precautions and procedures due to power line, static and lightening dischargers.

o The student should be able to list the situations requiring communications equipment and the type to use for these situations.

o The student should be able to describe the types of safety gear a stack sampling crew might need and the situations where it might be needed.

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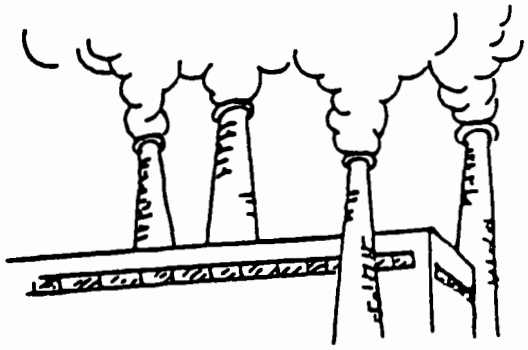
Introduction

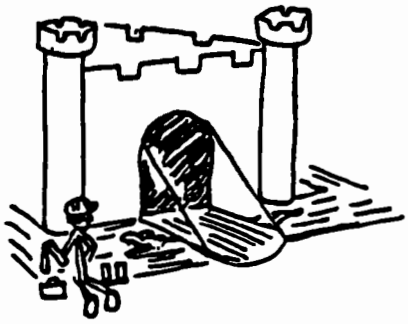


Stack sampling and source inspection present some safety and health problems that may not be encountered in other sampling environments. Stack sampling and source inspection often take place in complex industrial environments with many unexpected dangers, and sampling often requires working at heights. Stack sampling operations can also create hazards which may endanger plant personnel as well as sampling personnel.

This Unit will emphasize the hazards of working at heights, particularly in industrial environments, and the procedures and precautions that can and should be followed for safety.

Responsibilities

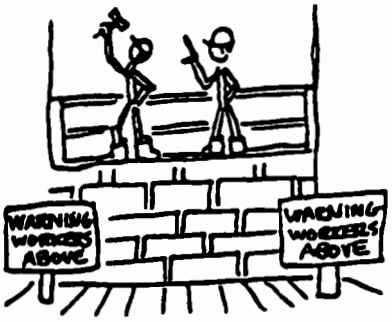
As the first step for preparing to work in an industrial environment, sampling crew members need to find out what hazards in the plant may endanger them and what the crew can do to protect themselves. (Some recommendations for gathering information on industrial plant hazards are discussed in detail in another Unit.)



Many industrial plants will provide safety and health information on request, and many have taken measures to guard and control hazards in their plants. However, you cannot rely upon industrial plants to provide safe working conditions for sampling personnel, even though plant management is responsible for providing a place of employment which is free of recognized hazards that are likely to cause serious physical harm. Sampling crews may have to work in plant areas that are not used by plant employees or that have unrecognized hazards, and crews may have to work in areas that have hazards that are not controlled or guarded. Therefore, sampling crews may have to

take more precautions and use more personal protective equipment than plant employees do.

Sampling crews also have an important responsibility to organize and conduct sampling operations so that they do not endanger crew members or plant employees, or cause damage to sampling equipment or plant property.



The sampling crew should provide control of any hazards that may be created as part of the sampling operation or source inspection, including hazards that may endanger plant employees or property. For example, the sampling team should rope off or barricade any area where tools or equipment may fall when they are being hoisted or used.

If any construction work has to be done to meet sampling requirements, such as erection of a scaffold or cutting a sampling port in a duct, an effort should be made to see that the work is done in ways that make subsequent sampling as safe as possible. For example, if a railing must be cut to provide for access of the sampling probe, the sampling organization should provide specifications for guarding the new openings in the railing with chain, rope, or strong temporary railings. If a new platform must be built or scaffolding erected, the new construction should have standard height guard railings, toeboards, and other safety features.

If you are assigned to be a project officer for stack sampling operations that are done by a Federal contractor, you will have a responsibility to see that the sampling is done according to the contract. Since all Federal contracts require compliance with Federal safety regulations and OSHA Standards, part of your responsibility is to advise the contractor <u>informally</u>

if safety precautions are not being followed and the contractor does not seem to be in compliance with Federal safety regulations. However, as a project officer you must not give directions to the contractor because any directions about contract performance must come only from EPA contract officers (otherwise you may become liable for the cost of the work done at your direction).

Ladders and Climbing

Since almost any source inspection or stack sampling activity will require crew members to climb fixed or portable ladders, this section begins with basic information on inspecting ladders for safety. Next is important information on how to climb ladders safely, and how to place them for safe climbing.

Inspection of Ladders

All ladders should be in good repair without any cracks or damage that will weaken the ladder. Fixed ladders attached to a structure should be securely fastened to the structure, and portable ladders should be positioned safely for use. All ladder rungs or cleats should be sound, securely fastened to the rails, and evenly spaced.

If ladder rungs and cleats are not evenly spaced, the ladder will be hazardous to climb. An even climbing rhythm depends on even spacing of rungs. Uneven spacing of rungs may cause a misstep which can result in loss of balance or grip and the possibility of falling. Climbing ladders with unevenly spaced rungs will require extra attention to avoid injury.

Climbing Ladders

Persons who are going to climb ladders should wear sturdy well-fitted

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gloves, sturdy boots in good repair, and clothing that is snug enough so that it is not likely to catch on the ladder.

Climbing and descending should be done facing the ladder. The foot should be placed on the rung so that the front edge of the heel is against the rung to prevent slipping, particularly on wet, oily or slippery rungs. The hands should firmly grasp the rungs, not the rails. Gripping the rungs for climbing, as firefighters are trained to do, provides greater control and less change of slipping than gripping the side rails of a ladder; the climbing rhythm followed so that at any time one had has a firm grip on a rung while the other is reaching for the next rung up or down.

Safe climbing requires both hands to be free for gripping the rungs of the ladder. Nothing should be carried in the hands while climbing. If tools and small equipment cannot be hoisted, they should be carried up ladders only in backpacks, on shoulder straps, or on belts. Care should be taken to prevent tools or equipment (in backpacks, in pockets, or on tool belts) from catching on a rung or rail and throwing the climber off balance, or from becoming dislodged from the pack and falling to a lower surface.

Portable ladders should be checked for total weight capacity. Never have more than one person climbing the ladder at one time. Check that there are no bows, bends, cracks, or rotted wood in the ladder. Never use a make-shift ladder constructed on site. Never use ladders as scaffolding or bridges to cross open areas. Ladders are designed to have part of the weight distributed in downward compression on the rail members. Use of a ladder as a scaffold or bridge may exceed its design strength.

Use only ladders that have cleated, non-skid feet or bottom pads. The single most frequent accident involving

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portable ladders is the bottom slipping outwards away from the vertical support surface. Make sure the bottom cleated pads rest on a non-slip, level surface. Beware of gravel, grass, smooth wet concrete, or oily slippery surfaces.

Before climbing a portable ladder, position a crew member at the foot of the ladder to stabilize the bottom while climbing is taking place.

Make sure the ladder is perfectly vertical before climbing. Never attempt to shift or move a ladder while still on it. Remove all equipment hanging from the rungs before shifting position of the ladder. When moving a ladder, position one crew member on each side to firmly grasp and stabilize it. Position the ladder with the base a safe distance from the vertical surface it is up against. If the base is too close to the vertical surface, there is the danger of the weight of the climber causing the ladder to fall backwards. If the base is too far from the surface, there is increased strain on the structural members of the ladder and a tendency for the bottom to slip away from the vertical surface. Table 10-1 gives recommended distances for given lengths of ladders.

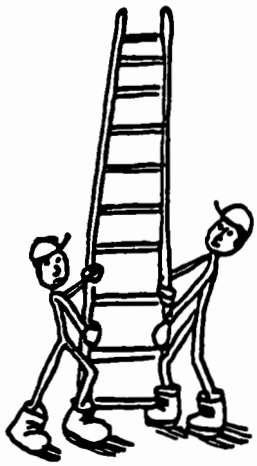


TABLE 10-1

PITCH OF FIXED LADDERS

Substandard Pitch Fixed ladders shall be considered as substandard if they are installed within the substandard pitch range of 60 and 75 degrees with the horizontal. Substandard fixed ladders are permitted only where it is found necessary to meet conditions of installation. This substandard pitch range shall be considered as a critical range to be avoided if possible.

Pitch Greater Than 90 Degrees Ladders have a pitch in excess of 90 degrees with the horizontal are prohibited.

Maintenance All ladders shall be maintained in a sale condition. All ladders shall be inspected regularly, with the intervals between inspections being determined by use and exposure.

SAFETY REQUIREMENTS FOR SCAFFOLDING

General Requirements for all Scaffolding Scaffolds shall be erected in accordance with this standard for persons engaged in work that cannot be done safely from the ground.

The anchorage for scaffolds shall be sound and capable of carrying the maximum intended. Unstable objects shall not be used to support scaffolds.

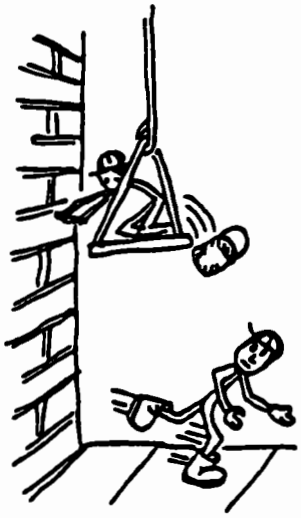
Guardrails should all be 2 x 4 inches, installed no less than 36 inches or no more than 42 inches high, with a midrail, when required, of 1 x 4 inch lumber. Supports should be at intervals not to exceed ten feet. Toeboards shall be a minimum of 4 inches in height.

Scaffolds shall be capable of supporting 4 times the maximum intended load.

Scaffolds shall not be altered or moved horizontally while they are in use of occupied.

Any scaffold damaged or weakened from any cause shall be immediately repaired and shall not be used until repairs have been completed.

Scaffolds shall not be loaded in excess of the working load for which they are intended.



Make sure the length of the ladder is adequate for the job. Reaching from a ladder that is too short is a prelude to disaster.

Protecting Areas BElow Work Platforms

Areas in the "impact zone" below sampling operations and hoisting operations should be roped off or barricaded to keep people out of the area where parts or equipment may fall.

Flooring of Work Platforms

Open-grating platforms used for stack sampling should be floored (with plywood) to prevent small tools and parts from falling through the grating. (This will help keep all the gear together, as well as keeping it from falling onto persons or equipment below.) If tools, equipment or hardware fall from a ladder or platform, the impact can cause damage or injury. If solid flooring and toeboards cannot be provided, tool belts and other devices should be used to prevent material falling from sampling areas.

To minimize tripping hazards in elevated locations, the flooring should be flat and level, and tape, tools, and small objects should be stored so that they do not clutter the work platform. Umbilicals and wires should be run so that they are kept out of the working path. Tripping hazards that cannot be eliminated should be minimized and marked to help reduce their danger.

Toeboards

Toeboards should generally be provided as curbs around the edges of working platforms to prevent equipment, small tools, and other gear from being pushed or kicked over the edge. Toeboards are not required if nothing in use can be dropped or if no one can walk

under the platform or close enough to the "impact zone" to be hurt.

Toeboards should generally be four inches in height from the top edge of the toeboard to the top of the working surface. Lumber that is 1" x 4" or 2" x 4" nominal is acceptable for toeboards.

Tools

It is important to prevent tools and other work material from falling off of elevated work platforms both for safety and for working without unnecessary interruption. Although toeboards and solid flooring will help, other measures may be needed.

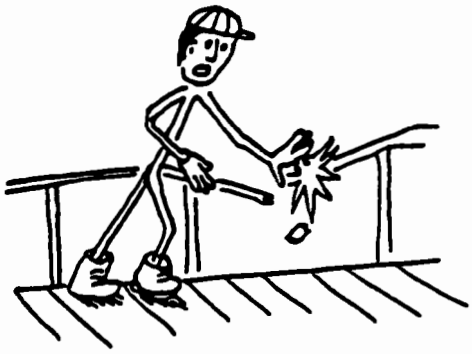
If tools or other equipment are used beyond the edge of the working platform, it is advisable to take special precautions to prevent them from falling. In some situations, it may be desirable to tie tools to the platform or other superstructure. For example, a tie line should definitely be attached to any wrench used to loosen a tight plug in a sampling port, in case the wrench slips and falls.

Protection Against Falls from Heights

Working platforms and scaffolds usually are built with standard guard railings, but roofs and temporary working surfaces seldom have any sort of railing. This section describes the standards for permanent and temporary guard railings, where railings are needed, and situations where safety lines may be needed.

Working platforms and elevated walkways should have guard railings high enough to prevent workers from falling off the elevated surfaces. If you find that the height of a guard railing is below your waist level or center of gravity, you will need to be aware of

that deficiency and use extra caution while you are working on the platform.



If you find that you have to work on a scaffold or platform that does not have a guard railing, you should find a way to get a temporary railing installed or use some other method to protect yourself, such as a fall-protection harness.

Standards for Guard Railings

Standard guard railings are generally required for any walking and working surfaces that are four feet or more above another level. Standard guard railings have a top rail that is 42-inches above the working surface, and a midrail that is about 21 inches above the working surface. (Midrails are intended to prevent workers from falling under the guard railings.)

Guard railings should be able to withstand a 200 pound force applied in any direction at any point on the top rail, in order to provide reliable protection. If a guard railing appears too weak to support you if you fall against it, do something to strengthen, supplement or replace the railing before you begin work on the platform or scaffold. If you decide to test a railing for any reason, try NOT to do it so that you fall if the railing fails.

Openings in Guard Railings

If sections of existing guard railing must be removed to provide access to sampling ports for long probes, there should be some alternative guarding of the opening in the railing. One alternative would be a temporary railing above and below the path of the sampling train.

Another alternative would be a protective railing that projects out beyond the opening and provides

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protection against falls.

If you encounter an unprotected opening in a guard railing, you should protect yourself by making a temporary railing with rope or other material.

If guard railings have openings for hoisting, stairs, or ladders that are near areas used for sampling operations, try to close the openings with a snap chain, rope or other temporary barrier to falling.

Since sampling operations must often be carried out in locations not designed for protection of work operations, existing railings may need to be augmented and temporary protection of openings may need to be added to prevent falls.

Temporary Guard Railings

If there is frequent need to walk or work near the unprotected edge of roofs or other elevated surfaces, a temporary guard railing can be installed to prevent falls. Such a railing can be provided by tightly-strung rope or cable at 21 and 42 inches above the surface. If rope or cable is used as a temporary guard railing, the rope or cable should have less than six inches of sway under a 200 pound force and no more than three inches of sag between supports. Strong vertical supports should be installed (safely) at intervals that do not exceed eight feet, so that the rope or cable can provide reliable protection.

On some high surfaces it may be desirable to provide a temporary guard railing or rope even if sampling personnel do not plan to work near the edge. If the surface slopes or is rough or slippery, there is need for a safety guard railing or rope or a safety line. In such hazardous situations, the 21-inch high mid-rail is particularly important to prevent someone from

slipping or sliding under the 42-inch high rope or guard railing.

Alternatives to Guard Railings

Although guard railings are usually required for walking and working surfaces that are four feet or more above another level, there are some situations where the risk of falling does not seem to justify the expense and hazards of erecting a temporary railing. For example, consider a one-story flat roof where sampling operations are twelve feet or more from the edge. Although sampling personnel can walk over to the edge, they will usually be working far enough away so they would not be likely to fall from the roof.

During set-up and take-down operations when the crew is hoisting equipment over the edge of the one-story roof, the hazard of the height is likely to be so obvious that the crew will pay great attention to the hazard and take precautions to avoid falling over the edge. However, if extra attention alone does not seem to provide great enough safety, some additional protection will be needed. If providing a temporary railing is hazardous, inconvenient or expensive, or if it interferes with hoisting operations, some other safety measure may be needed.

Under some extreme conditions, where guard rails or guard ropes cannot be provided for the work area and where fall distances could cause serious injuries, personnel should wear safety harnesses connected to well-rigged safety lines. Safety harnesses that provide protection against falls are the type with loops around the shoulders, legs and waist. Safety lines for fall interruption must be equipped with shock-absorbing devices to prevent serious or fatal injury from the impact of a sudden stop at the end of the rope.

Inspection and Erection of Scaffolding

If you are going to work from scaffolding, this section will list some important things to check before you go up on the scaffold. This section is also intended to give you some specifications and recommendations if you are responsible for supervising scaffold erection or contracting for it.

Inspection of Scaffolding

Portable scaffolds should be erected so that they are secure enough to minimize horizontal movement and to prevent them from tipping over due to wind, load, or working stresses. Scaffolds over twenty feet high should be secured or tied off at least at every twenty feet of elevation.

Working surfaces on scaffolding should obviously be strong enough to support personnel and equipment. If the floor of the platform is built of boards or sheets of plywood, they should not slide or fall off of the supports. If the floor is built of planks that overlap, they should overlap at least 12 inches or be nailed down or secured against movement. It is important that all plywood and planking be secured against wind forces which may move or lift them.

Before using a scaffold, use this safety checklist for the condition of the scaffold:

1. Are barricades or signs needed to prevent the scaffold from being struck by vehicles, and are they provided?

2. Is the feel of the scaffold stable and firm?

3. Is there an access ladder that is either built-in and continuous; or a temporary ladder lashed firmly?

4. Are all other connections made firm, either with pins, bolts, or nested construction?

5. Are there secure cross braces to prevent the scaffold from tipping?

6. Are the scaffold platforms at least twenty-two inches wide?

7. Are the scaffold platforms secured against teetering and being blown off by the wind?

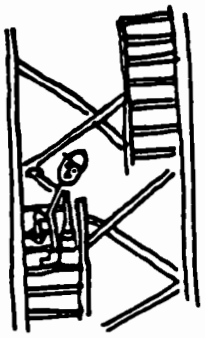
8. Do the platforms have 42-inch high guard rails with midrails, or does the cross-bracing give equivalent protection?

9. Do the platforms have toeboards?

10. Are the toeboards of sufficient height (3-1/2 inches or more) to prevent tools and equipment from falling?

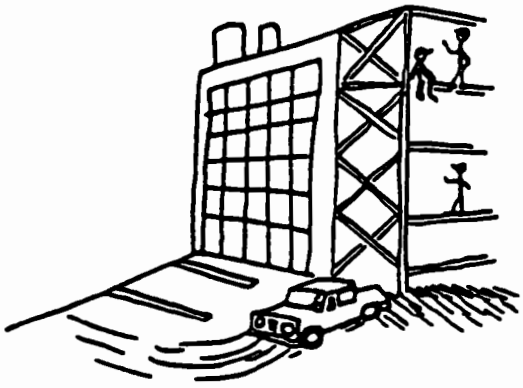
Erection of Scaffolding

Scaffolds should be cross-braced and erected on solid footings to avoid sinking into the ground or into the roof. Cross-braces serve the important function of keeping the scaffold erect by preventing it from tipping over or collapsing. Most sections of scaffolding should have the cross-braces connected, and the connections should be secured to keep the braces in place.



Scaffolds should be erected so the vertical sections are at right angles to each other to provide a rectangular area for the platform and greater strength.

Scaffolds with built-in ladder sections should be erected so that all the ladder sections are in a straight



run. This will facilitate use of the ladder and prevent injuries which may occur if personnel are unaware of, or forget shifts in the position of ladder sections.

If the scaffold is erected where it may be struck by vehicles, barricades and signs should be installed.

If you are responsible for erection of scaffolding, use the Checklist in the safety booklet as part of the specifications. The Checklist can also be used as informal safety information for anyone who may erect scaffolds Agency personnel may have to use.

Hoisting

Stack sampling usually necessitates raising equipment and replacement probes and supplies up to sampling sites, and lowering equipment and other material after the tests. Hoisting and lowering stack sampling equipment safely requires: rope, gloves, a clear path, a reliable method of stopping or controlling the rate of descent, a pulley or block and tackle for lifting heavy equipment, support for the hoisting device, methods of attaching loads, and reliable hooks and ropes. This section will discuss these requirements and the advantages provided by block and tackle.

Safe use of rope requires sturdy gloves for protection of the hands and for getting a secure grip on the rope. Gloves which have leather palms are effective.

Hoisting and lowering loads safely also requires communication and coordination between the person hoisting the load and the person guiding or receiving the load. If distances are great and ambient noise levels are high, the crew may need to have both visual and audible signals.

Clear Path

Hoisting equipment up to a sampling site requires a clear vertical path that is unobstructed and wide enough for safe passage of the equipment that has to be hoisted. If there is no clear path that can be used for hoisting, it will take a lot more effort to carry equipment up to the sampling site without risk of damage. As preparation for hoisting equipment and supplies up the sampling site, find out if there is a clear path for hoisting or what route will have to be followed. This information should be obtained as soon as possible, either during the initial visit or as a part of a pre-sampling or preliminary survey.

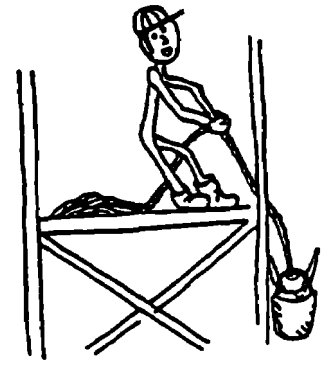
Hoisting Procedure

Before lifting any loads up to the sampling site, the hoisting area should be roped off or marked to warn passersby. Access to the hoisting area should be limited to the crew members doing the hoisting or guiding the load, who should definitely be wearing hard hats.

(The rope or signs should be removed after the hoisting has been completed and there is no danger of tools or equipment falling, or after the sampling has been completed. You may have to remove the signs and barricades around the hoisting area right after you complete the hoisting if the plant needs to use the area for work or for traffic.)

No one should be directly under a load being hoisted, even if block and tackle are being used.

If possible, when loads are lifted, the hoisting line should be directly above the load so that the load is lifted straight up from its resting position. Pulling a load sideways as it is being lifted may cause it to swing



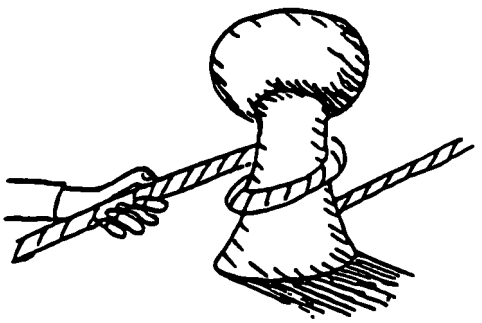
and damage the load.

To keep loads from swinging or blowing while they are being hoisted, a tail line or guide line is recommended for control. The tail line or guide line is controlled by the crew member on the lower level at the hoisting site.

Controlling the Rate of Descent

Controlling the rate of descent of a load is important to prevent damage to the load or injury to personnel. If equipment is lowered directly on rope by hand or over a simple pulley, personnel could lose their grip and drop the load or burn their hands on the rope as the load accelerates downward. Although the rate of descent can be controlled best by use of a power-driven hoist or a block and tackle, a load can be lowered safely on a rope if the controlling end of the rope is looped around a support so that friction can be used for braking.

If equipment is going to be lowered directly, it is possible to provide excellent control by looping the rope around a railing or post.



Control of the pull on the running end of the rope can control the friction of the rope around the railing or post and make it easy to lower the load gradually and safely with very little effort. (If a capstan or a capstan-like device is available to loop the rope over, it has the advantage that a loop may be thrown over the capstan without having to find the end of the rope.)

Pulleys and Block and Tackle

Although hoisting <u>without</u> pulleys has been common in stack sampling work, use of one or more pulleys is recommended. Using a pulley for hoisting a load will usually reduce the strength required for hoisting, and may

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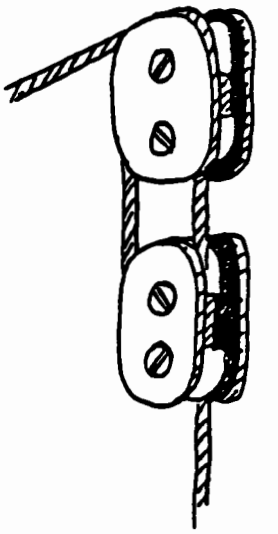
allow the person hoisting the load to work from a safer position. Pulleys and rigging should be standard equipment for stack sampling crews.

Sites over fifty feet high and those which are sampled regularly should have a pulley support installed. Some companies have installed gallows frames and pulleys permanently in such locations.

The condition of frames and supports should be checked before using them, particularly in corrosive atmospheres.



A block and tackle is a combination of rope and two pulleys used to reduce the amount of force needed for lifting. If heavy loads need to be lifted to stack sampling sites, or controlled carefully on long lifts, the job can be done with less stress on the crew by use of block and tackle. The reduction of force required to lift a load with block and tackle is offset by the need for longer rope and the time to pull it through the pulleys.

Rigging block and tackle is done by placing the blocks or pulleys close together in the same relative position as they will be used, and threading the end of the coiled rope through the pulleys to the connecting point on one of the pulleys. Then the blocks can be pulled apart as needed without kinking or tangling the line.

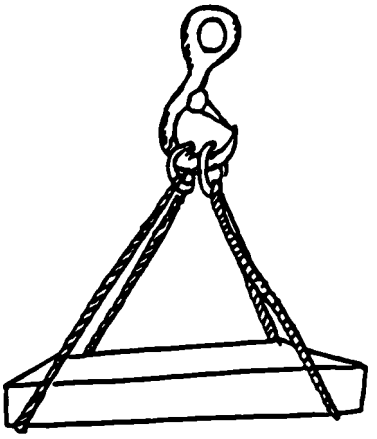
The recommended storage procedure for rope used in block and tackle is to pull the blocks together, coil the rope, and store the coiled rope with the end on the bottom and the block and tackle on top. With this procedure, the block and tackle are ready to use without tangling or kinking of the rope.

Hooks and Other Devices for Attaching Loads

Hoisting ropes should be provided with hooks to be used for attaching loads. All hooks used for hoisting should have safety catches to keep loads attached to the hook until the safety catch is released. The safety catch is designed to prevent the load attachment or supporting eye or line from slipping out of the eye of the hook.

The hook used for hoisting loads should be strong enough to hold the load without bending out of shape. (As a rule of thumb, the load in tons that can be carried safely by a hook is equal to the square of the diameter of the eye. As a rough estimate, a hook with a half-inch diameter eye could safely carry a one-quarter ton load and a hook with a one-inch diameter eye could carry a one ton load safely.)

Loads to be hoisted should have well-attached connections (such as an eye or sturdy handle) for the hoisting hook or the hoisting line.



If loads do not have connections, the loads should be supported in slings or be lashed so that the load will not shift or drop during the hoisting and lowering. When hoisting probes or other equipment without a specific attachment point, it is safer to provide a separate sling or binding rope than to use the hoisting rope to wrap or tie the load. The most commonly used sling is composed of two lengths of rope with a galvanized eye spliced into each end of each rope. To use the sling, one length is passed under each end of the load and the four eyes are hooked onto the tackle hook of the hoisting line.

If a connecting device such as a shackle or clevis is used in the sling, the safe load in tons is estimated to be the diameter of the pin in 1/4-inches

squared and divided by three. For example a half-inch diameter clevis pin is two quarter-inches, and two squared and divided by three is 4/3 or 1-1/3 tons.

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(These rules of thumb are not suggested as a substitute for accurate tables and reference material from manufacturers of hooks and connecting devices, but they may be useful as a safety check while in the field.)

Rope

Rope needs to be strong enough to support the load to be lifted, and large enough in diameter to allow a firm grip for the load to be lifted. For example, rope that is 1/4-inch in diameter is not large enough to allow a firm grip for a heavy load; 1/2-inch or 3/4-inch diameter rope will allow a firm and comfortable grip.

The estimated safe load for manila rope not larger than one-inch in diameter, in tons of weight-bearing capacity, is obtained by squaring the diameter of the rope in inches. For example, a one-inch rope could safely carry a load of one ton, and a 1/2-inch rope could carry a load of 1/4 ton. Sisal rope can carry only one-third the afe load of manila rope.

Care should be taken to avoid kinking or dmaging rope, getting it wet, or dragging it in the dirt. If rope gets direty, it should be hosed off and then loosely coiled to dry. If rope must be passed over sharp corners or edges, the charp corners or edges should be padded or protected (with chaging gear) to prevent damage to the rope.

Rope should be routinely inspected for wear, breaks or other defects either prior to each use or after each use (to save time when the rope is needed). Manila and sisl rope may need to be

replaced every year if used often or wetted frequently.

Rope that is rotten, frayed, or severely worn is not reliable and should not be used.

Elevators and Manlifts

Elevators

Passenger elevators are usually well maintained and regularly inspected where the passenger load and frequency of use are great, as in office and commercial buildings. However, small industrial elevators and hoists may seldom be used or inspected regularly and may be poorly maintained. Before a hoist or small elevator is going to be used for access to tall stacks, the sampling crew should test the operation of the hoist or elevator and test the alarms and phones to see if they work and if someone will respond to them. The crew should also check out what escape routes may be available if the elevator or hoist stops during use. (Before performing these tests, notify plant personnel.)

If the hoist or elevator seems to be unreliable, the sampling crew should see what maintenance or emergency assistance can be provided. If alarms do not work, or phones are not reliable, the crew should carry a radio or other signaling device so that assistance can be obtained if the hoist or elevator stops between landings. If there is the possibility that the hoist or elevator may stop between landings, find out whether it is possible to get out of the car and whether there is any safe way to get to a ladder or other route to the ground.

Manlifts

Manlifts are vertical conveyor belts for moving people from floor to

floor in less space and time than required by stairs. Manlifts are old-fashioned, dangerous and not designed to move equipment or freight. Do NOT use a manlift unless it cannot be avoided.

At the top of any manlift there should be two automatic safety devices which cut off the power and set the brake if the person does not step off the manlift at the top platform. (If there were no safety devices and you did not let go, you would go up over the top pulley and down the other side!) At the platform there should be a grab bar to permit the rider to swing free and on to the top landing if the emergency stops fail to operate at the top of the manlift.

Before riding a manlift, check to be sure that:

1. the emergency stop at the top of the manlift operates,
2. the emergency stop rope or rod beside the manlift operates,
3. there is a permanent ladder accessible at the side of the manlift,
4. the underside of the floors or platforms and cone-shaped guards to guide the ascending person through the floor opening,
5. there is sufficient illumination to see the platforms and stops,
6. there are instructions posted on each landing,
7. the belt has not been spliced and does not show wear, and
8. the top landing has a sign designating it as the top landing and to get off.

To ride a manlift safely:

1. Never carry tools or objects in your hands or protruding from your pockets or belt--they may catch in the floor openings.

2. Face the belt and get ready to grab the handhold and place your feet on the step quickly.

3. Do not leap to catch a step that has passed the floor landing.

4. Hold on to the handholds firmly with both hands.

5. Put both feet squarely on the step, quickly.

6. Be ready to get off quickly at the floor level you want.

7. Step away quickly to make room for the next person getting off the lift.

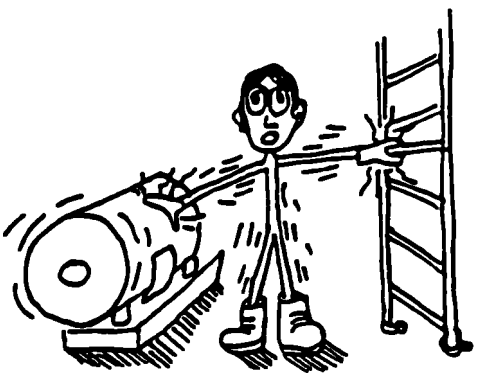
Electrical Hazards

Electrical hazards in stack sampling operations can come from three major sources: current leakage from line-powered electrical equipment, static electricity, and lightning.

Current Leakage from Equipment

Sampling personnel may be exposed to serious shock hazards from line-operated electrical equipment which does not have a safe and effective grounding connection.

Ungrounded electrical equipment can be deadly because exposed metal parts will be "hot" (at line voltage) if the "hot" side of the line has short circuited to the case or other exposed metal parts. If sampling personnel were to touch these exposed metal parts at the same time they touched a grounded metal object such as a pipe, they could be electrocuted. The hazard is insidious because such a short circuit will not necessarily keep the equipment from operating.



If the metal case or exposed parts

are connected to a grounding circuit, any internal short-circuit will trip the circuit breaker rather than injure someone. If grounding circuits cannot be provided, or if tests by the crew show that the grounding connection is not grounded, the crew should use a portable ground fault circuit interrupter (GFCI).

If any sampling apparatus has a noise-filtering capacitor, the apparatus will not operate on a circuit with a Ground Fault Circuit Interrupter (GFCI) because the capacitor will trip the GFCI. If you have this type of apparatus, a grounded circuit or connection to ground must be provided for safety.

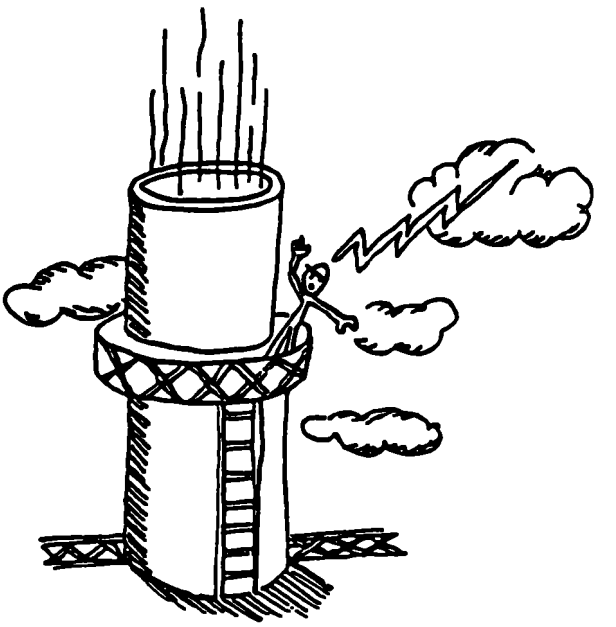
Static Electricity

Sampling personnel may also be exposed to shock hazards if they are sampling a process stream which carries a significant charge of static electricity from particulates in the process stream or from an electrostatic precipitator. Sampling probes should be grounded to remove static electricity and prevent shocks to sampling personnel.

Shocks from static electricity may cause discomfort or injury, or may startle sampling personnel and cause them to jump back and fall from an elevated platform.

Lightning

Sampling personnel working on stacks or other elevated structures are exposed to increased hazards from lightning, particularly if they are working with grounded electrical equipment. Personnel in such situations should be alert to approaching storms, since lightning may strike in advance of a storm. Sampling operations should be discontinued when there is a hazard of



lightning. In order to anticipate lightning hazards, sampling personnel should use a portable a.m. radio to monitor local weather reports and listen for static interference which may indicate lightning discharges in the vicinity.

Communications

There are three types of communication that are important for safe stack sampling operations: communications between members of the sampling crew, a communications link with plant personnel, and a portable receiver to monitor local stations for weather reports and for static which may indicate approaching storms.

If sampling sites are in locations where there may be flammable concentrations of gases or vapors, electrical equipment and radios should not be taken in without first finding out from plant personnel that they are safe or can be adapted to work safely in hazardous atmospheres.

Communication Between Members of the Crew

Rapid and effective communication is needed between members of sampling teams for routine operations and for emergency and safety-related messages. Delay or confusion in communication during setup and breakdown or during hoisting operations can result in damage to equipment and injury to personnel. Good communication is especially important for safe and effective operations that are not routine, that are carried out or assisted by another crew, or that require close cooperation between people who may not be used to working together.

Radios are recommended for communication between sampling team members, for carrying out routine

monitoring tasks, and for communicating about safety problems that may arise. Radio communication is effective for conveying special directions during setup and breakdown, and for describing emergencies and the type of help needed. EPA field experience has been that FM radios are needed, because CB channels are used so much that it is difficult to communicate quickly and without interference.

It may be possible to communicate effectively in sampling operations by means of shouting, if distances are not too great, winds are not too high, and noises in the sampling area are not too great. However, voice communication is easily interfered with by equipment noise, passing trains and other vehicles, and concentration on the work. Hand signals and gestures can be used for simple messages such as "move the probe," but usually some audible signal is needed to attract attention to the visual message.

Inexpensive whistles, horns or bells can be used either to call attention to visual signals or send audible signals. Where distances or ambient noise levels are too great for a hand bell or mouth-powered whistle or horn to carry clearly, there are Halon-powered hand-held horns that can be used effectively.

Communication Between the Crew and the Plant

It is also desirable to have a means of communicating with plant personnel in case of any emergency. In some cases it may be possible to borrow a radio that is on the plant frequency.

If an emergency occurs in or near the sampling operations (such as observation of lightning, or high winds, or damage to equipment, or injury to personnel) sampling personnel need to

have some means of communicating this emergency and obtaining the help that is needed.

In case of a plant emergency, such as a fire, tornado warning, or unexpected release of toxic chemicals, it is imperative that sampling personnel know the plant emergency signals and how to respond promptly and correctly.

Communication for Weather Information

It is desirable to have a portable receiver to monitor local stations for weather reports and for static which may indicate approaching storms.

Protective and Emergency Equipment

Protective Equipment for Routine Hazards

Stack sampling personnel should be sure to have the personal protective equipment that may be needed for exposures in sampling operations. Such equipment will include the personal protective and safety equipment for the routine exposures expected, and it may include emergency breathing equipment as a special precaution. (See Units pertaining to these subjects)

Under some conditions, stack sampling personnel may need air-purifying respirators, and under other conditions they may need self-contained breathing apparatus.

Approved air-purifying respirators provide acceptable protection only, for exposures to irritating or toxic gases and vapors in concentrations that are known to be within the limits of protection provided by the respirators. (See Units pertaining to these subjects.)

p

NOTES

Emergency Equipment

Emergency equipment should be provided at the working elevation for the types of emergencies which may occur there, because there will be a delay in emergency response from personnel at a different elevation. For example, if corrosive chemicals can be splashed in the eyes or on the skin, or if heat stress is severe, a supply of emergency water is needed at the working elevation. Adhesive bandages may be needed for minor cuts, and emergency lighting may be needed in case of power failure during night operations or operations inside of windowless buildings.

Approved self-contained breathing apparatus or air-line respirators must be provided and be within immediate reach of the crew if there are hazards of exposure to concentrations that are either unknown or beyond the limited capacities of filter-type respirators. Such breathing apparatus should also be provided if there is the possibility of release of high concentrations of deadly gases such as hydrogen sulfide, hydrogen cyanide, or hydrofluoric acid.

If unique hazards such as hydrogen sulfide, hydrogen cyanide, or hydrofluoric acid may be present in high concentrations, the sampling crew may need to have special protective and emergency medical equipment.

Weather Hazards

Snow, rain, and dust storms are likely to interfere with communication and cause other problems that will prevent safe sampling operations. Such storms may also reduce visibility and mobility and increase hazards to the extent that sampling operations will need to be stopped. If ladders, stairs, platforms and other walking and working surfaces are covered with ice or snow, or are icing up from a freezing rain, there should be no climbing (except to

"retreat") and no work at elevations.

Weather conditions can also affect sampling equipment and personnel working outside and increase the hazards of the sampling operation and the needs for protective equipment.

Heat Hot weather and direct sunlight can contribute to the heat load from process equipment and from physical activity, so that it may be necessary to monitor for signs of heat stress. High temperatures may also cause samples to volatilize and to pressurize sample containers so that there is risk of a leak or spray from the container. Metal in direct sunlight may become hot enough to cause thermal burns to unprotected skin. Heat stress may require special protective clothing, extra drinking water or other fluids, and monitoring of personnel for sunburn or symptoms of heat exhaustion or heatstroke.

Cold Cold weather, wet clothing and wind can cause frostbite, hypothermia, or other adverse effects. Low temperatures may also freeze lines and cause sampling equipment to malfunction.

STUDENT EXERCISE I

Examine Figure 1. List as many safety violations as can be found. (Hint: There are at least 10)

1. _____

2. _____

3. _____

4. _____

5. _____

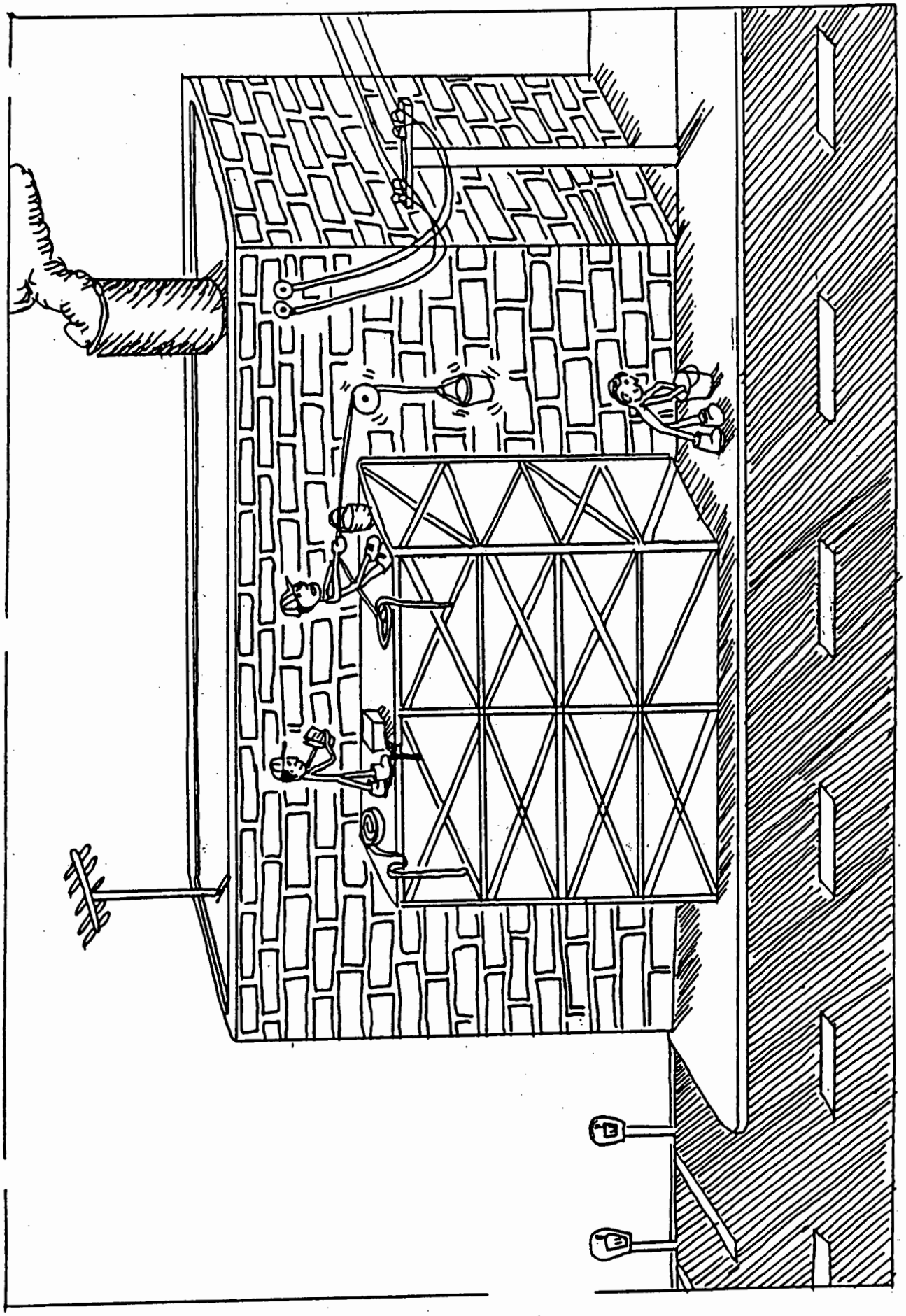
6. _____

7. _____

8. _____

9. _____

10. _____



STUDENT EXERCISE II

a. Will a hook with an eye of 1/2" safely support a load of 1,000 lbs?

b. Will a 1/4" clevis pin safely support a load of 1,000 lbs?

c. Will a manila rope of 3/4" diameter carry a load of 1,000 lbs?

UNIT 11

INSPECTION SAFETY FOR WATER AND WASTEWATER PLANTS

Educational Objectives

o Students should be able to list the most frequent types of accidents that occur at water and wastewater plants.

o Students should be able to identify where most accidents occur in water and wastewater plants.

o Students should be able to list the physical dangers of grit chambers, screens and comminutors.

o Students should be able to summarize the chemical hazards of grit chambers, screens and comminutors.

o Students should be able to recognize the essential safety precautions to be followed prior to entry into grit chambers, screens and comminutors.

o Students should be able to recognize the physical and chemical hazards of clarification and aeration facilities.

o Students should be able to list the minimum safety precautions to be followed before inspection of clarifiers and aeration tanks.

o Students should be able to identify the safety hazards associated with chlorine.

o Students should be able to list the safety precautions to be followed prior to entering a chlorine disinfection room.

o Students should be able to list the safety precautions to be followed when inspecting lagoons and ponds.

o Students must be able to recognize specific health hazards associated with common chemical names found in laboratories.

o Students must be able to summarize safety precautions that should be followed in a laboratory.

o Students should be able to recognize and define confined space.

o Students should be able to list potential hazards of confined spaces.

o Students should be able to describe the confined space environment classified as Class A, Class B, and Class C.

o Students should be able to list safety precautions to be followed for each class of confined space environment.

o Students should be able to demonstrate a knowledge of ambient air quality standards.

o Students should be able to recognize the physical hazards associated with confined space entry.

o Students should be able to list minimum safety equipment necessary for confined space entry.

o Students should be able to recognize and evaluate chemical hazards associated with wastewater.

o Students should be able to demonstrate a knowledge of the hazards of specific gases and vapors associated with wastewater.

o Students should be able to list diseases and symptoms commonly associated with wastewater.

o Students should be able to summarize the personal protection

necessary to reduce contact with pathogenic organisms.

o Students should be able to describe the personal hygiene required to prevent infection.

NOTES

Introduction

The safety and health of agency employees entering water and wastewater plants can be best analyzed by examining the overall hazards that exist at these plants. In the routine of a thorough inspection of such plants, agency personnel face, on a limited basis, all the potential dangers encountered by daily operations personnel.

Operational techniques used by various systems such as trickling filter plants or activated sludge plants pose unique hazards. It is not within the scope of this course to single out particular plant types. The possible hazards present at each of these types of plants will be handled collectively. As routine inspections will most likely include a wide variety of plant types. Inspectors should thoroughly aquaint themselves with all the hazards that may be encountered.

Types of Accidents and Frequency

The following is a summary of the types and locations of accidents and hazards routinely reported in water and wastewater plants (see Figure 11-1).

FIGURE 11-1

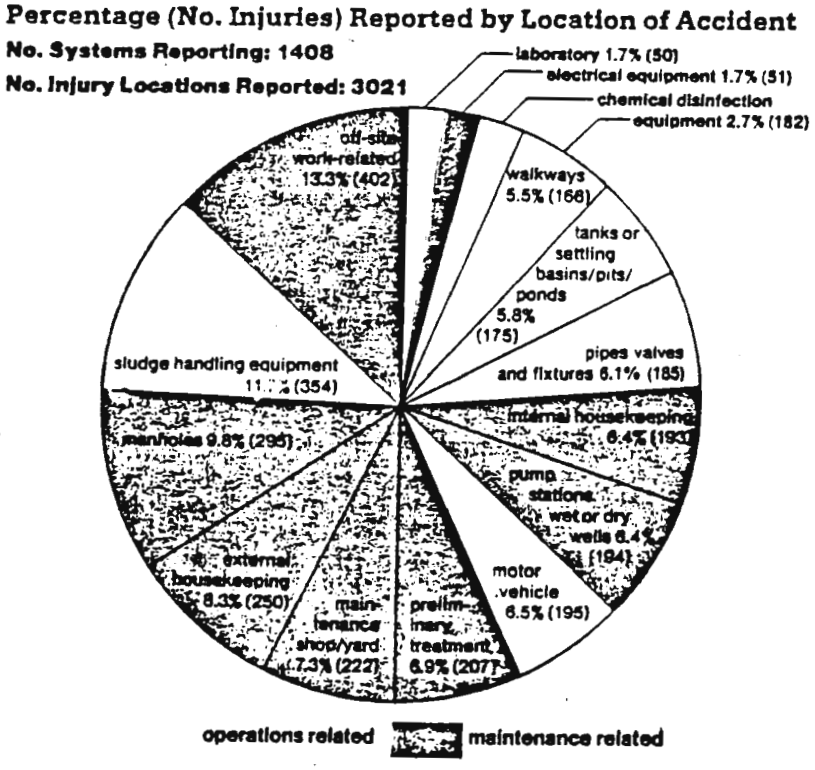

Percentage (No. Injuries) Reported by Location of Accident
No. Systems Reporting: 1408
No. Injury Locations Reported: 3021
laboratory 1.7% (50)
electrical equipment 1.7% (51)
chemical disinfection equipment 2.7% (182)
off-site work-related 13.3% (402)
walkways 5.5% (166)
tanks or settling basins/pits/ponds 5.8% (175)
pipes valves and fixtures 6.1% (185)
sludge handling equipment 11.7% (354)
internal housekeeping 6.4% (193)
manholes 9.8% (295)
pump stations wet or dry wells 6.4% (194)
external housekeeping 8.3% (250)
motor vehicle 6.5% (195)
maintenance shop/yard 7.3% (222)
preliminary treatment 6.9% (207)
operations related
maintenance related

Table 11-1 indicates a reversal in accident rates. Prior to 1983, the industry was recording a gradual decline in accident rates. The year 1983 saw the rate beginning to climb. Statistics indicate that at the present accident rate, one in every 10 workers will receive an injury requiring lost work time. In the last year seven fatalities were reported as a result of job related accidents at water and wastewater facilities.

Long Term Injury Rate for Treatment Plants and Collection Systems

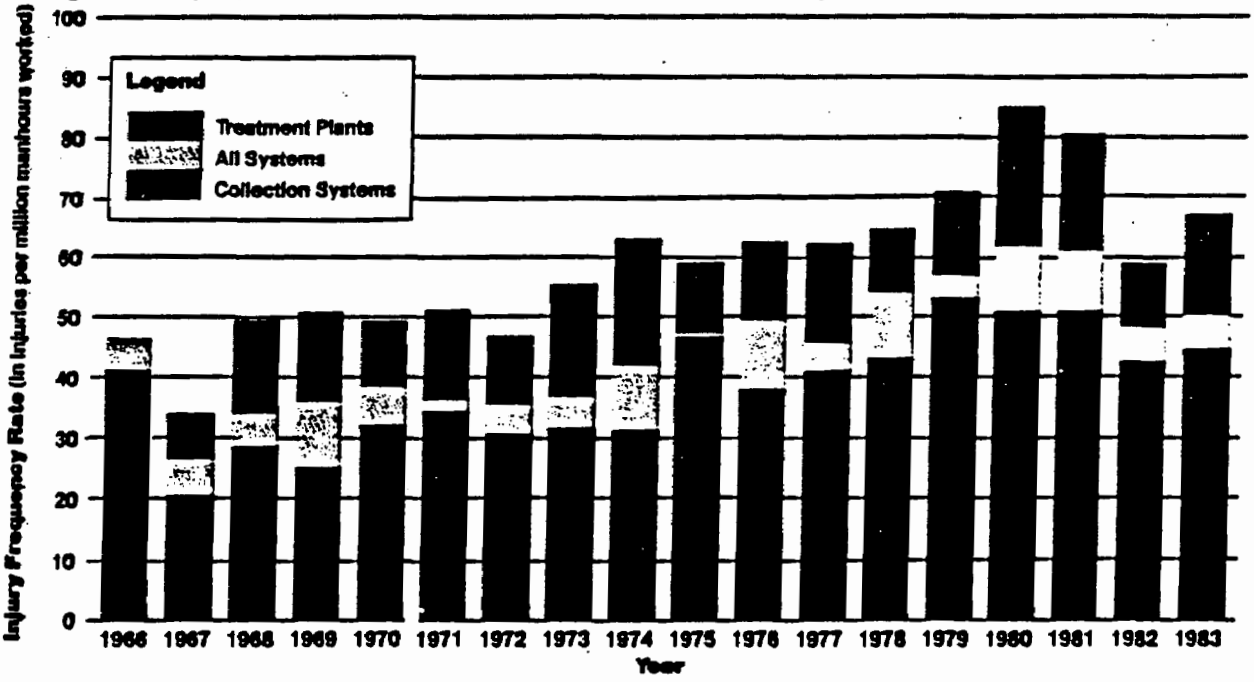


TABLE 11-1

1983 Personnel injuries in wastewater works U.S. and Canada (as determined from WPCF 1984 Safety Survey).

A	B	C	D	E	F	G	H	I	J
				Collection systems only					
< 10	255	1175	692	846.76	32	37.79	247.2	291.9	0
> 10 to 25	141	2346	676	1182.14	51	43.14	407.0	344.3	0
> 25 to 100	157	7654	1580	3111.58	241	77.45	3319.2	1066.7	1
> 100	48	18503	2550	4819.24	347	72.00	4553.0	944.8	0
Total	**601**	**29676**	**5498**	**9959.72**	**671**	**67.37**	**8526.4**	**856.1**	**1**
				Treatment plants only					
< 10	341	1692	1140	2137.94	51	23.85	525.2	245.7	0
> 10 to 25	212	3605	1593	3281.88	79	24.07	1090.0	332.1	0
> 25 to 100	192	9632	3664	7303.56	294	40.25	3723.5	509.8	2
> 100	76	32510	6899	13806.66	769	55.70	7676.2	556.0	3
Total	**821**	**47339**	**13296**	**26530.04**	**1193**	**44.97**	**13014.9**	**490.6**	**5**
				Others-reported only as collection and treatment					
< 10	299	1116	1054	1713.18	54	31.52	488.5	285.1	0
> 10 to 25	70	1169	639	1264.65	45	35.58	619.5	489.9	0
> 25 to 100	59	2886	1468	2900.23	139	47.93	1423.0	490.7	0
> 100	39	31531	10295	19818.41	1007	50.81	15276.6	770.8	1
Total	**467**	**36702**	**13456**	**25696.47**	**1245**	**48.45**	**17807.6**	**693.0**	**1**
				All systems					
< 10	700	3002	2886	4697.88	137	29.16	1260.8	268.4	0
> 10 to 25	304	5070	2908	5728.67	175	30.56	2116.5	369.5	0
> 25 to 100	262	14000	6711	13316.38	674	50.62	8405.8	635.8	3
> 100	122	68104	19744	38444.31	2123	55.22	27505.8	715.5	4
Total	**1408**	**90176**	**32249**	**62186.24**	**3109**	**49.99**	**39348.9**	**632.8**	**7**

A: Population Size Group (X 10^{-3})*
B: Number of Reports
C: Population Served (X 10^{-3})*
D: Total Number of Employees
E: Total Man-hours (X 10^{3})
F: Total Disabling Injuries
G: Injury Frequency per 10^{6} Man-hours
H: Total Days Lost
I: Severity Rate (days lost from work per 10^{6} man-hours)
J: Fatal Cases

*Population served is partly composed of industrial waste population equivalents

*Totals do not add up because of duplication in above groups

*A fatality represents 150 days lost as recommended in the National Safety Council's "1983 Accidents Facts" manual

It is evident from reported statistics that water and wastewater plants represent a persistently dangerous workplace. Table 11- 2 summarizes personnel disabling injuries, in 1983, wastewater works by U.S. EPA Region.

TABLE 11-2

1983 Personnel disabling injuries in wastewater works by U.S. EPA Region

A	B	C	D	E	F	G	H	I	J
I	96	2629	1279	2519.195	165	66.50	2954	1172.6	0
II	178	12099	3513	6719.333	342	50.90	3641	541.9	0
III	153	9242	4038	8079.715	293	36.26	4517	559.1	1
IV	113	6512	3820	7591.865	368	48.47	4054	534.0	2
V	411	24836	9180	17888.014	873	48.80	10917	610.3	1
VI	77	4607	1990	3958.465	238	60.12	2952	745.7	1
VII	107	5245	1902	3505.581	173	49.35	2058	587.1	2
VIII	52	3119	934	1788.352	69	38.58	750	419.4	0
IX	70	16880	3800	6871.774	452	65.78	5508	801.5	0
X	46	3285	1076	2075.527	79	38.06	1207	581.5	0
Total	**1302**	**88454**	**31532**	**60997.821**	**3052**	**50.03**	**38558**	**632.1**	**7**

A: EPA Region
B: Number of Reports
C: Population Served (X 10^{-3})
D: Total Number of Employees
E: Total Man-hours (X 10^{-3})
F: Total Disabling Injuries
G: Injury Frequency per 10^6 Man-hours
H: Total Days Lost
I: Severity Rate (days lost from work per 10^{-6} Man-hours)
J: Fatal Cases

Note: States contained in particular regions are as follows:
I Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
II New Jersey, New York
III Delaware, DC, Maryland, Pennsylvania, Virginia, West Virginia
IV Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee
V Illinois, Indiana, Michigan. Minnesota, Ohio, Wisconsin
VI Arkansas, Louisiana, New Mexico, Oklahoma, Texas
VII Iowa, Kansas, Missouri, Nebraska
VIII Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming
IX Arizona, California, Hawaii, Nevada
X Alaska, Idaho, Oregon, Washington

Statistics also indicate that the severity of injury increases as the size of the plant increases; even though studies also indicate that the larger the plant is, the more likely it is to have safety equipment available and safety programs in place. Increased personnel and opportunity for accident are the most probable causes for this disparity.

Figure 11-1 and Table 11-3 are summaries of the types of injuries suffered by personnel in the wastewater industry. Since the frequency of exposure of agency personnel to some of these types of injuries is less than others, concentration will be made on the following areas representing the most immediate threats:

1. Grit chambers, screens and comminutors.

2. Clarification and aeration facilities.

3. Disinfection

4. Lagoons and ponds

5. Sampling

6. Laboratory

7. Confined spaces (digestors), wet wells

8. Chemical hazards

9. Aerosols and microorganisms

10. Gases and vapors

FIGURE 11-1

Percentage (No. Injuries) Reported by Type of Injury

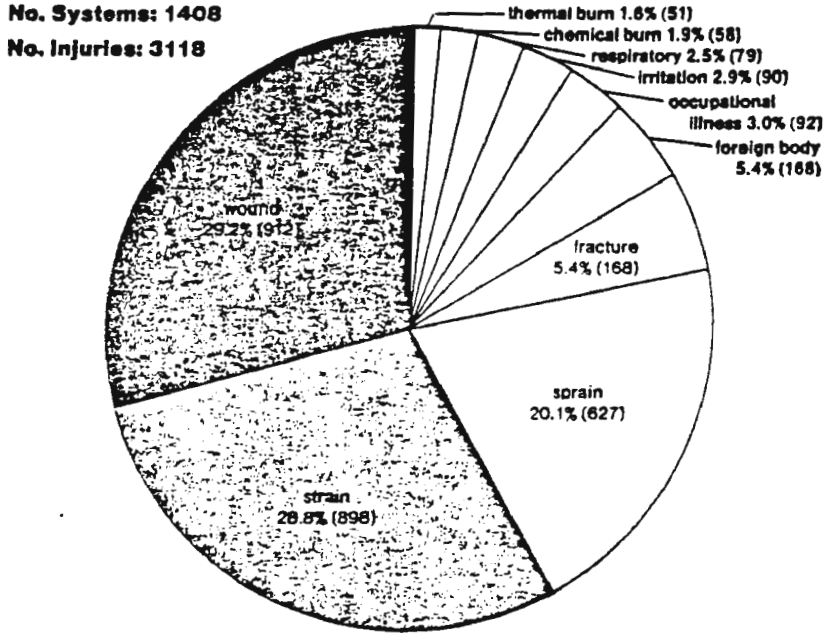


TABLE 11-3

Incidence of disabling injury by cause of accident.

Cause of Accident	*No. Disabling Injuries*	*% Total*
Sprain strain in lifting, pulling, or pushing objects	772	24.8
Sprains strains caused by awkward position or sudden twist or slip	546	17.5
Struck against stationary or moving object	264	8.5
Struck by falling or flying objects	259	8.3
Falls on same level to working surface	250	8.0
Falls to different level from platform, ladder, stairs, etc.	243	7.8
Struck by sharp or blunt object	183	5.9
Caught in, under, or between objects	169	5.4
Contact with radiations, caustics, toxic, or noxious substances	157	5.0
Occupational illness (vaccination reaction, typhoid, etc.)	67	2.1
Contact with temperature extremes (fire, frostbite, scalding, etc.)	55	1.8
Rubbed or abraded	53	1.7
Motor vehicle	51	1.6
Animal or insect bites	40	1.3
Contact with electric current	8	0.3
Total	3 117	

Grit Chambers, Screens and Comminutors

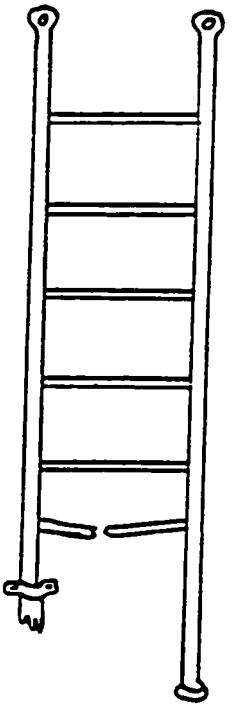
Volatile Gases and Oxygen Deficiency - Grit chambers, screens and comminutors generally serve the same purpose of reducing or removing objectionable material in raw wastewater. Depending on plant hydraulics and design, the devices are located in buildings often under ground, with limited ventilation. In extensive collection systems serving large metropolitan areas, wastes often arrive in a septic state containing industrial volatiles such as gasoline. The conditions prevailing in the housing building may be identical to wet wells or other confined space entry structures. The dangers and precautions discussed in the previous section on Confined Space Entry, should be followed in detail.

Physical Hazards - In addition to dangerous gas and oxygen deficiency, grit chambers, screens, and comminutors also present additional hazards. Generally, these areas remain constantly wet, with large amounts of grease and oil present. The combination of oils and greases with ladders, rails, and open fast moving machinery present formidable safety hazards.

Flammable Liquids - Due to the construction design of grit chamber inflow channels, oils and greases often accumulate in these areas prior to entering the main plant. In the case of gasoline, fuel oil, or other flammable materials that have been dumped or leaked into the drains, dangerous accumulations may be present at the grit chamber channels, with little or no evidence at other parts of the plant. Agency personnel are cautioned to be particularly alert and observant during these emergencies. Flow channels are usually designed to decrease incoming wastewater velocity by widening the

channel. It is at this point that volatiles usually accumulate.

Safety Precautions - As a minimum, the following safety precautions and gear should be adhered to before entering grit chambers, screens and chambers:



1. Confined area should be checked for appropriate ventilation.

2. Confined area should be monitored for explosive gases, toxic fumes, oxygen deficiencies. (See section on Confined Spaces Entry.)

3. Entry, work, and inspection areas should be checked for missing ladder wrungs, hand rails, poor lighting, missing machine guards, overhead conveyor belts, standing water, or grease.

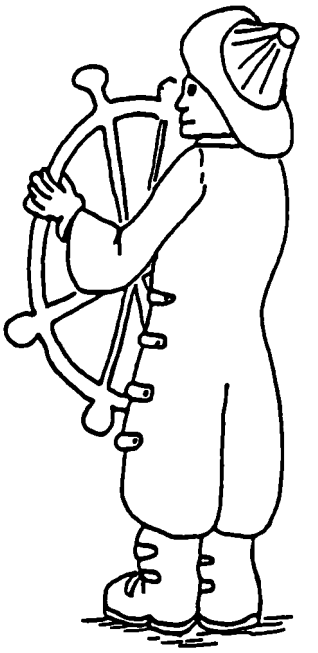
4. As a minimum, the following safety gear should be worn:

   a. Hard hat

   b. Safety splash goggles

   c. Rubber gloves

   d. Rubber soles, steel toed boots



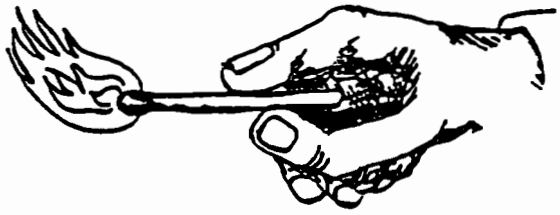
If conditions warrant further protections;

   e. Close fitting slicker or water repellent outerwear(loose or floppy fitting rain gear with drawstrings should be avoided when entering areas containing moving machinery)

   f. Knee-high rubber safety boots

g. Dust or organic vapor respirator

Clarification and Aeration Facilities



Flammable Liquids - The open design of clarifiers and aeration tanks generally precludes the dangers of confined space entry. Flammables and other volatiles may, however, be present in sufficient quantity to explode or ignite. Sources of ignition such as cigarettes, matches, or lighters should be prohibited in these areas, particularly in times of known spills.

Physical Hazards - The open nature of these tanks should be guarded by extensive hand rails. Life poles, life jackets, and life rings should all be present when entering these areas. Sample collections or D.O meter reading in the tank area should include the wearing of a life vest and the presence of a second person.

Safety Precautions - As a minimum, the following safety equipment should be worn by agency personnel entering into the clarifier or aeration areas:

1. Hard hat
2. Rubber gloves
3. Rubber soled safety boots
4. Splash goggles

In the case of sampling:

5. Life vest

Particular caution should be exercised during the winter months. Inclement weather may result in treacherous conditions on the walk-ways above clarifiers and aerators. Personnel are often heavily dressed for warmth during these times. The shock of cold water during a fall into a tank,

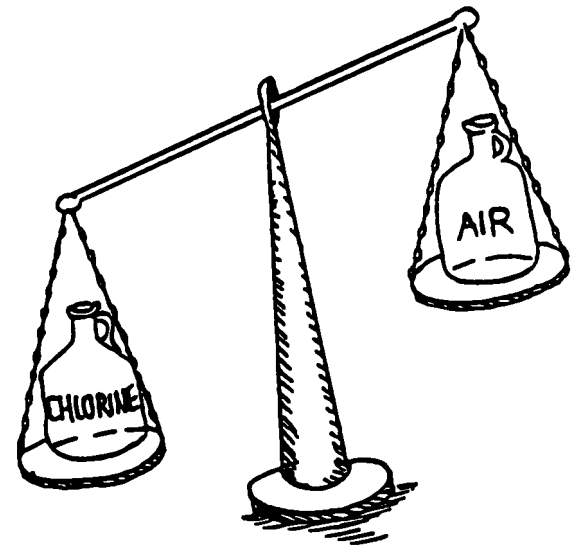
coupled with the weight of wet clothes could result in disaster.

Disinfection

Storage Facilities - The use of gaseous liquids, or solid chlorine as a disinfectant and odor suppressent is common place. For most facilities over cylinders containing one ton of chlorine and having an accumulative weight of 3,700 lbs. Such large amounts of a highly toxic and reactive chemical pose problems in storage and safety. Stored cylinders should be kept under roof away from direct contact with liquids. When chlorine gas comes in contact with moisture, it forms highly corrosive hydrochloric acid. Such acid is not only a threat to the worker and the inspector, but can accelerate the rate of leakage by further eroding the structural integrity of the cylinder.

Chlorination Room Safety

Chlorine as a gas is heavier than air and as a result, will accumulate at floor level or in manholes or depressions. Chlorination rooms should be separate from other facilities. Before entering such rooms, agency personnel should examine the exterior for floor level ventilation and power exhaust systems. If windows are available, a visual examination of the interior may provide evidence of the yellowish appearance of leaking chlorine gas. Many facilities have chlorine warning systems or instruments that can detect chlorine at 0.5 mg/l. Full face respirators should be found near the entrance to the chlorinator building. Never enter a chlorinator building alone. After satisfying oneself that ventilators are present, power exhaust systems are working, and no visual signs of chlorine can be seen, one person should enter the room and the other remain outside for rescue purposes until the all-clear has been reported. Exposure to even minute quantities of chlorine generally can be detected by smell and watering and irritation to the eyes and nose. Any such occurrence



should be cause to exit the room immediately. Minute leaks can often be detected visually by checking for droplets of moisture on the underside of connections and valves. Chlorine's affinity for water usually results in moisture accumulation near the leak.

Safety Precautions - At a minimum, after exercising all previously discussed precautions, Agency personnel should wear the following safety gear when entering a chlorinator room:

1. Hard hat
2. Rubber gloves
3. Safety glasses
4. Rubber soled safety shoes

If chlorine in any amount is detected, no entry should be attempted. Rescue attempts should be made with a full face SCBA.

Sludge Digestion

Anaerobic sludge digestors represent a formidable safety hazard. During the normal operations of the digestor, sludge is converted to, among other products, methane and carbon dioxide. Methane, when combined with oxygen at a ratio of 5:1 to 20:1, is highly explosive. Entry into an active digestor requires specific training and certification in confined space entry. The scope of this course does not allow specific detailed description of this type of training.

Lagoons and Ponds

Physical Hazards - Agency personnel in the normal inspection procedure, visit the sites of lagoons and ponds. All such ponds should have a protective fence surrounding the immediate area. Safety rings, life preservers, life

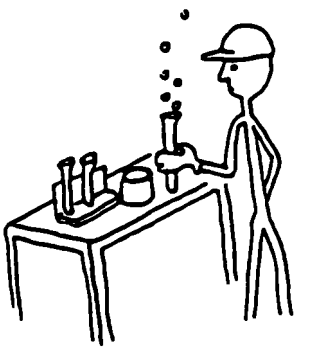
poles and boats should be found adjacent to these structures. When sampling, precautions should be taken to prevent slipping and falling down banks. Inclement weather, animal burrows and other such hazards may provide unstable footing. Wastewater ponds range from 4 feet to 10 or more feet deep. Such ponds represent a real threat to drowning as well as the ever present exposure to pathogens. When sampling is necessary, a second backup person should be present to effect a rescue if necessary.

Safety Precautions - As a minimum, agency personnel should wear the following safety equipment:

1. Hard hat
2. Splash goggles
3. Rubber gloves
4. Knee high rubber safety boots

Laboratory Health and Safety

Chemical Hazards - Agency personnel involved in water and wastewater plant inspections will normally be required to enter laboratories. Such laboratory visits do not normally require agency personnel to perform laboratory work. Even so, certain hazards are present by nature of the presence of the inspector in the laboratory environment. Routine laboratory analysis requires a wide array of chemicals, many of which pose certain hazards. The names and formulas of certain common acids should be known:



Hydrochloric Acid - HCl

Sulfuric Acid - H_2SO_4

Nitric Acid - HNO_3

Chromic Acid - $H_2SO_4 + K_2Cr_2O_7$

Phosphoric Acid - H_3PO_4

Not all acids react at the same speed; exposed personnel should not procrastinate if an accident occurs Eyes exposed to acid splashes should be rinsed in an emergency eye wash for a minimum of 15 minutes. Acid splashes on skin or clothing should be counteracted by first removing all contaminated clothing and thoroughly flushing the skin with water. Never attempt to neutralize acids splashed on the body with bases or other chemicals.

Bases are also corrosive and readily react with acids, organic solvents, clothing and skin. Frequently, skin contact with bases is not immediately noticed by the individual until significant damage is done. As with acids, exposure of the skin or eyes to bases should be countered with continuous flushing with clean water.

The names and formulas of common bases are listed below:

Sodium Hydroxide NaOH

Potassium Hydroxide KOH

Ammonium Hydroxide NH_4OH
(ammonia)

Sodium Carbonate Na_2CO_3
(soda ash)

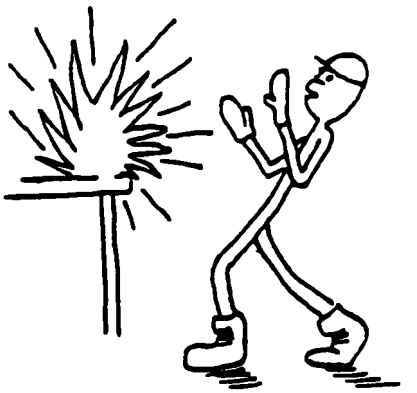
Sodium Bicarbonate $NaHCO_3$

Calcium Hydroxide $Ca(OH)_2$
(slaked lime)

Calcium Oxide CaO
(quick lime)

Although there are many chemicals that are commonly found in a water and wastewater laboratory, only one other group shall be discussed as representing

a significant hazard to Agency personnel, that of a group identified by the family name as oxidizers.



Oxidizers by nature react with organic substances such as skin, clothing, and organic solvents. The speed and intensity of the reaction depend on the specific combination of oxidizer and organic material, and the physical conditions surrounding the site. The reaction can be quite violent with spontaneous combustion or explosions resulting. By law, labels must clearly identify oxidizers. As a rule, oxidizers should be kept separate from any contact with organics.

Listed below are some of the common names and formulas of oxidizers frequently used in water and wastewater analysis:

Potassium dichromate $K_2Cr_2O_7$

Sodium Thiosulfate $Na_2S_2O_3$

Calcium Hypochlorite $Ca(OCl)_3$

Chlorine Cl_2

Sodium Persulfate $Na_2S_2O_8$

Nitric Acid HNO_3

Sulfuric Acid H_2SO_4

Perchloric Acid $HClO_4$

Physical Hazards - To the visitor or inspector, physical hazards to be found in the laboratory are generally classified as chemical splashes or contact, cuts from glassware, slips or falls.

Be cautious of liquids in unmarked glassware. Always assume its an acid or other hazardous chemical. Stay clear of glassware such as flasks and test tubes that are being heated. They have a

NOTES

tendency to suddenly spurt their contents out in the direction they are pointed. Assume any wet spot on a lab surface or on the outside of a reagent bottle to be hazardous. Many reagents such as basses, are as slippery as soap. Be cautious of slipping when laboratory floors are wet. When entering a laboratory, make note immediately of the location of safety showers, eye washes and other safety devices.

Safety Precautions - Agency personnel entering a laboratory should, as a minimum, wear the following safety equipment:

1. Splash goggles

2. Rubber soled safety shoes

If the inspection will require close proximity to active experiments, the following safety gear should be added:

1. Full face splash shield

2. Rubber apron

3. Rubber gloves

For other information regarding chemical properties and hazards, see units pertaining to Chemical Hazards and on Chemical Safety and Evaluation.

Confined Spaces

Definition - A "confined space" is defined as any enclosed or semi-enclosed space that has limited openings for entry and exit, that is not intended for continuous employee occupancy, and that does not have sufficient natural or mechanical ventilation to prevent the build-up of a hazardous atmosphere. Typical confined spaces in the wastewater industry are manholes, sewers, metering stations, valve or siphon chambers, pump stations, empty tanks, pits, or any other area in the system that has direct contact with

wastewater, sludge, or sludge gas, or conduits carrying these substances.

As wastewater is collected and treated, chemical and biological process changes take place, releasing or increasing the concentrations of toxic and combustible gases. Even when toxic or combustible gases are not present in concentrations high enough to cause physical harm, the biological or chemical changes may use up the oxygen in the atmosphere, creating an oxygen deficiency which will cause asphyxiation.

Potential Hazards - Since confined space entry has resulted in more deaths and injury that any other source in the wastewater industry, it is essential to recognize the dangers and carefully evaluate the situation prior to entry. The following list comprises the most serious hazards encountered in confined space entry:

- o Explosive gases
- o Toxic gases
- o Oxygen deficiency (asphyxiation)
- o Falling
- o Bumping into obstructions
- o Vehicular traffic
- o Suffocation

Safety precautions exercised before entry into a confined space are dependent upon the conditions that exist in that space. Oxygen level, flammability and toxicity all must be measured before any decisions can be intelligently made. Over protection limits the type, amount of work, and time a worker may remain in the space. Under protection, of course, endangers the health and safety of the worker. Table11-4 describes the minimum preparation required for three classes of confined space entry. Where

information on the table coincides with the actual work environment, the recommendations should be followed carefully. If the conditions in the space have the potential to change, monitoring must be done frequently and changes in safety and health requirements changed with the conditions.

TABLE 11-4

Confined space classification table

Parameter - Class A
Characteristics:
Immediately dangerous to life-rescue procedures require the entry of more than one individual fully equipped with life support equipment--communication requires an additional standby person stationed at the confined space
Oxygen
16% or less (a) 16.3 kPa (122 mm Hg) or greater than 25% (b) 25.3 kPa (190 mm Hg)
Flammability Characteristics
20% or greater of LEL
Toxicity
(b) IDLH

Parameter - Class B
Characteristics
Dangerous, but not immediately life threatening--rescue procedures require the entry of no more than one individual fully equipped with life support equipment; indirect visual or auditory communication with workers

TABLE 11-4 Cont'd.

Oxygen

16.1% to 19.4%
(a) 16.3-19.6 kPa (122-147 mm Hg) or 21.5% to 25%
21.7-25.3 kPa (163-190 mm Hg)

Flammability Characteristics

10%-9% LEL

Toxicity

Greater than contamination level, referenced in 29 CFR Part 1910 Sub Part Z (OSHA)---less than (b) IDLH

Parameter - Class C

Characteristics

Potential Hazard--requires no modification of work procedures; standard procedures; direct communication with workers from outside the confined space

Oxygen

19.5% to 21.4%
(a) 19.7-21.7 kPa
(148-163 mm Hg)

Flammability Characteristics

10% LEL or less

Toxicity

Less than contamination level referenced in 29 CFR Part 1910 Sub Part Z (OSHA)

(a) Based upon a total atmospheric pressure of 100 kPa (769 mm Hg) (sea level)
(b) Immediately Dangerous to Life or Health (IDLH)--as referenced in NIOSH

Registry of Toxic and Chemical Substances, Manufacturing chemists data sheets industrial hygiene guides or other recognized authorities.

Routine often results in carelessness. Plan every confined space entry with rescue in mind, even if the entry is to be a brief inspection. Asphyxiation or the effects of toxic gases require only seconds to render an

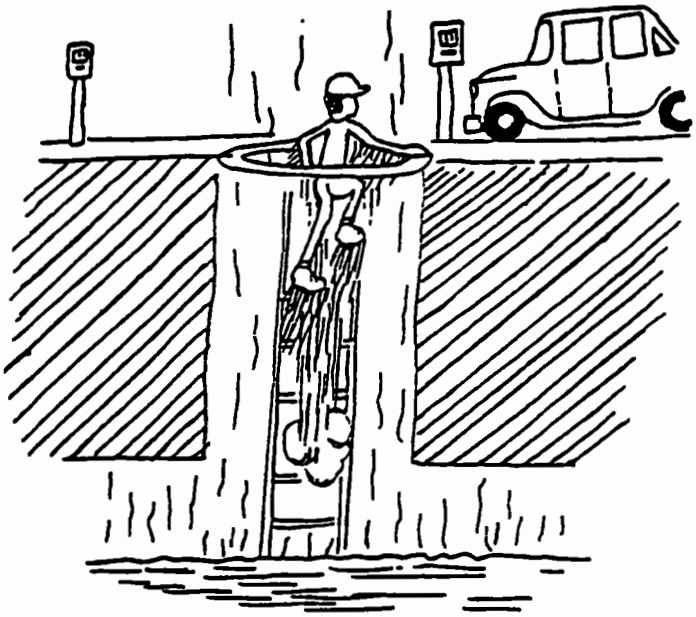
inspector unconscious. Rescue procedures should be designed for each entry. If a confined space has an A or B classification from Table 11-4, there should be a trained standby person with a fully charged, positive pressure, self-contained breathing apparatus (SCBA) at hand. Additional duties of the standby person are to maintain unobstructed life lines and communications to all employees within the confined space and to summon rescue personnel if needed. Under no circumstances should the standby person enter the confined space until he is relieved and is assured that adequate assistance in present.

It is evident that safe confined space entry is highly dependent on instrument monitoring of ambient air quality. See the unit of this manual which provides an overview of monitoring equipment availability and function.

All sewers and underground structures should be considered dangerous until they are adequately tested. Tests should be taken of the ambient air quality in the manhole before removing the cover. Most manhole lids have small openings in the cover to allow an instrument probe to be inserted. The principal tests are oxygen deficiency, explosion range and toxic gases. If Agency personnel are to remain in the hazardous environment for a prolonged period of time, continuous monitoring will be required. There have been instances, such as the arrival of spill material, when the nature of the atmosphere has changed quickly in a hazardous condition.

If a hazardous atmosphere is found, determination or correction of the source is mandatory before entry, or if the confined space has already been entered, exit must be undertaken immediately.

Entry into a confined space should not be attempted when tests indicate the concentration of flammable gases in the atmosphere is greater than 25% of the lower flammable limit (LFL), such as found in anaerobic digestors and some sewer conditions. It is necessary to determine the oxygen level prior to measuring the range of flammability to make necessary corrections in the flammability measurements. It is absolutely necessary that personnel be completely familiar with the operation, maintenance, calibrations, and limitation of equipment before using it to test life threatening environments.

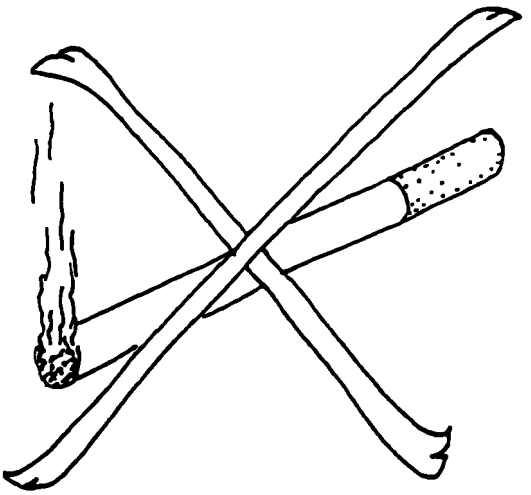


The percentage of oxygen for entry into a confined space should be no less than 19.5% or greater than 25% at 100 kPa (760 mm Hg). At sea level, the normal atmospheric pressure for air (20.9% O_2 + 78.1% N_2 + 1% Ar + trace amounts of other gases) is 100 kPa (14.7 psi or 760 mm Hg) absolute. The partial pressure of oxygen (p O_2) at sea level will be approximately 21.3 kPa (160 mm Hg); pO_2 can be reduced by reducing the O_2 level in air.

Oxygen deficiency resulting in anoxia is an insidious killer. The initial effects result in a psychological attitude that is manifested by the feeling of lassitude and well being and that will generally result in the inability of the victim to discern the need for help. At any indications of lassitude symptoms like those of intoxication, or decrease in alertness, the victim should be removed from the area immediately.

Not all manholes are vented or have holes for probes. In some cases, monitoring equipment does not have probes. Manhole covers should be lifted with care to avoid any sparks. When the cover has been removed, further testing of the atmosphere for combustible gases and/or toxic gases and oxygen deficiency

must be made, particularly at the lower levels where gases with densities greater than air will accumulate.



Before entering a confined space, inspect the access ladder for missing rungs, accumulations that will make footing and grasping difficult, obstructions that might interfere with passage and mechanical equipment without proper guards. Remember, wet wells may accumulate flammable liquids on their surface. Never enter any type of confined space with cigarettes, matches or a lighter. Be sure there is adequate lighting available, and, if entering a street manhole, that adequate traffic control has been instituted.

Safety Precautions

Confined space entry is one of the most hazardous priorities to be encountered in a wastewater plant. Advanced planning and training are absolute prerequisites before attempting entry. It is only within the scope of this course to give the basic fundamentals of confined space entry. Further training and certification is required before agency personnel should attempt entry.

At a minimum the following safety gear should be available for agency personnel:

o Atmospheric-testing equipment to guard against oxygen deficiency and combustible gases and toxic hydrogen sulfide (H_2S) gas.

o Self-contained air breathing apparatus for each person going underground and for the standby rescue crew.

o Protective clothing, including rubber boots, gloves, rain gear, hard hats with chin straps, and face shields or goggles.

o Explosion-proof lights.

o Communication equipment if the scope of the work makes it necessary.

o First aid kit (including amyl-nitrite capsules for H_2S exposure).

o Harness and individual life lines for each person going underground and for the standby crew above ground.

Table 11-5 is a summary of considerations for entry in confined spaces as described by Table 11-4.

TABLE 11-5

Check list of considerations for entry, working in, and exiting confined spaces

Item	Class A	Class B	Class C
Permit	X	X	X
Atmospheric testing	X	X	X
Monitoring	X	O	O
Medical surveillance	X	X	O
Training of personnel	X	X	X
Labeling and posting	X	X	X
Preparation			
Isolate/lockout/tag	X	X	O
Purge and ventilate	X	X	O
Cleaning processes	O	O	O
Requirements for special equipment/tools	X	X	O
Procedures			
Initial plan	X	X	X
Standby person	X	X	X
Communications/observation	X	X	X
Rescue	X	X	X
Work	X	X	X
Safety equipment and clothing			
Head protection	O	O	O
Hearing protection	O	O	O
Hand protection	O	O	O
Foot protection	O	O	O
Body protection	O	O	O
Respiratory protection	O	O	
Safety belts	X	X	X
Life lines, harness	X	O	
Rescue equipment	X	X	X
Recordkeeping/exposure	X	X	

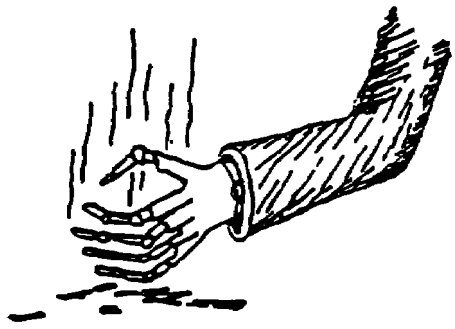
X - indicates requirement
O - indicates determination by the qualified person

Class A-Atmosphere immediately dangerous to life-oxygen deficiency, explosive, toxic, flammable.
Class B-Could cause injury or illness that can be protected against-not immediately dangerous to life or health.
Class C-Confined space hazard requiring no work procedure modification.

Chemical Hazards

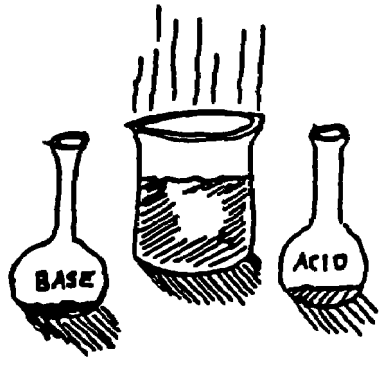
Normally, wastewater should not contain any significant amounts of hazardous chemical materials. If significant levels are found, they usually originate from normal industrial discharge, accidental spillage or illegal dumping.

The types of chemicals, chemical compounds and chemical mixtures that may be present in wastewater are endless. Wastewater plants serving industrial communities have a much greater probability of significant chemical content that do others. As industrial pretreatment standards come into effect, agency personnel may increasingly be exposed to a host of chemicals at the industrial treatment facility. Two of the most common exposures are to corrosive and solvent wastes.



Corrosive Wastes

Pretreatment facilities that are treating their wastes for pH often receive the wastes in a potentially harmful state of below pH 5.0 or pH above 9.0. Strong chemicals such as hydrochloric acid (HCl) and sodium, hydroxide (NaOH) are used to neutralize these wastes. High or low pH solutions are not only hazardous due to their corrosive effects on human tissue, but also are often responsible for the release of toxic gases such as hydrogen cyanide, ammonia and chlorine. The neutralization process itself is an exothermic process (gives off heat) and can result in local eruptions and splattering.



Small spills of should be treated with a buffering substance such as sodium bicarbonate. Never attempt to neutralize an acid with a base or vise-versa. The neutralizing is very exothermic and often results in splattering.

Solvent Wastes

Nearly all common solvents can be linked to some form of health hazard. Chlorinated solvents such as trichlorethylene have been identified as suspected carcinogens. Highly volatile solvents such as xylene and acetone can burn, explode, asphyxiate, or emit poisonous vapors. In addition, most flammables have a defatting effect on the skin that removes the protective oil film and leaves it susceptible to attack by weather, bacteria, or other chemical agents. Before entering any confined space such as wet wells, pump stations, grit or comminutor rooms, a thorough check, of ambient air quality should be undertaken. In the case of the anticipation of spilled material arriving at a plant, air monitoring should be continuous.

Gases and Vapors

Gases and vapors are the normal products of bacterial action on waste products as well as a result of industrial discharge of entrained gases into the treatment system. Of particular concern to agency personnel is that of significant levels of gases that are found in confined spaces, that exhibit the properties of explosiveness, flammability or toxicity. Due to the physical design of wastewater plants such as wet wells, as well as physical processes such as aeration, uncommonly high levels of these gases and vapors may be found. Table 11-6 lists the characteristics of gases common to the wastewater industry.

TABLE 11-6

Characteristics of gases common to the wastewater industry

Gas and chemical formula
Ammonia NH_3
Specific gravity
0.59
Explosive limits - LEL UEL

16 25
Maximum safe 60-min exposure (% vol. in air)
0.03
Maximum safe 8-hr exposure (% by vol. in air)
0.01
Common properties
Colorless, sharp, and pungent
Physiological effects
Irritates eyes and respiratory tract; toxic at 0.01%
Location of highest concentration
Up high
Most common sources
Sewer gas
Simplest and safest method of testing
Oxygen deficiency indicator; odor

Gas and chemical formula
Carbon Dioxide CO_2
Specific gravity
1.53
Explosive limits - LEL UEL

Nonflammable
Maximum safe 60-min exposure (% vol. in air)
4.0-6.0
Maximum safe 8-hr exposure (% by vol. in air)
0.5
Common properties
Colorless, odorless, nonflammable; may cause acid taste in large quantities
Physiological effects
Acts on respiratory nerves; 10% cannot be endured for more than a few minutes
Location of highest concentration
Down low but may rise if heated
Most common sources
Sludge, sewer gas, combustion carbon and its compounds
Simplest and safest method of testing
Oxygen deficiency indicator

Gas and chemical formula
Carbon Monoxide CO
Specific gravity
0.97

Explosive limits - LEL UEL

12.5 74.2

Maximum safe 60-min. exposure (% vol. in air)

4.0

Maximum safe 8-hr exposure (% by vol. in air)

0.005

Common properties

Colorless, odorless, tasteless, non-irritating; flammable, explosive, poisonous

Physiological effects

Combines with hemoglobin of blood causing oxygen starvation; fatal in 1 hr. at 0.1%; unconsciousness in 30 min. at 0.25% and causes headaches in a few hours at 0.02%

Location of highest concentration

Up high specifically if in presence of illuminating gas

Most common sources

Manufactured fuel gas, flue gas, combustion and fires

Simplest and safest method of testing

CO indicator

Gas and chemical formula

Chlorine Cl_2

Specific gravity

2.49

Explosive limits - LEL UEL

Nonflammable

Maximum safe 60-min. exposure (% vol. in air)

0.0004

Maximum safe 8-hr exposure (% by vol. in air)

0.0001

Common properties

Yellow-green color; irritating, pungent odor; nonflammable and supports combustion

Physiological effects

Irritates respiratory tract, causes irritation and burning of the skin, coughing and pulmonary edema in small concentrations

Location of highest concentration

Down low

Most common sources

Chlorine cylinder and feed line leaks

Simplest and safest method of testing

Chlorine detector

Gas and chemical formula

Ethane C_2H_6

Specific gravity

1.05

Explosive limits - LEL UEL

3.1 15

Maximum safe 60-min. exposure (% vol. in air)
No limit provided oxygen percentage (at least 12%) is sufficent for life
Common properties
Colorless, odorless, tasteless, flammable, explosive, non-poisonous
Physiological effects
Acts mechanically to deprive tissues of oxygen; does not support life
Location of highest concentration
Down low
Most common sources
Natural gas
Simplest and safest method of testing
Combustible gas indicator, oxygen deficiency indicator

Gas and chemical formula
Gasoline C_5H_{12}-C_9H_20
Specific gravity
3.0-4.0
Explosive limits - LEL UEL

1.3 7
Maximum safe 60-min. exposure (% vol. in air)
0.4-0.7
Maximum safe 8-hr exposure (% by vol. in air)
Varies
Common properties
Color, flammable, explosive, odor noticeable at 0.03% concentration
Physiological effects
Symptoms of intoxication when inhaled, difficult breathing and convulsions; fatal at 2.43%
Location of highest concentration
Down low
Most common sources
Service stations, storage tanks and dry cleaning operations
Simplest and safest method of testing
Combustible gas indicator; oxygen deficiency indicator

Gas and chemical formula
Hydrogen Sulfide H_2S
Specific gravity
1.19
Explosive limits - LEL UEL

4.3 46
Maximum safe 60-mi. exposure (% vol. in air)
0.02-0.03
Maximum safe 8-hr. exposure (% by vol. in air)
0.001
Common properties
Rotten egg odor in small concentrations; colorless, flammable and explosive

Physiological effects
Paralyzes the respiratory system; lessens the sense of smell as concentration increases; rapidly fatal at 0.2%
Location of highest concentration
Down low; can be higher if air is hot and humid
Most common sources
Coal gas, petroleum, sewer gas and sludge gas
Simplest and safest method of testing
Lead acetate paper, lead acetate ampoules, H_2S detector

Gas and chemical formula
Methane CH_4
Specific gravity
0.55
Explosive limits - LEL UEL

5 15
Maximum safe 60 min. exposure (% vol. in air)
No limit providing sufficient oxygen (at least 12%) is present
Common properties
Colorless, odorless, tasteless, explosive, flammable, and non-poisonous
Physiological effects
Deprives tissues of oxygen; does not support life
Location of highest concentration
At top, increasing to certain depth
Most common sources
Digestion of sludge
Simplest and safest method of testing
Combustible gas indicator; oxygen deficiency indicator

Gas and chemical formula
Nitrogen N_2
Specific gravity
0.97
Explosive limits - LEL UEL

Nonflammable
Common properties
Colorless, tasteless, odorless, and nonflammable
Physiological effects
In very high concentrations, reduces oxygen intake; does not support life
Location of highest concentration
Up high and sometimes in low areas
Most common sources
Sewer and sludge gas
Simplest and safest method of testing
Oxygen deficiency indicator

Gas and chemical formula
Oxygen (in air) O_2
Specific gravity
1.11
Explosive limits - LEL UEL

Nonflammable

Common properties
Colorless, odorless, tasteless; supports combustion

Physiological effects
Normal air contains 20.93% O2. Below 19% considered deficient; 13% dangerous; below 5%-7% fatal

Location of highest concentration
Variable at different levels

Most common sources
Oxygen deficiency from poor ventilation and chemical combustion of O_2

Simplest and safest method of testing
Oxygen deficiency indicator

Gas and chemical formula
Sludge gas

Specific gravity
varies

Explosive limits - LEL UEL

5.3 19.3

Maximum safe 60-min. exposure (% vol. in air)
Varies with composition

Common properties
Flammable, practically odorless, and colorless

Physiological effects
Will not support life

Location of highest concentration
Up high

Most common sources
Digestion of sludge

Simplest and safest method of testing
Combustible gas indicator, oxygen deficiency indicator

Pathogenic Hazards

Aerosols

Aerosols and mists generated at wastewater treatment facilities can be responsible for the spread of a host of diseases caused by viruses, bacteria, (see Tables 11-7 and 11-8) and fungi (see Table 11-9).

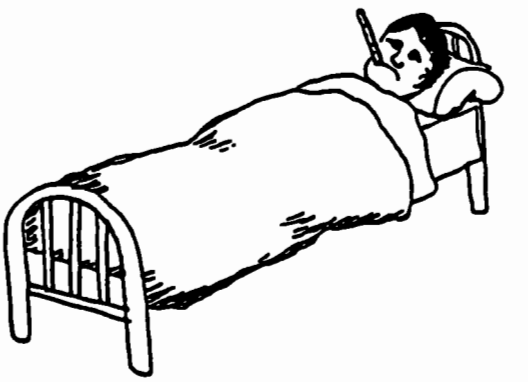


TABLE 11-7
Diseases Associated with Human Fecal Waste

Bacterial infections

- Typhoid fever
- Paratyphoid fevers
- Cholera
- Shigellosis (bacillary dysentery)

Viral infections

- Poliomyelitis
- Coxsackie infection
- Infectious hepatitis
- (very many other enteric viruses exist)

Protozoal infections

- Entamoeba histolytica

Helminthiasis

- Fish tape worm
- Beef tapeworm
- Pork tapeworm
- Pinwormv
- Roundworm
- Whipworm
- Hookworm

TABLE 11-8
Diseases Associated with Animal Fecal Waste

Salmonellosis

Infection from pig intestinal protozoan
(Balantidium coli)

Helminthiasis

- Pig ascaris
- Animal tapeworms
- Hydatid worm

TABLE 11-9
Fungus Diseases (Mycoses) Associated with Solid Wastes

Coccidioidomycosis
Sporotrichosis
Histoplasmosis
Candidiasis

Workers can be infected directly by inhalation or indirectly by droplets settling on clothing. Sources of aerosols include aeration tanks, weirs, and flumes, spray and irrigation sites. Indoor areas where aeration occurs are likely to have the highest aerosol concentrations.

Table 11-10 lists factors that may affect bacterial and viral survival in aerosols. By understanding the conditions for increased survival, Agency personnel may be better able to protect themselves.

TABLE 1-10
Factors that affect the survival and dispersion of bacteria and viruses in wastewater aerosols

Factor	Remarks
Relative humidity	Bacteria and most enteric viruses survive longer at high relative humidities, such as those occuring during the night. High relative humidity delays droplet evaporation and retards organism die-off.
Wind speed	Low wind speeds reduce biological aerosol transmission.
Sunlight	Sunlight, through ultraviolet radiation, is deleterious to microorganisms. The greatest concentration or organisms in aerosols from wastewater occurs at night.
Temperature	Increased temperature can also reduce the viability of organisms in aerosols mainly by accentuating the effects of relative humidity. Pronounced temperature effects do not appear until a temperature of 80 degrees F (26 degrees C) is reached.
Open air	It has been observed that bacteria and viruses are inactivated more rapidly when aerozolized and when the captive aerosols are exposed to the open air than when held in the laboratory. Much more work is needed to clarify this issue.

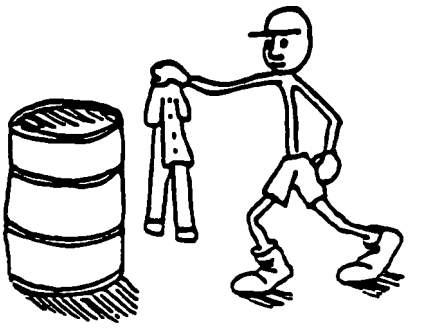
Parasitic Diseases

Parasitic diseases such as hookworm and ringworm can also be spread by contact with contaminated material and ingestion through the mouth, usually while eating or smoking, or contact with exposed skin.

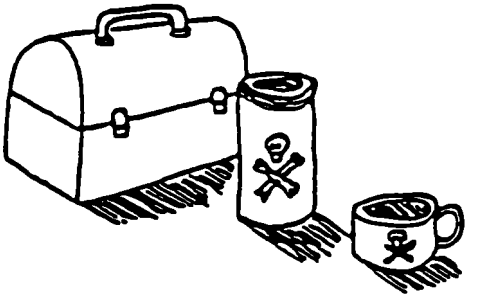
Safety Precautions

Use of proper protective equipment such as rubber gloves and washable or disposable coveralls will prevent

contact with contaminated surfaces. Washable coveralls should not be washed with other non-work related clothing or in the family washer. A washer dedicated to contaminated work clothes should be made available at Agency headquarters. Disposable clothing should be placed in a plastic disposable trash bag and sealed before being disposed of. Boots, gloves, and other non-disposable equipment should be thoroughly scrubbed in a strong soapy solution containing a bactericide such as tincture of Roccal or Wescodine.



Above all, care must be taken to institute a comprehensive program of personal hygiene. After contact with wastewater or inspection of a wastewater facility, agency personnel should shower before leaving for home. Never eat, drink, or smoke before thoroughly scrubbing hands. In high aerosol areas wear gauze-type respirators to reduce inhalation of pathogens. Always launder reusable clothes after each day of contact. Never wear disposable clothes more than once. Dispose of these clothes properly. Report any illness or infection promptly to your supervisor. Receive medical check-ups regularly.



STUDENT EXERCISE 1

Directions:

The following exercise is broken into four sections. Each section corresponds to a specific location in a typical wastewater facility. The student is to examine the given information (drawings and descriptions) and complete the exercise pertaining to that section's information. A list of available equipment is given at the beginning of the exercise.

General Description:

The plant to be inspected is a typical 3.0 mgd activated sludge plant located in Eau Claire, Wisconsin. The plant serves a small city of 100,000 with a fairly large manufacturing base consisting of electrical appliance manufacturers, rubber tire manufacturers, leather product manufacturrers and breweries. The outfall is a large river. The plant was built in the 1930's, with some improvements since. The date is late February, with a large accumulation of snowfall but very little melt-off.

Available Equipment:

30-minute airpack (SCBA)
Organic vapor respirator
Full face shield
Splash goggles
Safety goggles
Rubber safety boots
Rubber soled safety shoes
Hard hat
Rubber gloves
Rain gear (coat and hood)
Disposable water resistant overalls
Safety line and harness
2-way portable radio
Totally enclosed acid suit
H_2S monitoring equipment
O_2 meter
Explosive gas monitor (LEC meter)
First aid kit
Flashlight
Denim work overalls
Leather gloves
Disposable gauze face mask
Leather soled work shoes

STUDENT EXERCISE 2

A. After examining Figure 11-1, list at least 10 safety hazards that can be spotted.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

B. List at least 3 hazards that may be present but cannot be seen.

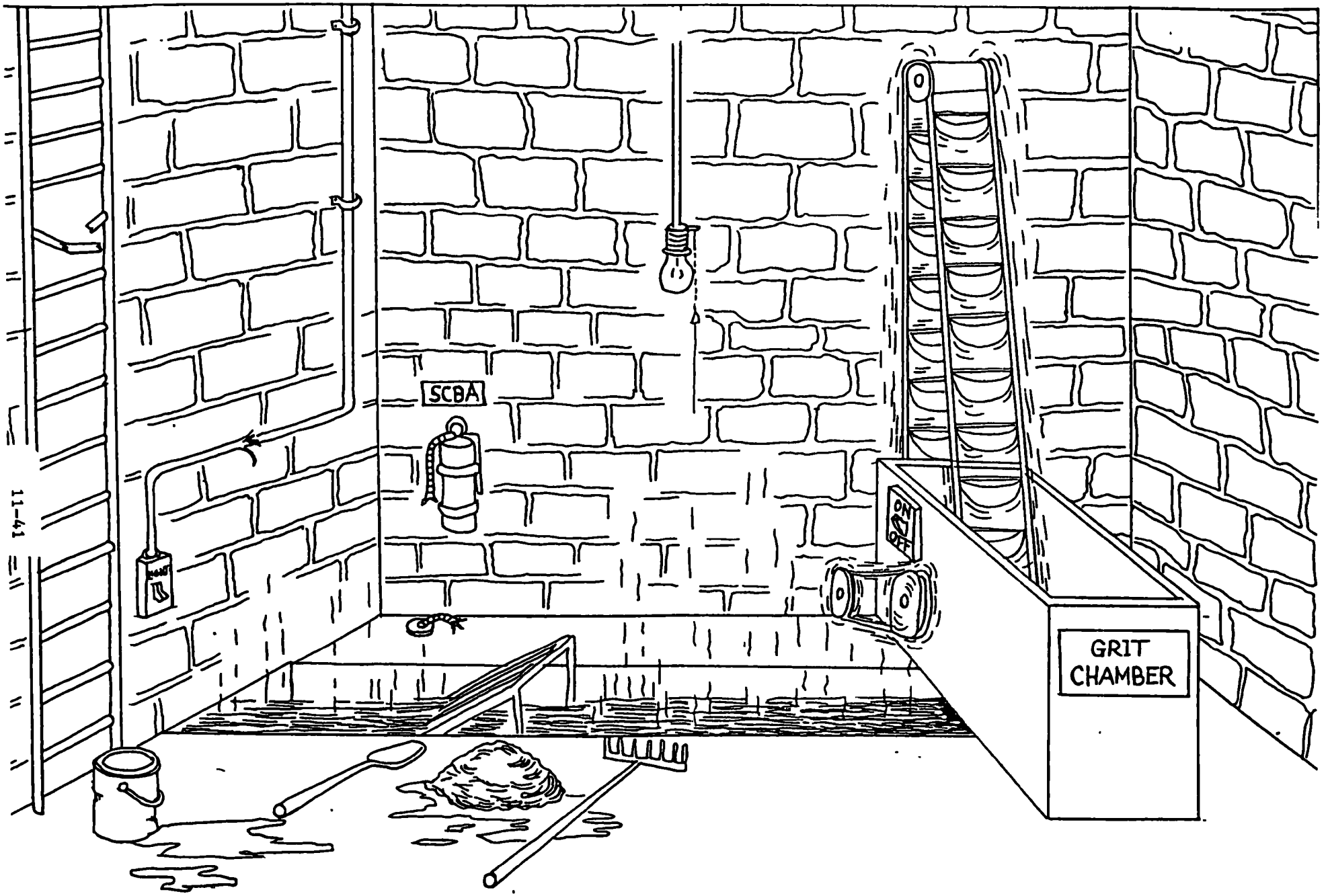
1. _____
2. _____
3. _____

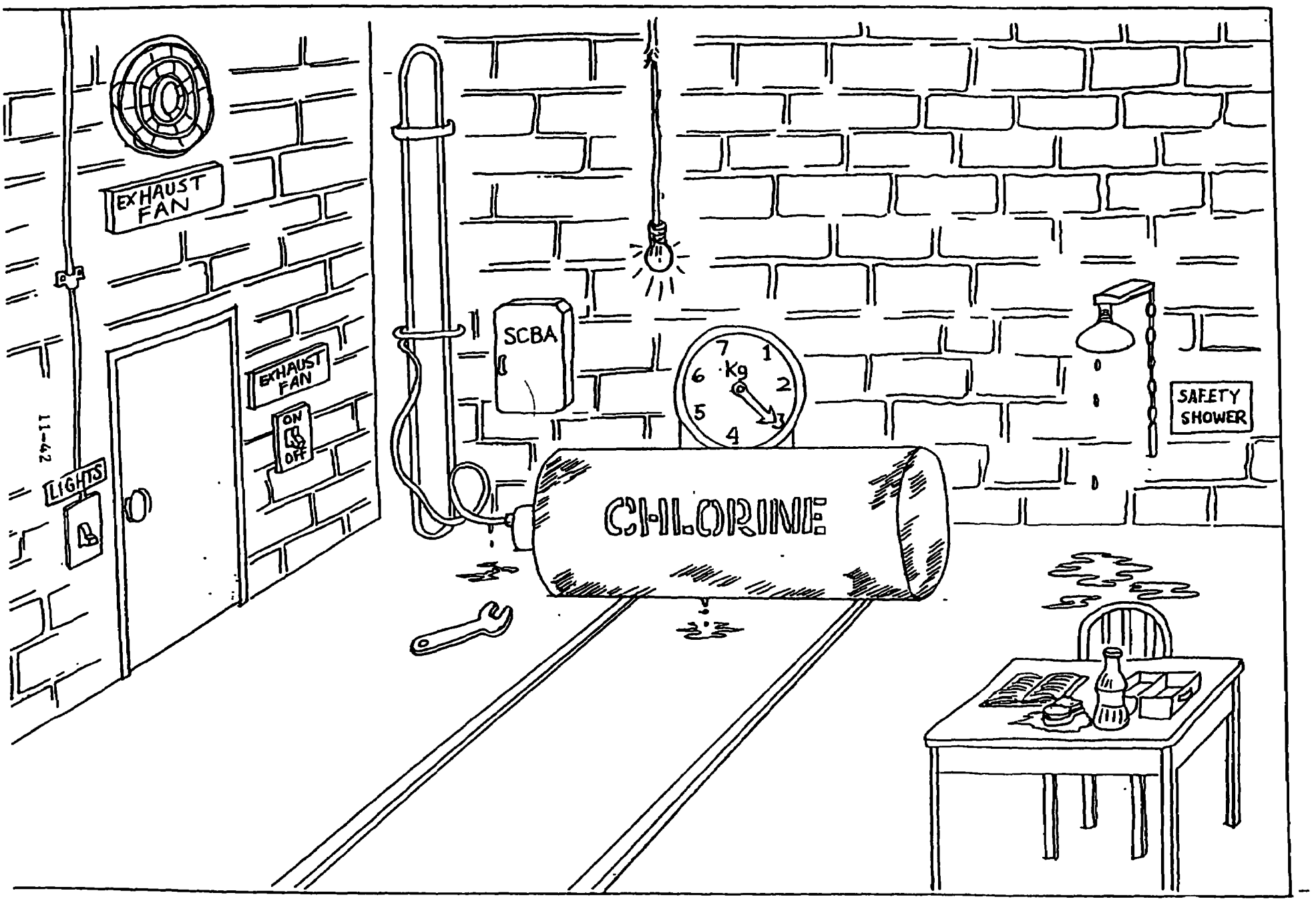
C. What safety precautions would you follow before entering an area similar to the one diagrammed?

1. _____
2. _____
3. _____

D. At a minimum, what safety equipment would you take before entering into an area similar to the one diagrammed?

1. _____
2. _____
3. _____
4. _____


SCBA
ON
OFF
GRIT
CHAMBER


EXHAUST FAN
EXHAUST FAN
ON
OFF
LIGHTS
SCBA
Kg
CHLORINE
SAFETY SHOWER

STUDENT EXERCISE 3

A. After examining Figure 11-2, chlorine disinfection room, list at least 10 safety hazards that can be spotted.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

B. For each of the hazards listed above, list in the corresponding number what should be done to eliminate the hazard.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

STUDENT EXERCISE 4

A. After examining Figure 11-3, list at least 10 different safety hazards than can be seen.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

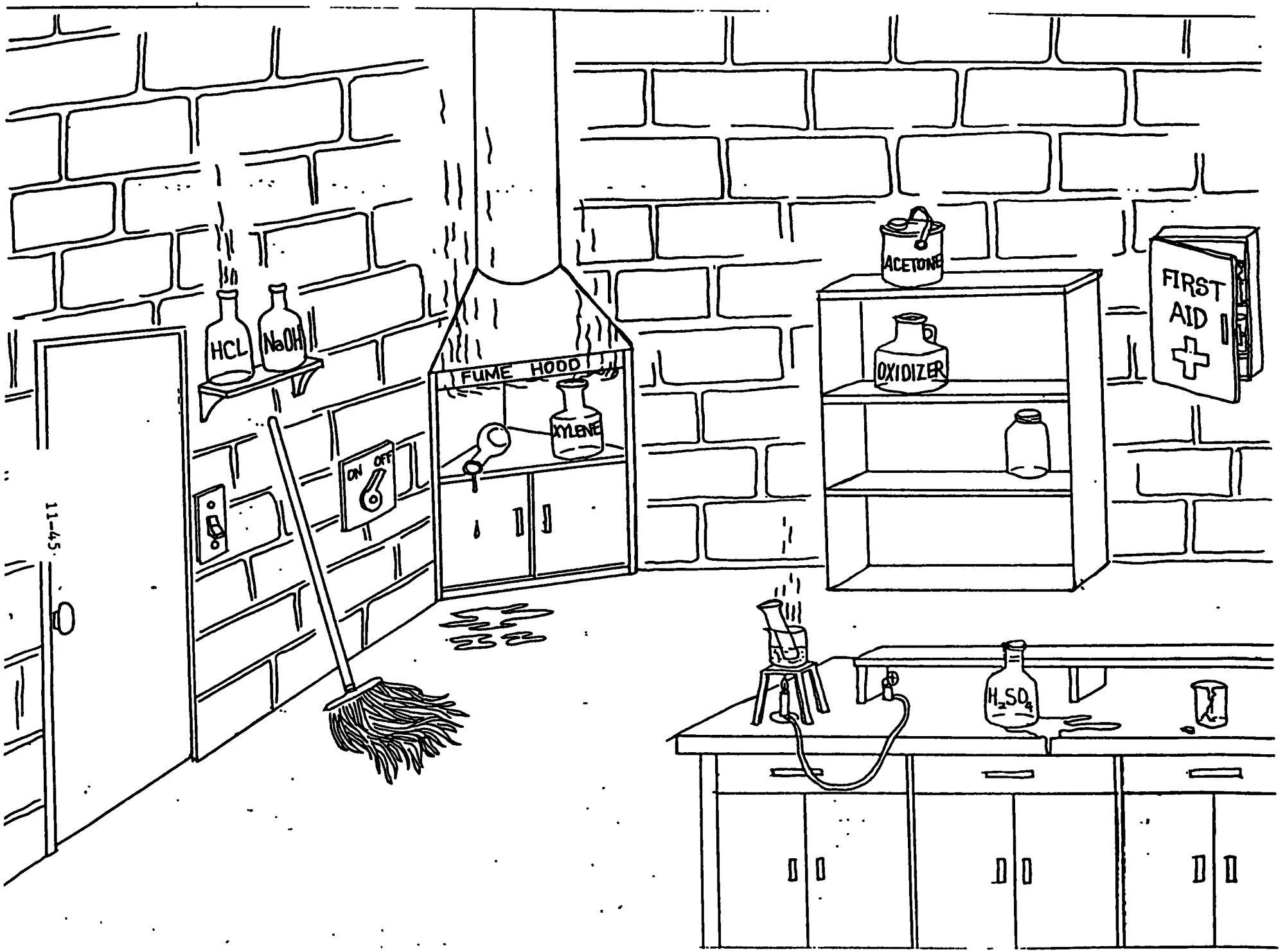
10. _____

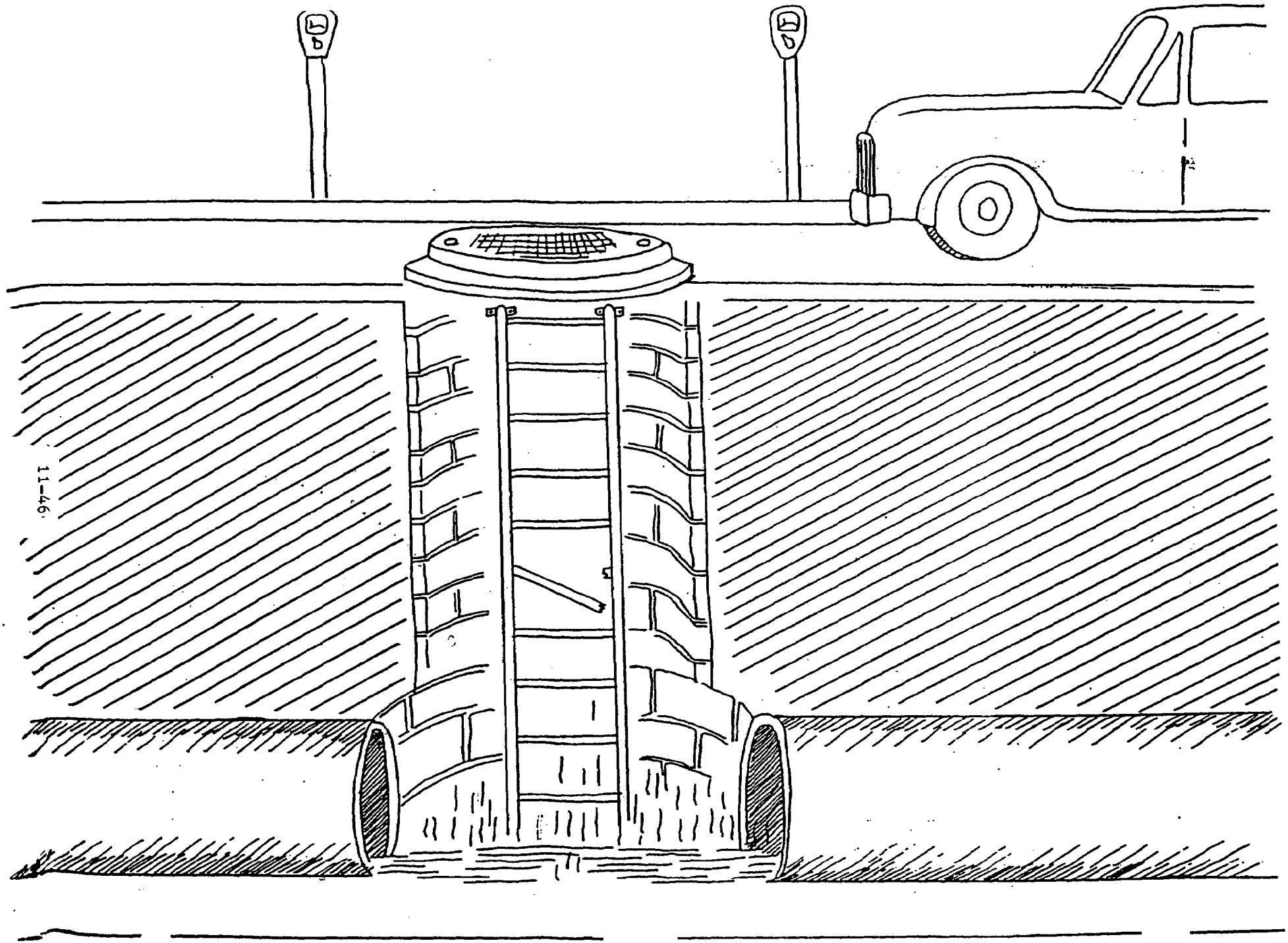
B. Explain your actions if the following laboratory accidents were to occur:

1. Acid is spilled on you:

2. A chemical gets into your eyes:

3. Acid is spilled on the floor:


HCL
NaOH
FUME HOOD
XYLENE
ON
OFF
ACETONE
OXIDIZER
FIRST AID
H_2SO_4



STUDENT EXERCISE 5

Examine Figure 11-4. An industrial site upstream is suspected of dumping a large quantity of toxic, highly volatile, chemicals into the sanitary sewer.

A. Using appropriate informational resources, determine if this situation is a Class A, B or C confined space.

Answer_____

B. Give the rationale for your choice in A:

C. List 10 safety precautions that should be taken before entering the manhole:

1._____

2._____

3._____

4._____

5._____

6._____

7._____

8._____

9._____

10._____

D. List the appropriate safety equipment that should be available before entering this Class of confined space:

UNIT 12: MINE SAFETY

OUTLINE	NOTES
1. Introduction	
2. Vehicles and Machinery	
3. Cave-in, Slides, and Supports	
4. Hazards of Blasting	
5. Mine gases and Oxygen Deficiency	
6. Protective Clothing, Equipment and Respiratory Protection.	
7. Mine Communications	

EDUCATIONAL OBJECTIVES

o Students should understand how to enter and inspect surface or undergound mines safely.

o Students should know how to inspect mine supports and surfaces, for signs of danger.

o Students should know how to stay clear of dangerous areas or equipment.

o Students should have some knowledge about mine gases and oxygen deficiency.

o Students should know how to choose and use protective clothing and equipmetn, especially gas masks and respirators.

o Students should be aware of mine communication systems.

NOTES

INTRODUCTION

Both surface and underground mines are regulated very strictly to assure the safest practical working conditions. EPA personnel who need to enter and inspect a mine should have comprehensive awareness of the dangers, and the rules, procedures, and equipment that are used to make this dangerous environment safer.

If you know what a well-run mine should look like, and know how to look for commonly occurring dangers, you will have a good basis for judgment about whether the mine is operated with safety in mind. If you have as much concern for the attitudes of management as for specific environmental problems, it will be helpful to you to know what to look at in a mine.

The mine operator must inform workers, and visitors of any need for special clothing or safety equipment and must provide safety orientation to tell all visitors (and employees) about the mine's safety precautions. The mine operator must provide the necessary special clothing and equipment for the employees. The mine management may lend you the clothing and equipment needed, but the management is not required to do so. Ask, in advance, if the mine operator will provide personnel with what is needed. In any event, personnel should provide their own hard hat, safety glasses, and safety footwear, even if the mine provides the other necessary items.

The hazards in mining include the possibility of earth slides or cave-ins, toxic gases, the use of explosives, a possible inadequacy of oxygen, and proximity to powerful machinery, including narrow gauge railroading, massive earth moving equipment, elevators and hoists.

Moving Vehicles and Machinery

Mining regulations stress equipment safety. Moving equipment must have safety and warning devices. All equipment operators and their supervisors must be trained people, and they must use signals before putting the equipment in motion.

Equipment maintenance or repaiir may take place only after power has been shut off and the equipment has been blocked to prevent movement. All machinery must be inspected regularly and maintained in safe condition. Loading and hauling equipment must be inspected before each use. Defective equipment or machinery may not be used until it hass been repaired.

Underground mine tunnels must serve both hauling equipment and people. There must be at least 30 inches of clearance between the sides of the hauling equipment and the walls, or else shelter holes at leasst four feet wide, with 40 inches of clearance must be provide, and they must be marked clearly with lightss, reflectors, or luminous paint.

In coal mines the shelteer holes must be at least 4 feet wide, 5 feet deep, and 6 feet (or the height of the seam, whichever is less) high, and located every 105 feet. The elevators and hoists are inspected daily, in underground coal mines, and the safety catches are tested bi-monthly.

In other underground mines,, hoists and elevators are inspected, tested, and maintained systematically, and records must be retained for three yearss.

Underground shuttle cars and mining equipment must have strong canopies or cabs to protect the operators from anything that might fall. All air compressors and boilers must be

inspected and maintained to meet the national safety standards. Finally, good housekeeping is required in all mines. Loose material, garbage, and unneeded gear must be kept away from machinery and equipment, and must be regarded as a hazard to be kept away from the work areas.

Hazards from Unstable Surfaces

A Federal regulation requires that inspections and testing of mine surfaces, in all mines, must occur as often ass necessary to insure safety. The mine operators must examine and test potentially dangerous surfaces before any work may begin or any machinery be started. Nevertheless, falls of rock from unstable mine surfaces (face, roof, and ribs) are the primary cause of injuries and deaths in mines.

In a mine, the ceiling is called the roof or back. The walls may be called walls, ribs, pillars, or the face. The face is the surface being mined, sometimes called the working face. The floor is called the floor, but it may also be the roof of the level below. In a coal mine, the roof directly (closest) overhead is called the "immediate roof" and the rock bed or beds above that are the "main roof." The immediate roof and the beds above are the "strata" (of layers of sedimentary rock in which the material being mined is found), and the material above the (coal, ore, etc., bearing) strata is called the "overburden."

If the immediate roof is not supported, its own weight (possibly enhanced by the weight above it) may cause the immediate roof to sag, crack or collapse. When that happens, methane gas may escape, or a space may be created where water can collect to weaken the roof further.

Coal mines use three systems to

NOTES

support the roof: **bolting**, in which roof bolts are the only supports; **conventional**, in which posts, timbers, jacks, cribs, sills, or beams are used in various combinations; and the **combinations system** which uses roof bolts plus other means of support. Roof control plans are required, but we will not take time to consider all the possible variations that can be employed.

Temporary supports must be installed before attempting the installation of permanent supports. No one should go beyond a temporary support unless it is within five feet of a permanent support, and only workers installing temporary supports may go beyond the last permanent support. Only experienced workers should attempt to recover roof supports during retreat mining and pillaring, and roof supports should be left in place if there is any sign of roof weakness.

Visual inspection of supports may reveal undue load on the supports (and thus roof weakness) if any of the following can be observed:

o bending or decayed timbers, posts, or crossbars;

o small chips or bark broken from supporting timbers;

o roof bolts showing stress; or

o caps squeezed down and over many posts.

Other danger signs are: slips, fractures, cleavages, or crumbling of coal, rock or ore; changes in the rock texture; or any moisture appearing in the roof after supports have been installed; or any wetness in a spot that previously was dry.

The roof may be tested audibly by

striking it. A solid, clear, ringing tone signals a sound, solid roof. A drum-like sound results when rock layers have separated ands the roof is loose. A loose thud signals loose rock or coal, and reveals a very dangerous condition that must be corrected immediateely.

An experienced worker will:

o test while standing under a supported roof;

o be sure there is a safe line of retreat;

o never turn away from the ribs, but always face them;

o always wear goggles;

o never assume someone else tested the roof; and

o examine the roof frequently during the working shift.

The most frequent falls come, not from roof, but from ribs or walls, when the roof pressure above causes pieces of coal, ore or rock to break off and fall or roll. Eternal vigilence might be the best motto for the miner. When "ground falls," or falls of material from the roof, are discovered, it is obvious that a dangerous situation exists. It must be corrected before work can continue in that part of the mine.

In surface mining, you will encounter some of the largest earth-moving equipment developed by our race. Pit design is an important consideration. The sides must not be so steep that the walls might slide or collapse, even in a torrential rain storm. Benches (level areas) may be incorporated in the walls, to provide roads on which equipment can enter or leave the pit. If the movement of material might occur and present a

hazard, barriers should be provided.

Loose and unconsolidated material must be moved back (stripped) at least 10 feet from the top of the pit (or quarry walls). Overhanging material, or hazardous banks, must be taken down so that nothing can fall on the workers (or visitors).

As a visitor, avoid dangerous banks or other possible unsafe ground, and don't walk between pit walls or banks and pieces of equipment--where you might be trapped in case of a fall or slide.

Hazards from Blasting Operations

Drilling and blasting are hazardous operations. Explosives are used only by miners who have been trained to use them. Explosives must be packed into blastholes and then non-combustible stemming (packing) material must be tamped in place. If the charge is not packed properly, a shot may blow out, and dust or gasses may ignite and explode--a much larger explosion than was planned. If the blasting material burns instead of exploding, toxic gases may form and be circulated by the ventilation system. The toxic gases may include

o carbon monoxide (CO), a very poisonous gas; and

o nitric oxide (NO), a toxic gas generated when explosives burn. When NO reacts with oxygen (O_2) in the air, nitrogen dioxide (NO_2) is formed, and it is potentially fatal when inhaled.

Explosives must be kept dry, and the detonators must be stored well away from the explosives. They all should be stored in secure containers until just before use.

When explosives are taken to the site where they will be used, they are

to be transported in closed containers of non-conductive material. In underground coal mines, explosives are moved on belts, in locomotive- or rope-towed cars, in shuttle cars, or in specially designed safety equipment. In other underground mines and surface coal mines, explosives are moved in separate vehicles and are separated from the detonators by at least four inches or hardwood or its equivalent.

A few words about explosives may be helpful. TNT (trinitrotoluene) is an excellent military explosive. It is powerful, but a Corps of Engineers blasting cap is required to make it explode. A common form consists of quarter-pound blocks, like hard plastic blocks. You can shoot at TNT with a rifle bullet going 3000 ft/sec, chop TNT with an axe, pound it to powder with a hammer, burn it in a fire, or explode black powder next to it; none of these will make it explode. It will seldom explode by accident, Nitroglycerine, in contrast, is a liquid that may explode if you drop the vial. Nitroglycerine was made safer by soaking it into sawdust; that form is called dynamite. Fresh dynamite is quite safe, but if dynamite is stored for a long time, the nitroglycerine may drain to the bottom, and old dynamite is about as unstable as plain nitroglycerine. Dyanamite is used frequently by miners, well diggers, and some terrorists. A new favorite explosive is ammonium nitrate (Scott's Turf Builder). In quantities of a few pounds, it is extremely safe, unless it is mixed with heavy oil. That slurry will conform to the shape of an uneven blasthole, and a blasting cap will set it off. Many miners, demolition men, and some terrorists, use ammonium nitrate. A very large quantity of ammonium nitrate can be exploded by a spark, even without the oil, as some unfortunate people found out while unloading fertilizer from a freighter off the Texas coast, but small

quantities are quite safe, until the oil is mixed in. There are many other explosives. These are simple examples that may aid your understanding of explosives and their uses, advantages, and dangers.

Only explosives handlers may ride in a vehicle carrying explosives, and then only if they are specifically needed. No other material may be carried in the vehicles that are carrying explosives, and those vehicles should be identified clearly and never left unguarded.

Regulations on explosives include the following:

o The areas around explosives must be cleared, guarded, barricaded, and marked clearly to warn miners and mine visitors.

o A warning must be given before any explosive is detonated.

o Smoking is prohibited within 25 feet of explosives or detonators.

o After blasting, searches must be made for fires and undetonated charges.

Smoking is always prohibited in coal mines and gassy mines (those with methane). Underground coal mines require special precautions:

o Methane tests must be made in underground anthracite mines before blasting; the methane level must be below one percent; and

o Combustible material must not be used to stem the blastholes.

Hazards of Mine Gases

The presence of toxic gases and the absence of sufficient oxygen are the twin hazards for those who breathe the

atmosphere in an underground mine.

The list of Dangerous Gases is usually headed by methane. Methane is flammable in air at concentrations from 5 to 15 percent, and it explodes very readily. Any mine in which methane can be detected is a "gassy mine," and the maximum allowable concentration is one percent. If methane exceeds one percent in any area, several things must happen (or NOT happen).

o No electrical equipment may be energized, operated, or taken into the mine.

o No blasting is permitted.

o No pillar recovery or intentional roof fall is permitted.

o Ventilation must be increased. Air used for ventilation may not contain more than 0.25 (one-quarter) percent methane.

o Power must be shut down.

Coal mine operators must conduct tests for methane three hours (or less) before each shift and at least once during each shift, in every work sector.

Gassy Mines: As stated earlier, any mine in which methane is found is a "gassy" mine, and all coal mines are considered to be gassy. Smoking is prohibited in all gassy mines. Welding requires continuous methane testing before and during the welding job. Correct door positions (Open or Closed) during ventilation must be identified clearly. Methane monitors are requiired on the mining equipment. And, all working areas must be tested for methane within three hours before a new work shift enters the mine.

If the methane concentration exceeds one percent within 12 inches of

the back, face, or rib, work must stop; and all equipment must be shut down until the methane concentration is reduced below one percent. If the methane concentration reaches 1.5 percent, or if the ventilation fans stop, the miners must be evacuated from the area, and all electrical power must be shut down.

In coal mines, methane monitors on such equipment as continuous miners, longwall and face cutting equipment, and loading machines must be as close to the working surface as possible, and they should be set to give an automatic warning if the methane concentration should reach one percent, and to shut off the equipment automatically if the methane reaches two percent or if the monitor malfunctions.

Other dangerous gases may occur: Carbon monoxide (CO) results from blasting, fires, or incomplete combustion or oxidation. It binds to hemoglobin ands prevents blood from carrying oxygen; it produced headache, nausea, weakness, confusion and death. It also burns. The Permissible Exposure Limit (PEL) is 50 ppm.

Nitric Oxide (NO) was discussed under blasting. It can be fatal. PEL = 25 ppm.

Nitrogen dioxide (NO_2) comes from gasoline or diesel engines, welding, blasting, or electrical discharges. PEL = 5 ppm.

Carbon dioxide (CO_2) is formed in fires and explosions, and released by the action of acid on carbonate rocks. It is mainly dangerous if itss formation removes too much oxygen from the air and thus causes suffocation. The PEL = 5000 ppm.

Hydrogen (H_2) is extremely flammable, with a lower explosive limit

1%=10,000ppm

(LEL) of 4 percent, and an upper explosive limit (UEL) of 75 percent. It is released when storage batteries are charged, and in some high temperature reactions.

Hydrogen sulfide (H_2) has the smell of rotten eggs, and it is very deadly. PEL = 20 ppm. It also will burn.

Welding may release, or cause the formation of, toxic metal fumes (from zinc), arsenic, or phosgene. Good ventilation is important to safe welding.

Oxygen deficiency is considered to exist if the oxygen drops from the normal value of about 21 percent in air to 19.5 percent or lower. Oxygen can be consumed by combustion (fires, lqiuid fuel engines, &c) or can be displaced by various other gasees such as carbon dioxide, methane, or hydrogen. Mine operators are required to test for oxygen frequently, and to stop work and take corrective action if the concentration should drop below 19.5 percent.

Personal Protection involves the use of propeer clothing and equipment, and the availability of suitable respirators or masks to permit survival in a toxic atmosphere.

Even mine clothing is regulated by Federal Law. Hard hats are mandatory wherever falling objects may threaten the safety of workers or visitors. If deep water exists within a mine, life jackets or safety belts must be available. Seat belts must be used if there is a possibility for a vehicle to turn over, and where roll-over protection is provided. Snug clothing must be worn around machinery or equipment that moves. Wherever special hazards of radiation, chemicals, mechannical irritants, or toxic or corrosive materials may occur, suitable

protective clothing or equipment must be worn or used. Miners in underground mines must wear personal cap lamps and carry portable electric lamps.

Respiratory Protection is an absolute necessity if people are to escape from dangerous atmospheres.

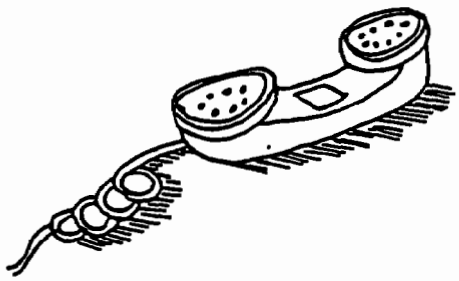
Self-rescue devices have a filter that reacts with carbon monoxide and will protect for one hour against CO concentrations up to one percent. A self-rescuer will enable a miner (or visitor) to get out of a mine that is contaminated with carbon monoxide. It will not supply oxygen nor protect against other toxic gases.

A self-contained breathing appratus (SCBA) with a tank of compressed air will protect against any dangerous atmosphere (but will not, of course, prevent an explosion). Another version is the self-contained oxygen-generating breathing device. It provides a 60-minute supply of oxygen.

Abandoned mines will, obviously, present a wide range of possibly unsafe conditions. Toxic gases or inadequatee oxygen are obvious possibilities, and weakened roof supports are another danger. If you must enter an abandoned underground mine, take SCBA equipment, atmosphere monitors, especiially explosive gas detectors, and don't go alone. Proceed with great caution, while a rescue team waits outside, or well back, to get you out if danger overtakes you.

Mine Communications

A mine operator must always know the location of every miner and visitor in the mine. Every mine worker must be able to contact any, or all, of the others. The surface (of an underground mine) must have communication with all parts of the mine, and the connection(s)



above ground must be attended at all times, and they should be located within 500 feet of the mine entrance. The communication system should have its own power source, independent of the electrical system for the mine.

Hoists and elevators require two signalling systems; one must be a telephone or speaking tube. Trolleys and railroads may have two-way radios or trolley phones. They may need their own, independent, power source. Some mines use time clocks or boards to record people entering (and their destination) and leaving. Other mines use two metal tags for each person entering; the worker keeps one tag and leaves the other with the cage man.

Surface mining communications needs are simpler, but any miner working in a hazardous area must be able to communicate with others. Federal regulations define other communicaticn needs according to conditions.

Mining is a dangerous occupation, and underground mines are danerous places to enter and inspect. Use this presentation as a beginning of understanding, and pay close attention to the orientation that will explain the safety precautions in any mine you may need to enter.

STUDENT EXERCISES

1 (a) You are looking at the roof support in a 5-year-old mine tunnel, to see if the roof is sound. What should you look for?

1 (b) If the roof, walls, and supports look good, you can still make an audible test. Describe that test, the possible results, and their meaning and significance.

2. Which dangers of underground mining are absent from surface mining or quarrying?

3. What do you think are the three greatest hazards of surface mining?

4. When blast holes were drilled into a mine face, some methane seeped out, but the methane monitor was acting very erratic, and the methane concentration was unknown. The new blasting expert, who started work a day earlier, said, go on and blast, becausse the blast would disperse that "little bit" of methane, and the ventilation system would carry it away. Discuss this situation.

5 (a) In an underground coal mine, a gasoline-powered generator for welding is running badly and making bad smells. Monitors show 20 ppm of carbon monoxide and 10 ppm of nitrogen dioxide, measured one foot from the exhaust pipe. Should the welding job be finished before the generator is sent "up" for repair? Explain your answer (no credit for a lucky guess).

5 (b) Can welding continue for another half hour if all the workers wear "self-rescue" masks? Explain why.

UNIT 13

DEFENSIVE DRIVING

EDUCATIONAL OBJECTIVES	NOTES
o The student should be able to determine whether an accident is preventable or not.	
o The student should be able to determine how to avoid a collision with a vehicle ahead.	
o The student should be able to determine how to avoid a collision with a vehicle behind.	
o The student should be able to determine how to avoid a collision with an oncoming vehicle.	
o The student should be able to determine how to avoid a collision at an intersection.	
o The student should be able to determine how to avoid a collision while passing or being passed.	
o The student should be able to determine how to avoid other common types of collisions.	

NOTES

Traffic accidents affect the well-being and safety of literally every man, woman and child in the United States because everyone at one time or another is a driver, passenger or pedestrian.

Traffic accidents are the leading cause of accidental death, killing nearly 50,000 persons a year, causing two million disabling injuries and economic loss of about $20 billion dollars. Note from the accompanying table that the number of traffic deaths for one year is almost as many as the number of U. S. Military casualties in the entire Viet Nam war. Here are some other traffic accident facts:

Accident Facts:

* Traffic accidents are the leading cause of death among youths under 25 years of age.

* Traffic accidents are the leading accident killer of U. S. workers.

* Every 12 minutes someone dies in an automobile accident—five die every hour, 129 every day.

* Driver failure is a contributing factor in an estimated 85 percent of all traffic accidents. Many individuals and organizations are involved in controlling this tremendous human and economic waste, including the federal government, the governor of your state, the mayor of your community, licensing authorities, your police department, traffic courts, traffic engineers, your schools and your national and local safety councils. As a driver, you too are involved both in the problem and in the solution.

War	Deaths			Nonfatal Wounds
	Total	Battle	Others*	
Total	1,155,000†	649,421	506,300†	1,580,000‡
Revolutionary War (1775-83)	4 435	4,435	N A	6 188
War of 1812 (1812-15)	2,260	2 260	N A.	4,505
Mexican War (1846-48)	13,283	1,733	11,550	4,152
Civil War (1861-65)				
Union Forces	364 511	140,414	224 097	281,881
Confederate Forces	133 821	74 524	59,297	N A.
Spanish-American War (1898)	2,446	385	2,061	1 662
World War I (1917-18)	116 708	53,513	63,195	204 002
World War II (1941-45)	407 316	292 131	115,185	670 846
Korean War (1950-53)	54 246	33 629	20 617	103 284
Viet Nam War (1961-74)	56,737	46,397	10,340	303,569

NOTES

How To Measure Safe Driving

Safe driving can be measured in terms of quantity and quality. A unit of driving is the trip. This is measured in terms of the distance between the point where you get into your card, drive to your destination, secure your car and leave it. The trip can be long or short, but it is the quality of the trip that is important. This, also, can be simply measured. The trip can be perfect or less than perfect. Perfect driving means that you complete every trip without accidents, without traffic violations, without vehicle abuse, without excessive schedule delays and without discourtesy.

Preventability—Possible and Reasonable

Perfect driving involves the ability to operate a motor vehicle in such a manner as to avoid being involved in a preventable accident. Most accidents are preventable by one or both of the drivers involved, even though this sometimes involves letting the driver in the wrong have the right-of-way.

The idea that most accidents are preventable makes it important to distinguish between the possible and reasonable precautions a motorist can take to avoid being involved in a traffic mishap. The most obvious possible precaution would be not to drive at all, but that's not a reasonable solution.

This course is designed to make you aware of the various reasonable precautions that relate to driving and to teach you how to apply them.

The Art of Driving To Stay Alive

Defensive driving is a key concept in the Driver Improvement Program. It represents an approach to the driving task that, when applied, can lessen your chances of being involved in a motor vehicle accident. Defensive Driving means driving so as to prevent accidents in spite of the actions of others or the presence of adverse driving conditions.

NOTES

Building a defensive driving technique involves improving your habits of

Observation, Communication, Coordination, Navigation and Consideration. It will increase your ability to predict the outcome of traffic situations earlier and more accurately and thus, to a degree, control that outcome so that no collision results.

The Standard Accident Prevention Formula

In order to do this, you'll need to know and apply the standard accident prevention formula, which involves three interrelated steps:

1. **See the Hazard:** Think about what is going to happen or what might happen as far ahead of encountering a situation as possible. Never assume everything will be "all right."

2. **Understand the Defense:** There are specific ways to handle specific situations. Learn them well so you can apply them when the need arises.

3. **Act in Time:** Once you've seen the hazard and decided on the defense against it, act! Never take a "wait-and-see" attitude.

How to Avoid Collision with the Vehicle Ahead

An extremely frequent, and costly accident, in terms of liability suits, is the collision with the vehicle ahead.

There are four simple steps that will help you avoid being involved in a collision with the car ahead:

1. **Stay alert:** Watch for signs from the driver ahead as to what he intends to do. Is his turn signal on? Are his brake lights lit? Has he been gradually drifting to the right or the left as if to prepare for a turn?

2. **Stay ahead of the situation:** Look beyond the driver ahead to see situations

that may force him to act quickly and thereby become a threat to you. Are there vehicles in the roadway or on the shoulder? Are the intersections marked or unmarked? Are there parked cars, pedestrians or livestock present?

3. **Stay back:** Allow one car length for every ten miles of speed--more in adverse weather or road conditions. The best way to do this is to use the Two-Second Rule to make sure that you have the correct following distance. If you stay two seconds behind the car in front, you will have the correct distance no matter what your speed. It works like this: Watch the vehicle ahead pass some definite point on the highway, such as a tar strip or overpass shadow. Then count to yourself "one thousand and one, one thousand and two." That's two seconds. If you reach the mark before you finish saying those words, you are following too closely.

4. **Start stopping sooner:** Slow down and touch your brakes the instant you see a hazard developing that may require you to stop or take evasive action. Failure to do this is known as "delayed braking," a serious flaw in defensive driving technique. A defensive driver should rarely if ever have to make a panic stop.

The time it takes you to stop depends upon your speed, the condition of the road, the condition of your car, and how alert you have been. Expressed as a formula:

Reaction Distance + Braking Distance = Total Stopping Distance

STOPPING ABILITY OF STANDARD PASSENGER CARS ON DRY, CLEAN, LEVEL PAVEMENT

Speed	(1) Driver Reaction Distance	(2) Braking Distance 15-85 Percentile Range	(3) Total Stopping Distance Range
mph	ft.	ft.	ft.
20	22	18-22	40-44
25	28	25-31	53-59
30	33	36-45	69-78
35	39	47-58	86-97
40	44	64-80	108-124
45	50	82-103	132-153
50	55	105-131	160-186
55	61	132-165	193-226
60	66	162-202	228-268
65	72	196-245	268-317
70	77	237-295	314-372
75	83	283-353	366-436
80	88	334-418	422-506

Know Accident Conditions

Throughout the Defensive Driving Course we will be discussing various types of accidents in terms of preventability. There are six principle conditions that play some role in accidents. These are light, weather, road, traffic, vehicle and driver.

It is possible to think of an accident situation in which all six of these conditions are unfavorable. Yet it is important to realize that in most accidents, all conditions except driver condition are favorable. This points up the importance of driver condition. Even so, the student of defensive driving must become an expert on all conditions and how to adjust to them.

Light Condition

The first requirement of safe driving is to see and be seen. This ability is affected

by light condition--the presence or absence of natural or artificial light. You can have too little light, or too much light. The hazard of too little light is found in the fact that the nighttime fatal accident rate is more than double the daytime rate.

Here are some things you can do to adjust to adverse light conditions:

1. Be sure all lights on your vehicle are in good working order.

2. Keep headlights clean and properly aimed.

3. Turn on lights promptly at the onset of darkness--even in midday if it becomes so dark that visibility is decreased.

4. Switch headlights to low beam when meeting another vehicle and when following another vehicle within 300 feet.

5. Do not look directly into approaching headlights.

6. Never wear sunglasses for night driving.

7. Be extra watchful for pedestrians and cyclists at night.

8. Always reduce speed at night.

9. When there is too much light, such as when driving directly into sun glare in the early morning or late afternoon, wear sunglasses and use your sun visor. A good pair of sunglasses is also helpful in preventing snow blindness when snow-glare is present. Ask your eye specialist for prescription sunglasses if necessary; they are worth the investment.

10. Rememoer that under adverse light conditions others also have difficulty seeing, so take care that they can see you.

11. Never drive with only your parking lights on.

Weather Condition

Bad weather can affect traction, visibility and vehicle control.

Rain, snow and ice can make road surfaces slippery. Adverse weather can obscure your vision with rain, snow, fog or road splatter, as well as steam up glass with interior vapor. Other drivers find it harder to see you, and pedestrians hide behind umbrellas so they fail to see cars approaching. High winds make steering difficult and cause vehicles to veer to the wrong side of the road.

Here are several defensive actions you can take to adjust to adverse weather conditions:

1. Clean windshield and all windows of accumulated snow or ice if your car has been outside. Don't try to see through a peephole.

2. In cold weather be sure your motor is warmed up enough to insure reliable performance. Turn on heater before you start to avoid sudden fogging of glass.

3. At the onset of rain, fog, sleet or snow, adjust your speed immediately to the changed conditions.

4. Be sure your windshield wipers, washers and defroster are in good working condition.

5. Turn headlights on low beam in fog, rain, extreme cloudiness or snow storms, even in the daytime.

6. Be sure your taillights, brake lights and directional signals are working.

7. If ice or snow accumulates on windows, windshield or lights, stop in a safe place to clear it off.

8. Sometimes weather can get so bad that the best thing to do is get completely off the road until conditions improve.

That's especially vital in heavy fog or rain. If you have to stop on the shoulder get as far away from the road as possible and turn off all exterior lights except flashers.

9. The early phase of rain is most dangerous because it raises a soapy-slick film of oil and grease drippings. After 20 to 30 minutes of hard rain, the slippery residue is washed off and the pavement has better traction. So at the onset of rain, slow down.

10. Bad weather by itself doesn't cause accidents. Accidents are caused by drivers who do not take immediate measures to adjust to the special hazards brought about by bad weather.

Road Condition

Road condition refers to the total roadway and the type and condition of the road surface. These can affect your ability to steer, stop and maneuver.

Adverse road conditions can be produced by weather. Conditions change from one kind of road to another--from a side street to a thoroughfare, from secondary road to a main highway, from a two-lane road to an expressway. Any trip may involve a number of different road conditions, each requiring adjustment in your driving.

Here are ways to cope with adverse road conditions:

1. Adjust your speed to road surface conditions. Posted speed limits are for ideal conditions only.

2. On snow or ice you must reduce your speed, not only to avoid skidding but also to make certain your stopping distance will be within your clear sight distance ahead.

3. On slippery surfaces, slow down sooner so you can use your brake sparingly, start braking sooner, and use less power in starting and accelerating.

4. To avoid locked-wheel skids, pump your brakes when stopping on slippery roads. Jab and release them quickly once or twice a second. This gives alternate intervals of braking and steering control. With disc brakes, application should be less rapid.

5. If you skid, steer in the direction the rear of the vehicle is sliding.

6. Wet leaves are very slippery, so use care.

7. Remember that ice forms more quickly on bridges, that shady spots remain icy longer, that concrete pavement usually ices up faster than warmer blacktop roads, and that "wet" ice at about 30 degrees is more slippery that ice at zero temperature.

8. Experience shows that accidents due to icy or wet streets most often occur soon after the sudden onset of the hazardous condition. If conditions are bad when drivers start a trip, they usually are on guard. But if the bad weather starts during the trip, drivers try to maintain their normal speed too long and get into trouble.

9. Speed, standing water on the pavement and tires with worn tread make a combination that can cause hydroplaning, a complete loss of steering and reduced traction. A wedge of water can build up between the front tires and the road and literally lift the tires from good contact with the pavement. Slow down in heavy rain that leaves standing water.

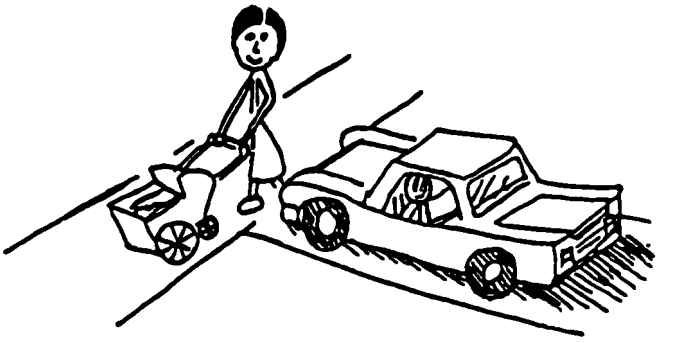
10. When starting out on a slippery day, test the traction by lightly applying the brakes at slow speed to get the "feel" of the road.

Traffic Condition

Traffic conditions are created by the number of vehicles and pedestrians using the same road or street at the same time you are, and to a large extent by how well the road has been engineered to accommodate the amount of traffic present at a given time. More

cars mean more conflict in traffic and more change for a collision.

Traffic conditions are influenced by the time of day, day of the week, even time of year in the case of holiday periods, and by the nature of the environment, such as a shopping center, sports arena, factory or school.

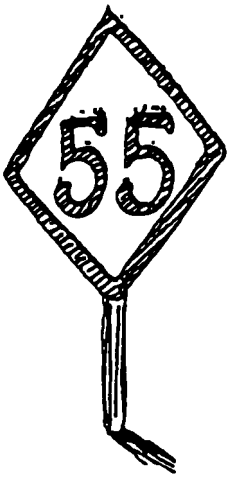


Here are ways to adjust to traffic conditions:

1. Remember that pedestrians and bicyclists may not always have the right of way, but cars must always yield right of way to a pedestrian.

2. Motorcycles are undersized and often overlooked. Allow them as much road space as you would another vehicle.

3. Be ready for wind turbulence when passing large trucks or campers.



4. Plan your driving routes to avoid congestion as much as possible and select the best regulated routes.

5. Speed zones are often established after observing the normal pace of most cars on a given stretch of street or highway. The defensive driver conforms to this pace. Driving faster or slower than traffic in general will create unnecessary passing movement, and passing increases the change for mistakes.

6. Dim your lights well in advance of oncoming cars, and never look directly into an approaching car's lights. If they are on high beam, flick yours as a signal. If the driver leaves them on high, keep yours on low beam and look to the right edge of the road or lane marker until the car is past. Never switch on your high beam in retaliation; that just compounds the danger.

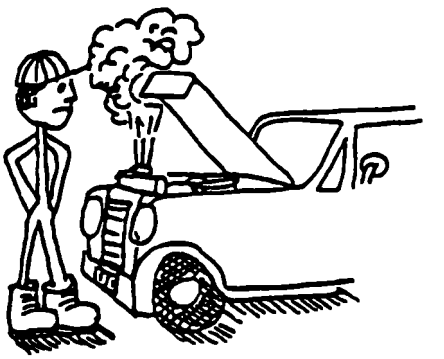
7. Because traffic conflicts can trigger emotional reactions among drivers, the defensive driver seeks to influence others by showing courtesy and consideration

to other motorists at all times.

Vehicle Condition

Vehicle condition affects your ability to control your vehicle, your ability to see and be seen, and to communicate with other drivers and pedestrians. Your chances of staying out of an accident are better with a vehicle in tip-top condition that they are with one that has operational defects.

You are the only one who knows when something isn't working right. Only you can spot possible vehicle defects and either repair them or get them corrected by a qualified mechanic.



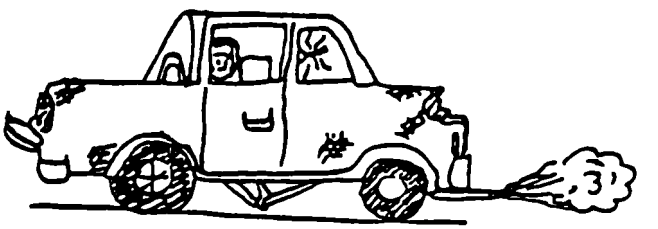
Here are several points to remember about vehicle condition:

1. Worn or poorly adjusted brakes cause trouble when the driver is faced with the necessity for stopping quickly.

2. Defective turn signals or brake lights can confuse other drivers about your intentions and cause a collision.

3. Worn tires increase the possibility of skidding or hydroplaning. A blowout can throw your car out of control. Good tire care is one of the essentials of a safe car.

4. A broken or burned-out headlamp not only cuts down your visibility, but makes it difficult for other drivers to judge the position of your car in a lane. Keep your headlamps aimed correctly.



5. Broken windshield wipers or worn-out wiper blades can mean the difference between life and death on a rain-swept highway.

6. The horn can be an important safety device. Horns should be used sparingly, but if you need to sound a warning and the horn won't work, the results can be serious.

7. A defective muffler and exhaust pipe often results in filling the vehicle with carbon monoxide. While the concentration may

not be enough to cause death, it can cause drowsiness and may be the unseen, undiscovered cause of many accidents.

8. A lap belt and shoulder harness should be worn at all times. If safety belts are in bad condition or stuffed behind the seat, they are of no use to even the most safety-minded occupant in an accident.

9. The interior of your vehicle can contribute to the "second collision" in the event of a crash. Heavy or sharp objects stowed on the rear shelf of your car can become lethal projectiles.

10. When renting a car or borrowing someone else's, take time to get familiar with the vehicle, the location of all controls and its operating characteristics.

Driver Condition

Driver condition refers to your physical, mental and emotional fitness to drive. It is the most important of the six accident conditions, because a driver in top physical, mental and emotional shape can adjust to all the other conditions and to the errors of other drivers as well.

Here are some important points to remember about driver condition:

1. Be as objective as possible about your fitness to drive, whether the trip is long or short. When you don't feel up to it, be willing to postpone the trip or have someone else drive.

2. The most dangerous physical condition is being under the influence of alcohol. The best rule is not to drive after drinking, but if you must drive, do so only if you understand how alcohol affects your capabilities. Know your limit.

3. Age is a special driver condition for those under 25 and over 65. The younger driver has good physical condition but lacks experience and mature judgment. The older driver has experience and, hopefully, good

judgment, but his physical and sensory faculties may have deteriorated. Each group can compensate for these weaknesses by knowing and adjusting to them.

4. The taking of prescription drugs, as well as illegal drugs, can affect driving. Medicines taken in combination, or when used with alcohol, can have a multiplying effect. Ask your physician about the effect prescription drugs may have on your driving ability. Needless to say, illegal drugs and driving are a dangerous mixture.

5. Emotions such as anger and worry can blot out the alertness needed to drive safely. If you are upset and unable to concentrate, don't drive. And never allow aggressive driving to become an outlet for anger and frustration.

6. Fatigue and sleepiness are other dangerous driving conditions. When you find yourself dozing at the wheel, don't fight it. Pull of the road for coffee, exercise and fresh air. If necessary, take a nap or let someone else drive.

7. Certain physical impairments, such an uncorrectable vision, uncontrollable epilepsy, hear disease or diabetes, add to driving risk. Discuss these with your physician, and have the wisdom to forego driving if he advises you to do so.

How to Deal with Tailgaters

It is sheer foolishness to take the legalistic position that "any driver who hits my vehicle from behind is in the wrong." An attitude like that can literally break your neck. You have a responsibility to the driver following you. You have to let him know what you are going to do in order for him to know what to do.

There are four measures you can take to avoid being hit from behind:

1. **Signal your intentions.** Use your directional signals (or arm signals) and brake lights.

NOTES

2. Stop smoothly. Once in a while, you have no choice but to jam on the brakes. Most of the time that shouldn't be necessary. If you follow the rule for avoiding a collision with the vehicle ahead, you will reduce at the same time the chance for a collision with the vehicle following.

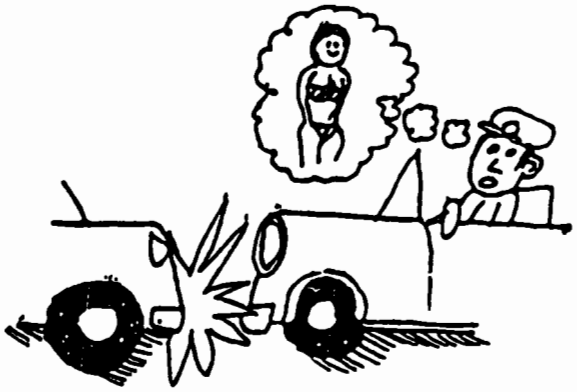
3. Keep clear of tailgaters. Don't let a tailgater rile you. Just slow down. This will eliminate the hazard by:

a. Encouraging him to pass you.

b. Increasing the following distance between your car and the car ahead so you won't have to brake suddenly and be hit by the tailgater.

c. Forcing him to slow down, thereby making it easier for him to stop safely when you stop.

4. Avoid a rear-end collision when stopped. Being struck from the rear while stopped in traffic accounts for 70 percent of rear-end collisions. This may happen to you when you are stopped behind a driver who intends to make a left turn. These precautions are recommended to avoid being struck in the rear while stopped in traffic:



* Keep foot on the brake to activate the brake lights.

* Stop at least 10 feet behind the car ahead to prevent any domino effect. A good way to do this is to stop so you can see the rear tires of the car ahead.

* Keep lights on at dusk or in rain and snow.

Defensive Driving: A Matter of Attitude

If you practice defensive driving, it's unlikely that you'll find yourself involved in a collision with a vehicle following your own. After all, defensive driving is largely a matter of attitude--the determination on your part to do everything reasonably possible to avoid being involved in a

preventable accident, regardless of what the law says, what the other driver does, or the adverse driving conditions you encounter.

There are a number of attitudes that characterize the defensive driver. How many do you display?

1. **Knowledge:** Do you know the traffic rules and regulations of your state? Are you aware of proper procedures for passing, yielding the right of way and other maneuvers you'll be called upon to perform when you're behind the wheel?

2. **Alertness:** Are you aware of what's going on around you? Are you conscious of traffic conditions ahead? Do you occasionally glance from side to side, and at the side and rear-view mirror?

3. **Foresight:** Do you "look ahead" when you drive? Can you predict what is likely to happen? Foresight includes both short and long-range predictions, such as getting ready to stop when you see a traffic light ahead and making a pre-trip mental inventory of driving conditions.

4. **Judgment:** Another word for good "horse sense." Judgment involves knowing what to do and doing it at the right time--every time.

5. **Skill:** Do you know how to handle your car? How to start, stop, turn, go forward and in reverse and how to execute various emergency maneuvers? Research has shown that skill is not simply the result of practice, but the result of training, plus practice.

Head Restraints Reduce Whiplash

Each year there are an estimated 3,800,000 rear-end vehicle crashes. In these, as many as one million drivers and passengers claim whiplash injury, one of the most common of crash casualties.

Since 1969, when head restraints were required as standard equipment in new cars,

nearly one-fifth of whiplash injuries have been eliminated. This despite the fact that a large number of adjustable head restraints have been found to be improperly adjusted.

Some pointers for head restraints:

* The padded section should be adjusted to fit against the back of the skull, and not against the base of the neck. Restraints left in their lowest position may actually increase certain whiplash injuries by serving as a fulcrum over which the head snaps in rear-end collisions.

* The front seat head restraints should not increase the change of injury to back-seat passengers in the event of an accident.

HOW TO AVOID A COLLISION WITH AN ONCOMING VEHICLE

The deadliest of all collisions is one that occurs with an oncoming vehicle. A number of factors contribute to the fatalities that result from such accidents.

* In a head-on collision, the cars involved stop almost instantly; unfortunately, their occupants keep hurtling forward--right into the windshield and dashboard.

* Since most head-on collisions occur slightly off center, one or both cars spin and their occupants often are thrown out of the car. This is where safety belts are really effective in saving lives.

Recovering from a Pavement Dropoff

Your efforts to steer back onto the road after your front wheel has dropped off the pavement can send you swerving into the path of an oncoming vehicle unless you follow these steps:

1. Don't panic and don't brake.

2. Slow down to a safe speed, keeping the car on a straight course.

3. Check for an opening in traffic and steer slowing back onto the pavement at a sharp angle.

Coping with Curves

The best way to take a curve is to slow down before you enter it. On curves to the right, keep to the right edge of the pavement. On left curves, stay in the middle of your lane. Apply light power to the wheels while in the curve.

The relative danger of a head-on collision in a curve depends on which direction the curve takes.

* On right curves. Never allow you car to drift into the other lane; centrifugal force will tend to pull it to the left toward the center line.

* On left curves. Be alert to the other vehicle's tendency to drift into your lane, since centrifugal force pulls him to the left toward you.

How to Avoid an Oncoming Vehicle

More times than one wants to experience, an oncoming motorist is found in your lane. Several things may account for this: the driver may have fallen asleep, he may wrongly have entered a one-way street, or he may have lost control of his auto trying to pass another driver. Whatever the reason, it presents a truly dangerous problem. Several steps should be taken:

* **Read the Road Ahead:** Be alert for an auto or pedestrian about to enter your lane or trying to pass in your lane.

* **Ride to the Right:** Never drive to the left. The oncoming driver may decide to swerve right to avoid you and hit you head-on.

* **Reduce Speed:** Reducing speed reduces distance traveled and impact force.

* **Ride Right Off the Road:** If

necessary, veer to the right and go off the pavement. Give him your lane—always avoid a head-op crash.

HOW TO AVOID AN INTERSECTION COLLISION

One-third of all traffic accidents happen at intersections and about 40 percent of all urban accidents occur there. Unless turns are prohibited, there are three things a driver can do at an intersection:

1. Make a right turn.

2. Go straight through.

3. Make a left turn.

The four general rules for intersection safety are:

1. **Know** your route and plan ahead.

2. **Slow** for intersections and expect the unexpected.

3. **Show** your intentions by position and signals.

4. **Go** with care.

Rules for Making a Right Turn at an Intersection

1. Get in the extreme right lane well in advance.

2. Turn on your right turn signal no less than 100 feet before the turn.

3. At the turn position place your vehicle so as to block out any vehicle that might try to squeeze between you and the curb.

4. Make sure that you have the right of way and that there is no cross traffic.

5. Make your turn when it is safe to do so.

Rules for Going Straight Through an Intersection

1. Be sure you have the right of way.

2. Slow down and be prepared to stop.

3. As you approach the intersection, have your foot off the accelerator and on the brake pedal to give yourself that extra split second of reaction time you need to stop if a vehicle or a pedestrian tries to cross in front of you.

4. Look first to the left, then to the right, because traffic coming from the left is closer to you and would cross your path first.

5. Accelerate through the intersection when it is safe to do so.

Rules for Making a Left Turn at an Intersection

1. Get in the left lane well in advance.

2. Turn on your left turn signal no less than 100 feet before the turn.

3. Stop and yield right of way to cross traffic and vehicles approaching from the opposite direction and close enough to present a hazard.

4. When it is safe, make your turn in such a manner as to enter the cross street on the right side of the center line in the lane nearest to the center line.

5. In meeting other vehicles also turning left, be sure to pass them so that they are on your right.

THE ART OF PASSING AND BEING PASSED

The final two positions of the two-car crash to be discussed are those that involve (1) your vehicle being overtaken and passed by another, and (2) your own passing maneuver.

NOTES

Both positions--passing and being passed--are potentially dangerous because they can result in head-on collisions, sideswipes or run-off-the-road accidents.

How to Be Passed

There are a number of things you can do to prevent accidents that can happen when other cars pass you:

1. Help the other driver pass. Check oncoming traffic. Slow down if the passing car will need more room to get back in line in front of you.

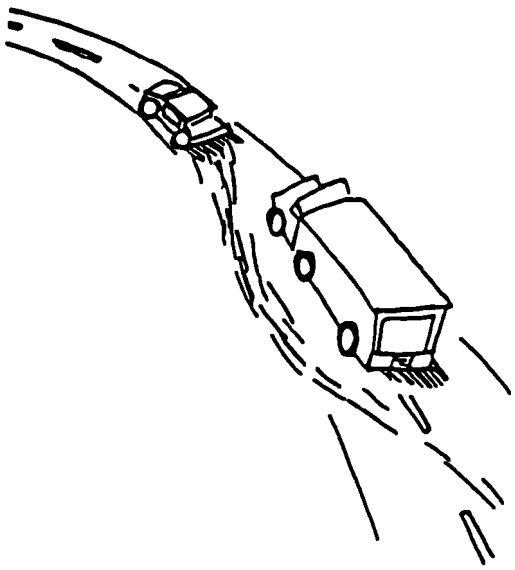
2. Before you change lanes, check your side and rear-view mirror and glance back to make sure your blind spot is clear. Use your land-change signal. Move over only when lane is clear.

3. Get into the proper lane for a turn early. When turning right stay close to the right curb to block anyone from passing on the right. Use your turn signal early.

4. Don't nose out of a parking space to check for oncoming traffic. Take a good look before you move. Signal your intentions, wait for a break in traffic and pull out slowly.

How to Pass

There are a number of reasons why you may want to pass another vehicle: You may feel it is going too slowly, you may be in a hurry, or you may simply want to be the front runner. There is nothing wrong with passing for the right reason, but it isn't likely to save you much time. And since passing often entails risk, the best rule is: When in doubt, don't!



In any passing maneuver, there are 12 things to do:

1. Decide if the pass in necessary.

2. Make certain you have maintained a safe following distance.

3. Check traffic ahead. If your vehicle and an oncoming car are both traveling at 55 mph, you are closing the gap between you at the rate of 1.8 miles per minute. Since it takes about 10 seconds to complete a pass, the oncoming car should be at least one-half mile away.

4. Check the traffic behind you before changing lanes. First check your mirrors, then your blind spot.

5. Signal before you change lanes.

6. Move into the left lane.

7. Accelerate as you move left.

8. Signal the vehicle you are passing by tapping your horn or flashing your lights.

9. Signal your intention to return to the right lane.

10. Return to the right lane when you can see all of the passed vehicle in the rear-view mirror.

11. Cancel your directional signal.

12. REsume cruising speed as soon as you have completed your passing maneuver.

HOW TO AVOID OTHER TYPES OF ACCIDENTS

You and the Motorcyclist

Motorcycles are more numerous on the nation's streets and highways with each passing year. With them comes an added responsibility on the part of the motorist. Half of the accidents that occur between the automobile driver and the cyclist are the fault of the autoist. Here are some tips to remember regarding motorcyclists:

Sharing the Road

Many motorists think motorcycles require less space on the road that do other vehicles, just because the cycle is smaller. That is not true. A cyclist is entitled to a

full lane, just as is any four-wheeled vehicle. Do not try to crowd him in any way, or try to force him to the edge of the road. Respect him as a fellow driver.

Re-Train your Eyes

Most cycle-auto accidents occur because the motorist simply doesn't see the cyclist. Often a cycle is hidden in the car's blind spot. Outside rear-view mirrors are not enough to rely upon; when changing lanes, it is a good policy to take a quick glance over your shoulder. Be alert for the presence of a cyclist on the outer edge of your traffic lane, especially on turns. A cycle often is screened by another car. Aware of his low visibility, the safety-conscious cyclist often keeps his single headlight on, even in daytime, to warn you of his presence.

Consider the cyclist as being less protected that you are, and watch his driving. He must contend with many more hazards than you do. Be especially cautious when passing a cyclist; the buffeting created by your windstream may cause him to wobble and lose control. The inexperienced cyclist should be given a wide berth. You can recognize him if his cycle jerks when making gear changes, or if he is hesitant in making decisions in traffic. Always give him plenty of room and be prepared to stop if something goes wrong.

Judging Distance

Because a cycle is smaller, it may appear to be farther away that it actually is, and it may seem to be moving slower. Always allow yourself more following distance when overtaking one. To judge your following distance, it is a good idea to add an extra second to the two-second rule of defensive driving: count to "one thousand and three." But this three-second interval is only for ideal conditions. Add to it for adverse conditions.

Watch for Cycle Hazards

Hazards for the cyclist can entrap the

auto driver, too. A cyclist ahead can lose control of his machine when sand, gravel, wet leaves or water are on the pavement. Always be aware of conditions that may cause him to spill. Give him plenty of room, and slow down.

How to Drive on Expressways

If you travel any distance, you'll be using limited-access highways. The technique for driving on them is different from that used on regular roads.

Here are driving hints for expressway safety:

1. Start with a full gas tank and check the tires. Study the map before you start; be sure you know your correct exit.

2. Entering an expressway, speed up in the acceleration lane so you can match the speed of through traffic and blend right in.

3. Never slow down abruptly in a traffic lane. Stay with the pace set by the majority.

4. Don't stop, and never back up. If you miss an exit, go on to the next one. In case of vehicle breakdown, pull as far onto the shoulder as you can.

5. When passing or changing lanes, use your turn signals, check to the rear and get into position early. After passing, wait until you can see the vehicle you've passed in your mirror before returning to your former lane.

6. Keep widely spaced. Stay well behind vehicles ahead as a precaution against chain-reaction crashes.

7. Read the signs; they are all important. You have little change for second-guessing.

8. When leaving the expressway, slow down in the deceleration lane to ramp speed. Believe your speedometer, not your senses.

Watch out for fatigue in expressway driving, and fight monotony with a rest at least every two hours. Keep your eyes moving, open the windows often, check the instruments, sing and chew gum.

If you must make an emergency stop on an expressway, pull completely off the road to the farthest edge of the shoulder. For help, raise the hood and tie a white cloth on the radio antenna or traffic-side door handle. Superhighways tempt you to overdrive your headlights at night. Remember, good lights illuminate about 450 feet.

That is a skimpy margin of safety for any evasive action you might need to take. In bad weather, expressways can be more dangerous than ordinary roads because of higher speeds. Adjust your driving to bad weather.

*Note: This section contains excerpts from the National Safety Council Defensive Driver Handbook.

NOTES

EDUCATIONAL OBJECTIVES

o Students should learn the legally required safety equipment, load limits, registration, and related inspections.

o Students should learn about other recommended equipment, other inspections and precautions.

o Students should learn how to prepare for boating.

o Students should learn about loading and boarding a small boat.

o Students should learn about boat handling.

o Student should learn the rudiments of nautical rules of the road.

o Students should become aware of essential emergency procedures.

NOTES

If a complimentary inspection is requested, a member of the Coast Guard Auxiliary will examine a boat for compliance with Federal regulations and any additional recommendations the local Auxiliary many consider desirable for safety. If the boat passes the inspection, a decal will be affixed, to the boat, to show that the boat has passed the examination. If the boat fails, a confidential list of deficiencies will be provided to the boat owner.

A Registration Number will usually be assigned by the state, or occasionally by the Coast Guard. The number is a handy identification, even for boats that may be exempt from the legal requirement.

The Load Capacity should be displayed on a plate mounted in the boat. A certificate of compliance for an outboard motorboat will show the manufacturer's rating of maximum horsepower of an engine that can be used, safely, on the boat. A combination capacity plate will also list the maximum number of persons and the maximum weight of persons that can be carried safely, as well as the maximum weight (of persons, motor, and gear) that can be carried safely by the boat. The certificate of compliance and the capacity may be shown on separate plates.

The load carrying capacity of the boat should not be exceeded, or the boat may not sail well, may ride too low in the water, and may take on water over the sides and swamp or capsize. If rough weather is expected, the boat should be loaded more lightly to let it ride higher and make it less likely to be swamped by waves. If samples are to be collected, their estimated weight should be included in the total

estimated weight load.

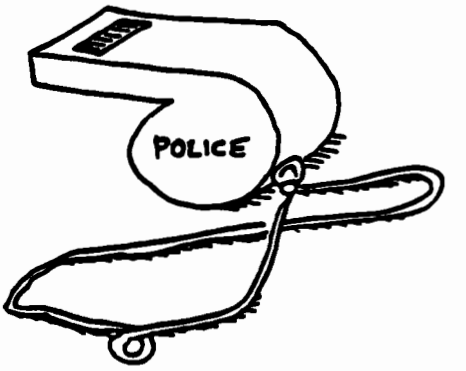
NOTES

RECOMMENDED EQUIPMENT, INSPECTIONS, AND PRECAUTIONS

Every motorboat should have a Fire Extinguisher approved for fighting electrical fires or burning liquids (e.g., gasoline fires). Fire extinguishers must be approved by the Underwriters Laboratories or another reputable testing laboratory. A 2.5 pound dry chemical extinguisher will satisfy the requirement, on boats under 26 feet long, but a 6 pound dry chemical extinguisher will offer a greater chance of putting out a liquid fuel fire. Halon extinguishers are as satisfactory as the dry chemical type. An additional fire extinguisher should be located in the fueling area to put out spill fires.

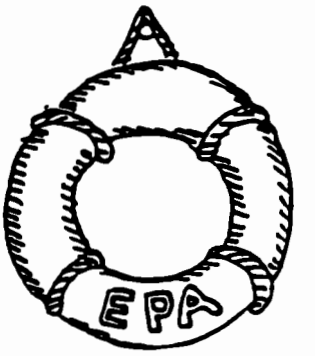
Audible Signals

Boats from 16 to 26 feet long must carry a whistle or horn that can be heard for at least a half mile. A police whistle will meet this requirement. Boats from 26 to 40 feet long must carry a bell for use in fog, and a whistle or horn that can be heard for at least a mile. The whistle or horn can be operated by hand or power. Boats over 40 feet long must have a power operated whistle or horn.



The signaling devices should be used in fog, or in any other weather condition that obscures normal visibility.

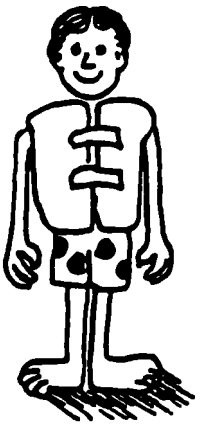
Boats with enclosed spaces where spilled fuel or fuel vapors can accumulate must have powered ventilation to clear away the fuel vapors. This requirement does not normally apply to open boats.



Wearable Flotation Devices (life jackets) are required for each person aboard the boat. Boats over 16 feet long must carry a wearable flotation device for each person, and also one throwable flotation device, for the

boat.

NOTES



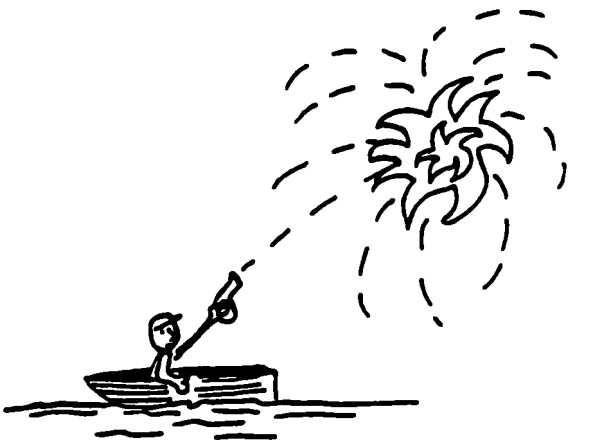
Although flotation devices of types I, II, III, IV, and V are approved for EPA field activities, only types I and II and V are designed to save an unconscious person from drowning because those are the only types that will turn an unconscious person from a face down position in the water. The type I device is the one that provides maximum flotation, and thus, maximum protection in rough water.

The type V device is a work vest that will float an unconscious person face up. It is designed for work activities, but it is not approved for use on recreational boats and is not available in stores that sell only recreational boating equipment.

Float coats or exposure suits, approved by the Coast Guard, are recommended for cold water operation. Wet suits can also be used, preferably with an additional flotation device.

Visual Distress Signals are required in boats 16 feet or longer (26 feet for sailboats), and are strongly recommended for any boat that may need a distress signal in any forseeable circumstance.

Non-pyrotechnic Devices are a special flag (for daytime use) and a special electric signal that flashes SOS signals four to six times a minute, for night use. These devices do not set spilled fuel afire if they are accidentally activated.



Pyrotechnic Devices include hand-held orange smoke signals, floating orange smoke distress signals that last 5 to 15 minutes, hand-held red flares, and pistol-launched parachute red flares. Rocket propelled flares are also available for night use. Pyrotechnic devices should be replaced 42 months from the date of the manufacture, and they are more common on larger boats.

Specified lights are required on any boat that is out on the water in the dark. Boats at anchor must show an anchor light: a white light, visible in all directions for at least one mile.

Vessels under way must show at least three lights:

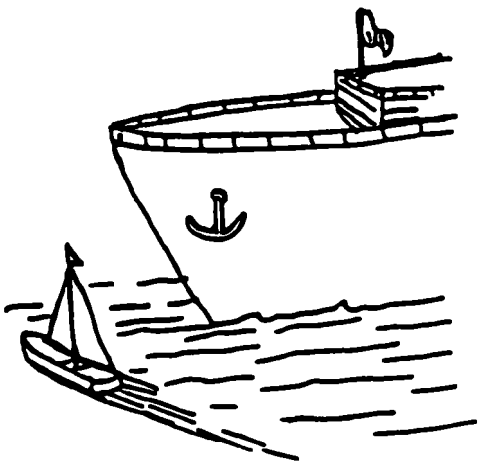
-A white light visible for two miles, in all directions; two white lights are required in international waters, and many boats will show two (or more) white lights regularly.

-A green light, visible from directly ahead through an arc of 112.5 degrees on the starboard (right) side. That 112.5 degree arc marks the zone in which your boat must yield the right of way to other vessels; any vessel that can see your green light has the right of way over your boat.

-A red light, visible from directly ahead through an arc of 112.5 degrees on the port (left) side of the boat. Boats that can see your red light should yield the right of way.

It is important to know that, outside of designated shipping channels, sailboats have the right of way over power boats. Don't expect a sailboat to get out of your way just because it can see your red light. That boat might be becalmed, might have tangled its rigging, or might have run its keel aground.

It is legal, but unwise, to expect very large ships (such as oil tankers) to yield to small boats, and you are required to stay out of their way in a shipping channel.



RECOMMENDED ADDITIONAL EQUIPMENT

In order to operate the boat with reasonable safety, you will also want to carry

-a recent chart (or charts) of the area in which you will be boating
-a compass
-paddles or oars
-a boat hook; and
-a bailing bucket or bilge pump.

NOTES

It is also prudent to carry an anchor (and anchor rope), a first aid kit, food and water, a radio with weather band reception, a flashlight, tools and spare parts, and a radiophone or CB radio for emergency communications. The anchor rope should be seven times as long as the greatest water depth you will encounter. Many types of anchors will work better if a three foot length of chain is attached to the anchor, to hold it down in a horizontal position; it holds better that way.

PREPARATION FOR BOATING

More inspections: Before a boat is taken out for a trip or a long job, it should be inspected to assure that everything works, that lights and motor are likely to keep on working, and that tools and spare parts are adequate and accessible. The Coast Guard Auxiliary has many helpful publications about this and other aspects of boating.

Refueling Precautions: Gasoline is very flammable. There are four basic rules for handling fuel:

-Keep all sources of ignition away from fuel vapors.
-Keep the nozzle of the fuel hose in contact with the fuel tank opening to avoid static sparks.
-Never overfill the tanks.
-Fill portable fuel tanks OUTSIDE the boat (never in the boat); fill them on the dock or at another location.

Inboard engines require special ventilation equipment. Use it.

Preparation for Boating

Plan your trip. Get the weather forecast; look at the charts and plan

your route; collect and weigh the passengers' personal gear, the sampling apparatus, and all other "stores" going aboard. Load the gear so that it will not roll or slide when the boat rocks or tosses.

NOTES

If the weather forecast is somewhat unfavorable, load the boat lightly so that it will float high in the water. If a storm is predicted, postpone the trip. When rough weather can capsize a small boat, it takes quite an athlete to swim home.

If your course takes you out of sight of land, at least one person aboard should know how to navigate. At least 2 people should know how to read charts and located sandbars, shallows, rocks, rapids, etc.

The Coast Guard recommends that you file a "float Plan" with someone who can request a search if you don't return as expected. The float plan should give a detailed description of the boat and its planned course, to aid a search. It should list the people aboard, the type and frequencies of the emergency radio, and the names and phone numbers of the Coast Guard or other agency personnel who should be notified if you fail to return as expected.

Personal gear should include shoes or boots with anti-skid soles and footwear that will be suitable for the sampling or other work to be done outside the boat, if that is part of the plan. Water repellent clothing and sufficient warm clothing should be taken along, and a change of dry clothing is often needed. If water temperatures below 60 degrees F are expected, take a wet suit or other suitable protective, immersible clothing.

Everyone should practice putting on the flotation devices before you set out. Life jackets should be stored so that they can be retrieved quickly and conveniently if the boat capsizes or swamps. This writer once had sailing

students out in a small sailboat that capsized. The life jackets were secured under shock cord below the deck. When the boat capsized, it was righted immediately, but no one could get the wet life jackets free from the wet shock cord! A disaster was averted, first, by clinging to the boat which could not sink, and second, by the fact that every student had to pass a swimming test before being admitted to the sailing school. Nevertheless, the incident stands as an object lesson in inadequate planning. YOU should try to do better.

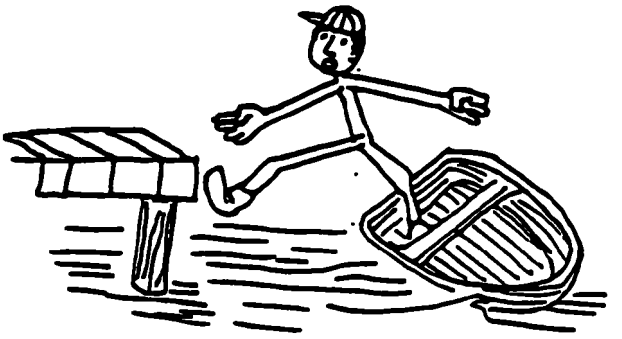
NOTES

If any passenger is a non-swimmer, that passenger should wear a life jacket whenever the boat is in water deep enough to drown in. That includes shallow water in which holes or depressions may be found. In a stream, the current may undercut a sandbar so that the water may be 8 feet deep 18 inches from the edge of the sandbar.

Plan your sampling procedures before you get out in the boat. If a boat has two passengers, and they both lean over the same side to set out 50 pounds of equipment, they may need to demonstrate their swimming skill. Swimming downstream, fully clothed, in pursuit of gear that floated away, is not a demonstration of good sampling technique.

LOADING AND BOARDING

When you board a small boat, try to grasp both sides of the boat and then step into the middle. If you put all your weight on the side nearest the dock, you may well push that side under water. If you step down and push the boat away, the boat may move away before you get into it; you may fall in, but at least the boat won't capsize. It helps to have someone else steady (hold) the boat while you step in, but understanding the problem helps even more. One last caution here: it's easy to jump lightly down into the center of the boat -- and then drop to the opposite side and tip the



boat (and yourself) away from the dock. Don't do that either.

NOTES

When one person is in the boat, a second person can pass gear and supplies to the one in the boat. If the cargo being passed over is heavy, watch your (and the boat's) balance! Distribute the weight evenly, and secure all cargo so it can't move when the boat rocks, Remember to keep the flotation devices accessible—or simply wear them.

BOAT HANDLING

At least one person should know how to handle the boat, and that person should instruct the others as quickly as possible. A boat does not handle like any land vehicle (with the possible exception of an ice boat). Techniques such as towing, going through locks or dams, and handling the boat in high waves, like the knack of knowing when to stop the motor and how to come in to a dock without hitting it, must be learned by doing. One or more of you must get some instruction in boat handling before you take the boat out. Reading is recommended, but it cannot substitute for hands-on experience.

You charts will show the location of storm warning display stations, and your radio will carry weather bulletins. A small craft warning means winds may reach 38 mph (33 knots) or conditions dangerous for the sort of boats generally used by EPA. A triangular red pennant, displayed at a storm warning display station, signals a small craft warning.

Two triangular red flags signal a gale warning: winds form 39 to 54 mph (34 to 47 knots).

A single square red flag with a black center, displayed at a storm warning display station, signals a storm warning: winds of 55 to 73 mph (48 to 63 knots).

Two square red flags with black centers signal a hurricane or tropical cyclone, with winds in excess of 74 mph (63 knots).

NOTES

RULES OF THE ROAD

The first International Rules of the road for preventing collision at sea were established in 1889. The USA has adopted similar rules for all U.S. waters.

The person in command of the boat is expected to know the rules for operation and navigation, local regulations, and rules of the road. The rules of the road cover three topics: lights, signals used to identify course and position in fog, and action to avoid collision with other vessels.

The vessel that has the right-of-way is called the "Stand On vessel" (formally the privileged vessel). The stand on vessel has a right to maintain its course and speed. It has a duty to maintain course and speed so that the other vessel can base its actions on known conditions. However, if a collision becomes imminent, the stand by vessel no longer has the right-of-way or any privilege.

The vessel that does not have the right of way is the "give way vessel", formerly called the "burdened vessel." When the give way vessel approaches another closely enough to create a possibility of collision, the give way vessel must slow, turn, or take other positive action to keep out of the way.

In a Meeting Situation, two vessels are approaching head on or nearly so, and neither has the right-of-way. Both must alter course to the starboard (right) so that they will pass port to port (left side to left side). A vessel will signal its intent to alter course to the starboard with a "course indication signal" of one or two short blasts of a whistle or horn. The other vessel will return the same signal to

indicate understanding and agreement, or will signal four short blasts (danger signal) to indicate its lack of understanding or agreement. [In international Waters, no response is required, and the danger signal is five short blasts.]

NOTES

In a Crossing Situation, when two vessels approach at an angle, the vessel on the right (starboard) has the right-of-way. Your vessel must give way to any vessel that approaches from the 112.5 degree arc in which your vessel shows its green light at night. The give way vessel must slow or alter course to avoid a collision. The stand on vessel should maintain course and speed.

In an overtaking situation, the overtaking vessel is burdened; it must give way until the overtaken vessel has been passed safely.

If the overtaking vessel wishes to alter course and pass to the starboard of the overtaken vessel, the overtaking (give way) vessel should give one short signal of whistle or horn. The signal to pass on the port side is two short blasts of whistle or horn. The stand on vessel must signal agreement (one or two short blasts) or disagreement (four short blasts).

If you see the white light of another vessel at night, you are overtaking that vessel and must follow the rules for overtaking.

In a narrow channel, your boat should keep to the right side of the channel. When you near a bend, signal to any vessel that may be out of sight by giving a long (four to six seconds) warning blast on a whistler or horn. A small vessel must yield the right-of-way to large, deep draft ships that may not be able to maneuver, or stop, quickly.

In general, right-of-way must be given to sailing vessels, fishing vessels, working vessels, and very large

vessels.

NOTES

Fog signals are required if the visibility is obscured, day or night, by mist, fog, rain or snow--in order to avoid collisions. A power vessel must sound one prolonged blast on the whistle, at least every minute. A vessel anchored outside a designated anchorage must ring its bell, or sound its horn or whistle, rapidly for five seconds, at least once each minute. Towing vessels underway must sound a series of three blasts (one long and two short blasts) in succession, once each minute.

Navigation aids, on navigable waters of the United States, consist of markers, buoys, and lights. They mark channels and constructions, provide direction, and show exact position.

The basic system uses red, triangular buoys or markers, with even numbers, to mark the right side of the channel when the vessel is moving upstream, against the current, returning from the sea ("red right returning"). The other side of the channel (on your starboard side going downstream) is marked with black, rectangular buoys or markers, with odd numbers. In the Great Lakes region, going west, or to the source of the lakes, corresponds to going upstream from the sea. On the Intracoastal Waterway and in coastal water, "upstream" is marked from New Jersey going south to Florida and west to Texas. On the Pacific coast, "upstream" is from California to Alaska.

On the Intracoastal Waterway, buoys and markers are marked with a yellow band, strip, square, or triangle. The yellow band or square identifies the buoy as being on the Intracoastal Waterway.

Regulatory markers may provide information or give warning (e.g., boat speed restriction).

Lightships or Texas Towers provide

warning and guidance in waters that are to deep for other navigation aids. A Texas is a large navigational buoy that has primary and standby generators to operate a high intensity light, a radio beacon, and a fog signal. It also monitors meterological conditions, air and water temperature, wind speed and direction, and other data. Texas Towers are replacing lighthouses at major harbor entrances.

NOTES

EMERGENCY PROCEDURES

If your boats capsizes, or collides with a solid object or another boat, or if the motor quits, or someone has a medical emergency, you should call for help. Use your radio, whistle, horn, or visual signals. On the radio, send "Mayday" on VHF channel 16 or 2182 kilohertz. Give this information:

- Boat ID and call letters;
- Location;
- Nature of distress;
- Number of persons aboard and the condition of any who are injured;
- Estimated seaworthiness of the boat (how long you may stay afloat);
- Descriptive details of boat;
- Any other information that may help rescuers find you.

If you have no radio, show visual distress signals.

If you hear or see a distress signal, give what aid you can. Use your radio to notify the Coast Guard on VHF Channel 16, or notify any listener on CB Channel 9. There is a "Good Samaritan" clause in the Federal Boat Safety Act of 1971 that protects from liability anyone who provides or arranges towing, medical treatment, or other assistance that any reasonably prudent person would provide under the circumstance.

If you have only pyrotechnic distress signals, save them until there is someone out there who can see them.

If your boat capsizes, stay with it. Boats have flotation chambers; they

will not sink. If you can right the boat, get into it. That may be warmer than staying in the water. If the water is cold, it is important to conserve body heat. Get out of the water if you can; if you can't; curl up. If several people are in the water, they should huddle close together. Don't swim for shore unless it is quite close or there is no chance of rescue. A boat is easier than a swimmer for rescuers to find.

NOTES

STUDENT EXERCISES

1. Power boats must show at least three lights when traveling at night. Describe those lights and their significance.

2. Name 10 items of equipment, other than food, that should be carried on the boat. (If food were allowed, 10 food items would count as only one "item" of equipment.)

3. What are the four basic rules for refueling/fuel handling?

4. A storm warning display station is flying two triangular red signal flags. What do they mean?

What action should you take if you have already set out for a day's work in the boat?

5. You are sailing up the middle of a channel, and a cabin cruiser is coming toward you, also in the middle of the channel. You signal with 2 short blasts on the whistle. The other vessel replies with 4 short hoots of a horn.

(a) What does your signal mean?

(b) What does his signal mean?

(c) What do you think you should do?

(d) Do you have a comment about the skill of the two boat captains?

UNIT 15

USE OF AIRCRAFT

EDUCATIONAL OBJECTIVES

NOTES

o Students should understand all passenger responsibilities in chartered aircraft.

o Students should be aware of pilot responsibilities and be able to monitor pilot performance and obtain complete pilot cooperation.

o Students should be capable of good advance planning: charter of a suitable aircraft with a capable pilot, knowledge of flight plan requirements, and ability to acquire and prepare suitable personal (including sampling) gear.

o Students should know how to prepare EPA materials for shipment by air or for stowing aboard a working aircraft. They must know how to approach and enter aircraft safely.

o Students must be aware of emergency preparations and procedures.

INTRODUCTION

NOTES

The Environmental Protection Agency uses aircraft frequently, for passenger flights, for the shipment of samples, and through the use of chartered aircraft to reach remote areas, make observations, including photographs, to collect air (or airborne) samples, or to spread materials over areas that need such treatment to remedy environmental damage.

When chartered aircraft are used, the EPA personnel involved must understand all aspects of the planning, operation, and use of small aircraft, of both fixed wing and helicopter types. This part of the EPA Field Training Course will provide an introduction to the use of aircraft.

PASSENGER RESPONSIBILITIES

Passenger flights with the scheduled airlines have been made so simple that no advice is needed for flying the "friendly skies." Arranging and participating in a charter flight in a small aircraft is, however, a less casual affair.

You will be the expert who decides just what needs to be done, and if you arrange the charter, it will be your responsibility to choose a competent pilot and a satisfactory aircraft for the EPA mission. The next section deals with Pilot responsibility, and that will guide you in choosing a pilot. As the working passenger (or one of a few), you will need to provide the pilot with the information needed for the flight plan (The Federal Aviation Administration [FAA] requires a flight plan.):

- the number of passengers and their weight;
- the weight of all the equipment and supplies to be carried;
- the destination, or the territory to be overflown;
- the time needed at, or over, the sampling or observations site.

It will be your responsibility to pack or supervise the packing, of the equipment and supplies. A subsequent section will discuss packing and stowing, but this may be the time to remind you that if any hazardous material (small tanks of hydrogen, strong acids, etc.) is to be carried, the pilot should be informed.

NOTES

EPA field personnel should take:

- Clothing suitable for the expected weather, terrain and activities;
- survival gear for the weather, terrain and mission;
- motion sickness medicine and any other maintenance medicine that any member of the team may need.

Your should also confirm that, if the flight passes over water, suitable flotation devices are aboard, and that the aircraft is equipped with distress signals, an Emergency Locator Transmitter, and any other emergency gear that could be needed.

RESPONSIBILITIES OF THE PILOT

The pilot is responsible for filing and choosing the flight plan(s) and for checking the fuel supply, radio, compass and other navigation equipment. The pilot will also see that cargo is properly secured and is loaded to comply with weight and balance requirements of the aircraft. The FAA requires the completion of a weight and balance plan.

Before take-off, the pilot should brief all the passengers on:

- no smoking and seat belt rules;
- location and use of emergency exits;
- emergency signals;
- emergency procedures in case of emergency landing or ditching;
- the use of emergency equipment (life jackets, life rafts, distress signals, etc.).

NOTES

The pilot should check the weather conditions and forecast along the flight route and at the destination. The pilot can get detailed weather information when the flight plan is filed at the FAA Flight Service Station. The weather maps are updated frequently. He will use the weather information to plot a route for the flight that is acceptable, given the known performance characteristics of the aircraft.

If weather conditions are unfavorable, the pilot may (and should) decide to postpone the trip. Don't argue. High winds or fog may make flying unsafe, and charter planes are likely to be quite small and unable to fly high enough to rise above a storm. Your flight may also be going into an area or airport without all the safety systems of a modern airport for scheduled airlines. When small boats head for port, small planes should stay on the ground!

The acceptable wind and weather conditions for helicopters are defined by the manufacturer. One concern of a helicopter pilot in turbulent weather, is the need to start and stop the main rotor blades without having them hit the tailboom. As a passenger, you might want to ask the helicopter pilot about the manufacturer's limitations with respect to weather conditions. If the pilot says "Don't go," acquiesce. If he says "Ok to go," it can't hurt to check to be sure he, your pilot, isn't trying to be a hero (heroine?). Your aim is to choose a pilot who is cautious, not intrepid.

Helicopter operations usually are limited to daylight hours.

PLANNING

Aircraft charter and choice of pilot are the most critical part of your advance preparation. Your safety depends on the skill and judgment of the pilot, and the reliability and

adequacy of the aircraft for the planned mission. If the charter company has met the qualifications for a Federal Aviation Regulations (FAR) Part 135 Certificate, that certificate will be displayed in the company office. It signifies that the aircraft have FAA Certification and that the pilots have FAA certification for charter service. The pilots will have at least 1500 hours of flight time, will have annual training in every aircraft used by the charter company, will have completed an FAA check ride every six months, and will be qualified on instruments if they fly multi-engine aircraft. The pilots of multi-engine aircraft will be qualified to navigate under Instrument Flight Rules (IFR) and Visual Flight Rules (VFR). Pilots of single engine aircraft need not be rated for IFR navigation.

The EPA has an inter-agency agreement with the Department of Interior for flight services. That department should be the first choice for air transport. The second choice would be a charter service that meets the FAR Part 135 regulations.

Obtaining use of aircraft through other Federal agencies, or a flight school, will not guarantee FAA certification or pilot experience equivalent to FAR Part 135.

It is inadviseable to rent an aircraft directly from a flight school and hire a pilot to fly it. Liability insurance is likely to be inadequate, and the pilot's qualifications could be minimal. FAA regulations require flight plans for all flights by certified charter companies; flight plans are recommended but not required for private pilots and non-charter (or non-commercial) flights.

Flight Plans are very important for your safety. The flight plan includes information on the number of passengers and the amount of fuel; that determines

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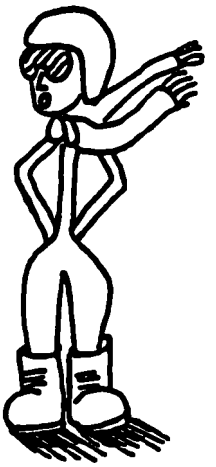
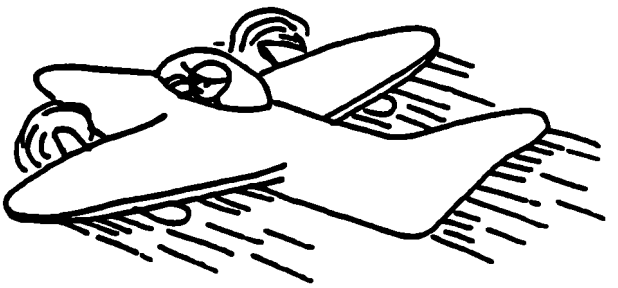




the maximum flying time. A flight plan is recorded on a form that is completed (closed) after the flight arrives at its destination. The information includes:

1. the type of flights;
2. the identification of the aircrafts;
3. the type of aircrafts;
4. the airspeed of the aircraft;
5. the point of departure; (numbers refer to the flight plan form)
8. the flight route;
9. the destination;
10. the estimated time en route.

The reverse side of the flight plan has a preflight check list for weather and meteorological information.

The pilot is responsible for filing the flight plan, for reporting any change in the flight plan, and for reporting arrival at the destination, which closes the flight plan.

If the aircraft fails to reach its destination within a short time after the Estimated Time of Arrival (ETA), the flight plan will provide the information necessary to guide a search for you. If your flight makes a forced landing without being able to radio for help, a search will be initiated quickly. When your aircraft is 30 minutes overdue, the FAA Flight Service Station serving your destination will call the station serving your point of origin to learn whether you returned there. If not, the station serving your destination will obtain the information from your flight plan; that will indicate how far you could have gone (if lost) and where to look for you.

When you are 60 minutes overdue, a message will be sent to all Flight Service Stations along your route to see if you have been heard from. Airports where you could have landed will be checked, physically, to see if your aircraft landed but failed to report.

The pilot's home will also be called to see if he returned home without closing the flight plan.

NOTES

If your aircraft has not been located within 90 minutes of your ETA, search planes will fly over your route to look for you! The search will continue, during daylight hours. If your plans should change, it is clearly important that your pilot should notify the nearest Flight Service Station so that an unnecessary air search will not be initiated.

Personal gear for flights over water or low levels, should include equipment recommended by the Coast Guard and Department of Interior such as flotation devices and wet suits or other protective clothing to protect against hypothermia in the water, if the water temperature is below 60 degree F, if the surface air temperature is below 32 degrees F, or if the combined air and water temperature readings are less than 120 F. All aircraft flying over water must carry one personal flotation device for each person aboard. The pilot may require the wearing of life vest at any time during the flight.

For low level flights, the recommended equipment includes a flight helmet to protect the head and protect hearing, and a Nomex flight suit to provide some protection against fire. Anyone who must lean out of the aircraft (e.g., when taking pictures) should use safety harness.

PREPARING AND LOADING

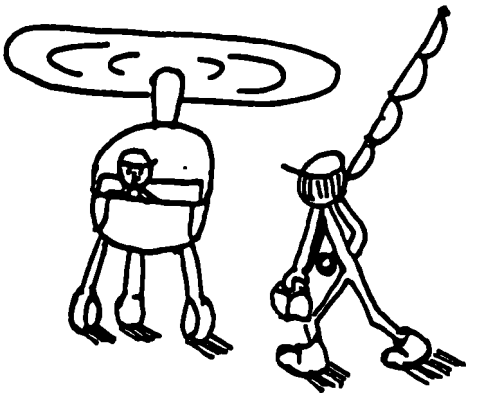
Packing and stowing of nazardous materials must conform to DOT regulations for packaging and shipping.

Aircrafts must not be damaged by exposure to chemicals or to samples collected. Chemicals and samples should be put into clean (why?) containers, protected by a plastic covering, and packed to prevent (or contain) leakage.

NOTES

Sample containers would be enclosed, and sampling equipment should be decontaminated or enclosed before being loaded back into the aircraft.

Weighing and weight distribution have already been discussed. Cargo should be placed wherever the pilot designates that it should go. Do not drop heavy objects on the floor of the cargo area or the lip of the door; costly repairs and delays could result.



Helicopters: The chin section of a helicopter is thin plastic (in front of the front passenger's feet). Don't place or drop anything there. If is better to load a helicopter when the rotors are stopped, but under no circumstances should you approach the helicopter with an object longer than 4 feet while rotors are turning.

Approaching an Aircraft requires the application of considerable common sense, or else attention to several rules:

- Always keep out of the way when a plane is taxiing and wait for the propellers to stop before you approach.

- Approach any aircraft in view of the pilot, or as directed by the pilot.

- Stay clear of a plane's propellers or a helicopter's rotors, whether they are turning or not.

- Stay 100 feet from helicopters at all times unless you must go nearer.

- If you must approach a helicopter, stay clear of the tail boom and avoid walking under or near the tail rotor blades.

- If you must approach while the rotors are turning, do so in full view of the pilot and under his direction. Approach from the same level as the helicopter; an approach from a higher level might bring you too close to the blades.

If you approach when the main rotor is turning, run in a crouched position; the main rotor blades can be blown below their normal operating level.

Pilots, passengers, and crew, around a helicopter, should wear protective helmets, hearing protection, and goggles to protect the eyes from dust and grit stirred up by the rotors.

NOTES

EMERGENCY PROCEDURES

Emergencies in an aircraft can take many forms, as any television watcher can attest. If an emergency cannot be coped with in the air, the aircraft will make an emergency landing, usually successfully.

During a forced landing, follow the pilot's instructions. The pilot will tell you when, where, and how to exit from the aircraft. The pilot may ask you to jettison doors, inflate flotation equipment, don protection gear, or assist the injured. You may be asked to help activate emergency signaling equipment.

If the plane comes down on (in) the water, life vests can be inflated by using a gas cartridge, or by blowing into a red tube on the shoulders of the vest. This type of vest fits over your head and has straps to be tightened, securely, around your waist.

The two cell inflatable life vest should be inflated after you are in the water, by jerking on red activating tab (or both). It will provide buoyancy, but you must keep your own face out of the water. One side can be inflated alone, or both can be inflated. Try it to see how much buoyancy you need.

Emergency Locator Transmitters (ELT) are activated automatically in the event of a crash. An ELT has a range of 150 miles on a UHF frequency of 234.0 megahertz.

NOTES

FAR Part 135 requires helicopters that operate offshore to carry an inflatable life raft with an ELT, food, and other survival gear such as fishing gear and a compass. The raft should also have a flare kit, day/night flares, a strobe signal light, a signal mirror, marking dye, and a whistle. A police whistle can be heard for a half mile or more over water. Signaling devices are similar to those used in boating. Some produce colored smoke, and some make a burst of light that can be seen at night. The dye marker is a fluorescent powder that can be seen, as a bright patch in the water, from a great distance away.

Offshore helicopters may have inflatable pop-out gear or fixed flotation gear, such as pontoons.

HELICOPTER DITCHING SURVIVAL

Helicopter ditchings (emergency landings into water) are rare, but they have occurred as a result of bad weather, lack of fuel, or mechanical failure. The pilot will consider several factors:

- the distance to a landing site on shore, or close to a source of assistance (platform, ship, or other aircraft);
- the expected time delay before rescue;
- the condition of the helicopter;
- the weather conditions;
- the water and air temperatures; and
- availability of survival equipment.

Before ditching, passengers should secure all tool boxes, cargo, and other loose equipment, and they should then fasten seat belts, locate the exits, and follow the pilot's instructions.

The problem when the craft hits the water may include:

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- inrushing water that tends to spin passengers around, force them into rear corners of the cabin, and cause disorientation;
- difficulty finding where the personal flotation gear is stowed;
- difficulty locating latches and opening exits. Emergency exit releases should be located before going under water;
- difficulty getting to the surface because the water is dark or murky; and
- problems that result from damage to the aircraft or from spilled fuel.

If you expect to do much flying, by helicopter, over water, it would be wise to get further information and training. The U.S. Geological Survey has a videotape, but hands-on training, if that can be arranged, should be much better.

STUDENT EXERCISES

1. Define

FAA: _____

_____

FAR _____

_____

IFR _____

_____

VFR _____

_____

ETA _____

_____

ELT _____

_____

2. You must fly over an area where industrial fumes have killed much vegetation, and take pictures from a height of about 300 feet. We know you need a camera. What other equipment should you use to do your job safely?

3. Your ETA was 10:30 a.m., and the personnel at the FAA Flight Service Station that serves your destination are awaiting your aircraft. At 11:00 a.m. your pilot has not reported in. What will the FAA Flight Station personnel do?

At 11:30 a.m., your aircraft has still not been heard from. What will the station people do now?

Your plane is still missing at noon. What action will be taken on your behalf?

UNIT 16

SELECTION AND USE OF FIRE EXTINGUISHERS

Educational Objectives

o Students should understand the classes of fires that they may encounter.

o Students should understand the mechanisms by which fires can be extinguished.

o Students should know the types of fire extinguishers, and how they are identified.

o Students should know how to select the most suitable fire extinguisher for any situation, and how to use that fire extinguisher on each sort of fire that might occur in any work area.

o Students should know the precautions to be observed before a fire extinguisher is used, and the precautions to observe when fighting a fire.

Introduction

A fire is an oxidation process. It requires fuel and an oxidant, usually the oxygen in the air. The fuel must (usually) be in a gaseous state before it will combine with oxygen to produce a fire. If that combustion can produce enough heat to vaporize more fuel, the fire will continue until the fuel or oxidizer is gone, or until some other process intervenes. We will be most interested, in this unit, in the intervention equipment, procedures, and mechanisms.

Even if fuel and a good oxidizer are present, a source of ignition energy is usually required. Spontaneous combustion can occur, and it will be discussed in the unit on chemical hazards; this unit is concerned with stopping the combustion process.

Once again, a fire needs enough heat to vaporize the fuel, an oxidizer (usually oxygen in the air), and a source of ignition. We can stop a fire if we cool the fuel below the vaporization point, or if we separate the fuel vapor from the oxidizer, which will happen naturally if either the fuel or the oxidizer is all used up.

Classes of Fires

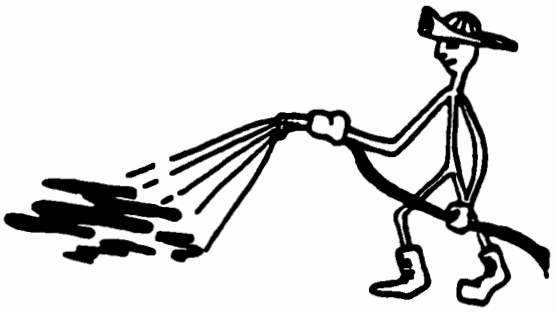
There are four classes of fires:

Class A: Ordinary combustible fuel such as wood, paper, cloth, and rubber. The fires burn into the material, but the solids must be heated to the point at which they vaporize if fire is to continue.

Class B: Flammable (combustible) liquids or gases such as gasoline, kitchen grease, fuel oil, propane gas, alcohol and many others. The fuel is vaporized and burns above the surface of a liquid, or near the point at which a gas escapes from confinement.

Class C: Electrical equipment. In addition to the fire hazard, there is danger of an electrical shock, until the current has been turned off (disconnected).

Class D: Combustible metals that burn vigorously ands react violently with water or some other extinguishing agent. Examples are sodium, potassium, magnesium, titanium, and zirconium.



Types of Fire Extinguishers

For Class A fires, the most common method of putting out the fire is to cool the fuel below its vaporization temperature. Water works very well, because such a lot of heat energy is used up in converting liquid water to steam. Steam won't (usually) burn, and the steam excludes oxygen, and thus stops combustion, while the vaporization of the water cools the fuel. Dry chemicals such as Halon 1211 or baking soda can also put out the fire, but they are less effective than water as cooling agents.

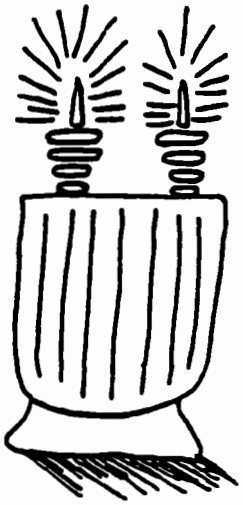
Solid fuel may come in large chunks that get quite hot, and even if the surface is cooled and the fire goes out, heat from within may reheat the surface, evaporate any water, and reignite the fuel. Fire departments soak Class A fires thoroughly, and firemen often stay in a burned house for many hours, to put out any fire that may reignite.

Unskilled, or careless, firemen sometimes soak a burned house and leave — and such houses have been known to reignite and burn a second time.

Class B fires burn above the surface of a liquid, or near the point at which a gas escapes. They are extinguished by excluding oxygen from the surface of a liquid fuel, or by interrupting the jet of gas. Water may not work on burning liquid. If the

liquid is lighter than water, it will float on top of the water and continue to burn. The water may only serve to spread (float or splash) the fuel over a larger area. Compressed carbon dioxide, dry chemicals, foam, Halon 1301 and Halon 1211 often work well. In the case of a burning jet of gas, even a hard blast of air may disperse and cool the fuel long enough to stop the fire. However, if the fire has heated any nearby surface, that hot surface may reignite the fuel again.

These are probably the sort of fires that inspired the rule: Never turn your back on a fire that has just gone out. This writer once watched a safety supervisor (who was conducting a fire school) turn his back after extinguishing some gasoline burning in a metal pan. The pan stayed hot; the gasoline reignited; and the instructor made an impressive standing broad jump to get his overheated backside away from the fire. Many flammable liquids release flammable vapors constantly at normal temperature and pressure.



A Class C (electrical) fire results when the electric energy is converted to heat (thermal) energy, and when that heat vaporizes and ignites any handy fuel. The first step is turn off the electricity, unless the fire, short circuit, etc., has already melted the wires. In any event, you should turn off the current to avoid touching a "live wire" capable of producing a dead person.

Your next concern should be the fact that much electrical equipment is massive, and it can get very hot and stay hot for a long time. Metal transmits heat very well, so the mass of overheated equipment may be quite large. These fires can be fought by excluding oxygen, by interrupting the flame reaction, or by cooling the hot equipment, preferably with agents that

don't conduct electricity. Dry chemicals, CO_2 gas under pressure, Halon 1301, and Halon 1211 have all been used successfully.

If you are sure the current is off, you can use water to cool the hot equipment, but remember that water may cause further problems when it is time to turn the electricity back on! Think before you act.

Class D (burning metal) fires should not be doused with water; that is likely to make matters very much worse. The agents to be used are called "dry powders" (NOT dry chemicals, which are different). Dry powders may include graphite, sodium chloride, or special materials, all treated to make them free flowing. You will need to know the combustion characteristics of the burning agent and have the proper extinguishing agent available. The use of water might cause an explosion, and the use of CO_2 may accelerate the rate of combustion.

If no proper extinguishing agent is available, try to isolate the fire and let it burn itself out.

Fire Extinguisher Identification

Unfortunately, there are two systems in use to mark fire extinguishers. You may find either one when you look at the equipment.

The old system uses the letters, A, B, C, or D, to indicate which type of fire the extinguisher is intended to put out, but there is more than that.

Class A will have "A" in a **triangle**, and the color green, with the words "ordinary combustibles" written just below the symbol.

The new system uses pictographs. A Class A fire is fought with an

extinguisher showing a burning wastebasket and a bonfire.

From now on, we will simply say "New:" to indicate the pictograph system, and "Old:" to indicate the old system. Because the old system uses the same letter as the type of fire for which the extinguisher is intended, we need only specify the old system, and you will know what sort of fire it's good for.

Like this:

Old: Class A, triangle, green, "ordinary combustibles."

New: Burning wastebasket and bonfire.

OK?

Old: Class B, square, red, "flammable liquids."

New: Container pouring liquid, and a fire.

Old: Class C, circle, blue, "electrical equipment."

New: Electrical plug and a receptacle with flames.

Old: Class D, star, yellow, "combustible metals."

New: No pictograph.

The pictograph (new) system will show the types of fires on which the extinguisher should not be used by showing the pictograph with a red, diagonal slash through it: forbidden, just like the pictograph for "no left turn."

Fire extinguishers may have multiple ratings. A carbon dioxide (CO_2) extinguisher carries both "B" and "C" ratings; it can be used safely on

both types of fire.

Please remember that any one type of Class D extinguisher is not suitable for all the different Class D fires. Choose the fire extinguisher for an area where a burning metal fire might occur with care and intelligence, and use it only for those metal fires for which it is recommended.

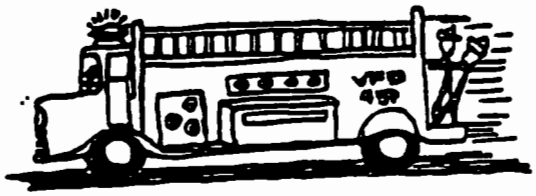
Precautions for Fighting Fires

Before you start to extinguish any fire, you should warn others so that the area can be evacuated. You must also call the local fire department; if you go ahead on your own, and then find that you can't put the fire out with the equipment on hand, it may then be too late for the local fire department to save the situation.

The third precaution is that you should judge the situation and decide whether you can fight the fire without endangering yourself. The fourth precaution is that you may be wiser to first contain the fire; prevent its spread, and then see if you can put it out completely. At least it won't (we hope) be out of control when the firemen arrive.

How can you accomplish these things? You warn others by shouting, turning in an alarm, or both.

You call the fire department, usually, with a telephone call. In many areas, that will be a 911 call. When you reach the fire department, you will need to tell them where the fire is; think about that.



If you are driven away by smoke and heat, shut the doors behind you as you retreat. Don't try to go back!

If you believe you can fight the fire safely, these are some safety

considerations:

o The fire extinguisher should have the rating and size for the fire. An extinguisher that's suitable for a wastebasket won't help much if two whole rooms are on fire.

o Have someone with a second extinguisher back you up, in case you get into trouble.

o Don't enter a burning building unless you are wearing fire repellent clothing and self-contained breathing apparatus. Of course, you will need some back-up protection there if you get in trouble.

Selection and USE of a Fire Extinguisher

You are facing a fire. What sort of fire is it, wood -- paper -- trash? Then it's Class A. Find that class of fire extinguisher, by Class A label or pictograph. If the closest extinguisher is the wrong type, keep looking.

You have now found the right sort of fire extinguisher. Take it off the hook, or out of the cabinet. As you approach the fire, get the extinguisher ready for use: There should be a locking pin near the head of the extinguisher; pull out the pin. If there is a simple nozzle, aim it at the base of the fire. If there is a hose (or tubing) in a holder, take it out of the holder and aim the nozzle or horn at the base of the fire. If there is a horn on a tube, raise it and then aim it at the base of the fire.

Squeeze the release trigger once before you get too close, to see how much extinquishing material comes out, and how far it may shoot. If the fire extinguisher doesn't work, go look for one that does. If the fire has now grown too big, you should leave, closing doors behind you. Let the firemen

handle the big jobs.

If you have an ordinary **Fire Hose,** the stream of water should reach about 30 feet. You can stand well back and aim the water at the base of the fire. If you get too close, the force of the stream might scatter the fire and spread it. A pressurized water extinguisher is a smaller version of the same sort of fire fighting method. You may be able to shoot intermittent jets of water by working the trigger.

If you have an old soda-acid type of extinguisher, turn it upside-down to mix the chemicals and start it squirting. It will tend to keep shooting out its stream until it is exhausted. If you tip it back up, it may stop, eventually.

With a small, aqueous charged, extinguisher, if it is not too powerful, as the fire grows smaller, you may be able to use your finger to spread the stream into a fan shaped fine spray.

Dry Chemical Extinguishers eject a fine powder at high speed. The powder may be as simple as sodium bicarbonate which gives off CO_2 when it gets hot. The dry powder has much more fire-fighting capacity than the compressed (liquid) carbon dioxide that is often used in small fire extinguishers. Dry chemical extinguishers are usually painted red (except for the label), and they should have a hose and nozzle, and may have a gauge on the top -- or a cartridge cover on the side. They will be pressurized. The pressure is needed to push out the high-speed spray of powder. Dry chemical extinguishers are usually rated "B" and "C," but some are rated "A," "B," and "C." Shoot your powder at the base of the fire, using a sweeping motion, from side to side. Cover a Class A fire with powder. Start spraying a Class B fire at the side closest to you and work away until the

fire is out, then watch for possible reignition (backflash). Don't get too close; you might splash the liquid around with the force of your high-velocity spray.

Liquid CO_2 Extinguishers discharge gaseous carbon dioxide at low velocity. Expanding gas gets cold, and you may have some artificial snow in the discharge, too. The flow of cold gas past the nozzle or horn will generate static electricity. It may also get cold enough to freeze your hand; hold the insulated handle and keep your hands off the cold part.

The discharge has an effective range of only two to four feet; you will have to get close. Don't use it on a BIG fire.

A **Foam type of Extinguisher** will use a cartridge and will mix in air to discharge an aqueous foam that will cover the surface of solvent fires to suppress vapors and keep away the air. It is effective on Class B or A fires. They use lots of foam at airports if a plane catches fire. Foam works well on fairly large fires.

More Precautions

These rules and methods should sound simple and obvious as you read this. When you are choking on smoke, and being blistered by heat, and the fire keeps reigniting as fast as you put it out, it's hard to keep cool (figuratively and literally). You really need to practice with the different kinds of fire extinguishers. Take advantage of every opportunity to get some practical experience before you fight your first real, unplanned fire.

Review all the previous precautions, then note these too:

1. If you are fighting a fire outdoors, keep the wind at your back; let it carry the smoke away from you and carry the fire-fighting substance to the fire. Inside a building, there still may be a draft. If moving air is carrying the fire toward you, inside or out, get out of there — FAST!

2. When you approach a fire, be sure you can retreat rapidly, in a straight line, if the need arises. Don't climb obstacles in your intrepid eagerness to get close to the fire; they may slow your retreat. As they always say, "Don't make an ash of yourself."

3. Never turn your back on a fire, nor on the place where the fire just was. It might reignite.

4. Remember, never use water on combustible metals, flammable liquids, or on electrical fires while the current is on.

He who fights fire from far away
May fight fire again some other day.

The best fire fighting strategy is fire prevention, but if you must fight a fire, do it safely.

STUDENT EXERCISES

1. List and define the 4 classes of fires, and give 2 examples of typical fuel for each type.

2. When you discover a fire, you should keep 4 precautions in mind. List them.

_____

_____

_____

_____

3. When you call the fire department to report a fire, you will be asked for the location of the fire. As a visitor to the site, you may not know just where you are! What do you think you could do, or should have done?

4. The wrong action is usually worse than no action in fighting a fire. List three wrong actions that we mentioned, or that you think we should have mentioned.

_____

_____

_____

UNIT 17
HAZARDS OF FLAMMABLE OR EXPLOSIVE ATMOSPHERES OR MATERIALS

Educational Objectives

o The student should be recognize and list the observations which indicate possible fire explosion or atmospheric hazards.

o The student should be able to determine the degree of hazard represented by on-site investigations

o The student should know what, when and how to use basic atmospheric monitoring equipment.

o The student should be able to recognize chemical names and groups that have serious potential for fire or explosion.

o The student should be able to list the steps to follow to prevent or limit the probability of fire or explosion.

o The student should define the emergency procedures to follow in the event of fire or explosion.

UNIT 17

HAZARDS OF FLAMMABLE OR EXPLOSIVE ATMOSPHERES OR MATERIALS

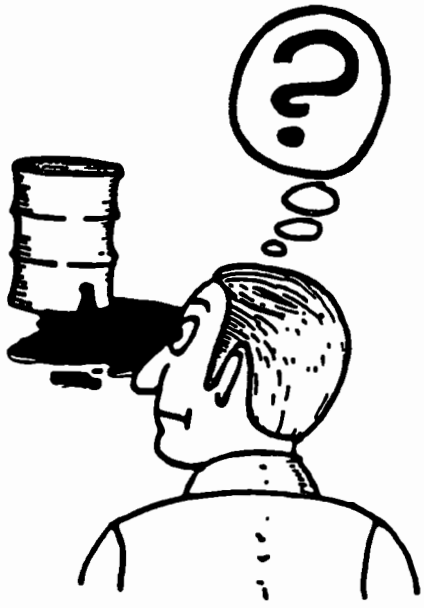
Introduction

Fire, Explosion, and Atmospheric Hazards

Fire, explosion and atmospheric hazards such as asphyxiation are risks which are encountered in many EPA field activities. To understand and react appropriately to these risks it is necessary to be able to; recognize the risk and the degree of hazard it represents; respond; control and if possible prevent an emergency from occurring.

Recognition

The single greatest danger faced by any agency personnel is the unknown. Before entering a confined space or hazardous environment take the time to carefully evaluate the dangers that might possibly exist.



First attempt to find our what substance you will be handling. Shipping invoices, safety data sheets, labels, manifests, company employees, marking and place cards are all extremely useful in determining the name of the product. Once the name is known refer to hazard reference sources such as those discussed in the unit on chemical recognition. These reference sources offer an abundance of safety information. Always check these sources before handling materials. Names such as benzene and benzidine sound very similar but have distinctly different hazards and degrees of hazards. Never try to simply recall hazards. Check and confirm.

Be sure that all personnel understand the information that is given in the hazard reference source. The Chemical Hazard Recognition Unit on the Chemistry of Hazardous Materials should be

reviewed to relate vapor pressure, flash point, combustible material and flammable material to the data obtained on the hazardous material to be handled.

Degree of Hazard

Informational resources such as the Coast Guard's Chemical Response Information System (CHRIS) provide valuable information on possible hazards of chemicals. These systems however cannot define the specific degree of danger present at the individual site. That evaluation must be done by agency personnel, using impartial observations.

Substances may change their degree of hazard according to the state they are in. Kerosene and diesel fuel in bulk quantities such as a drum are not readily ignited by an ordinary ignition source such as a spark, match or cigarette. These same substances volatialized, vaporized, sprayed or spread over a large area such as might be found in a spill can be come highly flammable or explosive. As the surface area of the substance is exposed to greater quantities of oxygen, the ability to ignite increases. Seemingly harmless substances such as flour, coal, or even the metals; aluminum and iron become highly explosive when small particles are heavily dispersed in air. Sites such as coal handling facilities and flour mills have a potential for devastating explosions. Solvents such as 1,1,1 trichloroethane which is normally considered inflammable becomes flammable when sprayed as a fine mist.

The same effect as spraying can be achieved by applying the material to a cloth or rag. Although kerosene in a drum will not readily ignite, clothing covered with kerosene will easily ignite. If a material is combustible, there is a excellent chance that its flammablity will increase as its

surface area exposed to oxygen increases.

Flashpoint is discussed in the unit on chemical hazards of hazardous materials. To review; the flashpoint of a liquid is the temperature at which it will give off enough vapor to allow a flame to travel or propagate through the vapor-air mixture.

The flashpoints of a material is important as an immediate indication of the potential hazard of a material for producing a flammable concentration. The lower the flashpoint or the higher the immediate ambient temperature the more hazardous the material.

Kerosene has a flashpoint of 100 F while gasoline has a flashpoint of 45 F. Normally we think of gasoline as being much more hazardous than kerosene. In ambient temperature of 100 F and above, they both represent high fire or explosion hazards.

Ignition temperature at which a substance at its flashpoint will ignite, is another factor to consider. While these temperatures vary considerably from switches, motors, cigarettes, and matches all have sufficiently high temperatures to ignite most common materials at their flashpoint.

The following table represents the more common flammable materials found a field work.Another factor contribution to the degree of hazard is concentration of oxygen and the concentration of the flammable material present in an atmosphere.

TABLE 1
FLAMMABLE MATERIALS

Flammable Liquids
Aldehydes
Ketones

Amines
Ethers
Aliphatic hydrocarbons
Aromatic hydrocarbons
Alcohols
Nitroaliphatics

Flammable Solids
Phosphorus
Magnesium dust
Zirconium dust
Titanium dust
Aluminum dust
Zinc dust

Water-Reactive Flammable Solids
Potassium
Sodium
Lithium

Pyrophoric Liquids
Organometallic compounds
Dimethyl zinc
Tributyl aluminum

It is necessary to have a proper fuel-to-air (oxygen) ratio (% fuel in air) to allow combustion. There is a range of fuel concentrations in air, at which each material can be ignited and sustain combustion. This is called the Flammable or Explosive Range. The lowest concentration of fuel in this range is the Lower Flammable Limit(LFL) or Lower Explosive Limit (LEL). Concentrations less than the LEL are not flammable because there is too little fuel to support combustion. The highest ratio that is flammable or explosive is the Upper Flammable Limit (UFL) or Upper Explosive Limit (UEL), concentrations greater than the UEL are not flammable or explosive because there is too much fuel displacing the oxygen or simply there is not enough oxygen to support combustion. Fuel concentrations between the LEL and UEL are optimum for starting and sustaining fire. The LEL for benzene is 1.3% (13000ppm). The UEL is 7.1 (71000 ppm), thus if an atmosphere contains a benzene concentration as monitored by a explosion meter, between 1.3 and 7.1% fire or explosion is a possibility. Concentrations below 1.3% do not represent and immediate threat

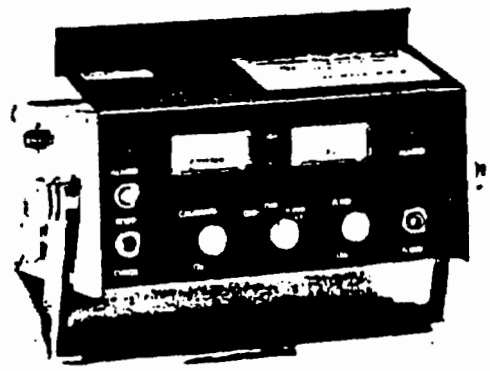
due of fire or explosion. Concentrations above 7.1% do not represent an immediate fire or explosion hazard, but they could possibly represent a danger of asphyxiation due to the deficiency of oxygen.

Atmospheric Monitoring Instruments

Several field instruments are used to analyze ambient air. Due to the limit of the scope of the Basic Field Activities Course, only a few basic monitoring instruments will be discussed. A greater variety of instruments will be covered in greater depth in the intermediate and advanced safety courses. At no time should EPA field personnel attempt to use or rely on a reading taken from an instrument unless sufficient training and practice have been completed.

Combustible Gas Indicators or Explosimeters

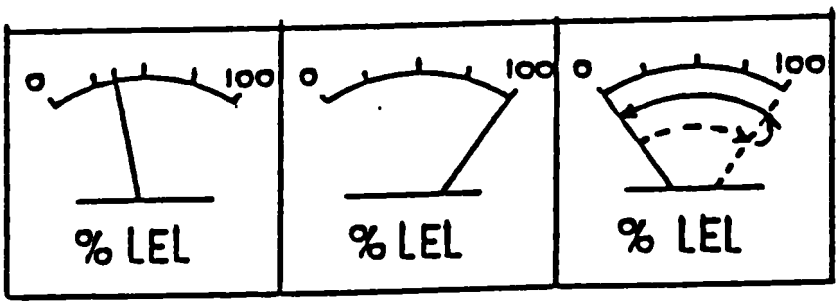
The combustible gas indicator should be one of the first instruments used when attempting to analyze the danger of fire a explosion. It measures the concentration of flammable vapor or gas in the air, indicating the results as percent of the Lower Explosive Limit (LEL) of the calibration gas or vapor. To get accurate results it is not only necessary to calibrate this instrument before use, but also to correctly interpret the results against the chart of the calibration gas measured and the gas present in the atmosphere.



Depending on the manufacturer and model, the meter needle indicator of 1.0 or 100% reveals that the test atmosphere contains a concentration of flammable material in the air at the LEL. This environment could ignite or explode in the presence of an ignition source. A meter reading of 0.5 or 50% indicates that the air contains approximately one half of the LEL. Generally any

concentrations in excess of 0.25 or 25% of the LEL are considered dangerous. In addition, the needle can climb to 1.0 (100%) pass it and then fall to zero or below. This does not indicate the monitoring device is malfunctioning or that the atmosphere contains no vapors. It indicates that the concentration of vapor a gas-in-air exceeds the Upper Explosive Limit (UEL) of the calibration gas. Such a situation calls for rapid evaluation due to explosion danger or the lack of oxygen. (See Figure 1.)

FIGURE 1



If the needle swings to 1.0 (100%) and remains in that position, it means the Explosive limit is between LEL and UEL. This is the optimum condition for explosion or fire and great care must be exercised to evacuate the area.

Oxygen Meters

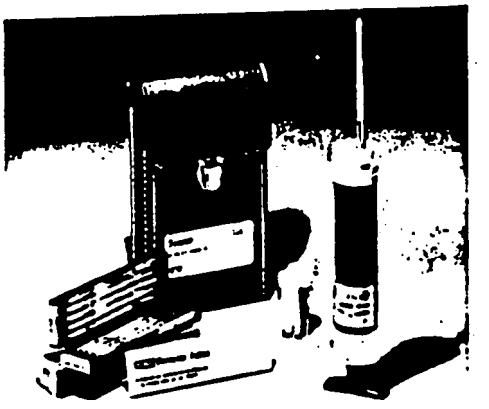
Explosimeters and oxygen meters should be used in conjunction with each other. Explosive meter readings are based on the assumption there is the normal 21% oxygen present. Greater or lesser amounts can change the LEL and UEL of many gases, making the meaning of the reading on the explosive meter questionable. If possible utilize and explosemeter/O_2 meter combination that integrates the two readings. Never enter an atmosphere with O_2 reading below 19.5%. Table 2 illustrates the results of oxygens deficiency.

TABLE 2

PHYSIOLOGICAL EFFECT OF OXYGEN DEFICIENCY

% Oxygen (by volume) At Sea Level	Effects
21	Nothing abnormal.
16-12	Increased breathing volume. Accelerated heartbeat. Impaired coordination.
14-10	Very faulty judgment. Very poor muscular coordination. Muscular exertion brings on rapid fatigue that may cause permanent heart damage. Intermittent respiration.
<6	Spasmatic breathing. Convulsive movements. Death in minutes.

Direct-Reading Colorimetric Indicator Tables



Quick, relatively accurate quantitative measurements of organic vapor and gas can be ascertained by use of devices using a color-change principle. Glass tubes filled with colormetric substances are used to interpret ppm or % concentrations of a variety of substance.

Colormetric indicators tubes consist of a glass tube impregnated with an indicating chemical. The tube is connected to a piston cylinder or bellows. A measured volume of contaminated air is drained into the tube, producing a color change whose length is proportioned to the contaminant's concentration. The tubes used are specific to the contaminant to be tested and have a printed shelf life. Care must be exercised to keep tubes current and use the correct tube. Accuracy of the colormetric tubes may vary from 35% to 1 to 5 times depending on the concentration. See Appendix E for the types of tubes available.

NOTES

Oxidizers

Most combustion must be supported by sufficient oxygen. Glowing or smoldering may continue with oxygen reaching concentrations as low as 8-10%. In some chemical combinations however, atmospheric oxygen may be completely absent and combustion is still supported by substance known as oxidizers. Such chemical substances are able to supply oxygen chemically or to supplement oxygen with other substances to support combustion. In many instances combustion is spontaneous, rapid and often explosive. Agency personnel should be particularly careful when handling substances that are identified or known to be strong oxidizers. Fires supported by oxidizers are often extremely difficult to control or extinguish. Of particular concern are mixtures of oxidizers and organic compounds. In these situations, combustion is usually spontaneous or requires no ignition source to ignite. Table 3 is a list of common oxidizers.

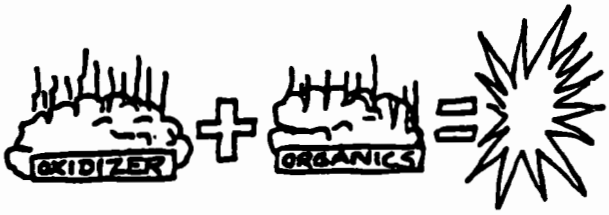


TABLE 3

COMMON OXIDIZERS

Nitrates	Chlorine
Perchloiates	Persulfates
Permanganates	Hypochlorites
Peroxides	Thiosulfates
Dichromates	Sulfuric Acid
Nitric Acid	Perchloric Acid

Prevention and Hazard Reduction

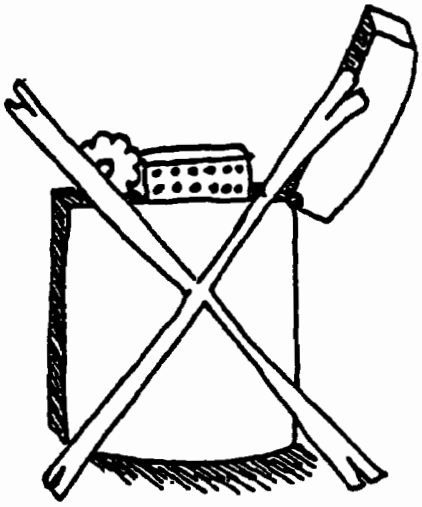
Prevention, and reduction of fire and explosion hazards can be accomplished by:

Control of ignition sources, and
Control of quantities & concentrations

NOTES

Control of Ignition Sources

Where you cannot control fuel sources, you need to control ignition sources as much as possible. Since many chemicals and petrochemicals are highly flammable, ignition sources should be excluded or carefully controlled during sampling and when handling flammable samples.



Sources of ignition include matches and cigarette lighters, electrical switches, electrical equipment, welding sparks, engines, catalytic converters on motor vehicles, and static electricity.

If you will be working in an industrial plant, it is important to find out if there are areas where there may be flammable concentrations of gases or vapors and where sources of ignition are not permitted. (Many plants do not allow employees or visitors to carry matches or lighters into the plant.)

Instruments and Equipment for Hazardous Locations

There are some particularly important fire safety requirements for any electrically-powered equipment which is to be used in atmospheres which may contain flammable concentrations of dusts, vapors, or gases. In order to prevent ignition and explosion, heating elements, sparking motors or other ignition sources must be protected from contact by the flammable atmosphere. All electrical equipment, sampling apparatus, portable instruments, and other possible sources of ignition must be safe for use in such atmospheres.

The EPA and OSHA standard for a hazardous atmosphere, based on extensive industrial experience, is one that contains a concentration of combustible gas, vapor or dust greater than 25% of the lower explosive limit of the material. Do not take any ignition source into any area where there is a

concentration of flammable vapors greater than 25% of LEL.

Most EPA field equipment and instrumentation that is battery - or line-powered is not safe for use in flammable atmospheres because the electrical elements are not protected from exposure to flammable vapors or gases or combustible dusts. Only the instruments used to test for flammable concentrations of gases or vapors are safe to use in certain flammable atmospheres.

To determine whether there is a need to take special steps to prevent ignition of flammable vapors, gases, or dusts in hazardous locations or atmospheres, see if the plant being visited has identified hazardous areas and specified precautions. If not, an assessment of the hazards must be made and a decision reached as to whether ignition sources need to be protected or kept out. In some situations, a test of the atmosphere is necessary to find out if ignition sources must be excluded.

Hazardous locations for ordinary electrical equipment are those in which fire or explosion hazards may exist due to concentrations of flammable gases, vapors, or dusts. Hazardous locations are classified by the type of material present, and by the likelihood that a combustible concentration is present.

Enclosure and Ventilation

Since most EPA electrically-powered field sampling equipment is not safe to use in hazardous atmospheres (whether it is powered by batteries or by line voltage), the equipment will have to be enclosed and ventilated as explained below. To provide enclosure and ventilation for sampling equipment, first identify all points where electrical connection, switches, motors, heaters, or other devices may provide

sufficient energy to ignite flammable mixtures of the material that may be present. Next provide, around the ignition sources, a relatively tight enclosure which can be ventilated with fresh air or purged with inert gas to prevent any flammable mixture from reaching the ignition sources.

Finally provide fresh air ventilation or inert gas purge, and interlock the equipment's source of electrical supply with the ventilation or purging flow so that if the flow is interrupted the equipment will be de-energized.

Equipment Approval

Electrical equipment which has been manufactured to be safe for use in hazardous locations will have attached a label specifying the Class and Group of atmospheres in which the equipment can safely be used. Electrical equipment which has been tested and approved by Underwriters Laboratories or Factory Mutual Laboratories will be listed in their publications of approved equipment. Each listing is specific, and equipment cannot safely be used in atmospheres for which it is not rated.

Control of Static Electricity

since static electricity can provide sufficient ignition energy to set fire to flammable concentrations of gases or vapors, it is important to recognize activities that can generate static electricity and to know what can be done to prevent accumulation and discharge of this energy.

Static electricity is generated by contact and separation of materials, such as particulates moving though a stack, gas issuing from a nozzle at high velocity, pouring or spraying of non-conducting liquids or solids. Static electricity is also generated when materials flow through pipes, hoses, or ducts, when a belt runs over a pulley,

and when a person walks across a floor.

Static electricity accumulates higher voltages in atmospheres with low humidity and during dry weather.

As examples of the hazards that can be caused by development of static electricity, pouring solvents can (under some circumstances) generate enough charge to ignite the vapors present, and a person can accumulate a static charge (by walking or by working near a process that generates static electricity) with sufficient energy to ignite flammable vapors and gases. (A person can easily build up a charge of 100,000 volts, which could release more than 40 times the energy needed to ignite hydrocarbon gases and vapors, and more than 1000 times the energy to ignite acetylene and hydrogen.

Practical measures to prevent accumulation or discharge of static electricity in field activities include:

-grounding all probes used for stack sampling;

- providing a bonding connection between metal containers when flammable gases or liquids are transferred or poured; and

- wearing footwear which has adequate conductivity for the hazardous conditions.

Conductivity is more critical in atmospheres which can easily be ignited, such as those with flammable concentrations of acetylene, hydrogen, ethyl ether, or hexane. If you are going to be working in such atmospheres, try to find out more about the hazards and the precautions needed. For example, rubber-soled footwear may allow the wearer to build up to great a charge of static electricity.

Emergency Procedures and Responses

In any field activity where there is a possibility of a fire, you should be prepared to deal with the emergency to protect yourself and other members of your crew. You need to know what to do in case of a clothing fire, and when and how to get quickly out of or away from an area where there may be a serious fire hazard or where a fire may endanger you. If the site you are visiting has an emergency plan and procedures and an alarm signal, find out before you begin work what the alarm signal sounds like and what emergency procedures to follow.

Everyone should know the emergency procedure to follow in case of a clothing fire. The procedure is recommended by the National Fire Protection Association:

1. Stop (do NOT run).

Stopping prevents a person from fanning the flames and making injuries much more serious.

2. Drop (to the floor or other horizontal surface).

Dropping gets a person's face and nose out of the path of smoke and hot gases, and prevents the flames from spreading rapidly upward. Dropping will lessen (but not prevent) injury from a clothing fire.

3. Roll (to smother the fire).

Rolling helps snuff out the flames and cool the burning clothing.

Try to prevent anyone from running while on fire, or from going to a fire blanket or safety shower. If a fire blanket is available, bring it to the victim.

If there is an emergency shower nearby, use it only after the clothing

Benzaldehyde C_6H_5CHO (Artificial Almond Oil) (Benzenecarbonal)	145 (63)	377 (192)			1.1	2.7	355 (179)	No	Water may be used to blanket fire.	2	2	0
Benzedrine $C_6H_5CH_2CH(CH_3)NH_2$ (1—Phenyl Isopropyl Amine)	<212 (<100)				0.93	4.67	392 (200)			0	1	
Benzene	See Benzol.											
Benzenecarbonal	See Benzaldehyde.											
Benzene Carbonyl Chloride	See Benzoyl Chloride.											
Benzine	See Petroleum Ether.											
Benzoic Acid C_6H_5COOH	250 (121)	1058 (570)			1.27	4.21	482 (250)	Slight		2	1	
	Note: Melting point 252 (122).											
Benzol (Benzene) C_6H_6	12 (—11)	928 (498)	1.3	7.1	0.9	2.8	176 (80)	No	Water may be ineffective.	2	2	0
	(Und. Lab. Class 95–100)											
	Note: See Hazardous Chemicals Data.											
Benzol Diluent	—25 (—32)	450 (232)	1.0	7.0	<1		140–210 (60–99)	No	Water may be ineffective.	2	2	0
	Note: Flash point and ignition temperature will vary depending on the manufacturer.											
p—Benzoquinone $C_6H_4O_2$ (Quinone)	100–200 (38–93)	1040 (560)			1.3	3.7	Sublimes	No		1	2	1
	Note: Melting point 234–237 (112–114).											
Benzotrichloride $C_6H_5CCl_3$ (Toluene,α,α,α,—Trichloro) (Phenyl Chloroform)	260 (127)	412 (211)			1.4		429 (221)	No	Water or foam may cause frothing.	3	1	0
Benzotrifluoride $C_6H_5CF_3$	54 (12)				1.2	5.0	216 (102)	No	Water may be ineffective except as a blanket.	4	3	0
	Note: See Hazardous Chemicals Data.											

Fusel Oil	See Isoamyl Alcohol.											
Gas, Blast Furnace			35	74					Stop flow of gas.	2	4	0
Gas, Coal Gas			5.3	32					Stop flow of gas.	2	4	0
Gas, Coke-Oven			4.4	34					Stop flow of gas.	2	4	0
Gas, Natural (Natural Gas)		900–1170 (482–632)	3.8– 5.3	13– 17					Stop flow of gas.	1	4	0
Gas, Oil Gas			4.8	32.5					Stop flow of gas.	2	4	0
Gas, Producer			20–30	70–88					Stop flow of gas.	2	4	0
Gas, Water			7.0	72					Stop flow of gas.	2	4	0
Gas, Water (Carburated)			5.6	46.2					Stop flow of gas.	2	4	0
Gas Oil	150+ (66+)	640 (338)	0.5	5.0	<1		300–700 (260–371)	No		0	1	0
Gasoline C_5H_{12} to C_8H_{18} 56–60 Octane	—45 (—43) —45 (—43)	536 (280)	1.4 1.4	7.6 7.6	0.8	3–4	100–400 (38–204)	No	Water may be ineffective.	1	3	0
73 Octane			1.4	7.6								
92 Octane			1.3	7.6								
100 Octane	—36 (—38)	853 (456)	1.4	7.4								
	(Und. Lab. Class 95–100)											
	Note: Values may vary considerably for different grades of gasoline.											
Gasoline 100–130 (Aviation Grade)	—50 (—46) (approx.)	824 (440)	1.3	7.1						1	3	0
Gasoline 115–145 (Aviation Grade)	—50 (—46) (approx.)	880 (471)	1.3	7.1						1	3	0
Gasoline (Casinghead)	0 (—18) or less							No	Water may be ineffective.	1	4	0

	FLASH POINT °F(°C)	IGNITION TEMP. °F(°C)	FLAMMABLE LIMITS Percent by Vol. Lower	Upper	Sp. Gr. (Water = 1)	Vapor Density (Air = 1)	BOILING POINT °F(°C)	Water Soluble	EXTINGUISHING METHOD See Intro.	SUGGESTED HAZARD IDENTIFICATION Health	Flammability	Reactivity
Methyl Acetate CH_3COOCH_3 (Acetic Acid Methyl Ester) (Methyl Acetic Ester)	14 (−10)	850 (454) (Und. Lab. Class 85–90)	3.1	16	0.9	2.8	140 (60)	Yes	Water may be ineffective. "Alcohol" foam.	1	3	0
Methyl Acetic Ester	See Methyl Acetate.											
Methyl Acetoacetate $CH_3CO_2CH_2COCH_3$	170 (77)	536 (280)			1.1	4.0	338 (170)	Yes	"Alcohol" foam.	2	2	0
P-Methyl Acetophenone $CH_3C_6H_4COCH_3$ (Methyl para—Tolyl Ketone) (p—Acetotoluene)	205 (96)				1.0—		439 (226)	No	"Alcohol" foam.	0	1	0
Methylacetylene	See Propyne.											
α—Methylacrolein	See 2—Methylpropenal.											
Methyl Acrylate $CH_2CHCOOCH_3$	27 (−3) (cc) Notes Polymerizes. See Hazardous Chemicals Data.	875 (468)	2.8	25	1.0—	3.0	176 (80)	Very slight	Water may be ineffective.	2	3	2
Methylal $CH_3OCH_2OCH_3$ (Dimethoxymethane) (Formal)	0 (−18) (cc)	459 (237)			0.9	2.6	111 (44)	Yes	Water may be ineffective. "Alcohol" foam.	2	3	2
Methyl Alcohol CH_3OH (Methanol) (Wood Alcohol) (Columbian Spirits)	52 (11)	725 (385) (Und. Lab. Class 70)	6.0	36	0.8	1.1	147 (64)	Yes	Water may be ineffective. "Alcohol" foam.	1	3	0
Methylaluminum Sesquibromide $(CH_3)_3Al_2Br_3$	Notes Ignites spontaneously in air.								Do not use water, foam or halogenated extinguishing agents.		3	3W*
Methylaluminum Sesquichloride $(CH_3)_3Al_2Cl_3$	Notes Ignites spontaneously in air.								Do not use water, foam or halogenated extinguishing agents.		3	3W*

Educational Objectives

- The student should be able to determine if equipment is packed safely.
- The student should be able to handle heavy equipment safely.
- The student should know the correct handling techniques for compressed gas cylinders.
- The student should be able to determine if electrical equipment is safe from electrical shock.
- The student should be able to determine if sampling equipment is approved for certain industrial environments.
- The student should be able to determine the proper electrical cord size for particular needs.
- The student should be able to determine safe practices for sampling.
- The student should know how to pack and transport samples and sampling reagents.

NOTES

Introduction

Field sampling represents one of the largest responsibilities of EPA field crews. As such, the probability of facing a hazardous condition is large. The diversity of environments, equipment used, p;personnel awareness and training all to a large extent, play a role in the type and severity of the hazard.

It is not possible to prepare field personnel for every eventuality. Crews must depend on alertness, planning and common sense for the unexpected.

This unit will help sharpen the backgrounds of personnel to enable them to have confidence in preparing and preventing accidents while sampling. Two major areas will be covered:

1. Physical Hazards of the Sampling Environment

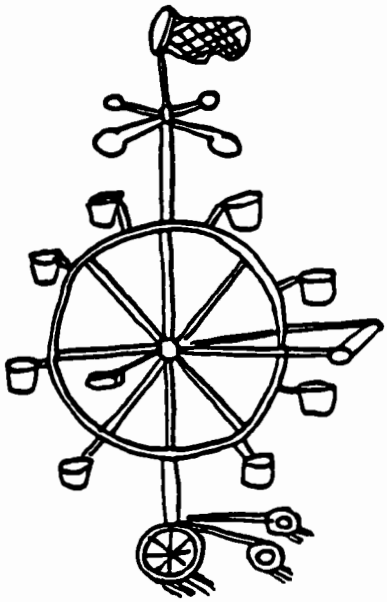
2. Hazards of Sampling

The specific topic of sampling drums is covered in the unit on Hazardous Waste Sites.

Physical Hazards of the Sampling Environment

Sampling Equipment Instructions

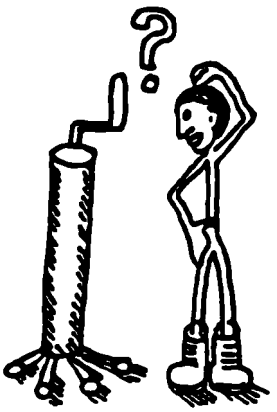
Sampling equipment is manufactured in an endless variety of sizes and shapes. In some cases, equipment has been modified or even built by Agency personnel. The Coliwasa has for many years been the mainstay for sampling liquids. Yet until a few years ago, there were no commercial manufacturers of the Coliwasa and units had to be built in-house.



Manufactured equipment usually comes with precise instructions as to procedures for safe set up and operation. It should become common

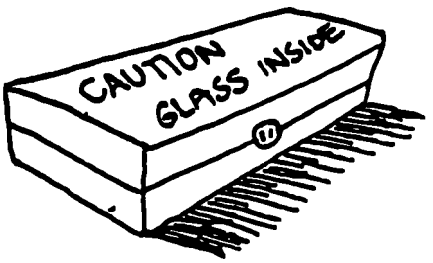
practice to thoroughly read these instructions before attempting to use the equipment. Instructions should be placed in clear plastic covers to protect them from inclement weather, chemicals, dirt and wear. If possible, the sheets should be taped to the inside covers of the carrying cases or if in multiple sheets or booklet, attached to the equipment by a light chain or durable string.

In the event of modifications to manufactured equipment, special use for which the equipment was not originally designed or in-house designed equipment, Standard Operating Procedures (SOP) should be developed before the equipment is authorized for field use. Copies of the SOP should be protected and attached to the equipment or carrying case. SOP should also be sent to all personnel that may have use for the equipment. The SOP should make special note of limitations or hazards that might exist. In some obvious cases, special note should be made on the outside of the carrying case to alert the individual of important hazards. Examples of these hazards are:



1. The carrying case contains hazardous chemicals.

2. There exists breakable parts or containers inside.



3. There is the danger of shock or explosion if used improperly or in certain hazardous conditions or atmospheres.

4. Improper use or mixing may generate a dangerous condition.

Carrying Equipment

Injuries to the back and abdominal muscles from lifting heavy loads is one of the most common injuries reported. Such injuries can range from relatively

mild strains to major permanently disabling injuries. Lifting heavy equipment should be approached with though as to:

1. Overall weight

2. Distribution of weight

3. Unwieldiness or awkwardness

4. Distance to be carried

5. Obstacles to be negotiated such as slippery banks, rocking boats and ladders.

6. Conditions such as wind, snow, ice and slippery surfaces.

7. Visibility

Whenever possible, assign two individuals to carry equipment. Simply the weight alone should not be the only consideration. A large sheet of plywood may not be particularly heavy but is awkward, blocks the view of the person carrying it, and can be extremely hazardous in high, gusty winds. Two individuals carrying two sheets together is a much safer practice than two individuals each carrying one sheet apiece. The incidence of individuals being blown from roofs and ladders while carrying large sheets is all too frequent.

Before lifting a case, check to see if equipment stored inside is secure. A sudden shift in weight while the case is being carried may throw the individual off balance and result in a dangerous fall.

Experimentally lift a corner of the equipment to be carried to determine its approximate weight. Check to see if carrying handles are fastened securely to the container and are in good condition. Check to see that tops,

drawers, etc., are securely fastened closed. Never lift equipment by makeshift strings or ropes. If equipment seems heavy, request help before lifting. Strains and hernias are usually caused during the initial strain of lifting. If passing a heavy piece of equipment to another individual, warm them of the approximate weight before handing them the equipment. Strains and hernias are often caused by improper position or stance, rather than by sheer weight.

Heavy equipment should be lifted by using the power of the leg muscles, rather than the back, stomach, or arm muscles. Approach the container so as to have it evenly balanced. Never bend over when lifting. The back should be kept straight and the arms nearly vertical with the body. The knees should be bent to grasp the load. Lifting should be by straightening the legs, with the back remaining in a nearly vertical position. Setting down the load is the reverse of lifting.

Never climb ladders while carrying a heavy load. Ladders require the use of both hands. Loads not only tie up the hands, but unbalance the body. Loads should be lifted by winch or pulley.

Never attempt to lift a heavy load from a small boat with only one person. The unstability of the boat along with the shifting weight, may result in the boat tipping over or a severe strain of the bodies of the lifters.

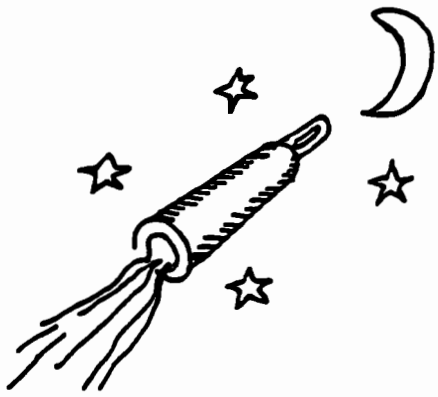
Likewise, never attempt to lift a heavy weight over a dock down into a boat. Not only is the strain severe, but the uneven weight may cause the individual to fall headlong into the boat or water. Heavy equipment should be set on the side of the dock within reach of personnel in the boat. Two individuals in the boat should grasp the equipment while steadying the boat. Be

sure the boat is securely tied at both ends to prevent the boat from pushing away from the dock while equipment is being lifted.

Compressed Gas Cylinders

Compressed gas cylinders are frequently used for analytical equipment or for recharging SCBA air tanks. These tanks represent a multitude of hazards. The empty tanks themselves are extremely heavy and due to their elongated shape, easily tipped over. Tanks should be carried on special dollys designed to hold cylinders. These dollys have a saddle to hold the tanks and an adjustable strap to prevent the tank from tipping forward when the dolly is lifted upright.

Never move or transport a tank without the protective threaded cap or top being in place. When full, the tanks are under extreme pressure, striking the valve at the top of the tank may shear off the valve assembly, venting the pressurized gas. In addition to the potential of fire or explosion, the velocity of the existing gas may propel the cylinder at extremely hazardous speeds.



When transporting the tank or when setting the tank up for use, securely chain or fasten the tank in an upright position to prevent shifting or falling over. In some cases such as acetylene, it is dangerous to lay the tank on its side. Such a practice may cause a separation of the acetone, acetylene mixture.

Always check tanks for pitting and rusting. Any sign of deterioration should be reported immediately and the tank removed from service. Never assume that the color of the tank indicates the contents. Color schemes are strictly the preogative of the company that moves the cylinders.

Never add adaptors or other gear to a regulator to make equipment fit. Often special threads and sizes are put on regulators to forewarn or prevent certain types of equipment from being used or attached to the tanks. These precautions shoulds be carefully heeded by field personnel.

Threads on tanks are often reversed from the normal directions used in common equipment. Never atempt to force threads or nuts. If a thread won't give, stop and analyze the direction you are attempting to turn the nut. In most cases, the threads will turn off in the opposite direction.

Never store tanks in direct sunlight or near excessive heat. Non-flammable gas such as carbon dioxide may rupture with a force equal to or greater than that of flammable gases.

The Sampling Environment

Before setting up and using sampling equipment, attempt to determine the type of environment you will be testing. In many cases, this is best done by contacting a plant representative such as a safety officer. Explain fully the nature of the test and exactly the type of sampling equipment to be used. Make sure the type of equipment is approved for the environment that you will be in. In most cases, electrical sampling equipment is approved for certain types of environments.

Certification

National groups such as Underwriters Laboratories (UL), Factory Mutual (FM), and the American National Standards Institute (ANSI), together with NFPA, developed test protocols for certifying explosion-proof, intrinsically safe, or purged devices to meet minimum standards of acceptance.

An electrical device certified under one of these test methods carries a permanently affixed plate showing the logo of the laboratory granting certification and the Class(es), Division(s), and Group(s) it was tested against.

Certification means that if a device is certified as explosion-proof, intrinsically safe, or purged for a given Class, Division, and Group, and is used, maintained, and serviced according to the manufacturer's instructions, it will not contribute to ignition. The device is not, however, certified for use in atmospheres other than those indicated.

Three methods exist to prevent a potential ignition source from igniting a flammable atmosphere:

o Explosion-proof: Encase the ignition source in a rigidly built container. "Explosion-proof" instruments allow the flammable atmosphere to enter. If and when an arc is generated, the ensuing explosion is contained within the specially designed and built enclosure. Within it, any flames or hot gases are cooled prior to exiting into the ambient flammable atmosphere so that the explosion does not spread into the environment.

o Intrinsically Safe: Reduce the potential for arcing among components by encasing them in a solid insulating material. Also, reducing the instrument's operational current and voltage below the energy level necessary for ignition of the flammable atmosphere provides equal protection. An "intrinsically safe" device, as defined by the National Electrical Code, is incapable "of releasing sufficent electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration. Abnormal conditions shall include accidental damage to any...wiring, failure of

electrical components, application of over-voltage, adjustment and maintenance operations and other similar conditions."

o Purged: Buffer the arcing or flame-producing device from the flammable atmosphere with an inert gas. In a pressurized or "purged" system, a steady stream of, for example, nitrogen or helium is passed by the potential arcing device, keeping the flammable atmosphere from the ignition source. This type of control, however, does not satisfactorily control analytical devices that use a flame or heat for analysis such as a combustible gas indicator (CGI) or gas chromatograph (GC).

There are six possible environments in which a hazardous atmosphere can be generated. However, not every type of control will prevent an ignition in every environment. To adequately describe the characteristics of those environments and what controls can be used, the National Electrical Code defines each characteristic:

o Class is a category describing the type of flammable material that produces the hazardous atmosphere:

* Class I is flammable vapors and gases, such as gasoline, and hydrogen. Class I is further divided into groups A, B, C, and D on the basis of similar flammability characteristics (see Table 1).

* Class II consists of combustible dusts like coal or grain and is divided into groups E, F, and G.

* Class III is ignitable fibers such as produced by cotton milling.

o Division is the term describing the "location" of generation and release of the flammable material.

* Division 1 is a location where the generation and release are

continuous, intermittent, or periodic into an open, unconfined area under normal conditions.

* Division 2 is a location where the generation and release are in closed systems or containers and only from ruptures, leaks, or other failures.

Using this system, a hazardous atmosphere can be routinely and adequately defined. As an example, a spray-painting operation using acetone carrier would be classified as a Class I, Division 1, Group D environment. Additionally, an abandoned waste site containing intact closed drums of methyl ethyl ketone, toluene, and xylene would be considered a Class I, Division 2, Group D environment. Once the containers begin to leak and produce a hazardous atmosphere, the environment changes to Class I, Division 1, Group D.

TABLE 1

Class I Chemicals By Groups

Group A Atmospheres

Acetylene

Group B Atmospheres

Acrolein (inhibited)
Arsine
Butadiene
Ethylene oxide

Hydrogen
Manufacturer gases containing more than 30% hydrogen (by volume)
Propylene oxide
Propylnitrate

Group C Atmospheres

Acetaldehyde
Allyl alcohol
n-Butyraldehyde
Carbon monoxide
Crotonaldehyde
Cyclopropane
Diethyl ether
Diethylamine
Epichlorohydrin
Ethylene
Ethyleneimine
Ethyl mercaptan
Ethyl sulfide
Hydrogen cyanide
Hydrogen sulfide
Morpholine
2-Nitropropane
Tetrahydrofuran
Unsymmetrical dimethyl hydrazine (UDMH, 1-, 1-dimethyl hydrazine)

Group D Atmospheres

Acetic Acid (glacial)
Acetone
Acrylonitrile
Ammonia
Benzene
Butane
1-Butanol (butyl alcohol)
2-Butanol (secondary butyl alcohol)
n-Butyl acetate
Isobutyl acetate
di-Isobutylene
Ethane
Ethanol (ethyl alcohol)
Ethyl acetate
Ethylacrylate (inhibited)
Ethyl diamine
Ethylene dichloride
Ethylene glycol monomethyl ether
Gasoline
Heptanes
Hexanes
Isoprene
Isopropyl ether
Mesityl oxide
Methane (natural gas)
Methanol (methyl alcohol)
3-Methyl-1-butanol (isoamyl alcohol)
Methyl ethyl ketone
Methyl isobutyl ketone
2-Methyl-1-propanol (isobutyl alcohol)
2-Methyl-2-propanol (tertiary butyl alcohol)
Octanes
Petroleum naphtha[1]
Pentanes
1-Pentanol (amyl alcohol)
Propane
1-Propanol(propyl alcohol)
2-Propanol (isopropyl alcohol)
Propylene
Pyridine

TABLE 1 Cont'd.

Group D Atmospheres

Styrene
Toluene
Vinyl acetate
Vinyl chloride
Xylenes

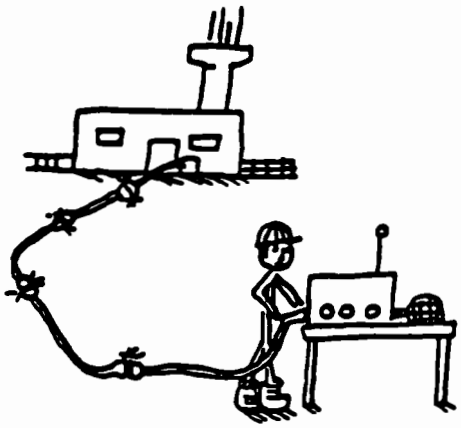
Source: National Electrical Code, Vol. 70, Table 500-2. National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210 (1981).

[1]A saturated hydrocarbon mixture boiling in the range 20° - 135°C (68° - 275°F). Also known by the synonyms enzine, ligroin, petroleum ether, or naphtha.

Electrical Hazards

Sampling often requires Agency personnel to reach remote or inaccessible places. In many cases such areas may contain electrical wires or transformers. Great caution should be exercised in these areas. Where practical, power should be cut to remove the danger. Where this is not possible, highly conductive equipment such as aluminum ladders, metal probes, and other metal sampling gear should be avoided if possible. Electrical insulating protective gear such as hard hats and gloves should be worn.

Of particular danger are overhead wires. Before raising or carrying ladders, check to see that equipment will clear. If there is danger Of coNtact, do not attempt to enter tha area.



A great deal of sampling equipment requires a source of electrical power to operate it. It some cases, an electrical power outlet may be some distance away. If possible, arrange for the company to provide power. Long extension cords may be a source of potential overheating and fire if a proper cord size is not selected.

Guidelines for Selection of Extension Cords

If an extension cord is needed to bring power to field sampling equipment or lights, there are important guidelines for selecting a cord that will be safe and serviceable. Extension cords should have three wires, two for power and one to provide a separate grounding circuit for safety. The wires need to be large enough in diameter to carry the needed power over the length of the cord without either significant voltage drop or overheating.

A long extension cord should have large enough diameter wires so that resistance in the cord will not lower the voltage more than 3 percent over the length of the extension cord. If the voltage supplied by the cord is too low, your analytical results may not be accurate and your equipment may not operate safety. Motors can burn out if the supplied voltage drops too low.

The other important requirement for wires is that they be of adequate size to carry the current drawn by your equipment, so that the cord does not overheat, damage the insulation, and possibly start a fire. (The current required by your equipment could overload the current-carrying capacity of an extension cord having wires of inadequate diameter without tripping the circuit breaker to which your cord is connected. In such a case the circuit breaker will not protect the extension cord from damage.)

Localized overheating can also occur if there is too small an area of contact between any plug blade and its socket connection. The effectiveness of surface contact areas can be estimated by use of a device with tests the tension provided by the contact blades within an outlet.

The procedure for selecting an extension cord will depend on whether you will use a cord that is available, or whether you are going to have an extension cord made up for a particular sampling activity.

In both cases you will need to know how much power is required by the equipment you will be using, what the voltage will be at the power source, and how far your equipment will be from a power outlet.

The basic steps for assessing or specifying an extension cord are as follows:

1. First find the total number of watts required for all of the equipment and lights that you plan to connect to the extension cord.

2. Find the lowest line.voltage that can be expected at the outlet to which the cord will be connected during the time personnel will be working. Personnel can inquire, test the voltage, or make a rough estimate.

If there is no data and the actual voltage cannot be measured on a line with a nominal voltage of 110 or 115, use the value of 100 volts for the calculation of the amperage the wires must carry.

3. Next, find out how many amperes the cord will have to carry by dividing the total number of watts of the equipment to be used by the line voltage expected at the outlet. Watts divided by volts equals the number of amperes of current to be carried by the cord.

4. Find out how long an extension cord will be needed to reach from an available outlet to the location of the equipment. Be sure to allow enough length so that the cord can go over or around obstructions or passageways.

Precautions for Use of Electrical Equipment

If personnel will be using any electrically-powered equipment, there are two precautions you should follow. The first is to see that there is no damage to the electrical insulation of the equipment or its cord, and the second is to be sure that you cannot touch uninsulated electrical conductors or metal parts which may be "hot" or energized.

There are four important requirements for electrical cords. The first is that electrical cords should have no breaks in the insulation.

Cords should be inspected periodically, with the cord disconnected from the power source.

Electrical cords should have plugs which keep the terminals insulated and which assure safe connection of wires to the terminals.

The fourth important requirement for electrical cords is continuity of the grounding wire.

If equipment with a grounding wire and a workable three-prong plug is connected to a two-wire extension cord, the grounding wire cannot perform its safety function.

Portable Electrical Equipment

With portable electrical equipment there are three practical steps that can be taken to prevent touching "hot" or energized metal parts. Any one of these steps will provide protection against electrical shock from the equipment:

1. Be sure that all exposed metal parts of electrical equipment are connected to an effective grounding circuit, or

2. Provide a Ground Fault Circuit Interrupter in the line, or

3. Use power tools which are "Double Insulated" to prevent any exposed metal surface from providing contact with a "hot" wire.

Grounding Exposed Metal Parts of Electrical Equipment

If personnel connect electrical equipment to an effective grounding circuit, they must be sure they they are grounding all exposed metal parts.

Ungrounded electrical equipment with only a two-wire electrical cord will usually continue to operate even if the hot wire comes into contact with the metal shell or exposed metal parts. If such equipment is held by a person who is also in contact with the earth or some grounded metal object, the individual could be shocked seriously and perhaps fatally.

If a hot wire in a piece of electrical equipment touches metal parts that are grounded (by connection to the green grounding wire), there will be a direct short circuit which will trip the circuit breaker and de-energize the electrical equipment. Electrical equipment will not continue to operate if there is a short circuit from the hot wire to metal parts that are grounded.

To assure that exposed metal parts of electrically-powered equipment cannot become electrically "hot" as a result of damage to the insulation of the hot wire, it is necessary to have a separate connection between exposed metal parts and the ground. This is usually accomplished by using equipment which has a third wire connecting the metal shell through the cord to a grounding connection in the electrical outlet. As an extra precaution you can check electrical equipment for leakage

currents between the metal parts and a grounded conductor.

In addition to having all of the equipment provided with a connection to the grounding wire, personnel must have a three-wire cord with a three-prong plug. It is also necessary that the grounding connection in the electrical outlet be attached to a ground. Outlets should be tested before use to see whether they do have an effective connection to ground or whether an alternative grounding method must be used.

Ground Fault Circuit Interrupters

If it is not possible to provide effective grounding for portable electrical equipment,, Ground Fault Circuit Interrupters can prevent injury if someone makes contact with a hot wire and the ground. When the device detects unbalanced current in a circuit, it will interrupt the current flow within a few milliseconds and prevent further flow of an injurious amount of current.

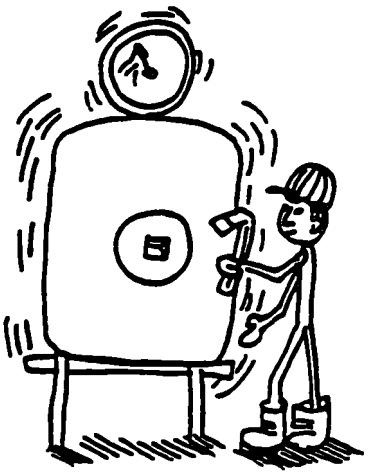
Portable ground fault circuiit interrupters (GFCI) are available for field use. They are recommended particularly in wet locations where the hazard of current flow to the ground is great. (Ground fault circuit interrupters do have the drawback that they will interfere with operation of any apparatus which uses a capacitor across the line as a noise filter.)

Double Insulated Electrical Tools

Electrically-powered tools are available with "Double Insulation" designed to prevent any exposed metal part from becoming energized and causing a shock to the user.

Electrically-powered tools identified by the manufacturer as being "Double Insulated" are considered

reasonably safe to use in locations where the user may contact either the ground or grounded equipment. Such tools should be in good condition with undamaged parts. As an additional precaution, such equipment should be checked to see that use or repairs have not damaged insulation and allowed exposed metal parts to come into contact with hot wires.



If personnel ever have to work on or enter electrically-powered equipment, be sure the power is shut off and the shutoff switch is locked so that no one can inadvertently turn the power on.

Sampling

Never open containers, tanks, mixers, etc., without first seeking the advice or approval of plant personnel. In many cases such containers may be under pressure or have extreme temperatures.

Drums should be moved only after careful observation of their condition. A normal filled drum weighs close to 500 pounds. Steel-toed shoes should be worn and equipment such as dollys, or fork lifts used to lift or tote barrels. A barrel tipped on its edge is highly unstable and difficult to control. A shift in its contents may cause the barrel to go out of control causing personal injury and increasing the risk of leaks, fire or explosion. Never stand or walk on containers to reach remote containers. If containers that must be sampled are not accessible, have company employees clear a path or move barrels.

Sample Size

Generally laboratories require very small quantities of samples. Take only the amount of sample needed to complete analysis. Containers of samples represent hazards. The larger the

sample size, the greater the hazard.

Sample containers must be checked for compatibility with the material sampled. Flammable liquids, corrosives and other highly hazardous materials should not be placed in glass containers unless the containers have special coatings to prevent shattering. Bakelite or PVC tops should be used in place of metal tops. Before the samples are removed from the sampling site, a check should be made to insure the tops are correctly and securely fastened. Decontaminate the outside of the sample container thoroughly before packing for transit. Never carry sample containers in Agency vehicles without securing them from rolling or bumping. A case designed for this purpose or a stout container filled with an inert packing absorbent such as vermiculite will prevent breakage, bumping or rolling about while in transit. If the material is to be shipped, special precautions must be exercised. (See unit on Sample Labeling and Shipping.)

Sampling procedures often require chemical reagents. Reagent bottles should be packed in absorbent, cushioning material to prevent bumping and leakage. Labels for reagents should be of indelible material and care taken to separate incompatible chemicals. In many cases, the reagent chemicals themselves represent a more serious threat of harm than the materials sampled. SOP's outling test procedures, as well as sampling hazards and chemical incompatibilities should be included with testing chemicals. In cases where reagents must be measured out, equipment contamination such as pipettes must be solved by disposables or decontaminating solutions.

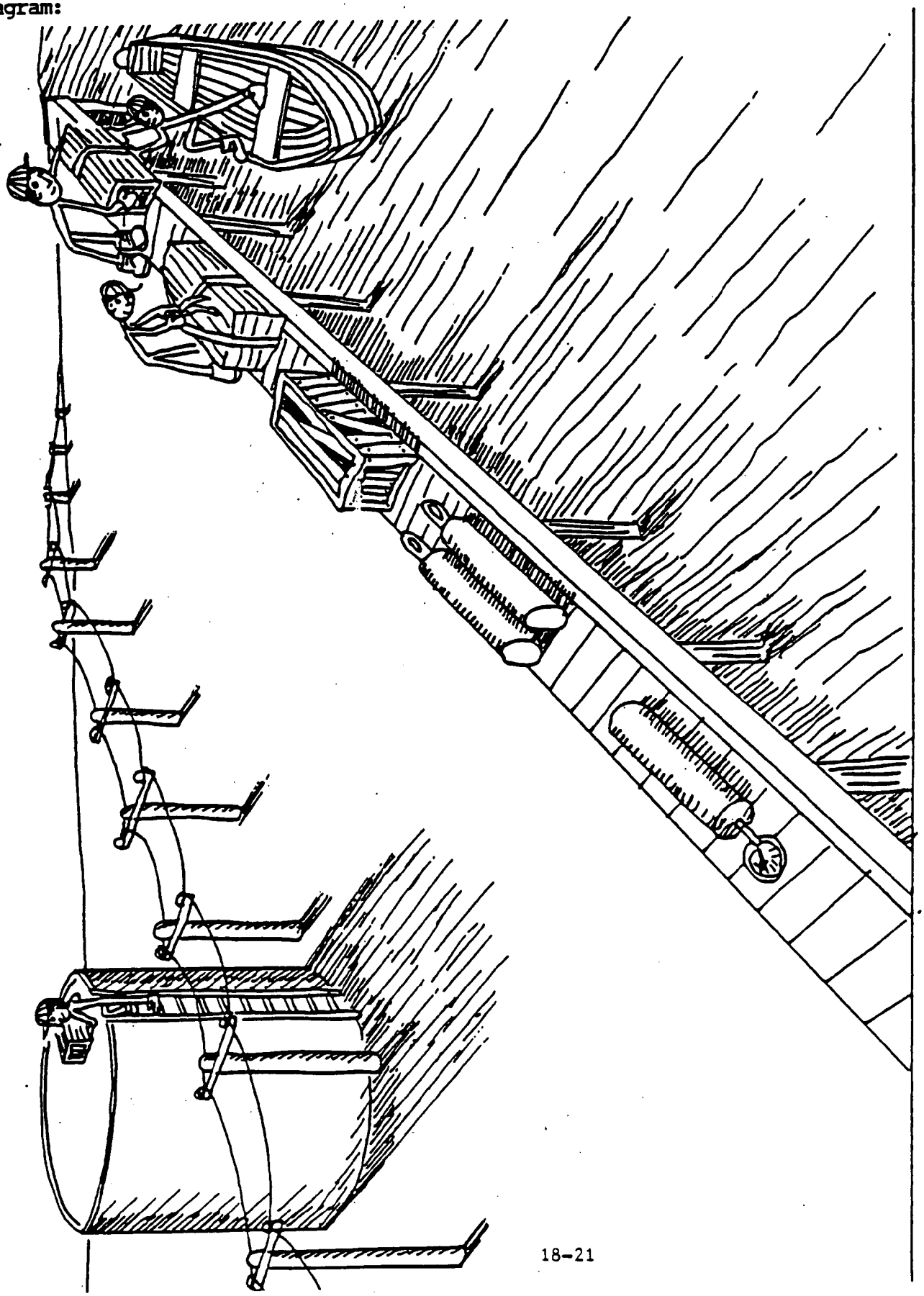
Reagents such as concentrated acids and bases are hygroscopic (attract water). Small drops on the outside of bottles will quickly dilute, running

become diluted, running down the sides of bottles and pooling at the bottom. Such pools can lead to unknowing skin contamination or eye burns.

STUDENT EXERCISES

Exercise I

Locate as many safety hazards as visible in the following diagram:



Exercise II

A piece of electrical sampling equipment draws 120 volts and uses 280 watts. The electrical source is 90' away. What size wire is needed?

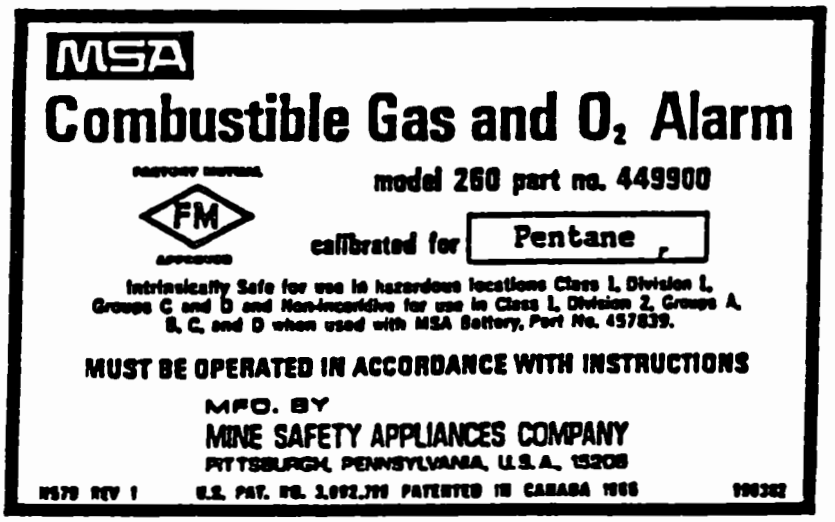
_____

Exercise III

Sampling is to be done in a closed environment that normally contains acetone. What type of approval must the equipment have to be safe in this type of environment?

_____

Is the following Instrument approved for this environment?



UNIT 19 NATURAL HAZARDS

Educational Objectives

o The student should be able to recognize poison ivy and poison oak.

o The student should be able to define the treatment for poison ivy and poison oak.

o The student should be able to recognize the common poisonous insects.

o The student should be able to recognize the various poisonous snakes.

o The student should be able to recognize the characteristics of rabid animals.

NOTES

EPA responsibilities require Agency personnel to enter remote, seldom visited, locations. Such places are the natural habitat of a variety of plants and animals, some of which pose a threat to personnel. It is the objective of this unit to familiarize personnel with these threats so that steps may be taken to avoid, as much as possible, contact with these hazards. In some cases a limited remedial action will be discussed.

Plants

There are very few types of plants that pose a threat to field personnel. Unfortunately, the ones that do are very common.

Poison Ivy and Poison Oak

Poison ivy is a vine that can be recognized by its three shiny green leaves and at certain times of the year, by clusters of white berries. It can be found growing up the sides of trees or building or as a dense ground cover 18" - 24' high. During the winter time the plant loses its leaves but the vines, if broken, may still pose a hazard. For highly sensitive people, smoke from the burning plants may be sufficient to trigger a reaction,

Medical tests indicate all individuals are allergic to poison ivy to some degree. If personnel have knowledge or suspicion of contact with poison ivy or poison oak, they should wash with strong soap within two to three hours of contact. The infecting agent in poison ivy is suspended in an oil base found on the leaves. Scrubbing with strong soap will eliminate or reduce the severity or spread.

If the blisters and itching, characteristic of poison ivy appear, medical attention should be sought. Secondary infection may be more serious

than the poison ivy itself.

Animals

Ticks

The natural habitat of the wood tick is bushes 18-36" in height. This parasitic insect usually burrows into the skin of its victim and sucks blood. Ticks are carriers of a number of diseases including the sometimes fatal disease of Rocky Mountain Spotted Fever. Personnel leaving a tick infested area should institute a search of themselves as well as other crew members. Ticks found burrowing under the skin should be removed by rubbing the area with rubbing alcohol. (Using a lighted cigarette or a hot needle is highly discouraged.) If the insect fails to be removed, or if the head of the insect breaks off, medical help should be sought. If fever or infection should set in, medical help should be obtained.

Snakes

Nearly every section of the country has a variety of poisonous snakes. Water Moccasons, rattle snakes, copperheads, and coral snakes all have potent venom that can be fatal. Most snake bites occur on the ankle or hand. When when enter an area known to have poisonous snakes, knee high boots, leather gloves, and snake bite kits should be considered an absolute necessity.

Most snakes are timid animals that strike only in defense. When suprising a snake, slowly back off and give the animal a chance to escape. Never attempt to kill, capture or molest a cornered snake. Never assume the snake is harmless.

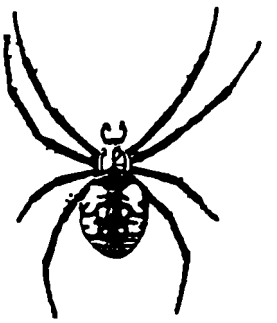
If the snake does strike, have the victim rest quietly. Ice packed in the area will reduce circulation, slowing

the spreading of the venom. If a pressure point can be located, cut or slow the circulation to the affected area. Get the victim to help as quickly as possible. If a snake kit is available it should be used with care. The practice of cutting the wound with a knife and sucking the venom out is no longer recommended.

NOTES

Spiders

There are only three types of dangerously poisonous spiders in the United States: the brown recluse, the black widow and the tarantula. The tarantula is generally found in the desert southwest. It is a large (2-4"), slowing moving spider characterized by its size and hairy body. The tarantula seldom bites unless provoked. Its bite is painful but seldom serious. Bites should be treated by medical personnel as quickly as possible.



The brown recluse is a small (1") brown spider found generally west of the Mississippi. It is secretive and prefers dark secluded areas. Although generally not fatal, its bite is quite serious, requires a long painful treatment, and often results in permanent scars.

The black widow is a fairly common spider of the mid-eastern and southeastern United States. It is easily identified by its 1-1/2" shiny black body, with a characteristic red hour-glass spot on the underside of the abdomen. It is a secretive creature that is often found in dark secluded places and under wood piles and barrels. The black widow bite is generally not fatal to adults, but the wound is painful, and medical attention should be sought immediately.

Bees-Wasps

Bees and wasps can be found nesting in a variety of habitats from rafters,

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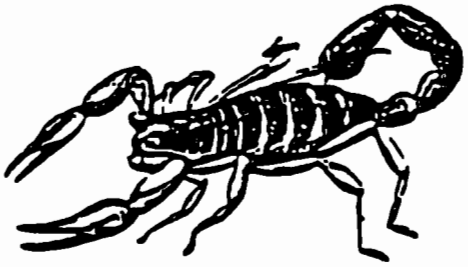
bushes, insides of barrels ,andunder ground. Agency personnel with known reactions to bee/wasp stings should let it be known that they are affected by stings, they should carry an emergency bee sting kit. In the absence of immediate help, the victim should be kept quiet, the stinger removed if possible, and the area of the sting packed with ice. For individuals that are highly allergic, bee stings may be fatal. Help should be summoned immediately. If unconsciousness occurs, nearby individuals should stand ready to administer CPR (see unit on First Aid).

Scorpions

In both the southeast and the southwest, scorpions represent a threat to field personnel. Scropions usually are found under rocks, barrels, trash, etc. Care should be exercised before reaching under these areas. While few scorpion stings are fatal to adult humans, the sting can result in a painful disabling injury. Poison similar to that found in ants and bees is injected under the skin. For individuals allergic to insect stings, a scorpion sting may be fatal if not treated immediately. Individuals that suffer from allergic reactions to insects should warn other team members of this problem and carry an anti-sting kit. If an allergic individual is stung, medical help should be sought immediately. If unconsciousness occurs before help arrives, CPR may be necessary (see unit on First Aid).



Fire Ants

Fire ants have become a serious problem in the southeastern part of the United States. Fire ants are identified by their characteristic 6-12" mound of dirt. The ants are small, reddish-brown insects that are very aggressive when disturbed. Their painful sting usually leaves a red welt or blister. Many individuals are highly allergic to the

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stinging substance (Formic Acid). Those individuals known to be allergic should be rushed to a medical center for treatment. If unconsciousness occurs before help arrives, CPR may be required (see unit on First Aid).

Rabid Animals

Prior to the early 1980's, rabies was seldom encountered. Rabies vaccines for pets have virtually eliminated the threat in domesticated animals. Recently however, there has been an alarming upsurge in the number of reported cases of rabies in wild animals. Rabies can infect any warm blooded animal, from racoons to bats. Agency personnel should be alert for wild animals that show a lack of fear or a certain aggressiveness. Other characteristics are drooping head, a peculiar trotting gait, or any other unusual behavior.

If a victim is bitten and the skin is broken, you should seek medical attention immediately. Without medical attention, the mortality rate for rabies is nearly 100%.

Educational Objectives

o The student should know how to select protective clothing for chemical resistance.

o The student should know how to select protective clothing based on the need for strength.

o The student should know how to select protective clothing based on thermal units.

o The student should know how to select equipment based on the need for decontamination.

o The student should know the role of economy in selecting equipment.

o The student should be able to list the performance standards for hard hats.

o The student should be able to define the safety standards for eye and face protection.

o The student should be able to determine appropriate standards for proper foot protection.

o The student should be able to list the types of ear protection.

o The student should be able to determine correct hand protection.

NOTES

Protective clothing is a collective term that includes all outerwear worn for the purpose of protecting the head, eyes, ears, torso, and feet. In the normal demands of field work, Agency employees will face a wide variety of hostile environments and situations. The opportunity for injury ranging from minor cuts and abrasions to major chemical burns, are numerous. It should be evident that taking steps to evaluate these hazards and provide for protection against them is in the very best interest of EPA and the employee. Department of Labor statistics indicate that over 60% of the work related injuries occur during routine job assignments. In many of these injuries, lack of enforcement by supervisors and lack of concern by the individual resulted in accidents that either could have been avoided or minimized by the wearing of correct protective clothing or equipment.

Selection of Protective Clothing

Agency employees faced with the necessity to select proper protective equipment can be quickly overwhelmed with the vast variety of equipment available. Unlike some areas of the work environment, protective equipment has few regulations or standards by which accurate judgement can be made. It is up to the individual to exercise caution, good sense, and proper judgement in making final determinations of worker protection.

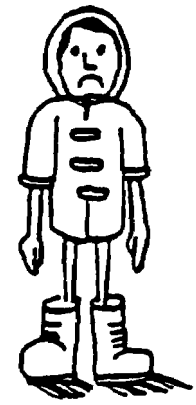
Rationale for Selection

Personnel protection must never be left to guesswork. It is imperative that the hazards to be faced are evaluated in every way possible. A wide variety of safety data sheets, CHRIS Manuals and the like are available to assist personnel in selecting equipment. However, they all depend on knowing what hazards the wearer is to face. It is

equipment. However, they all depend on knowing what hazards the wearer is to face. It is the unknown or the unexpected that can pose the greatest threat.

In all cases, review histories, talk to experienced personnel, check shipping papers, and test the testing or monitoring equipment to help select proper equipment. When facing an unknown, always prepare for the worst possible situation.

Before leaving for a field site, check the available inventories to be sure the correct type of equipment can be procured. A last minute substitution of proper equipment can leave personnel unprotected for the hazards at hand. If the proper equipment is not in Agency stock, attempt to borrow the equipment from another Region or office. If the proper equipment cannot be obtained, cancel the field activity until the proper gear can be found.



Have all crew members fit tested before leaving for the activity. Equipment or clothing that is too large or too small will not only make work difficult or uncomfortable, but may neutralize the protection of the equipment or be dangerous.

Criteria for Selection

Before a rational decision can be made as to the type of protective clothing needed, certain criteria must be considered.

1. Chemical Resistance - Before any other criteria can be considered, an analysis must be made of the type of material that will resist the chemical effects of the substance to be handled. Consideration must be given to the ability of the material to protect the wearer during splashes or contact without losing structural integrity.

Consider the expected extent of exposure to the chemical. Sampling usually will result in small splashes or spills, whereas cleanup may result in a longer and larger exposure. Many types of materials can withstand chemical contact for short periods, but fail over longer periods of time (see Table 18-1).

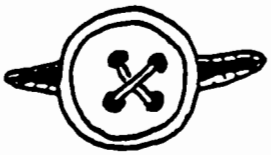
TABLE 18-1
Effectiveness of Protective Materials Against Chemical Degradation (By Generic Class) (1)

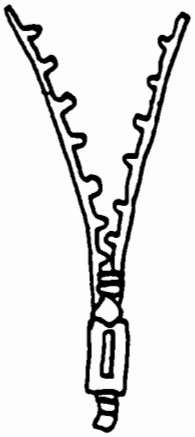
Generic Class	Butyl rubber	Polyvinyl chloride	Neoprene	Natural rubber
Alcohols	E	E	E	E
Aldehydes	E-G	G-F	E-G	E-F
Amines	E-F	G-F	E-G	G-F
Esters	G-F	P	G	F-P
Ethers	G-F	G	E-G	G-F
Fuels	F-P	G-P	E-G	F-P
Halogenated hydrocarbons	G-P	G-P	G-F	F-P
Hydrocarbons	F-P	F	G-F	F-P
Inorganic acids	G-F	E	E-G	F-P
Inorganic bases and salts	E	E	E	E
Ketones	E	P	G-F	E-F
Natural fats and oils	G-F	G	E-G	G-F
Organic acids	E	E	E	E

(1) E - Excellent F - Fair
G - Good P - Poor

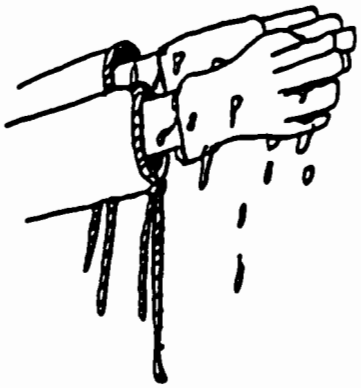
Protective gear should be checked routinely for signs of softening, brittleness, swelling, or permeation. If such conditions are noticed, a record of the effective duration of protection should be made for future reliability of the product.

Chemical resistance may also depend on factors other than the type of material used to make the gear. Permeability is directly related to the thickness of the material. Increased thickness is in turn related to the loss of flexibility and dexterity. It is obvious a compromise must be made between protection from permeability of chemicals and ability to work effectively and efficiently in the protective gear.





Another factor to consider in the overall chemical penetrability of the gear is its construction. Irregardless of the permeability of the material, button holes, zippers, cuffs, rips and punctures, unprotected stitches and seams all may compromise the overall protection provided by the gear. Before selecting protective clothing,, consider the task to be performed and the likelihood of contamination. Have crews familiarize themselves with gear before going out in the field. Literature and pictures may conceal drawbacks that can be quickly spotted with a pre-field review. Such factors as drawstring cuffs around the wrists requiring two hands free of protective gloves may be a real disadvantage when the strings come untied while working in a contaminated environment.



2. Strength - The ability of protective gear to withstand the rigors of field activities must be considered in the overall selection process. Materials with outstanding permeability characteristics such as Viton may have

very little ability to resist tears or punctures. In some cases, double layers of material must be worn to resist permeability, as well as wear and tear.

Particular attention should be made of areas such as knees and elbows where excess wear usually occurs. In some protective clothing, extra protection is provided in these areas.

Disposable clothing meant for single use before being thrown away are usually designed as light-weight protection. Vigorous physical activity may quickly exceed the design strength of the material. Manufacturers of such disposable clothing have provided a wide selection of materials from paper coated with vinyl, reinforced cloth or paper-cloth combinations to light-weight VPC material. Although the economics of such material varies appropritely, selection of the material should be based on the overall protective and use expected.

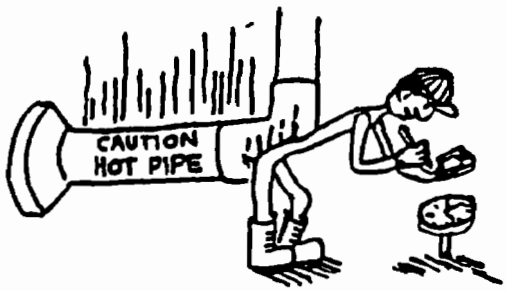
3. Thermal Limits - Protective clothing must also be selected for its thermal properties. In some materials, the protection factor is lost instantly if the material comes in contact with a hot surface. In others, exposure to cold may render the material brittle and subject to cracking. Since there are at present no uniform manufacturing standards for protective clothing, it is up to Agency personnel to experiment or research the effectiveness of protective clothing in weather extremes or under conditions where there may be contact with hot surfaces.

The comfort and health of the wearer of protective clothing must also be considered. When temperatures drop to freezing or above 70 degrees Farenheit, personnel are subjected to extreme discomfort which may be hazardous to their health or detrimental to their overall efficiency. (See Unit on Heat and Cold Stress.) Generally,

Comparative physical characteristics

Key: E—excellent; G—good; F—fair; P—poor

Characteristic	Neoprene	Natural latex or rubber	Milled nitrite	Butyl
Tensile strength	G	G	F	G
Elongation	E	E	G	G
Tear resistance	F	G	F	G
Abrasion resistance	G	G	E	G
Ozone resistance	E	F	P	E
Sunlight aging	E	F	G	E
Shelf-life aging*	F	E	E	E



the higher the protection factor, the more temperature stress can be expected on the wearer. Many manufacturers have made modifications to help regulate internal temperatures. Such modifications as ventilation holes must be carefully investigated as to possible compromise of protection.

In the case of encapsulating suites, cooling vests may be worn to help prevent heat stress and increase the overall efficiency of the wearer. Where such suits are required for vapor or splash protection and cooling vests are not available, short work periods with corresponding periods of rest are recommended.

4. Decontamination

Protective gear selection must also be based on ease of decontamination or cleaning. Such cleaning may involve a risk factor to personnel. It may also be expensive to thoroughly clean the gear than to select gear which is disposable.

Prolonged contact with the hazardous chemical may result in absorption into the material itself. In such cases, decontamination is virtually impossible.

5. Economy - Protective clothing may cost from a few dollars to many hundreds of dollars. Selection of such gear must be made with all of the above factors considered, as well as the overall cost. Although cost is never considered before safety, getting the most versatile, cost-effective gear available is in the best interest of all. Life expectancy, repair, maintenance and frequency of use must all be considered before final selections are made.

NOTES

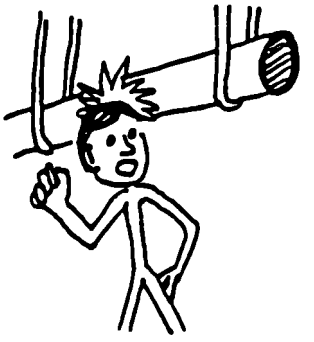
Types of Protective Clothing

The types of protective gear that Agency field personnel should wear is based on anticipated hazards to be faced. It is important to stress that most accidents occur in routine work when the individual least expects it. Whatever gear is selected, it should be worn as a part of daily dress. Like seat belts in an automobile, habits should be developed which when broken leave the individual with a feeling of insecurity.

It is no chance of fate that most accidents occur to individuals not wearing the proper safety gear.

1, Head Protection - Hard hats (or safety helmets) are designed to provide protection against impact, flying particles and electrical shock, and to provide shielding against the sun. Most hard hats provided for EPA field personnel will withstand an impact of 40 foot pounds, as well as insulation against electrical shock from voltages up to 2200. Hard hat standards of performance are set by the American National Standards on hard hats Z89.1-1981 and are tested by SEI or Safety Equipment Institute.

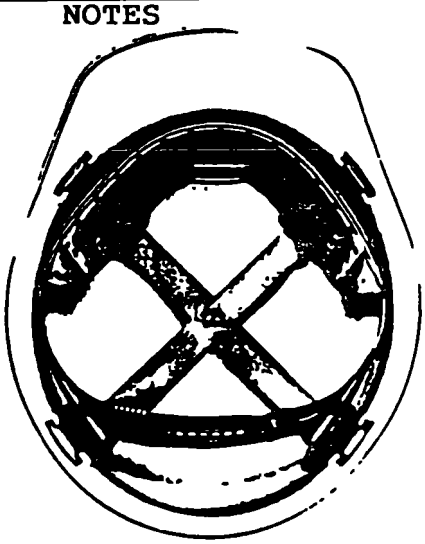
Hard hats should be used during field activities whenever there is the possibility of impact from falling objects or contact of the head with stationary objects such as pipes or overhangs. It should be remembered that hard hats provide limited protection. There can be no substitute for the precaution of staying out from under areas where work is going on overhead.



A great deal of the protection afforded by the hard hat comes from the separation of the head from the underside of the hard hat. The head band or suspension strap should be adjusted so that when worn there is about one inch separating the head and

NOTES

the hat. The one-inch provides cushion from impacts with the hat. Hard hats can also be equipped with insulating liners for protection from the cold and chin strap to prevent wind from blowing off hats or when leaning over.

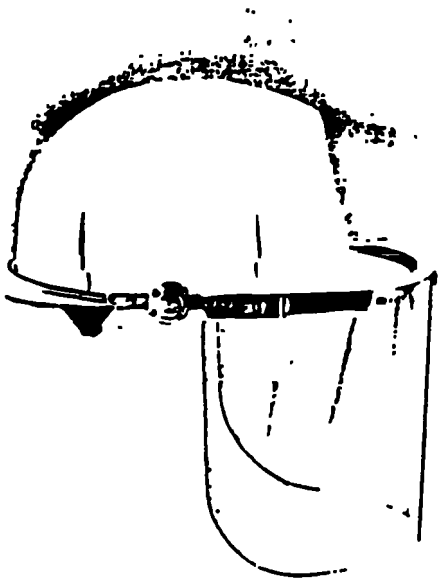


The common practice of carrying the hard hat in the back window of a vehicle can be a detriment to the strength of the hard hat. Plastic material may become brittle if allowed to be exposed to the sun for long periods of time. Store the hard hat out of the direct rays of the sun.

2. Eye and Face Protection - Eye and face protection should be worn in all field activities where there is danger from flying or falling particles or chemical splashes. Such eye and face protection should meet the standards set by OSHA Z87.1-1981 and the American National Standards for industrial eye protection. These vigorous standards preclude standard glasses as a form of protection.

Although all prescription glasses sold in recent years are required by FDA standards to resist some impact, glasses made to those standards will not provide the impact resistance or thickness requirements of the standards for industrial eye protection established by ANSI and required by OSHA.

Where eye glasses are required by Agency personnel, safety goggles or face shields covering the glasses or lenses placed in the goggles, or prescription safety glasses meeting OSHA standards should be attained.



Safety glasses and eye protection which meet ANSI standards for industrial eye protection will also have frames designed to hold the lens in place against impact. If the frames are not metal, the material will be slow-burning. New safety glasses will have the lenses and frames marked with the

standard number to show compliance with the ANSI standard.

Contact lenses have sometimes been considered a safety hazard in activities where chemical dusts, vapors or gases may be encountered; however, the only Federal prohibition is that they must not be worn under any type of respiratory protection.

Hard contact lenses are not considered to provide acceptable eye protection against impact. Hard contact lenses do not seem to aggravate chemical splash injuries according to information published in the Journal of Occupational Medicine.

Soft contact lenses are susceptible to absorption of vapors and may aggravate some chemical exposures, particularly if they are worn for extended periods. Manufacturers of soft lenses generally recommend they not be used in certain atmospheres.

3. Foot Protection - Foot protection should be selected with the type of protection in mind. The following types of protection should be considered:

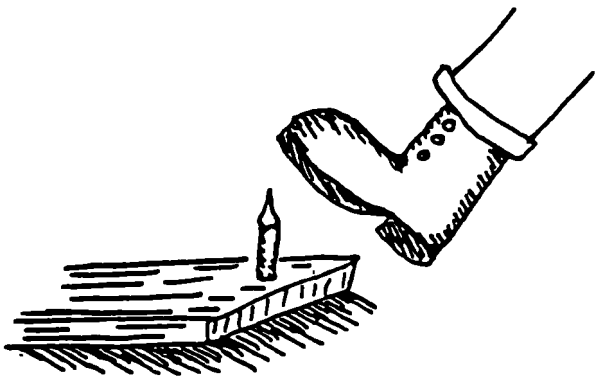
- o toe or foot damage due to impact
- o penetration of nails or other shop objects
- o contamination by chemicals
- o ankle twists and sprains
- o slippery surfaces
- o cold
- o static electricity

Toe or Foot Damage Due to Impact

Impact resistant footwear, such as safety shoes or safety boots are recommended for any field activity in which heavy objects (such as drums) may drop on the foot or injure the toes. Such safety shoes may be required to enter industrial plants.

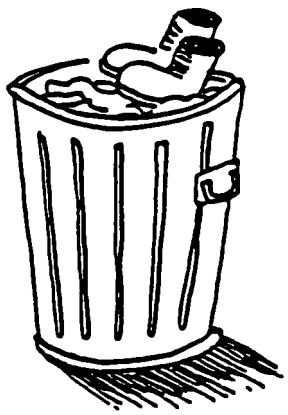
Safety shoes or boots provide impact resistance by the steel cap built into the toe of the footwear. The footwear can be ordered in various degrees of protection depending on expected hazards.

Penetration of Nails or other Sharp Objects



Normal street shoes provide very little protection from penetration of the soles by nails and other sharp objects. Construction sites, landfills, and many industrial sites have a wide variety of foot hazards. Agency personnel should never enter sites without proper foot protection. Most industrial work boots have reinforced soles or heavy rubber soles that will resist penetration of sharp objects. If such sharp objects do penetrate the foot, medical attention should be sought at once.

Contamination by Chemicals



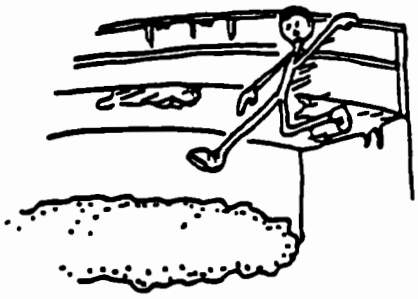
The type of footwear and the material it is made of must be selected based on anticipated chemical hazards. No other portion of the body is as likely to be contaminated with chemicals as are the feet. Although leather is the most common material in the manufacture of footwear, it is the least desirable where there is danger of chemical contact. Leather, due to its absorption capacity, is almost impossible to cleanse or decontaminate and most likely the footwear will have to be disposed of.

If there is an obvious chance of contamination, footwear worn over safety shoes should be selected. Such footwear includes pull-over boots, shoe covers, booties, or safety pull-on boots. Keep in mind that penetration of footwear with a contaminated object such as a nail, may lead to rapid and serious health effects.

Ankle Twists and Sprains

One of the most common injuries involving the feet are ankle twists and sprains. When Agency personnel are required to work on hazardous footing such as are found in construction sites or landfills, hightop industrial work shoes should be chosen. This type of shoe laces up the ankle providing extra support while walking. Such shoes, while not attractive, provide support low top or street shoes do not give.

Slippery Surfaces



No other industrial accident is more frequent or results in more disabling accidents than slipping and falling. Sprains, dislocations, broken bones, contact with dangerous machinery and drowning all are often attributed to unsure footing. On many wet or slippery surfaces, leather or smooth soles are treacherous. Material and design of soles should be selected with anticipated hazardous surfaces in mind. It is rare indeed when shoes appropriate to office wear are appropriate for field work.

Non-skid soles made of substances such as reinforced rubber are generally the best choice. Where particularly hazardous surfaces, such as those coated with ice are encountered, clamp-on ice spikes may be used.

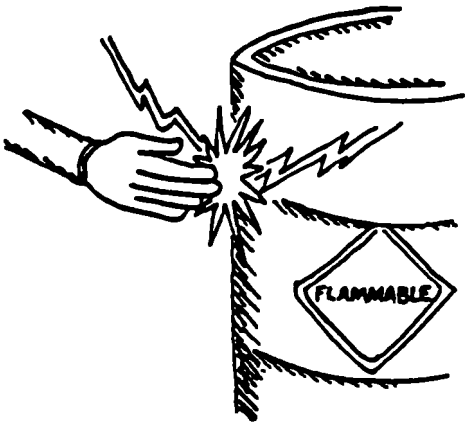
Cold

EPA field personnel are often required to spend long hours in the field during cold weather. Footwear for this type of work should be selected with high insulation ratings and somewhat over-sized (1/2 size) to provide room for heavy thermal socks. Cold weather is usually associated ice, snow and wind. Outer surfaces of footwear should be made of winter-proof materials or treated to make the material impervious to water. Wet, cold

feet can quickly lead to frost bite. Frost bite of the toes is a serious condition and can result in disabling injuries. (See Unit on Cold and Heat Stress.)

Static Electricity

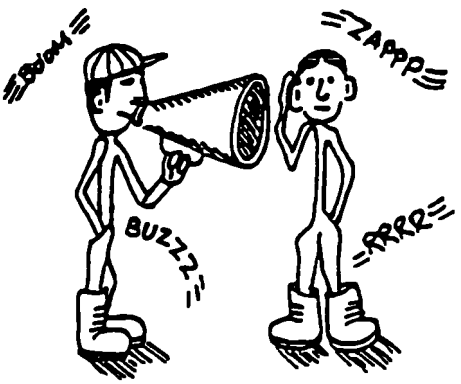
Due to various conditions such as low humidity, ribbing clothing, contact with certain surfaces, the body may build r mounts of static electricity. Voltage in excess of 10,000 volts are not uncommon. Such high voltage results in the shock common on cold, dry winter days. Such high voltage may also provide the energy to trigger explosions or fires in areas where these dangers exist. Rubber soled shoes act as an insulator preventing the static electricity build up in the body from escaping into the floor. When conducting surfaces are touched, such as the rim of a metal barrel, a discharge of electricity in the form of a spark is generated. In the right conditions, such sparks could be disastrous.



Special non-insulating shoes are manufactured to prevent static buildup. Devices that attach to the leg and special soles worn over rubber soles shoes also prevent static buildup. In some industrial settings such as the manufacture of explosives, these shoes are required before entry is permitted.

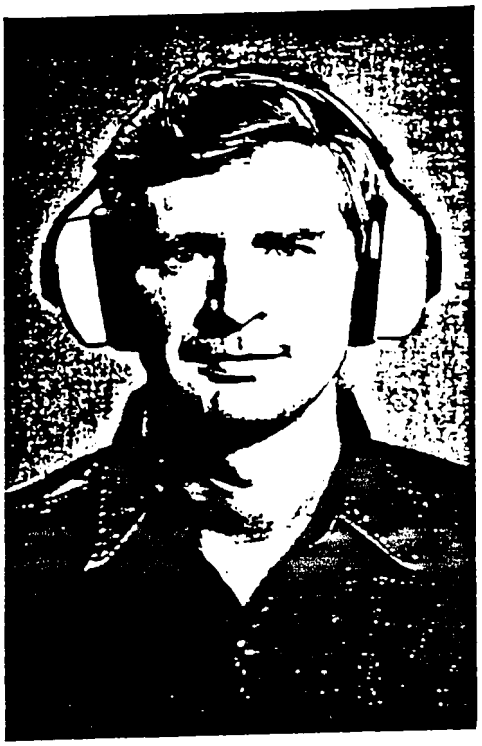
Ear Protection

Hearing protection may be necessary at some field sites to prevent temporary loss of hearing. Long-term exposure to high levels of sound can cause permanent loss of hearing in many frequency ranges as a result of nerve damage, and short exposures can cause temporary loss.



A simple test you can make to see if you need hearing protection is to try speaking to a person standing beside you. If you have to shout to communicate, you need hearing protection

to reduce the amount of sound reaching your ears. Although hearing protectors reduce the sound level in many frequency ranges, they can actually improve speech communication under noisy conditions by reducing the interference caused by the noise.



Earmuff hearing protectors generally provide the most effective protection. If glasses, sideburns or long hair prevent effective use of earmuff protectors, the next best protection is a set of earplugs.

Earplugs provide varying degrees of sound attentuation. The most effective earplugs are custom-molded to an individual user, and the least effective consist of a small wad of synthetic fibers which is shaped as it is inserted into the ear canal. The effectiveness of ear protectors is reduced by loose fit and work activities which allow leakage of sound. Actual protection seldom matches the rated protection recorded under test conditions.

Hand Protection

The second most common area of probable chemical contamination next to the feet and the most probable area for injury are the hands.

A wide variety of glove types are manufactured that provide protection against injury. When glove selection is to be made, the following list of considerations should be consulted:

- Injury due to abrasion, bruises, lacerations, splinters and other mechanical hazards
- Chilling, freezing or burns
- chemical and biological contaminants
- Dirt, grease, oil

o Electrical shock

When a variety of conditions exists, it may be necessary to select more than one pair of gloves to wear together. Viton for example, is relatively impervious to polychlorinated biphenyls but tears easily. A second pair of highly durable gloves may be worn over the Viton gloves to provide mechanical protection. Illustration 1 presents a few of the available types. Table 2 provides information for the type of material needed to resist chemical absorption.

DISPOSABLE GLOVES

TRU-TOUCH AMBI

ALL-PURPOSE VINYL

Ideal for general, light duty use. .0065" green vinyl is seamless, strong, liquidproof. Fits either hand. Disposable or reusable. Sulphur-free. S, M, L, Ex-L.

34-100 Dispenser Box: Contains 100 gloves of one size.

34-300 Dispenser Box: Contains 300 gloves of one size.

TRU-TOUCH® SHEER VINYL

Ideal for scientific research, food and small parts handling, etc., .005" white vinyl is seamless, liquidproof, sulphur-free. Fits either hand. Disposable. S, M, L, Ex-L.

34-525 Dispenser Box: Contains 25 gloves of one size.

POLY-D® POLYETHYLENE LINE

The POLY-D GLOVE provides low-cost product protection for food and precision parts handling. Gives superior touch sensitivity. Powderless and sulphur-free — can't mark delicate materials. Fits either hand. Disposable. Glove backing paper is absorbent and can be used as a towel to dry hands before putting gloves on.

36-122 Roll: Contains 100 gloves, .00125" gauge. Sizes S, M, L.

36-125 Dispenser Box: Contains 100 gloves, .00125" gauge. Sizes S, M, L.

36-126 Dispenser Box: Contains 1000 gloves, .00125" gauge. Sizes S,M,L.

36-129 Roll: Contains 1000 gloves, .00125" gauge. Sizes S, M, L.

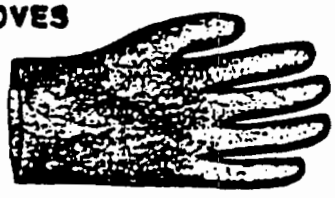
36-137 Roll: Contains 25 gloves, .0017S" gauge, 22" length. Size L.

36-150 Roll: Contains 50 gloves, .0017S" gauge, 22" length. Size L.

36-152 Roll: Contains 100 gloves, .0017S" gauge. Sizes S, M, L.

36-159 Roll: Contains 1000 gloves, .0017S" gauge. Sizes S, M, L.

GENERAL PURPOSE GLOVES

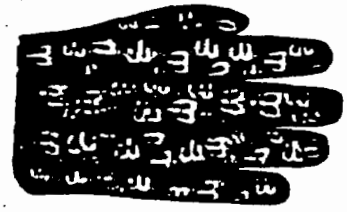


KSR VINYL COATED/KNIT LINED

Very light, flexible, comfortable. Replaces cotton, goatskin, brown jersey and light vinyl impregnated gloves for general use. Knit lining stretches to a snug fit. Yellow vinyl has excellent grip. Washable.

22-516: Slip-on. Men's M, L & Ex-L.
22-518: Slip-on. Women's M & L.

(continued next column)



WERX®

VINYL IMPREGNATED

Perforated back provides air-cooled comfort. Replaces cotton and goatskin. Outwears 8 oz. cotton at least 5 to 1 on straight abrasion. Excellent dexterity and grip. Washable. Color: buff.

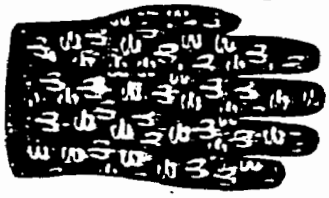
51-103: Perforated slip-on. Women's M & L. Patent No. 2913729

51-153: Perforated slip-on. Men's M & L. Patent No. 2913729

NON-PERFORATED STYLES

Same as above except without perforations.

51-101: Slip-on. Women's M & L.
51-102: Knitwrist. Women's M & L.
51-151: Slip-on. Men's M & L.
51-152: Knitwrist. Men's M & L.



WERX-LITE VINYL IMPREGNATED

Lightweight yet outwears 8 oz. cotton at least 3 to 1 on straight abrasion. Excellent dexterity, sense of touch and grip. For general purpose. Machine washable. Color: Tan.

41-141: Slip-on. Men's M & L.
41-171: Slip-on. Women's M.

HYNIT

NBR IMPREGNATED/KNIT LINED

Replaces cotton and light leather gloves for assembly, fabrication, and general use. Excellent dexterity, dry grip, cut and abrasion resistance. Repellent but not liquidproof. Washable. Color: blue. U.S.D.A. assorted.

32-105: Slip-on. Men's M & L.
32-109: Slip-on. Women's M & L.

HYCRON NBR COATED

Blue NBR coating gives superior service handling rough, abrasive items. Excellent flexibility, dry grip. Replaces leather and other coated gloves. Soft, 2-piece jersey lining. Curved fingers, wing thumb.

(con column)

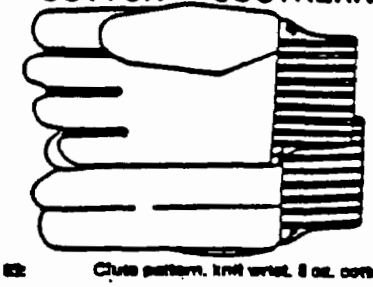
27-600: Palm coated knitwrist. Men's size.
27-601: Women's size. Palm coated knitwrist.
27-602: Fully coated knitwrist. Men's size.
27-603: Women's size. Fully coated knitwrist.
27-607: Palm coated safety cuff. Men's size.

MONKEY GRIP VINYL COATED

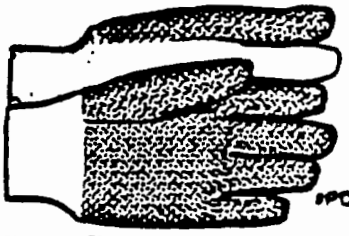
Economical for handling rough, abrasive materials. Excellent flexibility and dry grip. Comfortable 2-piece liner, curved fingers, and wing thumb. Color: yellow.

3-300: Palm coated knitwrist. Men's size.
3-320: Palm coated band top. Men's size.

COTTON — SOUTHERN



82: Chute pattern, knit wrist, 8 oz. cotton.



#PO-103

102: Chute pattern, knit wrist, 10 oz.
PO-103: Men's 10 oz. plastic dot on palm, thumb index finger. White knit wrist.
PO-103C: Same as above in Ladies' size.
PO-105T: Men's size, band top.

ADVANCE PERMATEX® GLOVES

518L

A Cotton-Vinyl Impregnated Glove that Really works.

• Outwears several canvas gloves • Washable • Odorless • Wonderful Dexterity—can replace thin leather gloves • Liquid Repellent • Comfortable—Hand Breathes Flexible • Good Grip • Excellent for use with small parts, etc. • Canary Yellow Color.

518L: Men's Large Slip On Style
518M: Men's Medium Slip On Style

TABLE 18-2

Glove Selector Chart

Determine the chemical or physical requirements of your job. Example: Nitric 10%, or abrasion resistance and flexibility. Then in the proper chart, chemical or physical, select the glove that is listed as best for your particular needs.

CHEMICAL RESISTANCE SELECTOR CHART

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALCOHOLS						
Methanol/Butyl/Alcohol/ Glycerine/Ethanol/ Isopropanol	E	E	E	E	G	E
CAUSTICS						
Ammonium Hydroxide 38%/ Sodium Hydroxide 50%/ Potassium Hydroxide 50%	E	E	E	E	E	E
CHLORINATED SOLVENTS						
Carbon Tetrachloride/ Perchlorethylene/ Trichlorethylene	G	F	F	F	N R	F
KETONES						
Methyl Ethyl Ketone/ Methyl Isobutyl Ketone/ Acetone	G	N R	N R	N R	G	N R
PETROLEUM SOLVENTS						
White Gasoline/Naphtha/ Mineral Thinner/Kerosene	E	G	G	E	F	G
ORGANIC ACIDS						
Citric/Formic/ Tannic/Acetic	E	E	E	E	E	E
INORGANIC ACIDS						
Hydrochloric 38%/ Hydrochloric 10%/ Sulphuric 10%/ Nitric 10%/	E	E	E	E	G	E
Chromic	E	G	G	E	N R	G
Sulphuric 98%/ Nitric 70%	F	G	G	G	N R	G
HYDROCARBONS						
Stoddard Solvent/ Toluene/Benzene/ Xylene	G	F	F	G	N R	F
Coal Tar Distillate	E	F	F	G	N R	F
Styrene	F	G	G	G	F	G
MISCELLANEOUS						
Lacquer Thinner	F	F	F	G	N R	F
Cutting Oil	E	E	E	E	F	E
Battery Acid	E	E	E	E	G	E
Phenol	E	G	G	G	G	G
Insecticides	E	E	E	E	F	E
Printing Ink	E	E	E	E	F	F
Dyestuffs	E	E	E	E	E	E
Penta	G	E	E	E	F	E
Formaldehyde	E	E	E	E	E	E
Vegetable Oil	E	E	E	E	G	E
Animal Fat	E	E	E	E	G	E
Acrylonitrile	E	G	G	E	E	G
Steam	E	E	E	E	E	E
Aniline	E	E	E	E	E	E
Hydraulic Fluid	E	E	E	E	F	E
Turpentine	G	E	E	E	F	E
Linseed Oil	E	G	G	E	N R	G
Soya Bean Oil	E	G	G	E	F	G
Carbon Disulfide	N R	F	F	F	G	F
Creosote	G	G	G	G	F	G
Paint & Varnish Remover	F	F	F	F	N R	F

E–Excellent G–Good F–Fair N R –Not Recommended

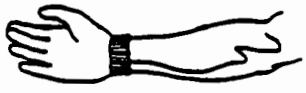
PHYSICAL PROPERTIES SELECTOR CHART

MSA GLOVE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NEOPRENE	G	E	E	G	E	G	E	F
PYTHON NEOPRENE	G	E	E	G	E	G	G	E
RIPPLE-TEXTURE	G	E	E	E	E	F	E	E
ALL-PURPOSE	E	N R	G	F	G	E	E	E
UTILITY	E	N R	G	F	F	E	E	F
FLEXIBLE VINYL PLASTIC	E	N R	G	F	G	E	E	E
SUPER FLEXIBLE VINYL PLASTIC	E	N R	G	F	E	E	E	G

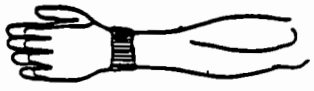
E–Excellent G–Good F–Fair N R.–Not Recommended

*Coated fabric gloves are generally not recommended for continual exposure to hot objects because the heat builds up in the coating and does not dissipate rapidly. For periodic handling of hot objects in a heat range under 250 F, they are satisfactory

GLOVE LENGTHS CHART



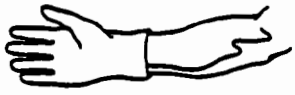
Fully Coated Knitwrist



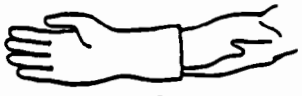
Palm Coated Knitwrist

Fully Coated Safety Cuff (Band Top)

Palm Coated Safety Cuff



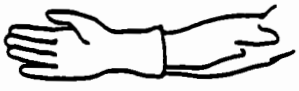
Fully Coated 10" Gauntlet (10" Safety Cuff)



Fully Coated 12" Gauntlet

Fully Coated 14" Gauntlet

Fully Coated 18" Gauntlet



Fully Coated 11" Gauntlet (Cadet Size)

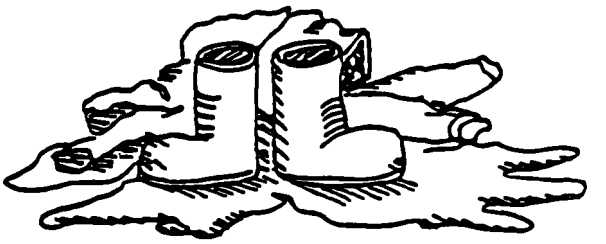
Fully Coated Knitwrist Mitten

Gloves should also be selected according to how they fit and the dexterity needed to do the job. It may be necessary to buy a variety of gloves to meet the needs of a field operation or to replace those with tears or that have become contaminated.

Donning and Doffing Protective Clothing

Realizing complete benefits from protective clothing depends on the techniques used for donning and doffing the clothing. In general, care must be taken to avoid tearing or puncturing the materials particularly when using gear such as SCBA units and avoiding contaminating the inside of the garments.

One of the basic precautions for donning protective clothing is to keep the inside of the clothing clean and uncontaminated before putting the garment on and while it is being put on. If protective clothing or equipment is stored where it can become contaminated, it may contaminate rather than protect personnel. It is a common habit to store all contaminated equipment in one place, allowing cross-contamination between, for example, boots and the inside of an encapsulated suit.



In a similar fashion, if the clothing or equipment becomes contaminated in the process of putting the equipment on, personnel wearing the gear may be in contact with the contamination all the time they are wearing or using the equipment.

Minimizing penetration of contamination into your protective clothing can be accomplished by a number of techniques. It is recommended that the pants of the protective clothing be pulled down over the boots and taped or a rubber band be placed around the bottom. This procedure reduces the chance of contaminants falling into the tops of the boots. Likewise, sleeves

should be tucked into cuffs of gloves and taped or pulled down over the wrists and taped. This prevents liquids from dribbling down the open sleeve when the arms are raised or falling into the tops of the gloves.

Always have at least one assistant to help don the clothes. Not only do they help in the actual work, but they can inspect the suit and gear to quickly spot rips and tears. Complex and bulky gear, a hot, sticky perspiring body, add up to a great deal of stress and strain on the individual and equipment which can lead to unforseen damage that may endanger the worker or abort the mission.

Using and Removing Gloves

Before putting on protective gloves, remove any jewelry that may puncture the material of the gloves.

If the material of the gloves is fragile, it may be important to trim your fingernails to avoid puncturing the gloves while you are putting them on, using them or taking them off.

If you are going to be dealing with known hazardous materials, try to obtain and use gloves made of a material that will provide predictable resistance to damage or permeation by the hazardous material.

If you are going to be dealing with unknown hazardous materials, try to obtain and use gloves that will resist damage or permeation by a wide range of materials and consider using two pairs of gloves with different qualities. It may also help to don gloves if the hands or gloves are sprinkled with talcum powder.

Removing Gloves

Removing gloves without contaminating the hands takes a

technique that can easily be learned with a little practice.

1. Loosen both gloves by pulling lightly on each fingertip of the gloves.

2. Be sure not to touch your skin with the outside of either glove.

3. Remove the first glove either by pulling on the fingertips or by grasping it just below the cuff on the palm side and rolling the glove off the fingers.

4. Remove the second glove by inserting the ungloved fingers inside the cuff on the palm side without touching the outside of the glove and pushing or rolling the glove off the fingers.

Using and Removing Boots

Before putting on protective boots over shoes, be sure the shoes do not have any sharp spots or adhering material which may puncture or abrade the protective boots.

If only known hazardous materials are to be handled, try to obtain and use boots made of a material that will provide predictable resistance to damage or permeation by the hazardous materials.

If there is the possibility of dealing with unknown hazardous materials, try to obtain and use boots that will resist damage or permeation by a wide range of materials. Consider using protective boot covers or a second pair of boots over the first.

Removing boots without contaminating the hands or feet requires an easily-learned technique which is similar to that used for removing gloves.

1. Gloves are needed to avoid

contaminating the hands unless the boots are very loose.

2. Loosen the boots by pulling them lightly with the gloved hands.

3. Be sure not to touch bare skin with the outside of either glove.

4. Remove the first boot either by pulling on the toe, or by grasping it at the heel and pulling it off the foot with a gloved hand or a bootjack.

5. Remove the second boot in the same way or by inserting the ungloved fingers inside the boot and pushing it off without touching the outside of the boot.

Using and Removing Fully-Encapsulating Suits

In atmospheres where there is a need for complete protection of the body from splashes or contact by vapors or gases, it is necessary to wear a fully-encapsulating suit over self-contained breathing apparatus. Use of fully-encapsulating suits requires special preparation for donning and doffing and special precautions for safe use of the suits and breathing apparatus.

Safe use of full protective equipment requires a team of persons who are physically fit and who are trained and practiced in use of self-contained breathing apparatus and use of the complete suits.

The team must include standby personnel who are equipped and prepared:

1. to carry out an emergency rescue if necessary, as well as

2. to assist the wearers get into the breathing apparatus and the suits.

The team must also be prepared:

3. to decontaminate the outside of the suit before it is removed, so that wearers are not exposed while they are getting out of the equipment.

Finally, the standby team must be ready:

4. to assist the wearers get out of the suits, both routinely and in an emergency such as running low on breathing air.

In preparation for sue of fully-encapsulating suits, all of the necessary gear should be assembled in a clean change area. In addition to trained personnel to assist and observe, use of fully-encapsulating suits requires:

1. SCBA for the suit wearers and the standby personnel

2. Fully-encapsulating suits for the team entering the hazardous area

3. Extra protective clothing and equipment for the team, and

4. Protective clothing for the standby personnel, such as gloves, boots and disposable suits or coveralls.

Each suit and breathing apparatus should be thoroughly inspected and checked to see that everything is in operating order. Any suit which has holes, rips, malfunctioning closures, cracked masks or other deficiency must not be used.

Since use of an encapsulating suit, use of self-contained breathing apparatus, and gathering samples all require physical exertion, the person wearing the equipment usually should strip down to a minimum of clothing to reduce heat stress. This is particularly important if the sampling takes place in the sun or near hot equipment, or during warm weather or

under high ambient temperatures within an industrial plant. A light weight suit of cotton should be worn to absorb the sweat and increase the surface area that evaporation can take place on, thus increasing natural cooling. The cotton garment also prevents chaffing and clinging of the protective gear. A thorough dusting of talcum powder will assist the donning operation and reduce possible damage to protective clothing.

Procedure for Donning Full Protective Gear

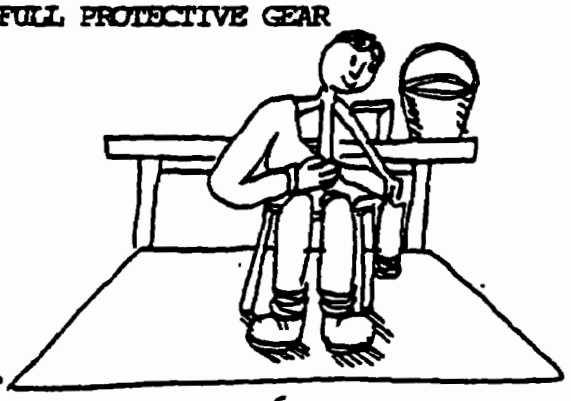
Donning a fully-encapsulated suit is a complex procedure requiring the coordination and assistance of a team of individuals. The following brief summary does not take the place of more advanced training required for certification.

1. Before attempting to don a fully-encapsulated suit, a review should be made of what equipment is needed. The equipment should be laid out within quick and easy reach of the team. A check list and practice will assist a team in preparing for an actual event.

- Cotton undergarments
- Encapsulating suit
- Antifog spray
- Boots
- Tape
- Talcum powder
- Stool
- Plastic clean sheet
- Plastic bags for disposal or storage
- Brushes for decontaminating
- Sprayer for decontaminating
- Knife or other device for emergency opening of suit
- Intrinsic Communication System
- Lifeline
- SCBA Units
- Buckets for decontaminating solutions

PROCEDURE FOR DONNING FULL PROTECTIVE GEAR

2



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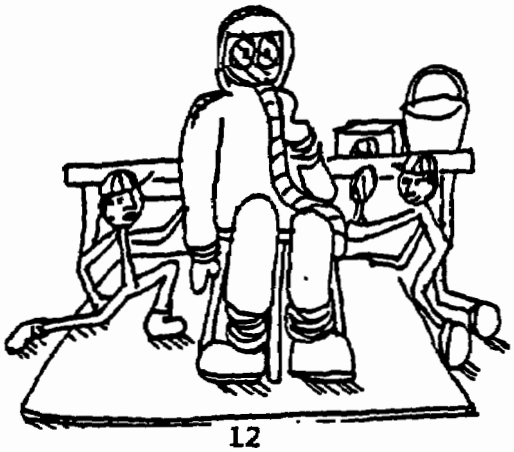
PROCEDURE FOR DONNING FULL PROTECTIVE GEAR (Cont'd.)



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tables. Boots will track contaminants to auto, office and home. Contaminated pencils and clipboards will transfer materials to unprotected hands, clothing, steering wheels, friends and family.

It is obvious that the magnitude of the problem can be immense. It should also be obvious that control of contamination requires careful thought and planning.

Controlling the Spread of Contaminants

The first step in controlling the spread of contaminants is to carefully plan and practice the field activities that can lead to contact with contaminants. Lay out activities such as sampling in a manner that will reduce or keep to a minimum, contact with contaminated surfaces. Part of this technique depends on planning your activities to limit the number of objects you have to touch, and part depends on setting aside specific areas for activities such as packaging samples and changing out of protective clothing.

The degree of effort necessary to set up "clean areas," and dirty change or contaminated area is a function or result of the amount of work or contact with the contaminants and the degree of hazard of the expected contaminants.

In the more advanced field training courses offered by EPA, detailed techniques will be covered which cover all situations that might be faced by Agency personnel. In this unit a basic program as would be needed for sampling will be covered.

To convey the basic principles of preventing contaminants from leaving a work site and entering an Agency vehicle, consider what would be necessary to prevent mud covered work overalls and boots from soiling a clean,

new automobile. It is quite obvious that just removing boots or gloves would be insufficient. Nor would taking off outerwear and boots while standing in mud solve the problem.

A better plan would be to find a clean, dry area free of mud and remove all gloves, outerwear, and boots that have been exposed to mud. Locate a pathway from this clean, dry area to the automobile that does not require exposing the clean clothes and footwear to mud. Prevent covering the trunk or back seat with mud from the removed outerwear by cleansing the gear. A second alternative would be to cover them or place them in a bag or container that will isolate them from their clean surroundings. A last precaution; hands must be thoroughly scrubbed to remove mud and a visual inspection made of likely areas of contamination such as knees, shoes, seat of the plants, elbows to ensure accidental contact has not been made. This activity would also extend to any passengers that intend to ride in the vehicle.

While chemical contaminants may not be so obvious as mud, the procedure for preventing spread of these chemicals is based on the same procedures.

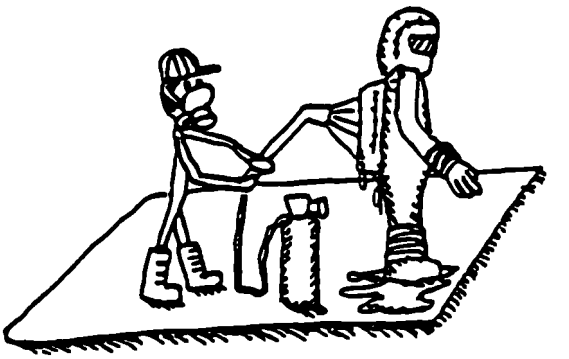
Basic Steps to Prevent Contamination

1. Place a clean plastic sheet closely adjacent to the contaminated work area.

2. Notify crew members or post warning signs as to the intent of the plastic change area.

3. Clearly establish "dirty" pathways from the plastic change or transition area to the work area, and "clean" pathways from the plastic change area to the outside.

4. To minimize traffic to the change area, carefully plan and equip



the area with tools, samplers, containers, decontamination equipment, safety gear, and disposal containers before work begins. Arrange to have clean equipment set on tables to lessen the chance of contamination while cleaning or decontamination is taking place. If decontamination is to be accomplished by sprayers, set the clean equipment table up wind of the area to be used for spraying. Make plans to collect decontamination solutions so they do not run into the clean area. All decontamination solutions and gear, such as brushes and buckets, should be regarded as hazardous waste and either disposed of on site or disposed of in the proper manner as a hazardous waste.

Decontamination solutions should be designed to react with and neutralize the specific, potential contaminants known to be at the site. In many instances, a strong solution of hot soapy water is all around the best decontamination solution.

If however, the contaminants are unknown, it may be necessary to use decontamination solutions that are effective for a variety of substances. Several of these general purpose decontamination solutions are listed below:

DECON SOLUTION A - A solution containing 5% sodium carbonate ($Na_2 CO_3$) and 5% trisodium phosphate ($Na_3 PO_4$).

DECON SOLUTION B - A solution containing 10% calcium hypochlorite ($Ca(ClO)_2$).

DECON SOLUTION C - A solution containing 5% trisodium phosphate ($Na_3 PO_4$). This solution can also be used as a general purpose rinse.

DECON SOLUTION D - A dilute solution of hydrochloric acid (HCl).

Cleaning or Disposing of Protective Gear

In instances where protective gear is of the disposable type, large double thickness plastic bags should be used to contain the gear. The bags should be sealed with tape and a hazardous waste warning sticker applied. These extra precautions will discourage scavanging of contaminated gear that is awaiting disposal.

Gear that is to be cleaned should be done so immediately before contaminants dry or soak into equipment. Always clean the gear with the thought that the next person using the gear is trusting their health to the effectiveness of your work.

In most instances, hot soapy water is best for cleansing of protective gear. Never use solvents or other solutions without consulting equipment manufacture date for directions. Many manufacturers sell disinfectants specifically for their equipment.

Before packing equipment away, allow the equipment to thoroughly air dry. Wet equipment not only may be damaged by being stored while wet, such conditions also can lead to unsanitary or unpleasant conditions such as the growth of molds or fungus.

Storage of Equipment

Everyone has experienced the frustrating task of putting something back into its original package. In the case of expensive protective gear, the investment in time and frustration of storing gear properly will undoubtedly result in longer life, reduced maintenance and increased availability of critical gear. In many cases, proper storage eliminates the stress of handling and transporting gear, reduces the change of cross-contamination with contaminated gear, and punctures and tears from gear stored near by.

STUDENT EXERCISE

Using tables, illustrations, and data included in this Unit, select the proper protective clothing for the job described.

A series of 55-gallon barrels have mysteriously shown up at a sanitary landfill. They were uncovered by heavy equipment leveling a pile of trash. Some of the barrels may have been damaged. Workmen report the following names on the barrels: Freon, Methyl Acetate, and Benzyl Alcohol. All work has stopped until the wastes can be sampled and the hazards of the contents can be ascertained. Weather conditions are sleet mixed with rain; temperature at 32°F; winds at 5-10 mph.

Body Protection _____

_____

Rationale _____

_____

Head Protection _____

_____

Rationale _____

_____

Hand Protection _____

_____

Rationale _____

_____

Foot Protection _____

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Rationale _____

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Eye and Face Protection _____

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Rationale _____

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NOTES

DECON SOLUTION D - A dilute solution of hydrochloric acid (HCl).

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Foot Protection _____

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Rationale _____

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Eye and Face Protection _____

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Rationale _____

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UNIT 21

RESPIRATOR PROTECTION

Educational Objectives

o The student should be able to recognize potentially hazardous atmospheres that may require respirator protection.

o The student should be able to define and apply to respirator selection, the terms Threshold Limit Value (TLV) and Immediately Dangerous to Life and Health (IDLH).

o The student should be able to define OSHA regulations for respirator use.

o The student should be able to define EPA policy on respirator use.

o The student should be able to recognize the markings of approval on respirator equipment.

o The student should be able to calculate the relationship between protection factor (PF) and allowable concentrations of contaminants.

o The student should be able to list the steps to proper fit testing.

o The student should be able to define the types of air-purifying respirators.

o The student should be able to evaluate and select the proper air purifying respirator and cartridge.

o The student should be able to define the types of air-supplying respirators.

o The student should be able to describe the proper steps to cleaning, inspection, and storage of respirators.

NOTES

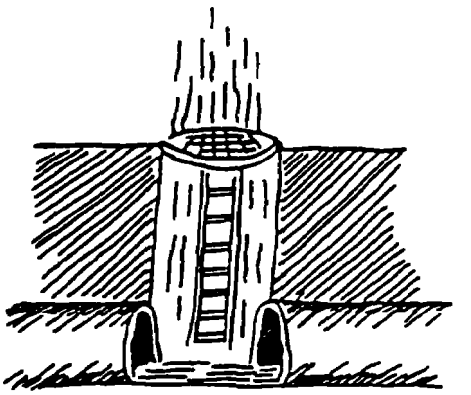
Introduction

In the day-to-day field activities under EPA jurisdiction, Agency employees are confronted with a vast variety of varying and sometimes hostile conditions. Few conditions are so immediately or potentially dangerous as hazardous atmospheres. While it is the policy of EPA to avoid sending personnel into life-threatening conditions, there are times when such danger cannot be anticipated or avoided. It is the objective of this unit to prepare Agency personnel with the basic information needed to make intelligent decisions as to when, where and how to use respiratory protective devices. The knowledge conveyed in the following unit does not take the place of the more comprehensive units given in the intermediate or advanced levels of training, which must be taken to work in certain anticipated hazardous conditions..

Recognizing Potentially Hazardous Atmospheres

Respiratory protection is needed if personnel must enter any area in which there may be either a deficiency of oxygen or a high concentration of hazardous material in the air. In such atmospheres, life or health may depend on using respiratory equipment which can provide a supply of breathing air.

Respiratory hazards may exist at spill scenes, in the vicinity of discharge or emission sites, within industrial plants, and at hazardous waste sites. EPA policies require respiratory protection when there has been a release of toxic gases or vapors, when there is a high potential for a sudden release of such material, or when it is necessary to enter an environment where toxic airborne contaminants are either known to be present or are likely



to be present.

Not all dangerous atmospheres are obvious. Some toxic gases have no odor nor visible sign of their presence. The need for respiratory protection may not be apparent.

The behavior of others may not be a good indication of the need for respiratory protection. For example, if you make a walk-through inspection of a plant, do you need to wear a respirator if the company representative does not wear one? The company representative who guides the Agency personnel may or may not be a good example to follow. He or she may not be aware of or believe there are hazards that require respiratory protection, or may not be willing to acknowledge that there are dangerous concentration of toxic materials in the air.

Even if hazards are recognized, if personnel plan to spend considerable time in the plant taking samples or making observations, they may need respiratory protection where others are not wearing it.

Some employees may have developed a tolerance to irritating materials, and others may have developed allergies and been transferred to other work areas. The reaction of EPA personnel to a particular atmosphere may be different from the reaction of employees who work there regularly.

Agency personnel may also need respiratory protection because the areas where they will be working may have higher concentrations of airborne toxic material than areas where employees work routinely.

Personnel in the sampling routine may be required to visit many different variety of toxic materials than someone

who works in only one place.

Respiratory Hazards

Oxygen Deficiency

When it is necessary to enter a confined space, one of the most important considerations is whether there is sufficient oxygen in the atmosphere to enter and work safely in the space. An oxygen deficiency and high concentration of hazardous materials may occur in unventilated and confined spaces such as the interiors of tanks, vats, pits, trailers, sewers, grain elevators, unventilated rooms and abandoned buildings.

Oxygen deficiency can occur if vapors or gases displace part of the air in pits and open tanks, or in other types of confined spaces. Oxygen deficient atmospheres can occur when air is displaced by gases and vapors, or where the oxygen is removed by oxidation processes such as fire, rusting, or aerobic microbial action. The effects of oxygen deficiency on a person can range from minor to extremely serious. (Table 19-1)

TABLE 19-1
Physiological effect of oxygen deficiency

% Oxygen (by volume) At sea Level	Effects
21	Nothing abnormal.
16-12	Increased breathing volume. Accelerated heartbeat. Impaired attention and thinking. Impaired coordination.
14-10	Very faulty judgment. Very poor muscular coordination. Muscular exertion brings on rapid fatigue that may cause permanent heart damage. Intermittent respiration.
10-6	Nausea. Vomiting. Inability to perform vigorous movement, or loss of all movement. Unconsciousness, followed by death.
<6	Spasmatic breathing. Convulsive movements. Death in minutes.

NOTES

Physiological effects of oxygen deficiency are not apparent until the concentration decreases to 16%. The various regulations and standards dealing with respirator use recommend that percentages ranging from 16-19.5% be considered indicative of an oxygen deficiency. Such numbers take into account individual physiological responses, errors in measurement, and other safety considerations. for hazardous response operations, 19.5% oxygen in air is the figure that decides between air-purifying and atmosphere-supplying respirators. EPA standards require special respiratory protection for entry in any atmosphere containing less than 19.5% oxygen.

NOTES

Aerosols

Aerosol is a term used to describe fine particulates (solid or liquid) suspended in air. Particulates include dust and other minute particles such as found with coal an asbestos, mists, fogs, smoke fumes, and sprays. The effect of aerosols range from irritation and inflammation to systemic poisons.

Gaseous or Toxic Materials

Gases or vapors containing toxic materials may have immediate or delayed health affects on the individual. Inhalation of certain toxic gases may have acute and deadly effects with as little as a few short breaths. No danger is more immediate, nor effect more persistent, than the action of toxic materials that enter by way of the respiratory tract. The following list gives the chemical classification of dangerous toxic substances that may enter through the respiratory track:

Chemical Classification

o Acidic: substances that are acids or react with water to form acids.

o Alkaline: substances that are bases or react with water to form bases.

o Organic: carbon compounds which may range from methane to chlorinated organic solvents.

o Organometallic: organic compounds containing metals.

o Hydrides: compounds in which hydrogen is bonded to another metal.

o Inert: no chemical reactivity.

Groups, of these substances, based on phjysiological (toxicological) activity include:

o Irritants: corrosive substances which injure and inflame tissue.

o Asphyxiants: substances which displace oxygen or prevent the use of oxygen in the body.

o Anesthetics: substances which depress the central nervous system, causing intoxication or a loss of sensation.

o Systemic poisons: substances which can cause pathology in various organ systems.

Measurements of Respiratory Hazards

Two values are used to describe respiratory hazards. The first, the Threshold Limit Value (TLV), is a time-weighted average concentration for a particular substance. Almost all workers can be exposed to this level 40 hours a week without suffering adverse health effects. The TLV is recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Table 19-2 illustrates a summary of TLV's of some common hazardous materials.

TABLE 19-2

SELECTED IDLH & 1984-85 TLV VALUES

Compound	IDLH ppm	TLV-TWA ppm
acetaldehyde	10000	100
acetic acid	1000	10
acetic anhydride	1000	5 C
acetone	20000	750
acrylonitrile	4000	2 skin (A2)
ammonia	500	25
arsine	6	0.05
benzene	2000	10 (A2)
benzyl chloride	10	1
bromine	10	0.1
2-butanone (MEK)	3000	200
carbon dioxide	50000	5000
carbon disulfide	500	10 skin
carbon monoxide	1500	50
carbon tetrachloride	300	5 skin (A2)
chlorine	25	1
fluorine	25	1
formic acid	100	5
hexane	5000	50
hydrazine	80	0.1 skin (A2)
hydrogen chloride	100	5 C
hydrogen cyanide	50	10 C skin
hydrogen fluoride	20	3
hydrogen peroxide	75	1
hydrogen sulfide	300	10
isoamyl acetate	3000	100
isopropyl alcohol	20000	400
liquified petroleum gas (LPG)	19000	1000
methyl alcohol	25000	200 skin
methylene chloride	5000	100
naphthalene	500	10
nitric acid	100	2
pentaborane	3	0.005
pentane	5000	600
phenol	100	5 skin
phosgene	2	0.1
phosphorous trichloride	50	0.2
propane	20000	- E
styrene	5000	50
toluene	2000	100
toluene-2,4-diisocyanate	2000	0.005
trichloroethylene	1000	50
turpentine	1900	100
xylene	10000	100

TLV notes: C - ceiling TLV
A1a - human carcinogen with assigned TLV
A1b - human carcinogen without assigned TLV
A2 - suspected human carcinogen
E - simple asphyxiant

IDLH can be based not only on toxicity, but also on other characteristics such as flammability. An atmosphere which is within the flammable or explosive limit of the contaminant is also considered IDLH.

EPA has further defined or simplified th meaning of IDLH as:

"Any atmosphere that poses an immediate hazard to life or produces immediate irreversible effects on health that will be debilitating."

Respirator Use

The Occupational Safety and Health Administration (OSHA) is the policy formulating regulatory agency for worker respiratory protection. The source of OSHA's policy is found in 29 CFR Part 1910.134 and is summarized as follows:

1. Written standard operating procedures governing the selection and use of respirators shall be established.

2. Respirators shall be selected on the basis of hazards to which the worker is exposed.

3. The user shall be instructed and trained in the proper use of respirators and their limitations.

4. Where practical, the respirators should be assigned to individual workers for their exclusive use.

5. Respirators shall be cleaned and disinfected regularly. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be cleaned and disinfected thoroughly after each use.

6. Respirators shall be stored in a convenient, clean, and sanitary location.

7. Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

8. Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

9. There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

10. Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

It is EPA policy to provide appropriate respiratory protective devices for EPA employees, and to require use of such protective devices whenever they are necessary to protect employee health. Employees are entitled to wear respiratory protection if they are irritated by any material even though the concentrations of material may not be expected to cause any adverse health effects, ands even though the concentrations do not seem to effect others nearby in a similar way.

EPA policy requires use of respiratory protection in four situations:

1. When there is a high potential

for a sudden release of toxic gases or vapors or there has been such a release.

2. When preparing to enter hazardous environments or locations such as waste or spill sites, where it is known, or there is a reasonable belief, that toxic airborne contaminants are present.

3. When preparing to enter confined spaces, such as manholes and unventilated buildings where there may be an oxygen deficiency.

4. During infrequent but routine operations where it is not feasible to limit concentrations of toxic material to safe levels by engineering controls.

Respirator Selection

Before selecting a respirator for use, check to ensure it has been approved by a recognized agency such as the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health Administration. (NIOSH). Approvals for respirators are based on tests conducted at the National Institute for Occupational Safety and Health (NIOSH) Testing Laboratory.

All respirators built to the same specifications will have an approval designation displayed on the respirator or its container. The designation will consist of the letters TC (for Testing and Certification) and two groups of numbers which indicate the type of equipment and the specific approval. The approval label will also include the names of the certifying agencies.

Respirators that meet Federal design and test standards will have an approval designation showing joint approval by the Mine Safety and Health Administration (MSHA) and NIOSH, and the respirators will be included in the

NIOSH Certified Equipment List.

If a respirator is approved and listed for protection against organic vapors, remember that the approval is only for organic vapors with adequate warning properties.

Recently-approved cartridges and canisters will show MSHA and NIOSH on the approval label.

(Note to Instructor: Older respirators may show the Mining Enforcement and Safety Administration (MESA) or the Bureau of Mines as the approval agency.)

A listing of all approved respirators and respirator components is available in the NIOSH Certified Equipment List. Editions and supplements are issued periodically. Chemical cartridge or canister respirators do not provide reliable protection against organic vapors without adequate warning properties, and such respirators must not be used for protection against such vapors.

The only organic vapors for which an air purifying respirator is approved or acceptable are those which provide a reliable odor or a noticeable irritation at a concentration which is at or slightly below the permissible exposure limit. Organic vapors are not considered to have adequate warning properties if they cause olfactory fatigue, or if they cannot be detected until their concentration exceeds the permissible exposure limit. They are also not considered to have adequate warning properties if they can be detected at extremely low concentrations, so that they are detected long before their concentration presents any hazard.

Periodically, NIOSH publishes a list of all approved respirators and

respirator components. The list is entitled the NIOSH Certified Equipment List. Respiratory apparatus can be divided into two general types:

Air-purifying - those that filter out contaminants.

Air-supplying - those that supply air by means of a cylinder of compressed gas or oxygen or by an air-line.

All respirators are composed of two main components, the facepiece and the device which supplies or purifies air. The facepiece comes in three configurations which relate to the amount of protection the respirator affords:

o Quarter Mask (Type B - Half Mask) fits from nose to top of chin and utilizes two-or four-point suspension.

o Half Mask (Type A - Half Mask) fits under chin and over the nose and must have four-point suspension.

o Full Facepiece - covers all of the face from under the chin to the forehead. It provides the best protection because it is more easily fitted on the face.

Respirator Fit-testing

One of the most important requirements of respiratory protection is proper fit-testing of respirators. Not all respirators fit everyone, so each individual must find out which facepiece fits best. To be approved, a respirator must be fit-tested utilizing accepted fit-test media and procedures.

There are two types of fit-tests, quantitative and qualitative. The quantitative test is an analytical test which measures the concentrations outside and inside the facepiece. The relative difference between

concentrations, termed the Protection Factor (PF), is used in conjunction with the accepted Threshold Limit Value (TLV) to determine the maximum concentration the user may be exposed to while wearing the tested respirator.

Table 19-3 lists all types of respirators and the PF's.

TABLE 19-3

Selected respirator protection factors

Type of Respirator	PF (Qualitative Test)
Air-purifying	
quarter-mask	10
Half-mask	10
Air-line	
quarter-mask	10
half-mask	10
Hose mask	
full facepiece	10
SCBA, demand	
quarter-mask	10
half-mask	10
Air-purifying	
full facepiece	100
Air-line, demand	
full facepiece	100
SCBA, demand	
full facepiece	100
Air-line, pressure-demand, with escape provision	
full facepiece (no test required)	10,000+
SCBA, pressure-demand or positive pressure	
full facepiece (no test required)	10,000+

The following example using PF information indicates the degree of difference between half-face masks and full-face masks:

If a respirator passes the qualitative test, it can be worn in concentrations determined by the assigned Protection Factor (PF). The maximum concentration is calculated by multiplying the TLV of the contaminant by its PF. PF's for cartridge and canister respirators are:

- o Half-face mask, 10X
- o Full-face mask, 100X

NOTES

Example: Protection (ppm) = PF x TLV

= 10 x 10

= 100 ppm

TLV(X) = 10 ppm
PF = 10

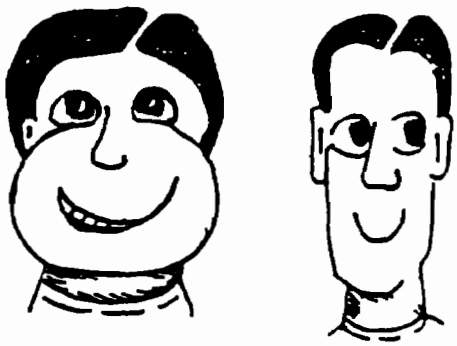
Thus, for substance x with a TLV of 10, the half-mask respirator provides protection up to concentration of 100 ppm of the substance.

Fitting a Respirator and Testing the Seal

Each person who may be expected to wear an air purifying respirator (or a demand type of air supplying respirator) for any field activity should have an opportunity before going into a field situation to find a facepiece that provides a good tight seal with his or her face. This requires trying on facepieces to find one that seems to fit, and then testing the seal to be sure the fit is adequate.

Fitting a Respirator

Not all sizes and shapes of faces can be fitted with a respirator facepiece that will provide the tight seal necessary for protection. Each person should be allowed to choose the most comfortable facepiece that provides a satisfactory fit. Respirators should be assigned to individual employees for their exclusive use, if possible. It a person cannot find a facepiece that fits tightly, the only way to get respiratory protection is to use equipment which provides a continuous flow of air or a positive pressure.



Each time a person puts on an air purifyiung respirator, the fit of the facepiece should be checked to be sure that the seal will provide as much protection as possible.

A tight seal is difficult or impossible to achieve if there is

anything which gets between the facepiece and the skin, such as parts of eyeglass frames, long hair, long sideburns, a beard or beard stubble. (In one EPA operation, standard procedures specified that male employees shaveevery day to assure optimum fit of the facepiece.) A tight seal is also difficult to achieve if a person chews gum or tobacco, or is missing one or both dentures!

Testing the Seal

Testing the fit of the facepiece seal is required with all negative-pressure respirators every time they are used. Negative-pressure respirators include all air purifying respirators except those that are powered. Any air supplying respirator that is operated in the demand mode should be tested for fit each time it is used. Three tests should be used to get maximum protection from a respirator.

Either the negative pressure test or the positive pressure test is required every time a negative-pressure respirator is used. The qualitative fit test is required only before the initial use of each different type of negative-pressure respirator and again annually.

To prepare for testing the fit of a respirator, place the respirator over the face and draw up the straps, one at a time, beginning first with the bottom straps. The straps are drawn up so that the facepiece fits securely, without being so tight that it causes discomfort.

Negative Pressure Test

The purpose of the negative pressure test is to see if the facepiece is tight enough to maintain a negative pressure without leakage.

Close off the cartridge or canister inlet with the palm of your hand.

Inhale gently for about ten seconds so that the facepiece is drawn against your face.

If you feel a flow of air along the edge of the facepiece, the inward air flow indicates leakage.

If you have leakage, tighten the straps and try the test again.

If the leakage continues, get another type of facepiece or another type of respirator.

If you are testing the fit of an air supplying respirator, such as an SCBA, close off the facepiece hose with the palm of your hand before you connect the hose to the regulator. Inhale gently to feel if there are any leaks of air into the facepiece along its edges. This test is optional if the apparatus will be operated in the positive pressure-demand mode.

Positive Pressure Test

The positive pressure test will determine whether the facepiece is tight enough to maintain a positive pressure.

Take a breath and hold it briefly while you take the next step.

Close off the exhalation valve with the palm of your hand.

Exhale gently for about ten seconds to build a positive pressure within the facepiece.

If a positive pressure cannot be built up and there is an outward flow of air, there is leakage.

If you have leakage, you can tighten the straps and try the test again.

If the leakage continues, get another type of facepiece or another type of respirator.

On an air purifying respirator, such as this one, the exhalation valve is usually the bottom valve. It opens when you exhale. The upper valve is the inhalation valve, which closes when you exhale into the facepiece.

Qualitative Fit Test

The qualitative fit test determines whether the fit is tight enough to prevent leakage of a detectable odor in through the seal. Respirators with particulate filters are tested by exposure to an irritant such as smoke, and those with chemical sorbent filters by exposure to an odorant such as isoamyl acetate (banana oil).

The test material is released close to the edges of the sealing surfaces of the facepiece, to find out if the wearer is able to detect any odor. First the leakage is tested with the wearer remaining sedentary for about a minute; then the wearer performs head and face movements that might occur naturally.

If leakage is detected, tighten the straps and retest.

If the leakage continues, get another type of facepiece or another type of respirator.

A variation of the qualitative test uses a test chamber, consisting of a special plastic bag or tent-like hood which can be filled with a concentration of the test material, and into which the wearer can insert her or his head while wearing the respirator. Leakage is

tested first with the wearer remaining sedentary for about a minute; then the wearer performs exercises simulating work, such as bending over and running in place.

Qualitative fit tests are recommended annually and whenever EPA employees are going to be entering or working in particularly hazardous exposures.

RESPIRATOR TYPES

Air-Purifying Respirators

I. Introduction

Any respirator is used because the concentration of a contaminant is high enough to cause some type of health effect. This may range from respiratory irritation through systemic damage to death. The guidelines used to decide the need for a respirator are the Threshold Limit Values. A concentration greater than the TLV requires respiratory protection. If the concentration is within the concentration use limits of an air-purifying respirator, then that type may be used. If it is greater, then an atmosphere supplying apparatus must be worn.

Air-purifying respirators can be used only under the following circumstances:

o The identity and concentration of the contaminant are known.

o The oxygen content in air is at least 19.5%.

o The contaminant has adequate warning properties.

o Approved canisters for the contaminant and concentration are

available.

o The concentration does not exceed the IDLH.

Individuals who use air-purifying respirators must wear a respirator which has been successfully fitted to their faces. Most individual respirators will fit only 60% of the working population. But with the variety of respirators available, at least one type should be found to fit an individual. An improperly fitted respirator delivers little of the protection promised.

II. Requirements for respirator selection.

A. Identification and Measurement

Before the appropriate air-purifying device can be selected, the contaminant must be identified and measured. This requires sampling and analysis. Selection of a device is based on the highest possible concentration of the contaminant.

Once a respirator has been selected and worn in the contaminated environment, the atmosphere must be monitored periodically. Otherwise, increased contaminant levels may present a hazard the respirator is not capable of handling.

B. Oxygen Content

The normal atmosphere contains approximately 21% oxygen. The physiological effects of reduced oxygen begin to be evident at 16%. Without regard to contaminants, the atmosphere must contain a minimum of 19.5% oxygen to permit use of an air-purifying respirator. This is a legal requirement of 30 CFR Part 11 and a recommendation of ANSI Z88.2 - 1980. BElow 19.5% oxygen, atmosphere-supplying respirators must be used instead.

C. Warning Properties

A warning property is a sign that a cartridge or canister in use is beginning to lose its effectiveness. At the first such signal, the old cartridge or canister must be exhanged for a fresh one. Without a warning property, respirator efficiency may drop without the knowledge of the wearer, ultimately causing a health hazard.

A warning property can be detected as an odor, taste, or irritation. Most substances have warning properties at some concentration. A warning property detected only at dangerous levels -- that is, greater than TLV -- is not considered adequate. An odor, taste, or irritation detected atr extremely low concentrations is also not adequate because the warning is being given all the time or long before the filter begins to lose its effectiveness. In this case, the wearer woulds never realize when the filter actually becomes ineffective.

The best concentration for a warning property to be detectable is around the TLV. Table 19-4 lists odor thrsholds for a number of substances and their respective TLV's (shown under the "adopted values TWA column). For example, toluene diisocsocyanate has a TLV of 0.005 ppm. The odor threshold, 2.14 ppm, is over 400 times the TLV, obviously not an adequate warning property. An odor threshold of 4.68 ppm for benzene, versus a TLV of 10 ppm, is an adequate warning property. Dimethuylformamide has a TLV of 10 ppm and an odor threshold of 100 ppm. An odor threshold 10 times greater than the TLV is not adequate.

If a substance causes olfactory fatigue (that is, the sense of smell is no longer effective), its odor is not an adequate warning property. For example, upon entering an atmosphere containing hydsrogen sulfide, the odor is quite

noticeable. After a short period of time, it is no longer detectable.

TABLE 19–4

Odor Thresholds In Air as Compared to Threshold Limit Values (1979)

Compound	ppm	Odor Description	Adopted Values TWA ppm	Adopted Values TWA mg/m	Tentative Values STEL ppm	Tentative Values STEL mg/m
Acetaldehyde	0.21	Green, Sweet	100	180	150	270
Acetic acid	1.0	Sour	10	25	15	37
Acetone	100.0	Chemical sweet, pungent	750	1780	1000	2375
Acrolein	0.21	Burnt sweet, pungent	0.1	0.25	0 3	0
Acrylonitrile	21 4	Onion-garlic pungency	(a)			
Allyl Chloride	0.47	Garlic-onion pungency, green	1	3	2	6
Amine dimethyl	0 047	Fishy	10	18	—	—
Amine, monomethyl	0.021	Fishy, pungent	—	—	—	-
Amine, Trimethyl	0.00021	Fishy, pungent	—	—	—	—
Ammonia	46 8	Pungent	25	18	35	37
Aniline	1.0	Pungent	2	10	5	20
Benzene	4 68	Solvent	10(b)	—	—	—
nzyl chloride	0.047	Solvent	1	5	—	—
enzyl sulfide	0 0021	Sulfidy	—	—	—	—
Bromine	0 047	Bleach, pungent	0 1	0.7	0 3	2
Butyric acid	0 001	Sour	—	—	—	—
Carbon disulfide	0.21	Vegetable sulfide	10	30	—	—
Carbon tetrachloride (chlorination of CS_2)	21.4	Sweet pungent	5(b)	30	20	125
Carbon Tetrachloride (chlorination of CH_4)	100 0					
loral	0 047	Sweet	—	—	—	—
hlorine	0.314	Bleach, pungent	1	3	3	9
Dimethylacetamide	46 8	Amine, burnt, oily	10	35	15	50
Dimethylformamide	100 0	Fishy, pungent	10	30	20	60
Dimethyl sulfide	0 001	Vegeable sulfide	—	—	—	—
Diphenylether (perfume grade)	0.1		—	—	—	—
Diphenyl sulfide	0 0047	Burnt rubbery	—	—	—	—
Ethanol (synthetic)	10.0	Sweet	—	—	—	—
Ethyl acrylate	0 00047	Hot plastic, earthy	5	20	25	100
Ethyl mercaptan	0.001	Earthy, sulfidy	0 5	1	2	3
Formaldehyde	1 0	Hay (straw-like) pungent	2(c)	3	—	—
Hydrochloric acid gas	10.0	pungent	—	—	—	—
Hydrogen sulfide (from Na-S)	0.0047	Eggy sulfide	10	15	15	27
Hydrogen sulfide gas	0 00047					
Methanol	100 0	Sweet				
Methyl chloride	(above 10 ppm)		50	105	100	205
Methylene chloride	214 0		100	360	500	1700
Methyl ethyl ketone	10.0	Sweet	200	590	300	885
Methyl isobutyl ketone	0.47	Sweet	100	410	125	510
Methyl mercaptan	0 0021	Sulfidy, pungent	0.5	1	—	—
Methyl methacrylate	0.21	Pungent, sulfidy	100	410	125	510
onochlorobenzene	0.21	Chlorinated, moth balls	—	—	—	—
itrobenzene	0.0047	Shoe polish, pungent	1	5	2	10
Paracresol	0 001	Tar-like, pungent	—	—	—	—
Paraxylene	0 47	Sweet	—	—	—	—
Perchloroethylene	4.68	Chlorinated solvent	100	670	150	1000

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TABLE 19-4 Cont'd.

Odor Thresholds in Air as Compared to Threshold Limit Values (1979) (con't)

mpound	ppm	Odor Description	Adopted Values TWA ppm	Adopted Values TWA mg/m³	Tentative Values STEL ppm	Tentative Values STEL mg/m³
nol	0 047	Medicinal	5	19	10	38
sgene	1.0	Hay-like	0.1	0 4	—	—
sphine	0 021	Oniony, mustard	0.3	0 4	1	1
dine	0 021	Burnt, pungent, diamine	5	15	10	30
rene (inhibited)	0 1	Solventy, rubbery				
rene (uninhibited)	0 047	Solventy, rubbery, plastic	50	215	100	425
fur dichloride	0.001	Sulfidy	—	—	—	—
fur dioxide	0 47		2	5	5	15
zene (from coke)	4 68	Floral, pungent, solventy	100	375	150	560
zene (from petroleum)	2.14	Moth balls, rubbery	—	—	—	—
ylene diisocyanate	2.14	Medicated bandage, pungent	0 005	0 04	0 02	0 15
hloroethylene	21 4	Solventy	50	270	150	805

Human carcinogen: Substance recognized to have carcinogenic potential without an assigned TLV

Chemical substance suspected of inducing cancer based on either (1) limited epidemiologic evidence, exclusive of clinical report of single cases or (2) demonstration of carcinogenesis in one or more animal species by appropriate methods

It is expected that this substance will soon be classified in category (b) above

D. Limits of Cartirdges or Canisters

Cartridges or canisters used to clean breathing air do not remove the contaminant efficiently forever. Eventually, they will no longer filter or sorb the contaminants. The higher the concentration, the faster the cartridge is used up. To avoid quick wearing out and afford longer service, cartridges are assigned a maximum use concentration above which they should not be used.

E. IDLH

An air-purifying respirator can be worn in atmospheres up to the concentration limits placed on its cartridge. This remains true as long as the maximum use concentration is not immediately dangerous to life or health (IDLH) -- that is, one that causes irreversible damage to life or health within 30 minutes by toxic action. An atmosphere which is within the flammable or explosive limits of the contaminant is also considered IDLH. If the concentration is at an IDLH level for any reason, and still within the use limits approved for the cartridge, no air purifying respirator can be worn. Only an approved positive pressure self-contained breathing apparatus is allowed.

III. Types of Air-Purifying Devices

Basically, respiratory hazards can be broken down into two classes: particulates, and vapors and gases. Particulates are filtered by mechanical means, while vapors and gases are removed by sorbents that react chemically with them. Respirators using a combination of mechanical filter and chemical sorbent will effectively remove both hazards.

A. Particulate-Removing Filters

Particulates can occur as dusts, fumes, or mists. The particle size can range from macroscopic to microscopic, and their toxicological effects range from severe or innocuous. The hazard posed by a particulate can be determined by its TLV. A nuisance particulate will have a TLV of 10 mg/m^3, while a toxic particulate may have TLV well below 0.05 mg/m^3.

Mechanical filters are classified according to the protection for which they are approved under schedule 21C of 30 CFR Part II. Most particulate filters are approved only for dusts and/or mists with TLV's equal to or greater than 0.05 mg/m^3. These duest are usually considered to produce pneumoconiosis* and fibrosis but are not toxic. Such filters have an efficiency of 80-90% for 0.6 millimeter (mm) particles.
*(chronic fibrous reaction)

Respirators approved for fumes are more efficient, removing 90-99% for 0.6 mm particles. This type of respirator is approved for dusts, fumes and mists with TLV's equal to or greater than 0.05 mg/m^3.

Finally there is a high efficiency filter, which is 99.7% effective against particles 0.3 microns in diameter. It is approved for dusts, mists and fumes with a TLV less than 0.05 mg/m^3.

Mechanical filters load up with particulates as they are used. As they do they become more efficient, but also become more difficult to breathe through. When a mechanical filter becomes difficult to breathe through, it should be replaced.

B. Vapor- or Gas-Removing Cartridges

Sorbents are manufactured to remove a specific chemical or group of chemicals. In contrast, particulate-removing filters remove particulates regardless of their composition. Sorbents are available to remove specific organic vapors, acid gases, and ammonia, among others. Each sorbent has a maximum concentration use limit for that specific contaminant. Once a sorbent has been filled up with the contaminant, it will "breakthrough" -- that is, it will allow the full ambient concentration of the contaminant to enter the facepiece. Again, in contrast, particulate-removing filters become more efficient (but harder to breathe through) as they fill up. There is no breakthrough.

Chemical sorbents also vary in their ability to remove contaminants (Table 19-5). For example, vinyl chloride takes only 3.8 minutes to reach a 1%% breakthrough — that is, for 1% of the ambient concentration to enter the facepiece. In comparison, it takes 107 minutes for chlorobenzene to reach 1% breakthrough. Thus, chlorobenzene is removed much more efficiently than vinyl chloride. Cartridge efficiencies (Table 19-5) should also be considered when selecting air-purifying respirators. Studies of cartridge efficiencies are referenced in the Appendix.

TABLE 19-5
Effect of Solvent Vapor on Respirator Cartridge Efficiency[1]

Solvent	Time to Reach 1% Breakthrough (10 ppm) Minutes[2]
Aromatics[3]	
Benzene	73
Toluene	94
Ethyl benzene	84
m-Xylene	99
Cumene	81
Mesitylene	86
Alcohols[3]	
Methanol	0.2
Ethanol	28
Isopropanol	54
Allyl alcohol	66
n-Propanol	70
sec-Butanol	96
Butanol	115
2-Methoxyethanol	116
Isoamyl alcohol	97
4-Methyl-2-pentanol	75
2-Ethoxyethanol	77
Amyl alcohol	107
2-Ethyl-1-butanol	76.5
Monochlorides[3]	
Methyl chloride	0.05
Vinyl chloride	3.8
Ethyl chloride	5.6
Allyl chloride	31
1-Chloropropane	25
1-Chlorobutane	75
Chlorocyclopentane	78
Chlorobenzene	107
1-Chlorohexane	77
o-Chlorotoluene	102
1-Chloroheptane	82
3-(Chloromethyl heptane)	63
Dichlorides[3]	
Dichloromethane	10
trans-1,2-Dichloroethylene	33
1,1-Dichloroethane	23
cis-1,2-Dichloroethylene	30
1,2-Dichloroethane	54
1,2-Dichloropropane	65
1,4-Dichlorobutane	108
o-Dichlorobenzene	109

TABLE 19-5 Cont'd.
Time to Reach 1% Breakthrough (10 ppm)

Solvent	Minutes [2]
Trichlorides[3]	
Chloroform	33
Methyl chloroform	40
Trichloroethylene	55
1,1,2-Trichloroethane	72
1,2,3-Trichloropropane	111
Tetra- and Pentachlorides[3]	
Carbon tetrachloride	77
Perchloroethylene	107
1,1,2,2-Tetrachloroethane	104
Pentachloroethane	93
Acetates[3]	
Methyl acetate	33
Vinyl acetate	55
Ethyl acetate	67
Isopropyl acetate	65
Isopropenyl acetate	83
Propyl acetate	79
Allyl acetate	76
sec-Butyl acetate	83
Butyl acetate	77
Isopentyl acetate	71
2-Methoxyethyl acetate	93
1,3-Dimethylbutyl acetate	61
Amyl acetate	73
3-Ethoxyethyl acetate	80
Hexyl acetate	67
Ketones [4]	
Acetone	37
2-Butanone	82
2-Pentanone	104
3-Pentanone	94
4-Methyl-2-pentanone	96
Mesityl oxide	122
Cyclopentanone	141
3-Heptanone	91
2-Heptanone	101
Cyclohexanone	126
5-Methyl-3-heptanone	86
3-Methylcyclohexanone	101
Diisobutyl ketone	71
4-Methylcyclohexanone	111

TABLE 19-5 Cont'd.

Solvent	Time to Reach 1% Breakthrough (10 ppm) in Minutes[2]
Alkanes[4]	
Pentane	61
Hexane	52
Methylcyclopentane	62
Cyclohexane	69
2,2,4-Trimethylpentane	68
Heptane	78
Methylcyclohexane	69
5-Ethylidene-2-norbornene	87
Nonane	76
Decane	71
Amines[4]	
Methyl amine	12
Ethyl amine	40
Isopropyl amine	66
Propyl amine	90
Diethyl amine	88
Butyl amine	110
Triethyl amine	81
Dipropyl amine	93
Diisopropyl amine	77
Cyclohexyl amine	112
Dibutyl amine	76
Miscellaneous materials[4]	
Acrylonitrile	49
Pyridine	119
1-Nitropropane	143
Methyl iodide	12
Dibromomethane	82
1,2-Dibromoethane	141
Acetic anhydride	124
Bromobenzene	142

1 Nelson, G.O., and C.A. Harder. Respirator Cartridge Efficiency Studies, University of California, Livermore. 1976.
2 Cartridge pairs tested at 1000 ppm, 50% relative humidity, 22° C, and 53.3 liters/minute (equivalent to a moderately heavy work rte). Pair cartridges preconditioned at room temperature and 50% relative humidity for at least 24 hours prior to testing.
3 Mine Safety Appliances Cartridges.
4 American Optical Cartridges.

Chemical sorbent cartridges and canisters have an expiration date. They may be used up to that date as long as they were not opened previously. Once opened, they begin to sorb humidity and air contaminants whether or not they are in use, and their efficiency and service life decrease. A cartridge should be discarded after it is used.

Cartridges are selected for the particular chemical they remove by a color coding system outlined in 29 CFR 19.0.135, Table 19-6.

TABLE 19-6

Atmospheric contaminants to be protected against	*Colors assigned**
Acid gases	White.
Hydrocyanic acid gas	White with ½-inch green stripe completely around the canister near the bottom.
Chlorine gas	White with ½-inch yellow stripe completely around the canister near the bottom.
Organic vapors	Black.
Ammonia gas	Green.
Acid gases and ammonia gas	Green with ½-inch white stripe completely around the canister near the bottom.
Carbon monoxide	Blue.
Acid gases and organic vapors	Yellow.
Hydrocyanic acid gas and chloropicrin vapor.	Yellow with ½-inch blue stripe completely around the canister near the bottom.
Acid gases, organic vapors, and ammonia gases.	Brown.
Radioactive materials, excepting tritium and noble gases.	Purple (Magenta).
Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors.	Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top.
All of the above atmospheric contaminants	Red with ½-inch gray stripe completely around the canister near the top.

*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister-label to determine the degree of protection the canister will afford.

IV. Respirator Construction

The facepiece is one of two major components of an air-purifying respirator (the air-purifying devide being the other). Essentially four types of facepieces and devices may be used:

- Half-mask with twin cartridges,

- Full-face mask with twin cartridges,

- Full-face mask with chin-mounted canister, and

- Full-face mask with harness-mounted canister (gas mask).

The facepiece is the means of sealing the respirator to the wearer. Attached to the facepiece is the lens (in the case of the full-facepiece) and the suspension for holding the mask to the face. An adapter is attached to the cartridge or canister. With the adapter and the mask is an inhalation check valve, which prevents exhaled breath from coming back through the cartridge or canister. An exhalation valve permits the xhaled breath to be exhausted and prevents air from entering it during inhalation. Some respirators provide an integral speaking diaphragm which is air-tight. Each respirator has different ways of assembling and attaching parts. This prevents hybridizing two different makes into one, which immediately voids its approval.

The recommended facepiece to use with cartridges or canisters is the full-facepiece. It provides eye protection, is easier to fit, and has a Protection Factor of 100X. The half-mask has a Protection Factor of 10X. Cartridges and canisters used in conjunction with the full-facepiece vary mainly in the sorbents and the

concentration of atmospheric contaminant that can be removed. (See Tables 19-7a and 19-7b.)

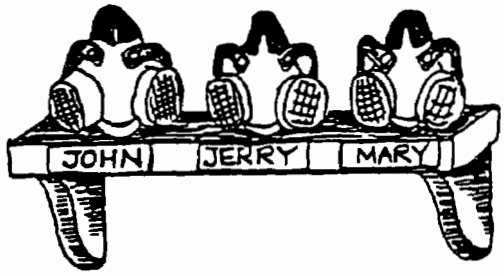
Organic vapors can be removed by appropriate cartridges, chin canisters, or the larger harness-mounted canisters. Cartridges are approved for use in atmospheres up to 1,000 ppm (0.1%) of organic vapors, chin style canisters up to 5,000 ppm (0.5%), and harness-mounted canisters up to 20,000 ppm (2.0%). Keep in mind that no air-purifying device is permitted in IDLH atmospheres. Using a cartridge or canister at lower concentrations effectively increases its service life.

The wearer should be familiar with the respirator to be used. The parts should be easily identified by function, which also is important in maintenance and cleaning.

Selection and Use

Approved respiratory protective equipment must be selected to provide protection against the hazards to which the user may be exposed.

If possible, respirators should be assigned to individual employees for their exclusive use. This will be important particularly for air purifying respirators in which a good tight fit of the facepiece has a greater effect on the protection factor than it does for air supplying respirators whichh operate in the continuous flow or positive pressure-demand mode.



Hazardous conditions in the work area must be kept under surveillance, and the degree of employee exposure or stress must be observed and kept to saffe levels. When work areas have or may have an oxygen deficiency or other exposure which is immediately danerous to life or health, EPA policy and other Federal standards require standby

personnel on the scene who are trained and equipped to carry out a rescue immediately. Surveillance and ready assistance are also necessary if EPA personnel are using air purifying respirators in areas which contain concentrations of hazardous material above the Permissible Exposure Limits (PEL). Close observation of employees working in hazardous conditions is important for limiting their exposure to hazardous materials by skin contact and for minimizing any adverse effects of heat stress.

Standard operating procedures for typical field activities must be developed by each working group. These procedures for selection and use of respiratory protective equipment must be in written form and must be implemented so that EPA employees will have effective protection from respiratory hazards. Standard operating procedures are needed particularly for entry of atmospheres which are immediately dangerous to life or health.

Work in dangerous atmospheres requires development of a standard operating procedure that will be understood and used by everyone entering or working in atmospheres which are dangerous to life or health. Working safely in such atmospheres also requires thorough training, and the presence of a buddy and a backup. It is important to recognize that the actual duration of protection provided by the breathing apparatus may be considerably less than the rated capacity because of heat stress, work rate, body weight and the wearer's training and ability to control his or her breathing rate.

Selection of adequate espiratory protection for field activities depends on the:

nature of the hazardous operation or process;

contaminant, type of hazard, concentration, and effects on the body activities to be conducted in the hazardous area;

length of time that respiratory protection will be needed;

time required to get out of the hazardous area to the nearest area having respirable air; and

specific characteristics of the respiratory protective devices that are available within the Agency or than can be purchased.

The initial step in selecting adequate rspiratory protection for a particular activity is to consider the nature of the activity and the type of respiratory hazard that will exist or that is likely to exist. There are three basic types of hazards for which respiratory protection is needed:

Oxygen deficiency

Flammable concentrations of combustible gas, liquid or dust contaminants in concentrations immediately dangerous to life or health (IDLH), and concentrations above Permissible Exposure Limits and below IDLH. The choice of respirators is very limited if the working atmosphere is oxygen deficient or contains a concentration of contaminants that are flammable or otherwise immediately dangerous to life or health. If an oxygen deficiency exists or is possible, the choice of adequate respiratory protection is limited to:

Self-contained breathing apparatus, or

Air-line respirator with an auxiliary self-contained air supply.

Flammable Gas, Liquid or Dust

It is EPA policy to measure flammable concentrations of gases and vapors before entering an area where such maerial may be present in hazardous amounts, and not to enter any area which has in excess of 25 percent of the lower explosive limit of any material present. However, unexpected spills or leaks may make entry of such hazardous areas necessary for rescue or other emergency reasons.

If it is every necessary to approach or enter areas in which flammable vapors or gases are present or possible in high concentrations, the respiratory protection must be either:

Self-contained breathing apparatus, or an

Air-line respirator with an auxiliary self-contained air supply.

Toxic Contaminant Exposures

Exposure to toxic contaminants can be divided into three broad categories, depending on the degree of hazard:

These three degrees of hazard are related to the concentrations of toxic materials which are present:

those immediately dangerous to life or health (IDLH),

those above Permissible Exposure Limits (but below IDLH),

those below Permissible Exposure Limits.

Selection of respiratory proection depends initially on which category of toxic hazard is present or is anticipated.

Concentrations Immediately Dangerous to Life or Health

There are several definitions of what atmospheres are considered "Immediately Dangerous to Life or Health." The NIOSH/OSHA Pocket Guide to Chemical Hazards describes IDLH as a concentration from which one could not endure for 30 minutes without any irreversible health effects.

The Federal standard on rspiratory protection defines IDLH as conditions that pose an immediate threat to life or health or severe exposure to contaminants which are likely to have adverse cumulative or delayed effects on health.

EPA has defined "immediately dangerous to life or health" as:

"Any atmosphere that poses an immedite hazard to life or produces immediate irreversible effects on health that will be debilitating."

If an atmosphere is or may become "immeditely dangerous to life or health," the choice of adequate respiratory protection is limited to:

self-contained breathing apparatus, or

air-line respirators with an auxiliary self-contained air supply.

Concentrations above Permissible Exposure Limits but below IDLH

Approved respiratory protection is requirred for exposures to hazardous materials in airborne concentrations which are above the Permissible Exposure Limits. The Permissible Exposure Limit for a hazardous material is the maximum concentration believed to cause no adverse effect in most people if inhaled during regular five-day work weeks.

Respiratory protection is also required for exposure to hazardous materials in concentrations which may be expected to cause chronic toxic effects afer repeated exposure, or acute adverse physiological symptoms after prolonged exposure.

Concentrations below Permissible Exposure Limits (and below IDLH)

When concentrations of hazardous material are below the Permissible Exposure Limits or judged to be at concentrations below such limits, respiratory protection is not required. However, respiratory protection may be needed or desired to prevent physical discomfort, irritation, sensitization, or other adverse health effects.

Respiratory Proection for Concentrations Not Immediately Dangerous

. Since air purifying respirators are lighter, less cumbersome and less expensive to use than air supplying respirators, air purifying respirators will usually be considered first for protection against hazrdous material concentrations not immediately dangerous to life or health. If there is no approved air purifying respirator that will provide the protection needed, it will be necessary to use an air supplying respirator.

Selection of an air purifying respirator for protection against hazardous atmospheres is limited to those in which the identity and concentration of material are known to be within the purification limits of the respirators. For safety and health reasons the concentration must be determined before and during use of the type of respirator. This basic limitation is EPA policy as well as a Federal standard.

The first steps in selection of

air purifying respirators are to:

1. Identify the contaminant or contaminants which are present,

2. Determine the Permissible Exposure Limit, warning properties and whether the wrning properties are adequate,

3. Determine the maximum concentration present in the working area.

The next steps in the selection of a respirator are based on the concentration and warning properties of the contaminants present:

4. If the concentration is below the Permissible Exposure Limit respirator use is optional;

5. If the concentration is above the Permissible Exposure Limit respirator use is required;

6. If the contaminant has adequate warning properties, an approved air purifying respirator may be worn. Select a respirator with a ffiltration system which will provide adequate protection and time for the concentration measured in the working atmosphere.

7. If the material has no warning properties or inadequate properties, an air supplying respirator is required.

8. If the concentration is above the level considered IDLH, a self-contained breathing apparatus is strongly recommended.

Summary of Factors for Selection of Type of Respiratory Protection

Air Purifying Respirators

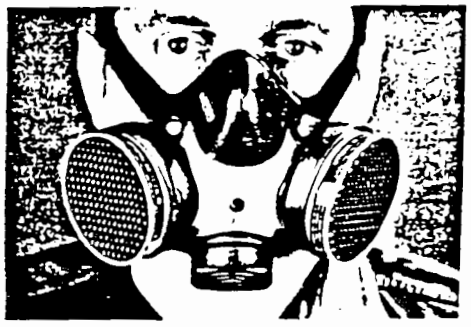
Air purifying respirators may be used under the following conditions:

1. the concentration of oxygen in the hazardous atmosphere is known to be 19.5 percent or more (but not more than 25 percent); and

2. the concentration of airborne toxic material is not immediately dangerous to life or health; and

3. the concentration of airborne toxic material does not exceed the capacity of the filter or cartridge/canister unit as marked on the unit or the respirator approval; and

4. the airborne toxic material does have adequate warning properties (irritation or odor) to signal failure of the cartridge/canister or filter unit. Some materials which do have adequate warning properties are ammonia, chlorine and sulfur dioxide.



Air Supply Respirators

Atmosphere-Supplying Respirators

Atmosphere-supplying respirators provide from five minutes to several hours of breathing air. The amount of protection provided is based on two factors: the tupe of facepiece and its mode of operation. The full-face mask provides the best protection. Of the three modes of operation, continuous, demand, and pressure-demand, the pressure-demand mode provides the best proection.

On the basis of construction, there are four types of atmosphere-supplying respirators: oxygen-generating, hose mask, airline, and self-contained breathing apparatus.

Modes of Operation

a. Continuous

In the continuous mode, air is constantly flowing to the respirator

user, usually from an air compressor or compressed air tank. The flow must be regulated so that the user gets as much air as he needs.

b. Demand

In the demand mode, a negative pressure is required inside the facepiece to open a valve and permit air to enter the respirator. The negative pressure may draw contaminated air through any gaps in the facepiece-to-face seal. This mode uses less air than the continuous mode.

c. Pressure-demand

The pressure-demand mode establishes a positive pressure inside the facepiece. Any leaks around the facepiece allow good air to enter from the tank. It continues to flow until a high positive pressure is built up by exhaling. When the internal pressure drops, more good air is admitted. Some positive pressure is always present inside the facepiece. This mode also conserves air because with a proper seal only the air that is exhaled is replaced.

Types of Devides

a. Oxygen-generating

The oldest respirator is the oxygen-generating respirator, which utilizes a canister of potassium superoxide. The chemical reacts with exhaled CO_2 and water vapor to produce oxygen. Oxygen-generating respirators have been used in the military and for escape purposes in mines.

b. Hose mask

The hose mask uses a maximum 75-foot long, large-diameter hose to transport clean air from a remote area. The user breathes the air in, or it is

forced in by a blower. The user can over-breathe this source.

Airline Respirators

The airline respirator is similar to the hose mask, except that the air is compressed. The mode of operation may be any one of three previously described. The air source must not be depletable. No more than 300 feet of airline is allowed.

Self-contained Breathing Apparatus

The self-contained breathing apparatus (SCBA) allows the wearer to carry a cylinder of compressed air or oxygen without the restriction of a hose or airline.

Depending upon the source of air, the SCBA can be either open or closed-circuit. Closed-circuit devices mix pure oxygen from a small cylinder with exhaled breath (CO_2 removed) to provide breathing air. This type of device, also referred to as a rebreather, is approved only as demand-type respirators.

Open-circuit SCBA's are approved as either demand or pressure demand. Demand SCBA's are being phased out of production because of the greater protection afforded by pressure-demand apparatus.

An escape SCBA must have at least five minutes of breathing air stored in a small cylinder or coiled stainless steel tube. Some devices on the market have 15 minute air supplies.

Under no circumstances are escape devices to be used for entry into hazardous atmospheres.

Modes of Operation

A. Demand

In the demand mode, a negative pressure is created inside the facepiece and breathing tubes when the wearer inhales. This negative pressure draws down a diaphragm in the regulator in an SCBA. The diaphragm depresses and opens the admision valves, allowing air to be inhaled. As long as the negative prssure remains, air flows to the facepiece.

The problem with demand operation is that the wearer can inhale contaminated air through any gaps in the facepiece-to-face sealing surface. Hence, demand apparatus is assigned a Protection Factor of only 100, the same as for a full-face air-purifying respirator.

B. Pressure-Demand

An SCBA operating in the pressure-demand mode maintains a positive pressure inside the facepiece at all times. The system is designed so that the admission valve remains open until enough pressure is built up to close it. The pressure builds up because air is prevented from leaving the system until the wearer exhales. Less pressure is required to close the admission valve than is required to openm the spring-loaded exhalation valve.

At all times, the pressure in the facepiece is greather than the ambient pressure outside the facepiece. If any leakage occurs, it is outward from the facepiece. Because of this, the pressure-demand SCBA has been assigned a Protection Factor of 10,000.

TYPES OF APPARATUS

A. Closed-Circuit

The closed-circuit SCBA, commonly called the rebreather, was developed especially for oxygen-deficient situations. Because it recycles exhaled breath and carries only a small oxygen supply, the service time can be considerable greater than an open-circuit device, which must carry all of its breathing air.

The air for breathing is mixed in a flexible breathing bag. This air is inhaled, deflatring the breathing bag. The deflation depresses the admission valve, allowing the oxygen to enter the bag. There it mixes with exhaled breath, from which carbon dioxide has just been removed.

Most rebreathers operate in the demand mode. Several rebreathers are designed to provide a positive pressure in the facepiece. The approval schedule 13F under 30 CFR Part 11 for closed-circuit SCBA makes no provisions for testing "demand" or "pressure-demand" rebreathers. The approval schedule was set up to certify only rebreathers that happen to operate in the demand mode. Thus, rebreathers designed to operate in the pressure-demand mode can be approved strictly as closed-circuit apparatus. Since regulations make no distinction, and selection is based on approval criteris, rebreathers designed to maintain a positive pressure can only be considered as a demand-type apparatus.

Rebreathers use either compressed oxygen or liquid oxygen. To assure the good quality of air to be breathed, the oxygen must be at least medical grade breathing air which meets the requirements set by the "U.S. Pharmacopeia."

B. Open-Circuit

The open-circuit SCBA requires a supply of 21% oxygen and 78% nitrogen breathing air. The user simply inhales and exhales. The exhaled air is exhausted from the system. Because the air is not recycled, the wearer must carry the full air supply, which limits a unit to the amount of air that the wearer can carry easily. Available SCBA's can last from five to 60 minutes. Units which have 5-to-15 minute air supplies are only applicable to escape situations. The wearer must have at least 30 minutes of air to enter a hazardous atmosphere.

The air used in open-circuit apparatus must meet the requirements in the Compressed Gas Association's Pamphlet G-7.1, which calls for at least "Grade D." Grade D air must contain 19.5 to 23.5% oxygen with the balance being predominantly nitrogen. Condensed hydrocarbons are limited to 5 mg/m^3, carbon monoxide to 20 parts per million (ppm) and carbon dioxide to 1,000 ppm. An undesirable odor is also prohibited. Air quality can be checked using an oxygen meter, carbon monoxide meter, and detector tubes.

When to Use SCBA

Air supplying respirators must be used to be sure of adequate proection if any one of these five special conditions exists or may reasonably be expected to exist:

1. the concentration of oxygen in the hazardous atrmosphere may have been ree fom the normal concentration of about 21% to 19.5% or less; or

2. the concentration of airborne toxic material exceeds a concentration which would be immediately dangerous to life or health; or

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3. the concentration of airborne toxic material exceeds the limited ability of the filter or cartridge/canister unit, as marked onthe unit or the respirator approval or

4. the concentration of airborne toxic material is not known to be less than the limited ability of the filter or cartridge/canister unit, as marked on the unit or the respirator approval; or

5. the airborne toxic material does not have adequate warning properties (irritation or odor) to signal failure of the cartridge/canister or filter unit. Some examples of materials which do not have adequiate warning properties are methyl bromide, dimethylformamide and phosgene.

Cleaning, Inspection and Storage of Respirators

Obtaining dependable protection from respirators requires cleaning, inspection and storage to maintain them and prevent damage or deterioration.

Respirators must be cleaned and disinfected after each day's use and more often if necessary. They must be cleaned and disinfected before they re used by another person.

In general, the cleaning procedure is to disassemble the respirator (without using tools), wash the facepiece and breathing hoses in cleaner and sanitizer solution mixed in warm water, rinse completely and dry in a clean area.

Most respirator manufacturers distribute cleaner-sanitizer material for cleaning their equipment. A mild detergent will usually do a satisfactory job, either with or without a mild bactericidal agent.

Part of the maintenance of respirators is regular inspection.

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Respirators must be inspected during cleaning, and worn or deteriorated parts must be replaced. Each person using a respirator should inspect the respirator before each use to be sure that it is in working condition.

Respirators for emergency use must be inspected after each use, and at least once a month between uses.

Storage for respirators must be in a convenient, clean, and sanitary location, or in a container which will keep them clean. If they are packaged in tight plastic bags and transported on field trips, protect the bag from being abraded or punctured. The respirators should also be protected against temperature extremes and exposure to direct sunlight for prolonged periods.

Training Requirements for Respiratory Protective Equipment

EPA standards require six hours of initial training for users of respirators, and two to four additional hours annually after the initial training. Records of training and fit testing of employees are to be maintained by the supervisor.

Safe use of respiratory protective equipment depends on thorough training. Every employee who may use a respirator needs to know: when it is needed, which type is needed, and the capabilities and the limitations of the equipment for specific exposures.

Every user of respiratory protective equipment needs to learn how to put on the equipment to be used, how to adjust it for a comfortable fit, and how to test the seal between the facepiece and the face to see that the equipment fits thightly enough to provide needed protection.

In addition, every user needs to have the opportunity to wear the

equipment in normal air for a period of familiarization, and then to wear the equipment in a test atmosphere.

The final selection of rrespirator type is based on a number of factors including the protection factor (PF), the Threshold Limit Value (TLV), the Immediate Danger to Life and Health (IDLH) and Agency policy. The following condensed charts will provide some assistance in helping field crews select the proper respirator type.

TABLE 19–7a

Selection of Respirators for Emergency or Short-Term Use on the Basis of Hazard and Expected Concentration (Gases and Vapors)

Toxicity	Expected Concentrations of Gases or Vapors			
	Two to five times TLV or up to 1000 ppm	Five to ten times TLV or 1000–5000 ppm	Above ten times TLV or 5000–20,000 ppm	Oxygen deficiency, emergency or above 20,000 ppm
Low	No respirator, or chemical cartridge needed	Canister gas mask	Canister gas mask or air-line respirator	Self-contained air or oxygen
Moderate	Chemical cartridge	Canister gas mask or air-line respirator	Air-line or self-contained air or oxygen	Self-contained air or oxygen
High	Canister gas mask	Air-line respirator	Self-contained air or oxygen	Self-contained air or oxygen

NOTES:
(1) TLV refers to the Threshold Limit Values for a number of substances published by the American Conference of Governmental Industrial Hygienists (see Section 1 and section 12).
(2) See Sections 1 and 2 for a discussion of toxicity ratings and their relation to TLV.
(3) When unavoidable conditions necessitate using respirators for longer periods (above 1 hour), use equipment in a higher protective category than shown above.
(4) Subject to limitiations (Table 2.1), hose-type respirators may be used in place of air line.

TABLE 19–7b

Selection of Respirators for Emergency or Short-Term Use on the Basis of Hazard and Expected Concentration (Particulates)

Toxicity	Expected Concentrations of Particulate Matter (Dusts, Fumes and Mists)			
	Two to five times TLV	Five to twenty times TLV	Above twenty times TLV	Oxygen deficient, emergency, highly corrosive
Low	Respirator not usually needed	Filter	Filter or air-line respirator	Where exposure is to extremely corrosive dusts or to dusts in an oxygen deficient atmosphere, a self-contained air or oxygen respirator must be used.
Moderate or High (toxicity no greater than lead)	Filter	Filter or air-line respirator	Air-line or self-contained air or oxygen	
Extremely High (toxicity greater than lead)	Filter or air-line respirator	Air-line respirator	Self-contained air or oxygen	

NOTES:

(1) TLV refers to the Threshold Limit Values for a number of substances published by the American Conference of Governmental Industrial Hygienists (Sections 1, 12).

(2) See Sections 1 and 2 for a discussion of toxicity ratings and their relation to TLV's.

(3) Expected concentrations of particulate matter have been shown only as multiples of the threshold limit values. Where these values are not available, the following concentrations may be used as a guide:

	Mineral Dusts	Other Dusts, Fumes, and Mists
2 to 5 (TLV)	up to 50 mppcf*	Up to 0.5 milligrams per cubic meter
5 to 20 (TLV)	50 to 1000 mppcf*	0.5 to 10 milligrams per cubic meter
Above 20 (TLV)	above 1000 mppcf*	Above 10 milligrams per cubic meter

(4) When unavoidable conditions necessitate using respirators for longer periods (above 1 hour), use equipment in a higher protective category than shown above.

(5) Subject to limitations (Table 2.1), hose-type respirators may be used in place of air line.

* Mppcf = millions of particles per cubic foot.

STUDENT EXERCISES

The following exercise has been developed to provide practical experience for field crew selection of respirator and cartridge type. Students should refer to charts and tables found in the unit.

An EPA crew has been sent to a now defunct solvent recycling company. A number of samples from a variety of environments must be taken. Determine the respirator type, cartridge if applicable, and rationale used for each selection.

I. Building A

Building A was used for storage and recyling of the nonchlorinated solvent acetone. Air monitoring indicates the oxygen level to be 20.1%, with the LEL for acetone at .30 or 30%.

A. Air-purifying type respirator (rationale)_____

_____

B. Cartridge type (rationale)_____

_____

C. Expected breakthrough time (rationale)_____

_____

D. PF of type selected_____

E. Maximum ppm this respirator is good for_____

Calc._____

F. Degree of warning properties - odor_____

_____

G. Air-supplyuing respirator (rationale)_____

_____

II. Building B

Air monitoring indicates ammonia to be present at 50 ppm, oxygen to be 19.8%.

A._____

B._____

C._____

D. _____

E. _____

F. _____

G. _____

H. _____

II. Building C

Air monitoring indicates perchlorothylene at 93 ppm, oxygen at 19.0%.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

UNIT 22

SAMPLING AT HAZARDOUS WASTE SITES

Educational Objectives

o The student should be able to list the essential steps in planning sampling at a hazardous waste site.

o The student should be able to list the conditions for each level of personnel protection (A, B, C).

o The student should be able to describe a hazardous waste site decontamination plan.

o The student should be able to define the preliminary steps necessary for a site survey.

o The student should be able to list equipment included in each level of personnel protection.

o The student should be able to select the necessary personnel protection for a known and unknown waste.

o The student should be able to define terms used in sampling drums.

o The student should be able to describe the various methods of opening drums safely and when to use each.

o The student should be able to describe the procedure for sampling a drum.

o The student should be able to list the steps in cleaning and decontaminating a coliwasa.

o The student should know the hazards involved with sampling ponds and lagoons.

o The student should know the hazards involved with the sampling of waste piles.

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It is the opinion of many that sampling at a hazardous waste site represents the most dangerous environment faced by field crews. Often crews are faced with a multitude of unknowns, in various physical states, often in highly concentrated amounts and in a variety of containers in dubious or poor condition.

Such combinations of threats and unknowns must be met with proper planning, training and practice.

It is fitting to say that nearly every unit in the Basic Field Training Course can be put to use when preparing to enter and sample a hazardous waste site.

Planning and Preparation

Planning and preparation for an investigation at a hazardous waste site may in some cases take more time than the investigation itself. There are three essential activities in planning work at a site.

Three essential activities in planning work at a site are to:

* Obtain information about hazards at the site.

* Decide on the personal protection needed in different areas.

* Define the boundaries of contaminated and decontamination areas.

As preparation for an investigation of a hazardous waste site, personnel need to:

* Prepare safety procedures and equipment.

* Gather all needed equipment

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* Provide training and practice in use of equipment and procedures.

* Conduct a preliminary survey to get more detailed information.

The number of field personnel that should be assigned to a hazardous waste site investigation depends on the number needed for safe use of protective equipment, the length of time each person can work under the particular stresses of the job, and on the time available for the investigation.

For example, a team of at least three people is required for safe and effective use of respiratory protection and a team of five persons for use of encapsulating suits, because of the requirements for teamwork and stand-by assistance. Working in air supplying respirators will require a compressed air supply, and extra cylinders or a special compressor. Rest periods are also required to reduce fatigue and heat stress that are generated by the work and by the use of the protective equipment and clothing. The amount of working time is also limited by the activities of getting into and out of protective equipment and decontaminating it.

Obtaining Information

The first step in a waste site investigation is obtaining information about the hazard expected at the site and about off-site sources of emergency assistance and supplies.

Information About Site Hazards and Conditions

Planning begins with gathering as much information as possible about the materials dumped at a site. The effort may include a long search through records, and interviews with former employees and people living near the

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site. After information is gathered on the identity of materials dumped, it may be necessary to find out what is known or suspected about the characteristics and hazards of those materials.

Information about physical conditions at the site should include geologic and topographic maps, road maps, and aerial photographs if available. Data on the prevailing wind and weather conditions expected at the site can be very important for carrying out the investigation safely.

Information should also be gathered about conditions, at the site, which may present safety and sampling problems, such as soft or marshy areas, large or unstable piles, and heaps of building materials or large pieces of reinforced concrete.

Off-Site Emergency Assistance and Resources

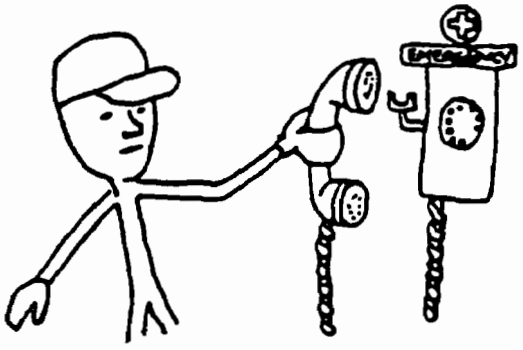
Obtain information concerning off-site emergency assistance and resources at a hazardous waste site before the investigation begins.

Find out if emergency medical assistance is available, such as an ambulance service or a fire department paramedic team. Find out how to request assistance and how to identify your location.

Find out which nearby hospital has Emergency Room service, and whether there are laboratories nearby that can perform useful tests in case of a chemical exposure emergency.

If there is any possibility of fire at the site, find out which fire department will respond (if any), how to contact the fire department that will respond, and how to identify the site so that they know where to respond.

Call all emergency numbers to find if they are accurate and up-to-date,



since hazardous waste sites are often remote from usual sources of supplies and protective equipment. Find a source of replacement supplies near the site or take extra supplies. If there are supplies that will be expended in great quantity at the site, try to find a company that stocks the items that will be needed.

Routine replacement of compressed breathing air should be arranged by finding a fire department or company that can provide a reliable supply. If possible, get a sample of the air that can be supplied and have it tested for quality.

Deciding on Levels of Protection

Deciding on levels of protection to be used at a hazardous waste site is an important but difficult process based on assessment of the known or suspected hazards at the site. For the purpose of choosing protective equipment, the hazards can be grouped in three categories: unknown or severe respiratory hazards plus severe skin exposure hazards; severe respiratory hazards without severe skin exposure hazards; and moderate respiratory hazards with skin exposure unlikely.

Several categories of hazards and the protection needed for each are as follows;

For convenient reference, special groupings of protective equipment have been designated as different "levels of protecion." EPA guidelines for evaluating hazards and selecting protective equipment are described in detail later in this unit.

TABLE 1

Hazards	Level	Protection Needed
Unknown or Severe Hazards Respiratory and Skin Contact Hazards	A	SCBA + Encapsulating Suits

Unknown or severe hazards which include respiratory and skin contact hazards, require Level A protection which consists essentially of SCBA and fully-encapsulating suits.

Unknown or Severe Hazards Respiratory Hazards Little or no skin hazard	B	SCBA + Protective Clothing

Unknown or severe hazards which include respiratory hazards but little or no skin hazard, require Level B protection which consists essentially of SCBA and protective clothing.

Moderate Hazards Respiratory Hazards Skin exposure unlikely	C	Air-Purifying Respirators + Protective Clothing

Moderate hazards which include limited respiratory hazards but skin exposure is highly unlikely, require Level C protection which consists of air purifying respirators and protective clothing.

For ordinary work environments which do not have any unusual chemical hazards, Level D protection consists of ordinary work clothing.

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Defining Special Areas for Contamination Control

An important part of planning an investigation and the protective equipment needed is defining special areas for contamination control. This requires defining the boundaries of the contaminatd site and the location of the decontamination area. For safety and convenience, only one level of protection should be required in each special area. Unprotected personnel should be excluded from these areas, by procedure, by marking the areas or by erection of a fence.

Preparation

Preparation should include developing special operating safety procedures, gathering necessary safety and protective equipment, and training personnel in use of protective equipment.

Getting in and out of bulky protective equipment, using it while collecting samples, and following emergency procedures should be practiced in advance of actual work. Practice will make it easier to carry out tasks in the limited time provided by special breathing apparatus. Practice will also make it easier to work in special protective equipment, with less stress.

If the planned sampling activities require field personnel to carry out operations that are not familiar, the operations should be rehearsed, particularly if they are hazardous or critical.

Conducting a Preliminary Survey

Before an investigation begins at a hazardous waste site, before collecting hazardous waste samples or working at the site, a preliminary survey should be conducted to get the detailed information needed for developing

specific safety and health plans and for completing preparations. As one part of the survey, it is important to observe physical hazards, measure atmospheric concentrations of contaminants and gather other information which can be used for selecting the levels of protection that will be required for subsequent sampling and investigation.

Assessing Physical Hazards

A preliminary survey should include a thorough inspecton to assess physical hazards at the site and make efforts to identify hazardous materials from container markings.

Look for and record problems such as rough terrain, open waste ponds or lagoons, unstable piles, bulged or leaking drums, confined spaces, dead vegetation, discolored soil, or standing water.

Monitoring the Atmosphere

Part of the preliminary survey is monitoring the atmosphere at the site for concentrations of the contaminants known, or likely, to be present in the air at the site. If the contaminants are not known, samples should be taken for laboratory analysis.

Measure the concentrations of organic vapors, including concentrations of combustible gases and vapors, and measure any ionizing radiation. Wind speed and direction should also be monitored.

Concentrations of organic vapors can be measured by a combination of two field instruments, an organic vapor analyzer and a photoionizer. The organic vapor analyzer is a portable hydrocarbon analyzer with optional capabilities for gas chromatography. It can be used for monitoring total

concentrations of hydrocarbons.

The response time of the organic vapor analyzer is relatively long. It does not respond fast enough to detect vapors at a rapid walking speed. Personnel using the analyzer and not walking slowly, could walk into a high concentration of vapors before the meter could respond.

The photoionizer has a wide detection range, but it too has a relatively long response time, and it is highly directional and must be held close to a source before detection is possible. High humidity and wind can cause the photoionizer to give false readings.

In the absence of other information, the total vapor concentrations measured during the initial survey can be used to decide the level of personal protection needed at a hazardous waste site and in the decontamination area.

If the total vapor concentrations are unexpectedly high in areas outside of that tentatively designated as the contaminated area, the boundaries may need to be enlarged.

Measuring Wind Speed and Direction

Wind speed and direction should be measured during the initial survey and during subsequent activities at a hazardous waste site. The wind indicator should be visible from all points in the contaminated area at which there may be leaks, so that personnel on site can see which way to evacuate in case there is a leak of vapor or gas. If there are buildings or large piles of waste on the site, there may be microenvironments in which the wind does not blow in the same direction as it does on most of the site.

Levels of Protection

Protecting personnel from contact with, or exposure to, chemicals at a hazardous waste site depends to a large extent on protective clothing and equipment. Crew members should select and use the combination of equipment that will provide adequate protection, without encumbering them any more than necessary.

Definitions of how much protective equipment is "necessary" are likely to vary subjectively from "everything" by an overly cautious person, to "very little" by someone who is not concerned about either immediate or delayed consequences of exposure.

Personal Protective Equipment for Hazardous Waste Sites

The personal protective equipment recommended for work at hazardous waste sites consists of several types of protective equipment or clothing:

1. Respiratory Protection, either Air supplying or Air purifying.

2. Protective Clothing for Body Protection.

3. Gloves and Boots for Hand and Foot Protection.

4. Eye and Face Protection.

5. Head Protection.

6. Communication Equipment.

The major difference in the level of protection recommended for different degrees of hazard is in the selection of respiratory protection and protective clothing.

The maximum level of protection available is called Level A, and it includes:

SCBA that operates in the Positive Pressure-Demand mode.

Fully-Encapsulating Suit with Gloves and boots attached.

Second Set of Gloves.

Second Set of Boots.

Two-Way Radio.

The conditions requiring Level A protection include the following:

Unknown Concentrations of Hazardous Material.

Vapor Concentrations from 500 to 1000 ppm.

Concentrations Immediately Dangerous to Life or Health (IDLH).

Material that Could Affect Skin or Eyes.

Toxic Amounts of Material that Could be Absorbed.

An Oxygen Deficiency.

Necessity to Enter Confined Spaces or a Hazardous Environment

The next lower level of protection is called Level B, and it includes:

SCBA operating in the Positive Pressure-Demand Mode.

Hooded Suit that is Chemical Resistant.

Gloves and Boots.

Second Set of Gloves.

Second Set of Boots.

Two-Way Radio.

The conditions requiring Level B protection include:

Unknown Concentrations with a Skin Risk that is Slight.

Vapor Concentrations from 5-500 ppm.

Concentrations Immediately Dangerous to Life or Health (IDLH).

Concentrations Too High for an Air Purifying Respirator.

Toxic Amounts that Could NOT Be Absorbed Through Skin.

Oxygen Deficiency.

Confined Spaces or Hazardous Environment.

The minimum acceptable level of protection at a hazardous waste site is Level C, and it includes:

Air Purifying Respirator with a Full-Face Mask.

Escape Mask.

Fire Resistant Coveralls.

Gloves (optional).

Cover Boots Over Shoes or Boots.

Eye Protection if for any reason a full-face mask is not used.

Conditions requiring Level C protection include vapor concentrations of less than 5 ppm, in which an air purifying respirator is acceptable.

Remember that the term "Level of Protection" describes a combination of equipment and clothing that should provide protection against a particular group of hazards. The levels of

protection provided should change if hazards change. It is appropriate to increase the level of protection required in an area if the hazards increase after a level of protection has been chosen for work in that area.

Known Materials and Known Concentrations

Selection of appropriate protective equipment to prevent contact with or inhalation of excessive amounts of toxic chemicals is relatively easy if personnel know what chemicals they will be exposed to and at what concentrations. Then it is possible to pick a respirator which will protect against the inhalation hazard and the clothing which will protect against skin contact.

However, simply selecting protective equipment for a known exposure concentration may lead to problems. Concentrations can change. Containers can rupture or leak and release more material, the wind can shift or change velocity and the sun can increase the pressure within containers and increse evaporation from exposed liquids. Using equipment with very little margin for safety or with protection against only a limited range of materials could lead to trouble if concentrations increase or if other materials should be released into the immediate environment.

Unknown Materials or Unknown Concentrations

It is much more difficult to select an appropriate level of protection if the potential exposures are to unknown hazardous materials, or to unknown concentrations. To prepare for these situations, EPA has developed some guidelines for judging the hazards and selecting protective equipment.

At a waste site, the basic presumption is that there can be

exposure to hazardous materials and that protective clothing and equipment must be used. (Any assumption otherwise should be made only if there is strong evidence that there is no hazard of adverse exposures to the respiratory system, skin or eyes.)

If the potental exposure includes both inhalation and skin contact hazards, the basic protection required is SCBA and fully-encapsulating suits, which are designed to prevent penetration even of vapors and gases. SCBA and fully-encapsulating suits are part of Level A protection.

If the potential exposure hazard is limited to inhalation hazards only, the basic protection required is self-contained breathing apparatus (SCBA), which is part of Level B protection.

Special Hazardous Areas

Level A or B protection is required for entry into special hazardous areas such as confined spaces, oxygen-deficient atmospheres, and concentrations of toxic materials that are Immediately Dangerous to Life or Health.

Vapor Concentrations

If organic vapors of unknown identity are present in total concentrations greater than 5 ppm, Level A or B protection is required. Level B protection is required for concentrations from 5 to 500 ppm, and Level A protection is required if the total organic vapor concentration is over 500 ppm.

Experience with use of portable field equipment, reported by the EPA Emergency Response Division, has shown that vapor concentrations around 5 ppm result when the measurements are taken close to a main source of contamination,

and that the concentration will not routinely approach or exceed 500 ppm except inside a closed building or in a contaminant spill area.

Protection for Preliminary Surveys

The minimum protection recommended for a preliminary survey of a hazardous waste site is self-contained breathing apparatus and Level B protection. This assumes that exposure of areas of the skin unprotected by Level B protective clothing is expected to be either unlikely or not hazardous. If materials are present which are likely to be absorbed through the skin, Level A protection is recommended.

The only conditions where limited protective clothing (Level C) may be acceptable at a hazardous waste site are:

1. Taking environmental samples or making environmental measurements in the vicinity of the site, but out of areas likely to be highly contaminated.

2. Making preliminary surveys where the hazards of the waste are known and there is not likely to be any significant contact because the material is confined, ventilated by the wind, or does not release hazardous concentrations under conditions at the time of the survey.

Work Limitations in Protective Equipment

In assigning work and assesing its effects, keep in mind the work limitations in protective equipment. Wearing <u>any</u> protective clothing or equipment increases the weight carried, the breathing effort and the heat load. The incrased heat load from working in an encapsulating suit is great enough to require careful attention to prevent severe heat stress effects. (Guidelines for assessing environmental and physiological factors and managing heat

stress are provided in the unit on heat and cold stress.)

Using protective equipment may make it necessary to reduce the maximum working period between breaks and the total working time per day. The working time for which it is safe to allow a person to wear protective equipment depends on the physical work load and on the heat load. Under "normal" conditions, it is recommended that personnel work in respirators and protective suits for no more than about three hours in one day. Under hot conditions, the on-site working time may be as little as 20 minutes at one time, and as little as 2 hours in one working day.

Contamination Control Areas

One means of simplifying the choice of personal protective equipment required at a hazardous waste site is to establish clearly-marked contamination control areas in which contamination levels will be considered uniform. If these areas are defined and used correctly, only one level of protection will be required in each area.

The first special area to be established is the contaminated area. If the hazardous waste and exposure to the waste can be kept within a fenced area, defined as the contaminated area, protective equipment for that exposure hazard will not need to be used outside of the fence.

Since walking, sampling and working in the contaminated area of a hazardous waste site can contaminate shoes, sampling equipment and other equipment, there should be a decontamination area to reduce the spread of hazardous waste beyond the boundaries of the controlled areas.

One of the important reasons for

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marking the boundaries of the contaminated area and controlling entry and egress is to prevent tracking and transfer of hazardous material into areas that are cleaner.

The third special area that needs to be designated for work at a hazardous waste site is the clean area, or the support area, which can be kept uncontaminated for storage of supplies and for communication and control activities.

Contaminated Area

There will be a problem of setting boundaries when the site includes waste containers which, if opened, can release hazardous vapors. If space is available, the contaminated area can be made large enough to provide adequate distance for vapors to dissipate. If space is limited, sampling activities will have to be conducted in a way that will minimize evaporation.

Boundaries of the contaminated area may have to be changed if more hazardous waste is uncovered at the site or if operations begin to spread contamination beyond the boundaries.

Access to the contaminated area should be limited to one or two points at which protective equipment will be put on when entering and removed when leaving. Part of the access area should be reserved for clean equipment and part for decontamination.

Decontamination Area

A decontamination area should be set up at the point of entrance to and exit from the contaminated area, so that everything coming out of the contaminated area can be cleaned to prevent spread of contamination.

Support Area

Supplies, showers, generator and other equipment for work at the waste site should be in a support area located where it will remain uncontaminated and "clean." No protective clothing should be needed in the clean area.

The support area should be located where it is accessible to the decontamination area and where it can be reached from a road. Generally, the support area should be upwind and uphill from the contaminated area.

Control and Communication Area

In the clean support area there needs to be a location that is identified and equipped for communication and for control of activities at the hazardous waste site. (This location is sometimes referred to as the Command Post.)

Decontamination

An important but difficult task at a waste site is preventing or reducing the spread, of hazardous material, by sampling and other activities at the site. Ideally, all contamination that is picked up on samples, sampling apparatus, protective equipment and other items used at the site is removed <u>at</u> the site and left there.

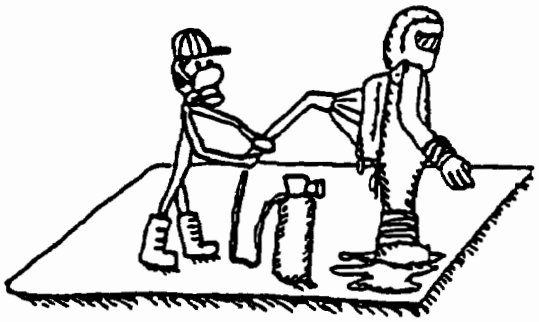
Decontamination is difficult even if the contaminants are known and effective cleaning materials are available. Protective clothing, gloves, and boots can sometimes absorb and retain contamination, making decontamination difficult or impossible. If this is a problem, disposable protective clothing or protective coverings are recommended.

While it would be ideal if <u>all</u> contamination could be removed within the decontamination area at the waste

site, it may only be possible to remove

major contamination or to reduce the contamination to a level that is reasonably safe. Equipment can be packaged for subsequent testing and decontamination.

Since it is virtually impossible to prevent transfer of contaminants from protective clothing to the wearer, even though careful techniques are used, one of the important ways of protecting personnel is to decontaminate the protective clothing before it is removed. This difficult task requires protectivve equipment for the personnel who assist, and it requires speed if a person in a fully-encapsulating suit has little breathing air left.



Unless the contamination is severe, the level of protection required for helpers working in the Decontamination Area will probably be Level C with air purifying respirators.

If the waste at a site is considered extremely toxic, personnel should have an opportunity to wash and shower, preferably at the site.

Decontamination generally consists of washing the contaminated item, followed by rinsing or a series of rinsings. The washing should be done with a cleaning material which will most effectively remove the contamination. If the contaminant is known, the cleaning solution should be one which will dissolve or react with the contaminant to change its form, composition or solubility (without destroying the protective material). If the contaminant is unknown, the solution will probably have to be detergent and water.

Contaminated Solutions and Equipment

The appropriate steps for handling contaminated solutions and equipment are to collect them for proper disposal, store them within the contaminated area, and decontaminate or package them for later decontamination.

Decontaminating solutions should be collected fo proper disposal.

The solutions and supplies such as brushes and sponges can be stored within the contaminated area (if it is fenced).

Protective equipment can be cleaned in the decontamination area, and cleaning solutions can be collected and disposed of properly.

It is generally appropriate to leave the decontaminating solutions and supplies in the contaminated area at the waste site since the quantity of hazardous waste at the site is not changed significantly by doing so. If, however, the decontaminating solutions are solvents which when used become hazardous waste, they must be disposed of as required by the Resource Conservation and Recovery Act. (This should be planned for in advance so that the waste can be packaged and disposed of safely and conveniently.)

Equipment which cannot be decontaminated or which has been contaminated with extremely toxic material may have to be packaged at the site and decontaminated later under controlled conditions.

Collection of Samples

Generally, the most intermittent and immediate exposure to hazardous chemicals comes during the process of sample collection. Both the immediate dangers of fire, explosion, injury or splash, and of contamination are highest at this point. Personnel should

carefully plan the collection activity to minimize danger as well as contact. A carefully thought out and practiced procedure will insure proper equipment, and help foresee difficulties and hazards.

Not all sampling situations can be foreseen or discussed. This Unit will concentrate on the most frequent and most hazardous situations normally encountered by EPA personnel.

Drums

The 55-gallon drum has become synonymous with hazardous waste disposal. It is the most frequently used container for disposal. Because of the drum's frequent appearance at hazardous waste dump sites and the number of problems associated with sampling it, special precautions and techniques must be followed.

Safety

Safety considerations for these operations must be considered. During puncturing and sampling, the operator must be protected from accidents. The following safety equipment is a minimum requirement: rubber boots, rubber gloves, safety glasses, and a hard hat.

Equipment for puncturing has been designed to remove the operators from the puncturing area to a distance of at least 50 feet, where they may be protected by barriers. Material handling equipment -- backhoes, fork lift trucks, tractors, etc., should be shielded to protect the operators from any spraying or spillage of the chemical in the drum.

Equipment

All tools used for drum opening should be of non-sparking construction, i.e., drum hand wrench, and air or

hydraulic operated tools. A trade-off was made on the drum plungers described elsewhere in the Unit. Stainless steel was chosen instead of bronze because it is more durable. However, stainless steel is more capable of generating a spark, and for that reason, the minimum recommended distance for operators from the plunger during operations is greater.

Air and hydraulic equipment should have hoses of such a length as to remove the operators to a safe area.

All drum handling equipment -- backhoes, fork trucks, tractors, etc., should have polycarbonate or comparable shields to prevent operators from being injured by a release. The drum handling equipment would be more efficient if a utility type industrial tractor were used. These tractors can be designed to be equipped with the following attachments: backhoe, a drum handling attachment with the ability to invert a drum, a front-end bucket, and an attachment for the front-end bucket which would allow the use of forks for equipment loading and unloading.

Operators shall wear prescribed safety equipment when opening or sampling drums, as described in an earlier section of this Unit.

Layout

The drums at the site should be placed in a marshaling area or arranged in a manner which will allow sampling personnel to work at the task of sampling without moving the drums. Rows, usually two drums deep with an aisle space between, are adequate.

Drums that can be opened with hand tools should be opened and sampled in place.

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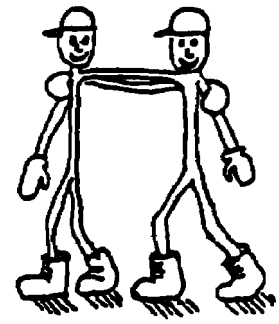

Those drums that cannot be opened with hand tools must be opened with a puncturing device.

At no time should an operator work alone in an area where sampling or puncturing is being performed.

Only the large bung will be removed for sampling.

Drums are to be arranged in a vertical position for puncturing and sampling.

Definitions

Structurally Sound Drum - A drum which can be handled with mechanized equipment without rupturing or puncturing.

Structurally Unsound Drum - High risk drum which is capable of being handled but with extreme caution, and is in one of the following categories:

a. A drum which has a bulged head which is most likely due to internal gas pressure.

b. A drum which is bulged on the side or bottom most likely due to freezing and expansion of the contents.

c. A drum which has been deformed due to mishandling.

Drum with No Structural Integrity - A drum which has corroded to the extent that only portions of the drum remain or with the drum liner exposed.

Marking - A system of marking the drum and the sample collected from the drum for later reference.

Identification Marking - A system of marking the drum which identifies the contents of the drum, to assist in the task of consolidation.

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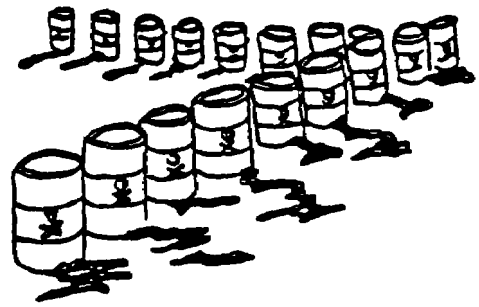
Small Drum Site - A disposal site with one to 300 drums that does not warrant the use of a mechanized sampling system.

Medium Drum Site - A disposal site of 300 to 700 drums that warrants the use of mechanized equipment, but not so large as to require a production type of operation.



Large Drum Site - A disposal of over 700 drums which will require the use of production type of puncturing procedures.

Controlled Area - Designated area where drums can be sampled and/or punctured while:

a. limiting access to only personnel involved with sampling or puncturing,

b. providing for the ability to recover the contents if the drum should rupture, and

c. providing adequate fire and safety precautions for personnel as prescibed by the site manager.

Puncturing Methods

All of the methods listed below are designed to remove the operators from the equipment area for maximum safety.

Remote Drum Conveyor Method - The remote drum conveyor method is recommended for large drum sites (see Figure 1). It is not recommended that drums be adjacent to each other during puncturing in case fire or explosion should occur. A pan is included with a drain to recover any liquid spilled from a ruptured drum. The pan should be emptied after each spillage.

Backhoe Method - The backhoe method is a modification of the standard single drum grabber mechanism. A hydraulic cylinder (see Figure 2) has been added

with a frame to provide a plunger to puncture the top of the drum. The backhoe would grab a drum, relocate it over a spill containment pan and puncture the drum. The pan would recover any spillage or the contents of a drum in case of rupture. The pan should be emptied after each spillage.

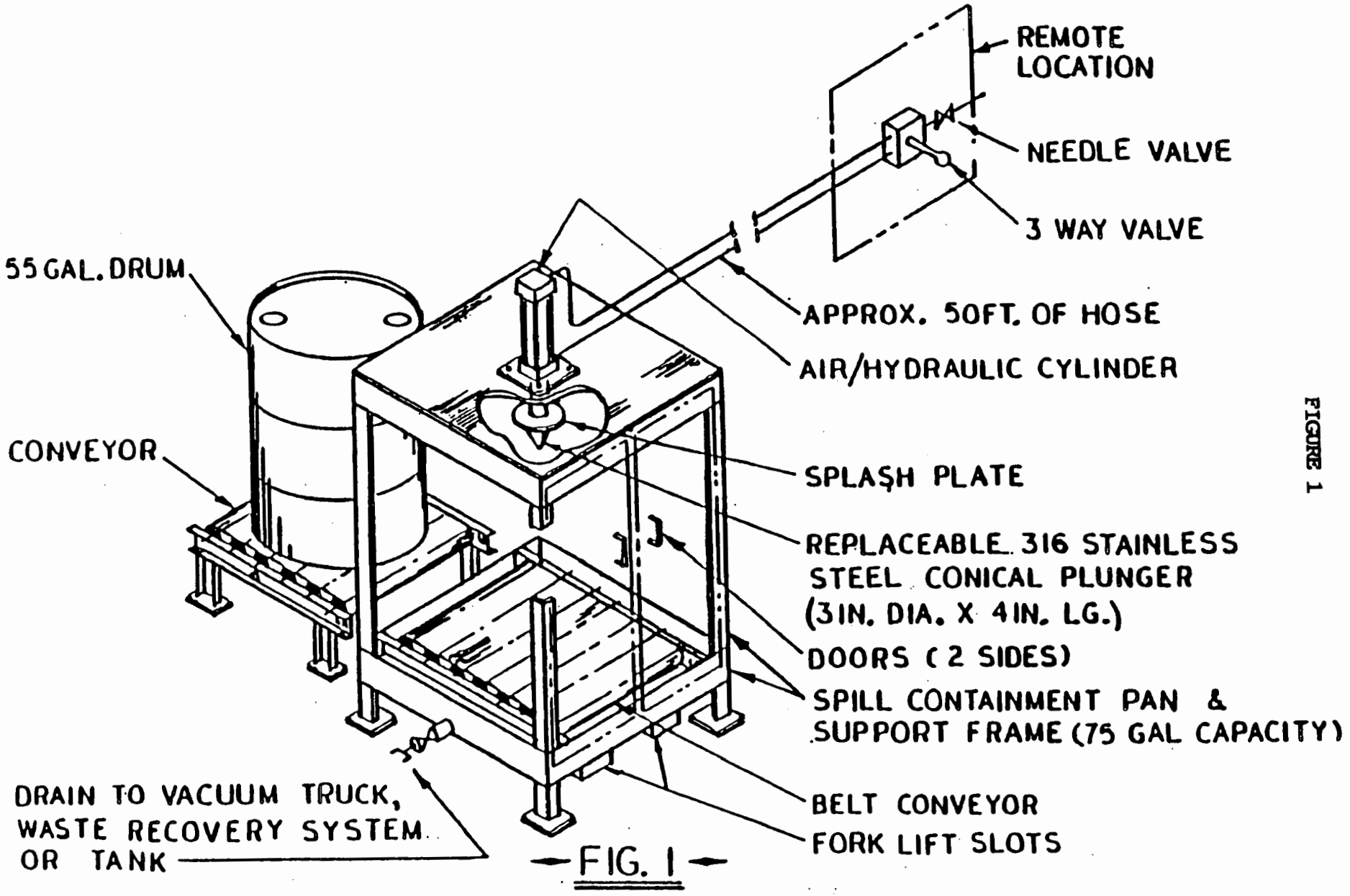


FIG. 1

REMOTE DRUM PLUNGER ARRANGEMENT AND CONTAINMENT BOOTH

FIGURE 1

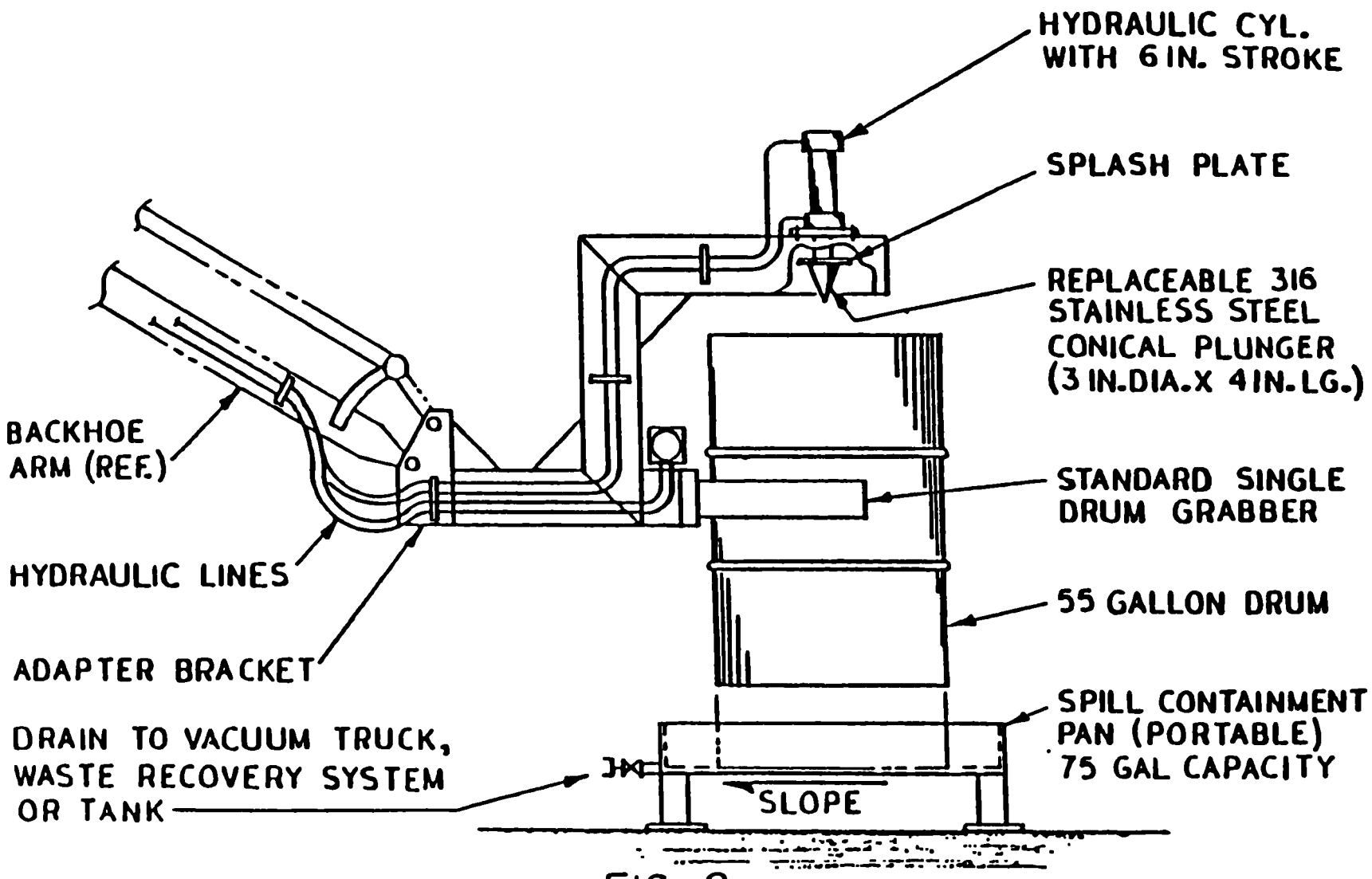
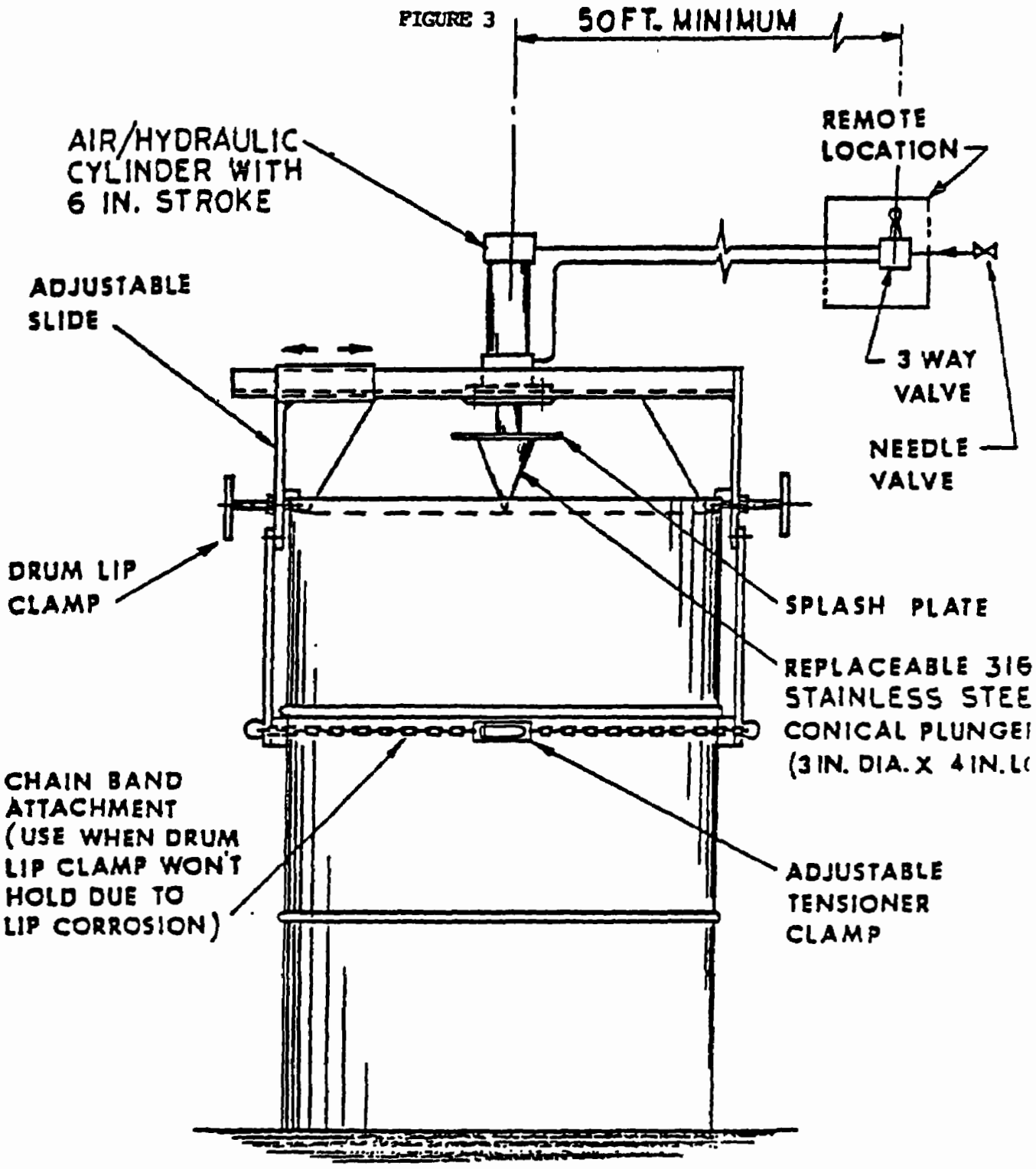


FIG. 2

BACKHOE DRUM PLUNGER ARRANGEMENT

FIGURE 2

Portable Drum Opening Method - The portable drum opener can be attached to the top lip of a drum if it has not corroded away, or it can be banded around the drum as shown in Figure 3. This method should be used only if the drums are structurally sound, or are in an area where a spill due to rupture could be controlled easily and recovered. If puncturing occurs in the field, all personnel must be notified and cleared from the area before puncturing. The hoses for the portable opener should be at least 50 feet long to remove the personnel from the drum to be opened. Other drums should not be relied upon to shield personnel.



— FIG. 3 —

PORTABLE DRUM PLUNGER

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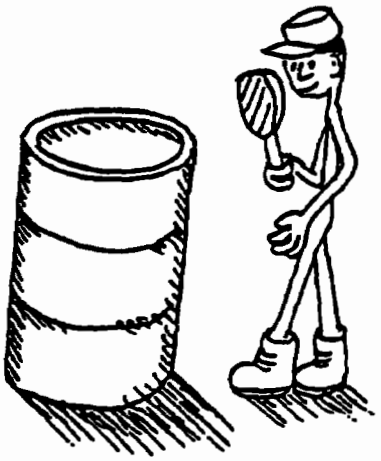

Assessment of Each Drum - Each drum should be checked for bulges, buckling, deformations, and corrosion. If a drum has been subjected to any of the aforementioned abuses, the drum will be classified as a high risk drum. Treatment of the high risk drums will be addressed later. All other drums can be classified as structurally sound drums.

Structurally Sound Drums - These drums present the least amount of risk of rupture during mechanical handling. A responsible member of the sampling party should determine whether the drums can be opened or punctured and sampled in place. This decision will be based on the extent of clean-up in case of rupture, the danger involved in a rupture and other factors such as the size of site and drum spacing. Whenever possible, it is safest to puncture or sample in a controlled area.

Opening the Drum - The first step is to use the manual hand wrench. Only the large bung should have to be removed. Caution must be taken to avoid causing a spark which would detonate an explosive gas mixture in the drum. Slowly loosen the bung to allow any gas pressure to escape. Once the bung is removed, the drum is ready to be sampled. If the bung cannot be removed, the drum will have to be punctured.

Sampling the Drum - See the section on Sampling Procedures.

Puncturing and Sampling in the Field - After it has been determined that the bung cannot be opened, the drum will have to be punctured. The methods for puncturing are listed below based on site size.

Small Drum Site - If the number of drums is small, the method most cost effective would be the portable plunger method (see Figure 3). This mechanism can be attached to the top drum lip or banded around the drum body. Hoses of

approximately 50 feet long enable the operator to stand clear of the drum during puncturing. (All personnel should evacuate the area during this operation due to the possibility of an explosion.) After puncturing, the drum is ready to be sampled.

Medium Drum Site - When the number of drums is between 300-700, the backhoe method will be the most effective method. With the backhoe method shown in Figure 2, the puncturing can be done with the drum sitting in a pan to catch any liquid if the drum ruptures. Care must be taken to insure that no personnel are in the area during puncturing. After puncturing, the drum can be situated for the sampling team to complete the sampling procedure.

Large Drum Site - If the number of drums is large, a mechanized conveyor method is recommended for puncturing drums (see Figure 1). With the conveyor method, drums should not be adjacent to each other while being punctured for safety reasons in case of an explosion or fire.

Structurally Unsound Drums - These drums are high risk drums; that is, they could rupture during mechanical handling. Therefore, extreme caution and safety methods should be used when sampling these drums. Due to the high risk nature, all of these drums should be punctured and sampled in a controlled area. The controlled area should be away from any other drums in case of an explosion or fire, it should have limited access both for personnel and traffic and it should have stringent fire and safety precautions. Puncturing of high risk drums should be done in a catch pan for safety and ease of clean-up in case of a drum rupture. The methods of puncturing are the same as for the structurally sound drums.

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Drums With No Structural Integrity - These are drums which have little of the drum shell left due to corrosion or punctures. These drums may have liners which are easily ruptured. The use of a vacuum system to remove a sample and the contents of the drum is the optimum method of handling these drums. In preparation for this, if there is any room around the drum, dig a "moat" to contain the contents of the drum. If the drum ruptures during the attempt to get a sample, the sample can be obtained from the moat, and the remaining liquid can be pumped into a new drum.

Sampling Procedures - Wear necessary protective clothing and gear.

Choose the plastic or glass COLIWASA for the liquid waste to be sampled, and assemble the sampler as shown in Figure 4.

Make sure that the sampler is relatively clean. Any solids should be removed and the sampler drained to prevent reactions before further sampling is attempted.

Check to make sure the sampler is functioning properly. Adjust, if necessary, the locking mechanism to make sure the neoprene rubber stopper provides a tight closure.

Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

Slowly lower the sampler into the liquid waste. Lower the sampler at a rate which permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sampler tube is lower than that outside the sampler, the sampling rate is too fast and a nonrepresentative sample will be obtained.

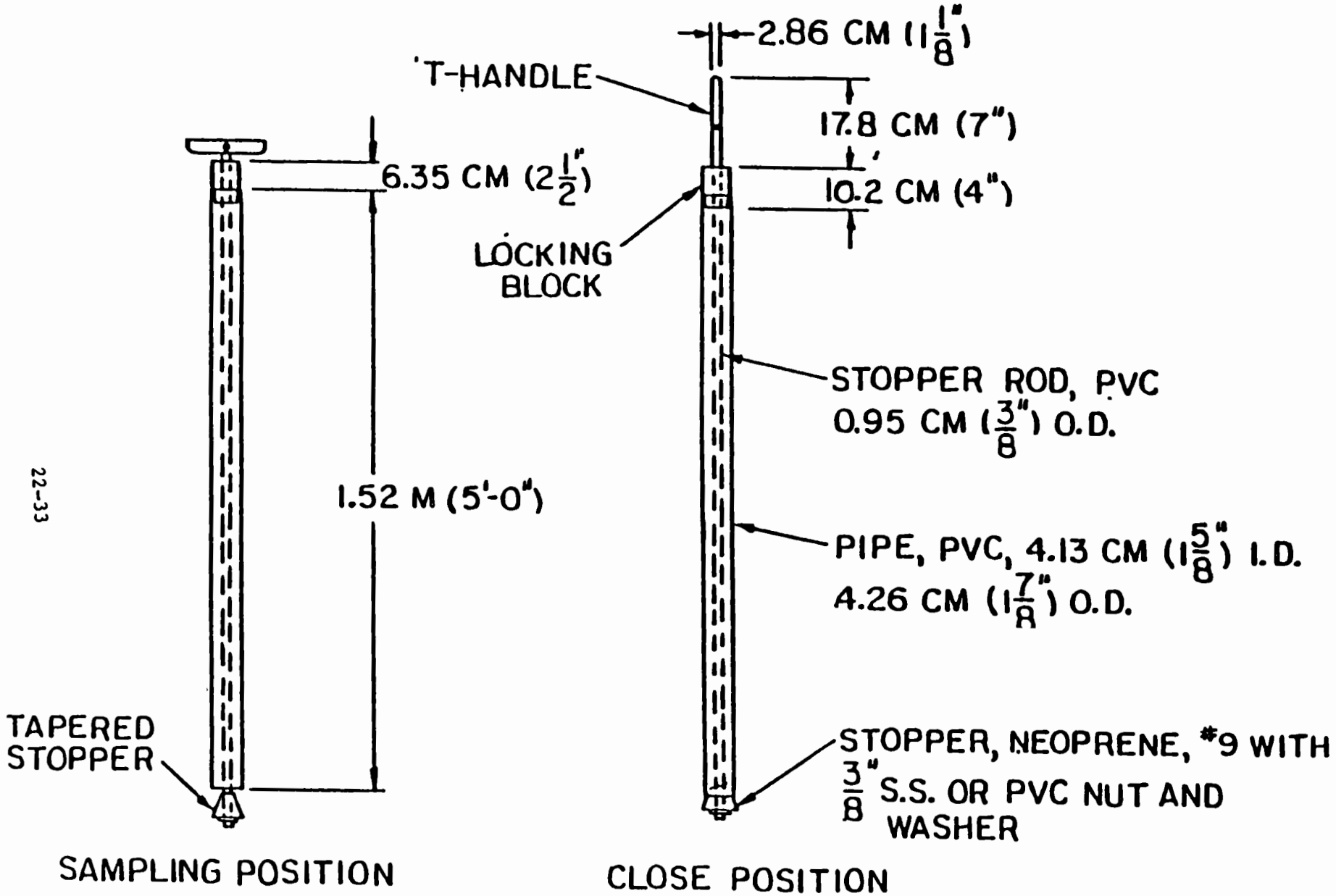


FIG. 4.

COMPOSITE LIQUID WASTE SAMPLER (COLIWASA)

FIGURE 4

When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end tightly rests on the locking block. (It should be noted that this sampler will not sample the botton one-two inches of the drummed material, nor will it sample solids.)

Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand. Place the cloth into an appropriate container.

Carefully discharge the sample into a suitable container by slowly opening the sampler. This is done by slowly pulling the lower end of the T-handle away from the locking block while the lower end of sampler is in the sample container.

Sample Container - Be sure the sample container has a wide-mouth large enough for the Coliwasa to fit into and the container size is sufficient to hold the volume contained in the Coliwasa. Also be sure the sample container material and its cap are compatible with the collected waste. Polyvinyl chloride sample bottles should be used for acids and bases and other water soluble materials. Glass, preferably with a safety plastic coat, should be used for hydrocarbons and solvents. Bakelite tops with Teflon seals should be used with glass bottles.

After the sample bottle has been securely closed, invert the sample bottle a few times to check for leaks.

Regardless of whether visible leaks are detectable or not, wipe the bottles with rags to remove any wastes on the outside. The rags should be disposed of at the site, as are other hazardous

wastes. All sample bottles should be thoroughly decontaminated in the proper area before being shipped off site.

Marking the Sample and Drum - After the sample has been taken, cap the sample container, attach the label, and mark the drum with paint or other indelible marking system. The marking system should correspond to the proposed laboratory sample marking protocol. Put a plastic cap over the drum, or reinstall the bung, to prevent any liquid (rain, etc.) from entering. Do not mark the cover as it may be blown off by wind.

Sampler - Although the Coliwasa and its improved models remain the most frequently used sampler for liquids, the problem of cleaning and decontamination have yet to find simple solutions.

Court cases and Agency enforcement actions are highly dependent on the integrity of the sample, hence the sampling procedure and the cleanliness of the equipment used are very important. Furthermore, subsequent handlers of sampling equipment seldom have protective gloves on during the initial handling, storing, and transporting of equipment. Agency crew members should take care to practice Coliwasa decontamination procedures before entering a site. The following steps are recommended between each sampling and before leaving the site:

1. Select the type of body tube that is compatible with the suspected material to be sampled. PVC tubes are best for acids, bases, or other water-based substances. Glass is best for hydrocarbons such as solvents. The Coliwasa tube is designed to be economical enough for disposal if cleaning and decontamination prove to be difficult or impractical. Always take extra tubes with the sampler.

2. While raising the filled Coliwasa from the barrel, wipe the excess from the outside with a disposable rag. Hold a rag under the tube as it is lifted to the sample container.

3. Secure the sample bottle from tipping over. Slowly release the Coliwasa T-handle to prevent the contents from splashing.

4. Using a long-handled brush, rags, and a solvent, clean the tube both inside and out.

5. Using a separate brush and rags, wash with soap and water, then rinse with clean water.

6. Before sampling again, inspect the tube for signs of deterioration due to chemical incompatibility.

7. All wash materials must be decontaminated or disposed of on site as a hazardous waste.

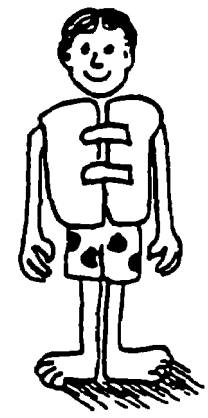
Ponds and Lagoons

The threat from ponds and lagoons comes from both chemical hazards and physical hazards such as drowning. Representative sampling procedures usually require five or six samples that include both the aqueous phase and the bottom sludge material. During the sampling, it is common practice to lean or reach as far away from the bank as possible, increasing the danger of slipping or falling into the pond. The following safety precautions should be observed:

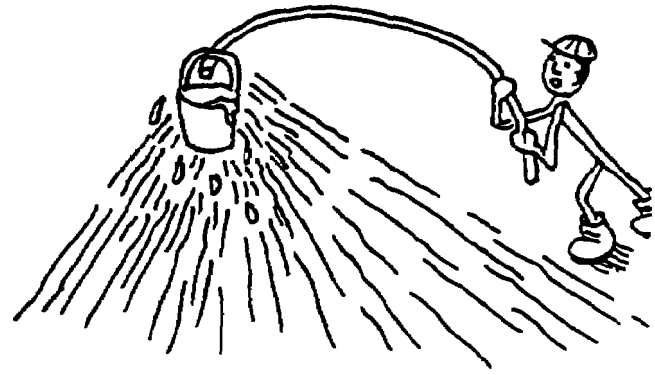
1. Wear protective gear including boots, gloves, and splash goggles.

2. Always sample with two people present.

3. Wear a life preserver or a safety line held by an assistant.



4. Remember, a sample container when full, particularly at the end of a long pole, will weigh considerably more that when empty. Such an unanticipated strain may cause the sample taken to over-balance and fall into the pond. If possible, lift samples straight up, using the power of the legs rather than the back or arms.



If the sampling is being done over the side of a boat, the added weight of a full sampler may be sufficient to cause the boat to tip or rock dangerously. Notify other passengers in the boat when you are about to lift the full sampler. Such warnings will allow passengers to prepare to counterbalance the affects of the weighted sample being lifted.

Samplers should be emptied into sample containers in a spill pan to catch spillage, drippings, or overflow. Such pans facilitate cleanup and decontamination. Gear such as samplers and sampler lines, should be stored in the pans, rather than the bottom of the boat where decontamination and cleanup are difficult.

Waste Piles

Hazardous materials stored in waste piles are frequently of a small granular size, such as sand and dust. The particles frequently are easily blown, as dust, when the hazardous materials are disturbed, or dropped into the tops of open boots or shoes. Agency crews should wear, as a minimum, protective gear including air purifying, particulate removing, respirators; protective coveralls; boots that can be laced up and taped inside of pant legs; gloves, and protective eye gear.

Waste piles should be approached from up wind. Large piles, or piles near or inside of buildings with open sides, are prone to whirlpool or

multiple-direction gusts. Efforts should be made to disturb the pile as little as possible, minimizing the amount of dust.

While you are in the vicinity of pile, clothing, boots, and other gear contaminated with the dust should be thoroughly rinsed down to remove dust.

STUDENT EXERCISES

For sampling at the following hazardous waste sites, describe the type of protective gear and the rationale used for the selection.

A. 1. Known Waste - Hydrogen Cyanide

2. Vapor Concentration - 3 ppm

3. Oxygen - 21%

4. Wind - 20 mph

5. Site - Open Field

6. Containers - Drums

Rationale _____

_____

_____

_____

Protective Gear _____

_____

_____

_____

_____

_____

Level _____

B. 1. Unknown

2. Vapor Concentration - 25 ppm

3. Oxygen - 18.1%

4. Wind - 0

5. Site - Building

6. Containers - Drums

Rationale _____

_____

_____

_____

Protective Gear _____

_____

_____

_____

_____

_____

Level _____

C. 1. Known Waste - Trichloroethane

2. Vapor Concentration - 4 ppm

3. Oxygen - 21%

4. Wind - 10-15 mph

5. Site - Open

6. Containers - Tank

Rationale _____

_____

_____

_____

Protective Gear _____

_____

_____

_____

_____

_____

Level _____

D. 1. Known Waste - Chloroacetic Acid

2. Vapor Concentration - 0

3. Oxygen - 21.1%

4. Wind - 5-10 mph

5. Site - Open

6. Containers - Drums

Rationale _____

_____

_____

Protective Gear _____

_____

_____

_____

_____

_____

Level _____

If all of the above were represented at the same site:

Rationale _____

_____

_____

_____

Protective Gear _____

_____

_____

_____

_____

_____

Level _____

UNIT 23

SHIPPING REGULATIONS FOR CHEMICALS AND SAMPLES

Educational Objectives

o The student should know how to use the Hazardous Material Tables.

o The student should know how to label a Hazardous Material Sample.

o The student should know the definitions needed to ship a hazardous material properly.

o The student should know how to ship Environmental Samples.

o The student should know the Rules for Placarding.

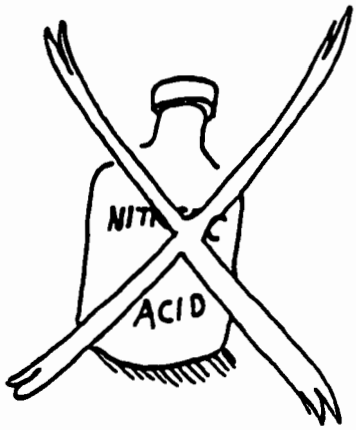
o The student should know the DOT Hazard Label Priority.

o The student should know the rules prohibiting certain types of hazardous materials.

NOTES

Introduction

Preventing spills, fires and explosions of hazardous materials during transportation is a major goal of the U.S. Department of Transportation (DOT). In order to protect the environment, the public, and transportation employees from such incidents, the DOT has developed and adopted rigorous standards for packaging and identifying hazardous materials that are shipped by any mode of transportation.



The DOT standards must be followed if you ship hazardous chemicals or samples by any means of transportation other than an EPA vehicle. DOT standards must also be followed for any chemical, sample or hazardous material you may take with you (or check in your baggage) on a flight by scheduled or chartered aircraft. Some materials (such as nitric acid) are considered so hazardous that they are totally prohibited from being shipped or carried on aircraft.

The DOT standards can serve as a useful guide for handling field samples and the chemicals and solvents needed for field activities. Familiarity with the principles of the regulations can help you package and identify hazardous materials for your protection even if they are not regulated by DOT.

There is another use that can be made of information in the DOT standards. If personnel ever have to respond to a transportation spill of hazardous materials, they can obtain important information about the identity of the materials carried in the vehicle from the DOT-required shipping papers, placards and identification numbers. New DOT regulations require cargo tanks and tank trucks to be marked on all four sides with a four-digit number

identifying the specific material being carried, and the DOT has published a list of the numbers and corresponding hazardous materials.

This unit will outline the general requirements of DOT regulations that may apply to Agency personnel: classification of hazards, packaging, marking and labeling, shipping papers, and loading and placarding vehicles. This unit will also describe how EPA has interpreted the regulations for handling environmental samples and hazardous waste samples.

General Requirements

DOT regulations specify that no person may offer a hazardous material for transportation by any commercial carrier within the United States unless that material meets a series of specific safety requirements.

The regulations list materials which must not be shipped by or carried on aircraft, and some that are so sensitive to explosion that they cannot be shipped by any mode of transportation.

Shipments of hazardous material must first be properly classified for their hazards. The DOT regulations require that "each person who offers a hazardous material for transportation shall describe the hazardous material on the shipping paper," and shall include details on the classification of the material. Hazardous materials must be prepared and packaged safely for shipment, and the packages and shipping containers must be marked and labeled to show the hazards of the contents.

The DOT regulations also include requirements for loading vehicles and for marking vehicles with warning placards and material identification numbers.

The DOT has established specific definitions of Hazardous Materials, and has recently broadened its regulations to define and regulate Hazardous Substances and Hazardous Waste. DOT regulations for hazardous materials that are shipped in low concentrations or small quantities are not as restrictive as the regulations for commercial concentrations or quantities.

"Hazardous material" is defined as a substance or material which has been determined to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated by the Secretary of Transportation.

"Hazardous substance" is a category that has been added to the DOT regulations in cooperation with the Environmental Protection Agency. Substances which have long term health effects in the environment, such as PCB's, have been added to the DOT regulations. Such substances are identified in DOT tables by an E, and their reportable quantities in case of spill have been listed.

"Hazardous waste" is defined as any material subject to the hazardous waste manifest requirements of EPA regulations, or any that would be subject to those requirements if there were no interim authorization to a state.

"Passenger-carrying aircraft" is defined as an aircraft that carries any person other than a crewmember, company employee, an authorized representative of the United States or a person accompanying the shipment.

"Cargo-only aircraft" is defined as an aircraft that is used to transport cargo and is not engaged in carrying passengers.

"Vessel" includes every description of watercraft used or capable of being used as a means of transportation on the water.

"STC" or single-trip container is a container that may not be refilled and reshipped after having been previously emptied, except as provided in DOT regulations.

"NRC" or non-reusable container is a container whose reuse is restricted in accordance with the provisions of DOT regulations.

"Carrier" means any person, group or company engaged in the transportation of passengers or property by civil aircraft, or by land or water, as a common, contract or private carrier.

Classification of Hazards

Safe shipment of hazardous material depends on packaging and handling which provide protection for the specific hazards of the material. In order to provide appropriate protection, it is necessary to identify the hazards.

Samples which must be transported for laboratory analysis may, if a reasonable doubt exists as to the hazard class and labeling requirements, be given a tentative classification based upon the:

o definitions of hazards in the DOT regulations

o highest ranked hazard classifications in which it fits, and the

o shipper's knowledge of the material.

Although the DOT regulations list and define <u>twenty</u> different hazard classifications, all of them fit within <u>two</u> broad categories:

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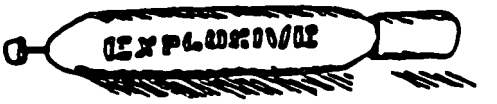
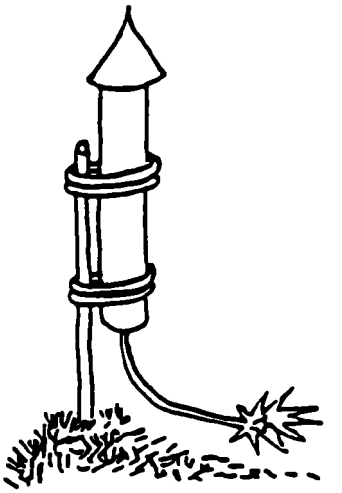
Fire and explosion hazards,
Health hazards,

Fire and explosion hazards include the following classes of material:



Explosives,

Radioactive materials that could be explosive,



Flammable gases, liquids, and solids (including those that are spontaneously combustible or water-reactive),

Pyrophoric liquids,

Combustible liquids,

Oxidizers and organic peroxides, and

Compressed gas cylinders.

Health hazards include the following classes of material:

Poisonous materials (gases, liquids, solids),

Etiologic agents (disease microorganisms or toxins),

Radioactive materials,

Corrosive materials, and

Irritating materials.

The DOT regulations define each classifications of hazardous materials and provide convenient Tables listing the classifications for many commonly-used materials. However, the regulations apply to all materials which meet any of the specific definitions, whether or not they are listed in the Tables. In preparing to ship a material which may be hazardous, first look to see if it is listed in the Tables; if it

is not, then determine whether it is hazardous by any DOT definition.

In order to classify the major hazard, or hazards, of materials which are not listed in the Tables, the DOT regulations establish a priority order of hazards. The classification of hazards is listed here in a tabulation with the more serious hazards having the lower numbers.

The highest DOT hazard classification is explosive material, material that is designed to function by explosion.

Since EPA should not be shipping any military ordnance, the listing starts with Radioactive Material, followed by (READ LIST):

DOT Classification of Hazards of Materials

1. Radioactive material
2. Poison A
3. Flammable Gas
4. Non-flammable Gas
5. Flammable Liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive material that is liquid
9. Poison B
10. Corrosive material that is solid
11. Irritating materials
12. Combustible liquid in containers exceeding 110

gallons

(DOT has additional classifications but they include materials of types and quantities not likely to be shipped by EPA, such as organic peroxides and etiologic agents.)

Following are instructions to explain how this information could be used. For example, if personnel determine that a material not listed in the Tables matches the definitions for Poison A, Oxidizer, and Corrosive Liquid, how sould they classify it? Because Poison A appears on the priority list before the other two hazards, they must classify the material as Poison A. (See section on Labeling)

These twelve classes of hazards can be grouped into five broad categories:

Radioactive Material

Poisonous, Corrosive and Irritating Materials

Flammable Gas and Non-flammable Gas

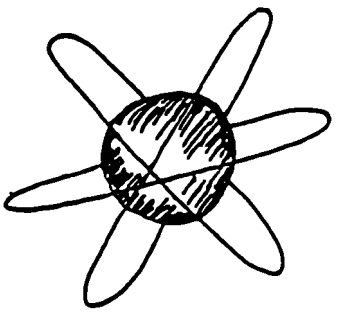
Flammable Liquid, Flammable Solid, and Combustible Liquid

Oxidizer.

Consider the definitions for materials in the three categories of radioactive material; poisonous, corrosive and irritating materials; and oxidizers. (Flammable and combustible materials are discussed in the unit on Fire and Explosion Hazards.)

Radioactive Material

Agency personnel are not likely to be shipping any radioactive material unless they encounter it in an unusual environmental or hazardous waste site sample. Based on DOT regulations, a



sample would not be classified as Radioactive Material if the estimated specific activity is not greater than 0.002 microcurie per gram of material, and if the radioactivity is essentially uniformly distributed through the material.

If the estimated specific radioactivity is greater than 0.002 microcurie per gram, or not distributed uniformly, the sample should be classified as Radioactive Material and packaged and labeled accordingly. If personnel expect to encounter radioactivity in their field work, and take samples that will be classified as radioactive material, they should plan to take to the field the special equipment needed to identify the hazard and the packaging required for the sample.

Poisonous Materials and Corrosive Material

There are four classifications of hazard in the grouping of poisonous materials and corrosive material.

Poisonous materials are divided into three groups, according to their hazard in transportation. The mutually exclusive groups, in descending order of hazard, are: Poison A, Poison B, and Irritating material (known previously as Poison C).

Poison A Materials - Materials classified as Poison A (or extremely dangerous poisons) must be labeled as Poison Gas. Poison A materials are defined as "poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air, is dangerous to life."

Ten materials are listed in the text of the DOT regulations and ten others are listed in the Tables. The ten examples given in the text of the regulations include bromoacetone,

cyanogen, cyanogen chloride, hydrocyanic acid, phosgene, and nitrogen tetroxide-nitric oxide mixtures containing up to 33.2 percent of nitric oxide by weight. Most of the ten materials have uses in organic syntheses; several are reported elsewhere as military poison gases. The ten other materials classed in the Tables as Poison Gas include arsine, germane, nitric oxide, phosphine and several insecticides, including two liquids shipped in combination with compressed gas.

Poison B Materials - Materials classified as Poison B are liquids or solids which "are known to be so toxic to man as to afford a hazard to health during transportation" or which are presumed to be toxic to man because of the toxic effects shown when tested on laboratory animals.

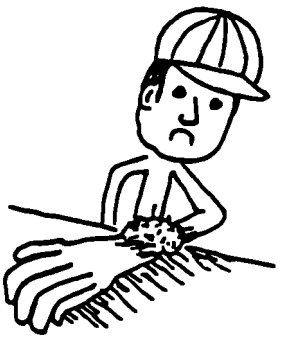
If you have to decide whether a hazardous material must be classified as a Poison B material, you can do so by comparing the toxicity information reported in the NIOSH Registry of Toxic Effects of Chemical Substances with the DOT criteria for Poison B material. (Test data and the DOT definitions may differ slightly.)

There are three tests which define a Poison B material: oral toxicity, inhalation toxicity, and skin absorption toxicity.

Oral Toxicity: A material is classified as a Poison B material if in the oral toxicity tests, a single dose of 50 milligrams or less per kilogram of body weight, administered orally, causes death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams.

Inhalation Toxicity: A material is classified as a Poison B material if a continuous exposure of one hour or less, at a concentration of

vapor, mist or dust of 2 milligrams or less per liter, produces death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams.



Skin Absorption Toxicity; A material is also classed as a Poison B material if, in skin absorption toxicity tests, a dosage of 200 milligrams or less per kilogram of body weight, administered by continuous contact with the bare skin for 24 hours or less, produces death within 48 hours in half or more than half of a group of 10 or more rabbits.

There is an exception that if experience shows that the physical characteristics of a material, or the probable hazards to humans, will not cause serious sickness or death, the material does not need to be classified as a Poison B material, even if test data would otherwise require such a classification.

Examples of materials which are classified as Poison B include: aldrin, mecuric chloride, methyl bromide, sodium cyanide, and almost all pesticides.

The only materials classified as Irritating Material are tear gas and four compounds described as being usable as tear gas.

Corrosive Material

A corrosive material is a liquid or solid that causes visible destruction or alteration of human skin tissue at the site of contact, or that has a severe corrosion rate on steel. A material is considered to be corrosive if specified tests on rabbit skin destroy, or irreversibly change tissue at the site of contact after an exposure period of 4 hours or less, or if the corrosion rate on steel exceeds 1/4-inch per year in a specified test.

Examples of corrosive materials include hydrochloric acid, nitric acid in a concentration of 40 percent or less, sodium hydroxide, and sulfuric acid.

Nitric acid in a concentration of more than 40 percent is also classified as an Oxidizer, and is required to be labeled as both an Oxidizer and Corrosive.

Oxidizer

DOT defines "oxidizer" or "oxidizing material" as one which yields oxygen readily to stimulate combustion of organic materials.

Examples of materials classified as oxidizers by DOT are chlorates, permanganates, nitrates, and inorganic peroxides.

DOT classifies as "organic peroxide" any organic compound containing a bivalent oxygen structure which is considered a derivative of hydrogen peroxide. However, the classification excludes some peroxides.

Examples of materials classified as organic peroxides by DOT are acetyl peroxide solutions containing not over 25% peroxide, benzoyl peroxide, lauryl peroxide, and methyl ethyl ketone peroxide solution containing not over 9% active oxygen. (DOT prohibits shipment of acetyl peroxide solutions containing over 25% active oxygen, and methyl ethyl ketone peroxide solutions containing more than 9% active oxygen.)

Packaging of Hazardous Materials

"Packaging" is defined as the assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of DOT regulations. Packaging, as defined by DOT, includes

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containers, portable tanks, cargo tanks, and tank cars including tanks with multiple compartments.

DOT specification for packaging to be used for shipping hazardous materials, is required to be designed and constructed, and to have contents limited, so that under normal transportation conditions:

There will be no significant release of the hazardous materials to the environment,

The effectiveness of the packaging will not be substantially reduced, and

There will be no mixture of gases or vapors, in the package which could rupture the packaging.

The DOT regulations contain elaborate and detailed specifications for hundreds of different types of containers, ranging from bottles to tank cars to barges. Although many of the specifications include details that Agency personnel do not need to be familiar with, such as the quality of lumber, thickness of steel, and container construction features, there are some general requirements that may apply to shipment of field samples.

Closures must be adequate to prevent inadvertent leakage of the contents under normal conditions of transportation. Gasket closures must be fitted with gaskets of efficient material which will not deteriorate in contact with the contents of the container.

Polyethylene used for containers must be compatible with the material placed within the container, and must not be so permeable that a hazardous condition could be caused during transportation and handling.

In order to prevent rupture of

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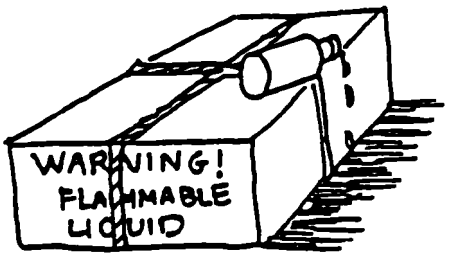
containers of liquids due to thermal expansion, DOT regulations specify that packagings must not be completely filled. The regulations specify that sufficient expansion space, or outage, must be provided within the container so that it will not be liquid full at 55°C (130°F).



All containers must be tightly and securely closed, and inside containers must be cushioned to prevent breakage or leakage. Samples generally can be shipped in non-specification containers, if the quantities are limited to about one pint, and if the containers are tightly closed and securely cushioned to prevent breakage.

Marking and Labeling

Marking and labeling regulations require that each person who offers, for transportation a hazardous material in a package having a rated capacity of 110 gallons or less shall mark and label the package to meet DOT requirements.

The required marking must include:

1. the proper shipping name of the material, and

2. the identification number assigned to the material.

It must also include:

3. the EPA-required markings if the material is a hazardous waste, and

4. special markings if the package contains liquid materials.

Required marking must include:

5. the required hazard label or labels, and

6. the Cargo Aircraft Only label, if required because the shipment

is not permitted aboard passenger-carrying aircraft.

Proper Shipping Name

The "proper shipping name" for a hazardous material is the name which has been assigned and listed in the DOT regulations. The proper shipping name is usually the technical name for the material, but there are some exceptions. It is necessary to check the DOT listing and use the name specified there.

If the proper shipping name for a mixture or solution that is a hazardous substance does not identify the constituents making it a hazardous substance, the name or names of such hazardous constituents must be entered with the proper shipping name shown on each package.

Identification Number

The package is to include the four-digit identification number listed in the DOT Hazardous Materials Tables, preceded by UN or NA as appropriate. (The numbers preceded by UN are associated with descriptions considered appropriate for both international and domestic shipments, and those preceded by NA are associated with descriptions appropriate for shipments within the United States and Canada.)

Hazardous Materials Tables

See the Hazardous Materials Table in Section 172.101 (or Appendix A, Table 2); this is the basic reference for using the DOT shipping regulations.

Column 1 has four coded designations, the most significant of which is the letter E which identifies materials which are subject to the requirements pertaining to hazardous substances if the concentration of the

material 10%, or a lower concentration, depending on the quantity.

Column 2 lists the proper shipping name of materials designated as hazardous materials.

Column 3 contains a designation of the hazard class corresponding to each proper shipping name. A material for which the entry in this column is "Forbidden," is prohibited from being offered or accepted for transportation unless the materials are diluted, stabilized, or otherwise modified to reduce the hazards to an acceptable level.

Column 3A lists the identification numbers assigned to hazardous materials.

Column 4 specifies the label required to be applied to each package.

Column 5 references the applicable packaging section of the DOT regulations. Exceptions are noted in Column 5A, and reference to specific packaging requirements and certain additional exceptions are noted in Column 5B.

Column 6A specifies the maximum net quantity permitted in one package, for transportation by passenger-carrying aircraft, and Column 6B specifies the maximum quantity permitted in one package, for transportation by cargo-only aircraft. Notice that the quantity allowed in cargo-only aircraft is greater.

Look now at the specific information for acetone, the eighth entry on the part of the page shown.

In Column 2 it can be seen that the proper shipping name for acetone is acetone.

In Column 3 it can be seen that

acetone is classified as a flammable liquid. The identification number for acetone is UN1090. The required label is Flammable Liquid. The packaging exceptions are listed, and it is seen that the maximum net quantity of acetone allowed in one package in a passenger-carrying aircraft is one quart. If personnel had to ship a large quantity of acetone to a field site, they would be permitted to ship up to ten gallons in one container in an aircraft that carried cargo only.

Marking for Hazardous Liquids

Liquid hazardous materials must be packed with closures upward and the outside package must be legibly marked "THIS SIDE UP" or "THIS END UP" to indicate the upward position of the inside packaging. (There is a limited exemption from this requirement for ground transportation of packages containing Class 1C flammable liquids in containers of one quart or less.)

Hazard Warning Labels

Each package must be clearly labeled with the required diamond-shaped hazard warning label. Labels generally must be placed on the surface of the package near the proper shipping name. (Labels may be placed on a securely attached tag, or affixed by other suitable means to compressed gas cylinders, to packages with very irregular surfaces that would prevent affixing a label, and to packages which have dimensions less than those of the required label and which contain no radioactive material.)

When labeling is required, labels must be displayed on at least two sides or two ends of, each package containing radioactive material, and each package having a volume of 64 cubic feet or more.

Warning labels are usually required for only one hazard.

Although most hazardous material packages are required to be labeled to signal only one class of hazard, there are some materials with more than one hazard, which require labeling of two classes of hazard.

For example, any material that is classed as Explosive A, Poison A or Radioactive and that meets the definition of another class as well, must be labeled as required for each class.

Any material classed as Poison B material that also meets the definition of a Flammable Liquid must be labeled as both: POISON B and FLAMMABLE LIQUID.

Any material classed as Oxidizer or Flammable Solid that also meets the definition of a Poison B material must be labeled for both hazards.

OXIDIZER	and	POISON
FLAMMABLE SOLID	and	POISON

A material classed as a Flammable Solid, that also meets the definition of a water reactive material, must have two labels attached:

FLAMMABLE SOLID and DANGEROUS WHEN WET

Since July 1, 1983, there are five other combinations of hazards that require packages to bear two different classes of warning labels:

CORROSIVE	and	POISON
POISON	and	CORROSIVE
FLAMMABLE LIQUID	and	CORROSIVE
FLAMMABLE SOLID	and	CORROSIVE
OXIDIZER	and	CORROSIVE

Here are four examples of some of the materials currently required to have two labels:

Fluorine, which is in the hazard class of nonflammable gas, is required to be labeled with Poison and Oxidizer hazard labels.

Germane is required to have the Poison Gas and the Flammable Gas hazard labels.

Nitric acid with a concentration over 40%, which is classed as a corrosive liquid, has to be labeled as an Oxidizer and as a Corrosive.

Fuming nitric acid has to be labeled as an Oxidizer and as a Poison.

TABLE 1

Material	Class of Hazard	Required Labels
Fluorine	Nonflammable Gas	POISON and OXIDIZER
Germane	Poison A	POISON GAS and FLAMMABLE GAS
Nitric acid, over 40%	Corrosive Liquid	OXIDIZER and CORROSIVE
Nitric acid, fuming	Oxidizer	OXIDIZER and POISON

Shipping Papers

Each person who offers a hazardous material for transportation must describe the hazardous material on the shipping paper in an exact and specific manner.

The shipping paper must include:

o proper shipping name for the material

NOTES

o identification number for the material (2 letters and 4 digits), and

o hazard class (unless the hazard is included in the shipping name)

If any solid or liquid material in a package meets the definition of a poisonous material, notwithstanding the class to which the material is assigned by DOT regulations, the word "Poison" must be entered on the shipping paper in association with the shipping description.

If the hazardous material is to be offered for transportation by air, and the regulations prohibit transportation aboard passenger-carrying aircraft, the words "Cargo Aircraft Only" (or Cargo-Only Aircraft) must be entered on the shipping paper after the basic description of the material.

The shipping paper must show the total quantity of the hazardous material being shipping.

The shipping paper must also include a certification that the hazardous materials listed on the shipping paper are properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to DOT regulations.

The shipping paper must include the shipper's signature.

See Figure 1 for an example of a commercially-available shipping paper. On shipping papers, hazardous materials must be given prominent attention, usually be being entered first, or possibly in a contrasting color, or by an X in a special column for noting hazardous materials. The second column on this shipping paper with the HM is for noting Hazardous Materials.

See Figure 2 for another example of a shipping paper with the second column for hazardous materials highlighted in red. There is a reminder in the third column to be sure to enter the proper shipping name for any hazardous material. The next column is for the hazard class, and the last column shown is for the identification number required.

Placarding of Vehicles

DOT regulations require shippers to provide, and carriers to use, placards for vehicles transporting more than 1000 pounds of hazardous material in one load. Placards are required on both sides and both ends of vehicles and railcars carrying more than 1000 pounds of hazardous materials.

Placards on railroad cars can provide important information, particularly if the car has been derailed.

Cargo tanks and tank cars are required to have the contents identified with a four-digit hazard identification number. The numbers may be placed within the placard, except for Poison Gas, Radioactive Material, and Explosives. If the numbers are not placed within the placard, they are to be 4 inches high on an orange background located below the placard.

The DOT has published an Emergency Response Guidebook for Hazardous Materials, which is available through the Government Printing Office and book stores. The Guidebook lists the materials alphabetically with their identification numbers, and also lists all numbers in numerical order to provide a cross-reference to the shipping names of materials.

Loading of Vehicles

DOT regulations for loading vehicles can be used as guidelines for EPA field activities. Any container or package of hazardous material placed in a vehicle should be secured against movement within the vehicle in which it is being transported, and should be braced or secured to prevent movement against other containers of hazardous material.

Reasonable care should be taken to prevent undue rise in temperature of containers and their contents during transit.

All reasonable precautions must be taken to prevent dropping of containers, or batteries, containing corrosive liquids. Storage batteries containing any electrolyte should be loaded so they are protected against other material falling onto or against them.

Shipping Samples

DOT regulations were not intended to cover shipment of samples collected by Agency personnel. However, the Agency has deemed it prudent to comply with the regulations for shipment of all samples which may be hazardous.

The designation of samples as "hazardous" is based on judgement of the conditions where the sample is taken and the possibility that the sample may be hazardous, in transportation, or to personnel receiving the samples in the laboratory. If a sample can be hazardous in transportation, as defined by the DOT regulations, it <u>must</u> be packaged and identified according to the regulations.

If the sample does not meet DOT definitions but may, nonetheless, be hazardous to personnel handling and receiving it, it should be packaged and

identified to the same standards.

Environmental Samples

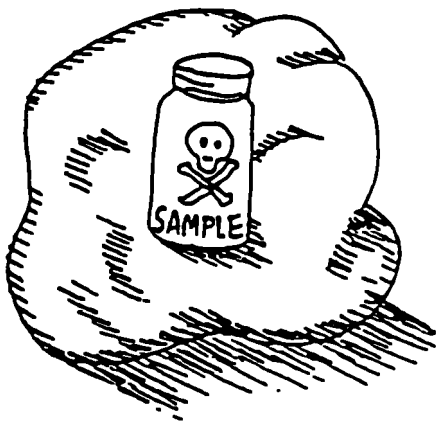
In general, "environmental samples" are those that are not expected to be grossly contaminated with high levels of toxic or hazardous materials. Examples of environmental samples are those taken from streams, ponds, or wells and from the ambient air.

Environmental samples that are preserved with hazardous materials such as nitric acid or sulfuric acid will in most cases have such dilute concentrations of the preservative that the sample will not have to be handled as a hazardous sample.

Environmental samples should be packaged just as securely as hazardous samples, mainly to protect the integrity of the sample. However, no DOT labeling should be used, no DOT shipping papers are required, and there are no restrictions on the mode of transportation (unless dry ice is used for preservation).

Hazardous Samples

"Hazardous samples" are those that are taken where high concentrations of hazardous materials are likely. For example, soil or water at spill sites or hazardous waste sites, samples from drums or tanks, leachates from hazardous waste sites, and water sources that are likely to be highly contaminated such as pits, ponds, lagoons and sampling wells.



Samples of hazardous materials must first be classified into the DOT categories of hazards. Then the samples must be packaged, and marked and labeled. Finally, the samples must be shipped as specified in DOT regulations.

If the material in the sample is known, or can be identified in the

field, determination of the DOT hazard class and required labeling can be done simply by reference to the DOT regulations. If, however, the specific hazards of a sample cannot be determined with certainty in the field, informed judgement must be used.

Procedure to Judge Hazard Class of Unknown Suspected Hazardous Material

There are several steps which should be taken to judge the appropriate DOT class of a material that is suspected of being hazardous. The following is a generalized procedure for classification of hazards, including the simplified steps that can be used by agreement between EPA and DOT.

This procedure should be used only when reliable identification of the material cannot be made in the field. The purposes of using this procedure are to meet DOT regulations as well as to provide protection for field and laboratory personnel. If a material fits within the definition for a particular class of hazard, the sample should be classified accordingly and subsequent handling, packaging, labeling and shipment should comply with the corresponding DOT regulations for that class.

Here is a simple outline of the order of judgement or determination necessary to classify the hazard of a sample:

If the material is likely to be an Explosive, it is classified as an Explosive.

If it is not, is it a radioactive material? If it is, classify it accordingly.

If not, is the material likely to be a compressed gas which may fall into the category of a Poison Gas, a

Flammable Gas, or a Non-flammable Gas?

If a material does not fit into any of these classes of hazard, a field sample can be classified as a Flammable Liquid, by agreement between EPA and DOT.

Use of the flammable liquid classification avoids the need for field testing, which might be almost impossible in some situations. The packaging that is required for a Flammable Liquid will provide all of the protection required for any material with a lesser hazard. Using the flammable liquid label is acceptable for samples which have no greater hazard. However, frequent use of the flammable liquid hazard label for materials which are not flammable liquids may eventually create problems in the laboratory if the label comes to be considered meaningless.

Classification of Hazards

1. Is the material likely to be an Explosive?

If the sample has been taken from the waste stream or effluent of a plant manufacturing explosives, it would be prudent to handle, package and ship the sample as if it were an Explosive Material.

2. Is the material likely to be Radioactive?

If the sample has been taken from an area known to be naturally radioactive, or to be contaminated with radioactive waste, and it is not possible to make radiation measurements, it would be prudent to handle, package, and ship the sample is if it were a Radioactive Material.

3. Is the material likely to be a Poison Gas, or a Poison Liquid in a

pressurized container?

Most of the materials classified as Poison A are gases, or liquids packaged under compressed gas, or liquids with very low boiling points. Poison A materials are usually shipped in cylinders, rather than in drums or drum-type containers.

If the material is in a compressed gas cylinder, or is for any reason suspected of being in the class of Poison Gas, precautions must be taken before sampling to prevent release of any of the extremely dangerous material. Protection must be provided for the person taking the samples and for everyone else who may be exposed if the poisonous material is released while a sample is being taken.

Samples of materials known to be, or suspected of being, in the class of Poison Gas must be packaged in a compressed gas cylinder for handling and shipment.

4. Is the material likely to be a compressed gas,, which could be a Flammable Gas or a Non-flammable Compressed Gas?

If the material is not in a compressed gas cylinder or other pressurized container, the material is not likely to be a compressed gas in either hazard class. If the material is likely to be a compressed gas, judge whether it is a Flammable Gas or a Non-flammable Gas, and handle, package and ship it as required for a material in that hazard class.

For samples containing unknown materials which may be hazardous but which do not fall into any of the previously listed classes, EPA generally will classify, package and ship them as a Flammable Liquid.

5. Is there any way to be certain that the material is not a Flammable Liquid.

If you can afford the time, we recommend that you try to use the labeling that will, in your judgement, most accurately describe the hazard of the sample, if it can be determined not to be a flammable liquid. Use of a hazard label that is reasonably descriptive of the expected hazards of the samples will assist in safe handling of the sample in the laboratory and will avoid encouraging a disregard of the Flammable Liquid hazard label.

You can be reasonably sure that a sample is not a flammable liquid by testing the material carefully with an explosimeter or other meter which gives readings in Percent of L.E.L. (lower explosive limit).

You may be able to make a judgement that a material to be sampled from a container or source that has been open to the atmosphere for some time is not likely to be a flammable liquid, based on the likelihood that any flammable liquid in the material would have evaporated during the time that the material was exposed to the atmosphere.

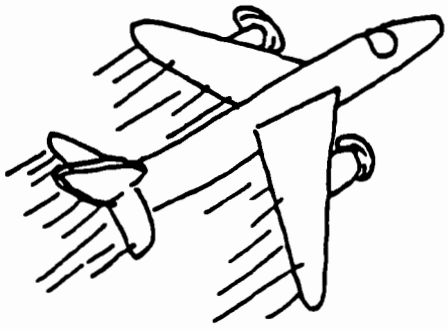
6. If the material is considered hazardous, but has none of the previously listed hazards, it should be packaged as flammable liquid, but it should be classified in one of the other DOT hazard classes:

- o Oxidizer
- o Flammable Solid
- o Corrosive liquid
- o Poison B
- o Corrosive solid
- o Irritating material
- o Combustible liquid

Communication about Hazards of Samples

For protection of both field and laboratory personnel we believe it is important for every person taking a sample to notify others about the hazards of the sample. DOT labels do not give enough information about combinations of hazards or unique characteristics of field samples. Therefore, we recommend the use of several channels of communication about unusual or particularly hazardous samples: Precautionary information such as a written note accompanying the sample or information written on the outer container holding the sample, a phone call to the laboratory which will receive the sample, or use of a hazard signal system.

Samples and Hazardous Materials to be Shipped or Taken on Aircraft



Samples and chemicals to be shipped or taken on aircraft deserve special attention. DOT regulations prohibit shipment of certain hazardous materials, and Federal law forbids the carriage of hazardous materials aboard aircraft in your luggage or on your person. Violations can result in severe penalties, up to $25,000 and five years imprisonment.

Hazardous materials include explosives, compressed gases, flammable liquids and solids, oxidizers, poisons, corrosives and radioactive materials. There are exceptions for small quantities of medicinal and toilet articles carried in your luggage and certain smoking materials carried on your person. If you need further information, contact your airline representative.

Dry Ice, or solid carbon dioxide, has a limited hazard classification if used to preserve samples shipped by aircraft. Packaging must be marked with

the designation ORM-A and arrangements to ship dry ice must be made in advance with the carrier.

Any chemicals or solvents that need to be transported to or from a field site rapidly can be shipped by aircraft only if you can comply fully with DOT regulations. Samples and materials that cannot be shipped by any passenger-carrying aircraft can, in many cases, be shipped by cargo-only aircraft.

Although there are many companies that ship air freight on cargo-only aircraft, shipment may depend on available space, and delivery time may not be predictable. If you select a shipping company that specializes in rapid shipment and delivery of small packages, be sure you know what limitations they have for accepting hazardous materials.

Recommendations

Taking solvents and analytical chemicals to the field, and bringing samples back to the laboratory, entails the risk of having a container break or leak during the trip. If this occurs there can be loss of material, risk of injury to personnel, and contamination of equipment and the environment.

Packaging hazardous materials to prevent spills or leakage is as important for protection of Agency personnel as it is for carrier employees. Marking and labeling packages and containers of hazardous materials should be routine within EPA, even for materials which may never be shipped by a carrier.

It is believed that it would be appropriate for every EPA vehicle which carries hazardous materials or hazardous samples to have a list of hazardous materials being carried in the vehicle. In case of an accident, the list would

provide information on hazardous materials in the vehicle, just as shipping papers are used for information on hazardous materials involved in large transportation incidents.

STUDENT EXERCISES

The following samples are to be shipped. Answer the following questions concerning each.

1. What is the proper hazardous material label for 40% nitric acid?

_____

2. If a material is a flammable liquid as well as a Poison B, what is its proper hazard label?

_____

3. If a substance is both a corrosive and a flammable liquid, what is its proper label?

_____

4. Environmental samples do not require what three things for shipping?

_____

_____

_____

5. If a substance is unknown, but is not believed to be explosive, corrosive, or poisonous, what is its DOT hazard class?

_____

APPENDICES TABLE OF CONTENTS

APPENDIX A FIGURE 1
HAZARDOUS MATERIALS FROM NON-SPECIFIC SOURCES

§ 261.31 Hazardous wastes from non-specific sources.

Industry and EPA hazardous waste No	Hazardous waste	Hazard code
Generic:		
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons, and sludges from the recovery of these solvents in degreasing operations.	(T)
F002	The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, and trichlorofluoromethane; and the still bottoms from the recovery of these solvents.	(T)
F003	The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; and the still bottoms from the recovery of these solvents.	(I)
F004	The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents.	(T)
F005	The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; and the still bottoms from the recovery of these solvents.	(I, T)
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.	(T)
F018	Wastewater treatment sludges from the chemical conversion coating of aluminum.	(T)
F007	Spent cyanide plating bath solutions from electroplating operations (except for precious metals electroplating spent cyanide plating bath solutions).	(R, T)
F008	Plating bath sludges from the bottom of plating baths from electroplating operations where cyanides are used in the process (except for precious metals electroplating plating bath sludges).	(R, T)
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent stripping and cleaning bath solutions).	(R, T)
F010	Quenching bath sludge from oil baths from metal heat treating operations where cyanides are used in the process (except for precious metals heat treating quenching bath sludges).	(R, T)
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations (except for precious metals heat treating spent cyanide solutions from salt bath pot cleaning).	(R, T)
F012	Quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process (except for precious metals heat treating quenching wastewater treatment sludges).	(T)

[46 FR 4617, Jan. 16, 1981, as amended at 46 FR 27477, May 20, 1981]

§ 261.32 Hazardous wastes from specific sources.

Industry and EPA hazardous waste No	Hazardous waste	Hazard code
Wood preservation: K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.	(T)
Inorganic pigments:		
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments.	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments.	(T)
K004	Wastewater treatment sludge from the production of zinc yellow pigments.	(T)
K005	Wastewater treatment sludge from the production of chrome green pigments.	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated).	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments.	(T)
K008	Oven residue from the production of chrome oxide green pigments.	(T)
Organic chemicals:		
K009	Distillation bottoms from the production of acetaldehyde from ethylene.	(T)
K010	Distillation [illegible]	[illegible]
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile.	(T)
K015	Still bottoms from the distillation of benzyl chloride.	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride.	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.	(T)
K018	Heavy ends from the fractionation column in ethyl chloride production.	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.	(T)
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production.	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production.	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene.	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene.	(T)
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene.	(T)
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene.	(T)
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene.	(T)
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene.	(T)
K026	Stripping still tails from the production of methyl ethyl pyridines.	(T)
K027	Centrifuge and distillation residues from toluene diisocyanate production.	(R, T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane.	(T)
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane.	(T)
K095	Distillation bottoms from the production of 1,1,1-trichloroethane.	(T)
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane.	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.	(T)
K083	Distillation bottoms from aniline production.	(T)
K103	Process residues from aniline extraction from the production of aniline.	(T)
K104	Combined wastewater streams generated from nitrobenzene/aniline production.	(T)
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes.	(T)
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes.	(T)
Inorganic chemicals:		
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used.	(T)
K073	Chlorinated hydrocarbon waste from the purification step of the diaphragm cell process using graphite anodes in chlorine production.	(T)
K106	Wastewater treatment sludge from the mercury cell process in chlorine production.	(T)
Pesticides:		
K031	By-product salts generated in the production of MSMA and cacodylic acid.	(T)
K032	Wastewater treatment sludge from the production of chlordane.	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane.	(T)
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane.	(T)
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane.	(T)
K035	Wastewater treatment sludges generated in the production of creosote.	(T)
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton.	(T)
K037	Wastewater treatment sludges from the production of disulfoton.	(T)
K038	Wastewater from the washing and stripping of phorate production.	(T)
K039	Filter cake from the filtration of diethylphosphorodithoic acid in the production of phorate.	(T)
K040	Wastewater treatment sludge from the production of phorate.	(T)
K041	Wastewater treatment sludge from the production of toxaphene.	(T)
K098	Untreated process wastewater from the production of toxaphene.	(T)
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T.	(T)
K043	2,6-Dichlorophenol waste from the production of 2,4-D.	(T)
K099	Untreated wastewater from the production of 2,4-D.	(T)
Explosives:		
K044	Wastewater treatment sludges from the manufacturing and processing of explosives.	(R)
K045	Spent carbon from the treatment of wastewater containing explosives.	(R)
K046	Wastewater treatment sludges from the manufacturing, formulation and loading of lead-based initiating compounds.	(T)
K047	Pink/red water from TNT [illegible]	[illegible]

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
K052	Tank bottoms (leaded) from the petroleum refining industry.	(T)
Iron and steel:		
K061	Emission control dust/sludge from the primary production of steel in electric furnaces.	(T)
K062	Spent pickle liquor from steel finishing operations.	(C, T)
Secondary lead:		
K069	Emission control dust/sludge from secondary lead smelting.	(T)
K100	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting.	(T)
Veterinary pharmaceuticals:		
K084	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
Ink formulation: K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead.	(T)
Coking:		
K060	Ammonia still lime sludge from coking operations.	(T)
K087	Decanter tank tar sludge from coking operations.	(T)

[46 FR 4618, Jan. 16, 1981, as amended at 46 FR 27476-27477, May 20, 1981]

§ 261.33 Discarded commercial chemical products, off-specification species, container residues, and spill residues thereof.

The following materials or items are hazardous wastes if and when they are discarded or intended to be discarded:

(a) Any commercial chemical product, or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section.

(b) Any off-specification commercial chemical product or manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

(c) Any residue remaining in a container or an inner liner removed from a container that has held any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraph (e) of this section, unless the container is empty as defined in § 261.7(b)(3) of this chapter.

[*Comment:* Unless the residue is being beneficially used or reused, or legitimately recycled or reclaimed; or being accumulated, stored, transported or treated prior to such use, re-use, recycling or reclamation, EPA consider residue to be intended for discard or a hazardous waste. An exam- would be where the residue remains in the container and the container is used to hold the same commercial chemical product or manufacturing chemical product or manufacturing chemical intermediate it previously held. An example of the discard of the residue would be where the drum is sent to a drum reconditioner who reconditions the drum but discards the residue.]

(d) Any residue or contaminated soil, water or other debris resulting from the cleanup of a spill into or on any land or water of any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section, or any residue or contaminated soil, water or other debris resulting from the cleanup of a spill, into or on any land or water, of any off-specification chemical product and manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

[*Comment:* The phrase "commercial chemical product or manufacturing chemical intermediate having the generic name listed in . ." refers to a chemical substance which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of chemical that are produced or manufactured is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the substances listed in paragraphs (e) or (f). Where a manufacturing process waste is deemed to be a hazardous waste because it contains a substance listed in paragraphs (e) or (f), such waste will be listed in either §§ 261.31 or 261.32 or will be identified as a hazardous waste by the characteristics set forth in Subpart C of this Part.]

(e) The commercial chemical products, manufacturing chemical intermediates or off-specification commercial chemical products or manufacturing chemical intermediates referred to in paragraphs (a) through (d) of this section, are identified as acute hazardous wastes (H) and are subject to be the small quantity exclusion defined in § 261.5(e).

[*Comment:* For the convenience of the regulated community the primary hazardous properties of these materials have been indicated by the letters T (Toxicity), and R (Reactivity). Absence of a letter indicates that the compound only is listed for acute toxicity.]

These wastes and their corresponding EPA Hazardous Waste Numbers are:

Hazardous waste No.	Substance
U023	Acetaldehyde, chloro-
U002	Acetamide, N-(aminothioxomethyl)-
U057	Acetamide, 2-fluoro-
U058	Acetic acid, fluoro-, sodium salt
U086	Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-, methyl ester
U001	3-(alpha-acetonylbenzyl)-4-hydroxycoumarin and salts
U002	1 Acetyl-2-thiourea
U003	Acrolein
U070	Aldicarb
U004	Aldrin
U005	Allyl alcohol
U006	Aluminum phosphide
U007	5-(Aminomethyl)-3-isoxazolol
U008	4-aAminopyridine
U009	Ammonium picrate (R)
U119	Ammonium vanadate
U010	Arsenic acid
U012	Arsenic (III) oxide
U011	Arsenic (V) oxide
U011	Arsenic pentoxide
U012	Arsenic trioxide
U038	Arsine, diethyl-
U014	Aziridine
U013	Barium cyanide
U024	Benzenamine, 4-chloro-
U077	Benzenamine, 4-nitro-

Hazardous waste No.	Substance
P014	Benzenethiol
P028	Benzyl chloride
P015	Beryllium dust
P016	Bis(chloromethyl) ether
P017	Bromoacetone
P018	Brucine
P021	Calcium cyanide
P123	Camphene, octachloro-
P103	Carbamimidoselenoic acid
P022	Carbon bisulfide
P022	Carbon disulfide
P095	Carbonyl chloride
P033	Chlorine cyanide
P023	Chloroacetaldehyde
P024	p-Chloroaniline
P026	1-(o-Chlorophenyl)thiourea
P027	3-Chloropropionitrile
P029	Copper cyanides
P030	Cyanides (soluble cyanide salts), not elsewhere specified
P031	Cyanogen
P033	Cyanogen chloride
P036	Dichlorophenylarsine
P037	Dieldrin
P038	Diethylarsine
P039	O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate
P041	Diethyl-p-nitrophenyl phosphate
P040	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	Diisopropyl fluorophosphate
P044	Dimethoate
P045	3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino)carbonyl] oxime
P071	O,O-Dimethyl O-p-nitrophenyl phosphorothioate
P082	Dimethylnitrosamine
P046	alpha, alpha-Dimethylphenethylamine
P047	4,6-Dinitro-o-cresol and salts
P034	4,6-Dinitro-o-cyclohexylphenol
P048	2,4-Dinitrophenol
P020	Dinoseb
P085	Diphosphoramide, octamethyl-
P039	Disulfoton
P049	2,4-Dithiobiuret
P109	Dithiopyrophosphoric acid, tetraethyl ester
P050	Endosulfan
P088	Endothall
P051	Endrin
P042	Epinephrine
P046	Ethanamine, 1,1-dimethyl-2-phenyl-
P084	Ethanamine, N-ethyl-N-nitroso-
P101	Ethyl cyanide
P054	Ethylenimine
P097	Famphur
P056	Fluorine
P057	Fluoroacetamide
P058	Fluoroacetic acid, sodium salt
P065	Fulminic acid, mercury(II) salt (R,T)
P059	Heptachlor
P061	1,2,3,4,10,10-Hexachloro-6,7 epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4,5,8-dimethanonaphthalene
P037	1,2,3,4,10 10-Hexachloro-6,7-epoxy-1,4,4a,5 6,7,8 8a-octahydro-endo,exo-1,4,5 8-dimethanonaphthalene
P060	1,2,3,4,10 10-Hexachloro-1,4,4a,5,8 8a-hexahydro-1,4 5,8-endo- *g-dimethanonaphthalene

Hazardous waste No	Substance
P060	Hexachlorohexahydro-endo,exo-dimethanonaphthalene
P062	Hexaethyl tetraphosphate
P116	Hydrazinecarbothioamide
P068	Hydrazine, methyl-
P063	Hydrocyanic acid
P063	Hydrogen cyanide
P096	Hydrogen phosphide
P064	Isocyanic acid, methyl ester
P007	3(2H) Isoxazolone, 5 (aminomethyl)-
P092	Mercury, (acetato-O)phenyl-
P065	Mercury fulminate (R,T)
P016	Methane, oxybis(chloro-
P112	Methane, tetranitro- (R)
P118	Methanethiol, trichloro-
P059	4,7 Methano-1H-Indene, 1,4,5 6,7 8 8-heptachloro-3a,4,7,7a tetrahydro-
P066	Methomyl
P067	2 Methylaziridine
P068	Methyl hydrazine
P064	Methyl isocyanate
P069	2 Methylactonitrile
P071	Methyl parathion
P072	alpha Naphthylthiourea
P073	Nickel carbonyl
P074	Nickel cyanide
P074	Nickel(II) cyanide
P073	Nickel tetracarbonyl
P075	Nicotine and salts
P076	Nitric oxide
P077	p-Nitroaniline
P078	Nitrogen dioxide
P076	Nitrogen(II) oxide
P078	Nitrogen(IV) oxide
P081	Nitroglycerine (R)
P082	N Nitrosodimethylamine
P084	N Nitrosomethylvinylamine
P050	5-Norbornene-2,3-dimethanol, 1 4 5 6,7,7-hexachloro, cyclic sulfite
P085	Octamethylpyrophosphoramide
P087	Osmium oxide
P087	Osmium tetroxide
P088	7-Oxabicyclo[2 2 1]heptane-2 3-dicarboxylic acid
P089	Parathion
P034	Phenol, 2-cyclohexyl-4 6-dinitro-
P048	Phenol, 2,4-dinitro-
P047	Phenol 2 4-dinitro-6-methyl-
P020	Phenol 2 4-dinitro-6-(1 methylpropyl)-
P009	Phenol, 2 4 6-trinitro-, ammonium salt (R)
P036	Phenyl dichloroarsine
P092	Phenylmercuric acetate
P093	N-Phenylthiourea
P094	Phorate
P095	Phosgene
P096	Phosphine
P041	Phosphonic acid, diethyl p-nitrophenyl ester
P044	Phosphorodithioic acid, O O dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	Phosphorofluoric acid, bis(1 methylethyl)-ester
P094	Phosphorothioic acid, O O-diethyl (ethylthio)methyl ester
P089	Phosphorothioic acid, O O-diethyl O-(p-nitrophenyl) ester
P040	Phosphorothioic acid, O O-diethyl O- pyrazinyl ester
P097	Phosphorothioic acid, O O-dimethyl O-[p-[(di-

Hazardous waste No	Substance
P070	Propanal, 2-methyl-2 (methylthio)-, O-[(methylamino)carbonyl]oxime
P101	Propanenitrile
P027	Propanenitrile, 3-chloro-
P069	Propanenitrile, 2-hydroxy-2-methyl-
P081	1,2 3-Propanetriol, trinitrate- (R)
P017	2 Propanone, 1-bromo-
P102	Propargyl alcohol
P003	2-Propenal
P005	2 Propen-1-ol
P067	1 2 Propylenimine
P102	2-Propyn-1-ol
P008	4-Pyridinamine
P075	Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts
P111	Pyrophosphonic acid, tetraethyl ester
P103	Selenourea
P104	Silver cyanide
P105	Sodium azide
P106	Sodium cyanide
P107	Strontium sulfide
P108	Strychnidin-10-one and salts
P018	Strychnidin-10-one 2,3-dimethoxy-
P108	Strychnine and salts
P115	Sulfuric acid, thallium(I) salt
P109	Tetraethyldithiopyrophosphate
P110	Tetraethyl lead
P111	Tetraethylpyrophosphate
P112	Tetranitromethane (R)
P062	Tetraphosphonic acid, hexaethyl ester
P113	Thallic oxide
P113	Thallium(III) oxide
P114	Thallium(I) selenite
P115	Thallium(I) sulfate
P045	Thiofanox
P049	Thioimidodicarbonic diamide
P014	Thiophenol
P116	Thiosemicarbazide
P026	Thiourea (2-chlorophenyl)-
P072	Thiourea, 1-naphthalenyl-
P093	Thiourea, phenyl-
P123	Toxaphene
P118	Trichloromethanethiol
P119	Vanadic acid, ammonium salt
P120	Vanadium pentoxide
P120	Vanadium(V) oxide
P001	Warfarin
P121	Zinc cyanide
P122	Zinc phosphide (R T)

(f) The commercial chemical products, manufacturing chemical intermediates, or off-specification commercial chemical products referred to in paragraphs (a) through (d) of this section, are identified as toxic wastes (T) unless otherwise designated and are subject to the small quantity exclusion defined in § 261.5 (a) and (f).

[*Comment:* For the convenience of the regulated community, the primary hazardous properties of these materials have been indicated by the letters T (Toxicity) R (Reac-

Hazardous Waste No.	Substance
U090	Benzene, 1,2-methylenedioxy-4-propyl-
U055	Benzene, (1-methylethyl)- (I)
U169	Benzene, nitro- (I,T)
U183	Benzene, pentachloro-
U185	Benzene, pentachloro-nitro-
U020	Benzenesulfonic acid chloride (C,R)
U020	Benzenesulfonyl chloride (C,R)
U207	Benzene, 1,2,4 5-tetrachloro-
U023	Benzene, (trichloromethyl)-(C,R,T)
0234	Benzene, 1,3,5-trinitro- (R,T)
U021	Benzidine
U202	1,2 Benzisothiazolin-3-one, 1,1-dioxide
U120	Benzo[j,k]fluorene
U022	Benzo[a]pyrene
U022	3,4-Benzopyrene
U197	p-Benzoquinone
U023	Benzotrichloride (C,R,T)
U050	1,2 Benzphenanthrene
U085	2,2' Bioxirane (I,T)
U021	[1,1' Biphenyl]-4,4'-diamine
U073	[1,1' Biphenyl]-4 4'-diamine, 3,3'-dichloro-
U091	[1,1'-Biphenyl]-4,4'-diamine, 3 3'-dimethoxy-
U095	[1,1'-Biphenyl]-4 4'-diamine, 3,3'-dimethyl-
U024	Bis(2-chloroethoxy) methane
U027	Bis(2-chloroisopropyl) ether
U244	Bis(dimethylthiocarbamoyl) disulfide
U028	Bis(2-ethylhexyl) phthalate
U246	Bromine cyanide
U225	Bromoform
U030	4-Bromophenyl phenyl ether
U128	1,3-Butadiene, 1,1,2 3,4,4-hexachloro-
U172	1 Butanamine, N-butyl-N-nitroso-
U035	Butanoic acid, 4-[Bis(2-chloroethyl)amino] benzene-
U031	1-Butanol (I)
U159	2 Butanone (I,T)
U160	2-Butanone peroxide (R,T)
U053	2 Butenal
U074	2 Butene, 1,4-dichloro- (I,T)
U031	n-Butyl alcohol (I)
U136	Cacodylic acid
U032	Calcium chromate
U238	Carbamic acid, ethyl ester
U178	Carbamic acid, methylnitroso-, ethyl ester
U176	Carbamide, N-ethyl-N-nitroso-
U177	Carbamide, N-methyl-N-nitroso-
U219	Carbamide, thio-
U097	Carbamoyl chloride, dimethyl-
U215	Carbonic acid, dithallium(I) salt
U156	Carbonochloridic acid, methyl ester (I,T)
U033	Carbon oxyfluoride (R,T)
U211	Carbon tetrachloride
U033	Carbonyl fluoride (R,T)
U034	Chloral
U035	Chlorambucil
U036	Chlordane, technical
U026	Chlornaphazine
U037	Chlorobenzene
U039	4-Chloro-m-cresol
U041	1-Chloro-2 3-epoxypropane
U042	2-Chloroethyl vinyl ether
U044	Chloroform
U046	Chloromethyl methyl ether
U047	beta-Chloronaphthalene
U048	o-Chlorophenol
U049	4-Chloro-o-toluidine, hydrochloride
U032	Chromic acid, calcium salt
U050	Chrysene

Hazardous Waste No.	Substance
U055	Cumene (I)
U246	Cyanogen bromide
U197	1,4-Cyclohexadienedione
U056	Cyclohexane (I)
U057	Cyclohexanone (I)
U130	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexa- ch
U058	Cyclophosphamide
U240	2,4-D, salts and esters
U059	Daunomycin
U060	DDD
U061	DDT
U142	Decachlorooctahydro-1,3,4-methano-2H-cyclobuta[c,d]-pentalen-2-one
U062	Diallate
U133	Diamine (R,T)
U221	Diaminotoluene
U063	Dibenz[a,h]anthracene
U063	1,2:5,6-Dibenzanthracene
U064	1,2:7,8-Dibenzopyrene
U064	Dibenz[a,i]pyrene
U066	1,2-Dibromo-3-chloropropane
U069	Dibutyl phthalate
U062	S-(2,3-Dichloroallyl) diisopropylthiocarbam
U070	o-Dichlorobenzene
U071	m-Dichlorobenzene
U072	p-Dichlorobenzene
U073	3,3'-Dichlorobenzidine
U074	1,4-Dichloro-2-butene (I,T)
U075	Dichlorodifluoromethane
U192	3,5-Dichloro-N-(1,1-dimethyl-2-propynyl) benzamide
U060	Dichloro diphenyl dichloroethane
U061	Dichloro diphenyl trichloroethane
U078	1,1-Dichloroethylene
U079	1,2-Dichloroethylene
U025	Dichloroethyl ether
U081	2,4-Dichlorophenol
U082	2,6-Dichlorophenol
U240	2,4-Dichlorophenoxyacetic acid, salts esters
U083	1,2-Dichloropropane
U084	1,3-Dichloropropene
U085	1,2:3,4-Diepoxybutane (I,T)
U108	1,4-Diethylene dioxide
U086	N,N-Diethylhydrazine
U087	O,O-Diethyl-S-methyl-dithiophosphate
U088	Diethyl phthalate
U089	Diethylstilbestrol
U148	1,2-Dihydro-3 6-pyridazinedione
U090	Dihydrosafrole
U091	3,3'-Dimethoxybenzidine
U092	Dimethylamine (I)
U093	Dimethylaminoazobenzene
U094	7,12-Dimethylbenz[a]anthracene
U095	3,3'-Dimethylbenzidine
U096	alpha alpha-Dimethylbenzylhydroperoxide
U097	Dimethylcarbamoyl chloride
U098	1,1-Dimethylhydrazine
U099	1,2 Dimethylhydrazine
U101	2,4-Dimethylphenol
U102	Dimethyl phthalate
U103	Dimethyl sulfate
U105	2,4-Dinitrotoluene
U106	2,6-Dinitrotoluene
U107	Di-n-octyl phthalate
U108	1 4-Dioxane
U109	1 2- Diphenylhydrazine
U110	Dipropylamine (I)

Hazardous Waste No.	Substance
U076	Ethane, 1,1-dichloro-
U077	Ethane, 1,2-dichloro-
U114	1,2 Ethanediylbiscarbamodithioic acid
U131	Ethane, 1,1,1,2,2,2-hexachloro-
U024	Ethane, 1,1'-[methylenebis(oxy)]bis[2-chlo
U003	Ethanenitrile (I, T)
U117	Ethane,1,1'-oxybis- (I)
U025	Ethane, 1,1'-oxybis[2-chloro-
U184	Ethane, pentachloro-
U208	Ethane, 1,1,1,2 tetrachloro-
U209	Ethane, 1,1,2,2 tetrachloro-
U218	Ethanethioamide
U247	Ethane, 1,1,1,-trichloro-2,2-bis(p-metho phenyl).
U227	Ethane, 1,1,2 trichloro-
U043	Ethene, chloro-
U042	Ethene, 2-chloroethoxy-
U078	Ethene, 1,1-dichloro-
U079	Ethene, trans-1 2-dichloro-
U210	Ethene 1,1 2,2 tetrachloro-
U173	Ethanol, 2 2' (nitrosoimino)bis-
U004	Ethanone, 1-phenyl-
U006	Ethanoyl chloride (C,R,T)
U112	Ethyl acetate (I)
U113	Ethyl acrylate (I)
U238	Ethyl carbamate (urethane)
U038	Ethyl 4 4'-dichlorobenzilate
U114	Ethylenebis(dithiocarbamic acid)
U067	Ethylene dibromide
U077	Ethylene dichloride
U115	Ethylene oxide (I,T)
U116	Ethylene thiourea
U117	Ethyl ether (I)
U076	Ethylidene dichloride
U118	Ethylmethacrylate
U119	Ethyl methanesulfonate
U139	Ferric dextran
U120	Fluoranthene
U122	Formaldehyde
U123	Formic acid (C,T)
U124	Furan (I)
U125	2 Furancarboxaldehyde (I)
U147	2,5 Furandione
U213	Furan, tetrahydro- (I)
U125	Furfural (I)
U124	Furfuran (I)
U206	D-Glucopyranose, 2-deoxy-2[3-methyl-3-ni trosoureido]-
U126	Glycidylaldehyde
U163	Guanidine, N-nitroso-N-methyl-N'nitro-
U127	Hexachlorobenzene
U128	Hexachlorobutadiene
U129	Hexachlorocyclohexane (gamma isomer)
U130	Hexachlorocyclopentadiene
U131	Hexachloroethane
U132	Hexachlorophene
U243	Hexachloropropene
U133	Hydrazine (R,T)
U086	Hydrazine, 1,2-diethyl-
U098	Hydrazine, 1,1-dimethyl-
U099	Hydrazine, 1,2-dimethyl-
U109	Hydrazine, 1,2-diphenyl-
U134	Hydrofluoric acid (C,T)
U134	Hydrogen fluoride (C,T)
U135	Hydrogen sulfide
U096	Hydroperoxide, 1-methyl-1-phenylethyl- (R)
U136	Hydroxydimethylarsine oxide
U116	2-Imidazolidinethione
U137	Indeno[1,2,3-cd]pyrene

Hazardous Waste No.	Substance
U142	Kepone
U143	Lasiocarpine
U144	Lead acetate
U145	Lead phosphate
U146	Lead subacetate
U129	Lindane
U147	Maleic anhydride
U148	Maleic hydrazide
U149	Malononitrile
U150	Melphalan
U151	Mercury
U152	Methacrylonitrile (I,T)
U092	Methanamine, N-methyl- (I)
U029	Methane, bromo-
U045	Methane, chloro- (I,T)
U046	Methane, chloromethoxy-
U068	Methane, dibromo-
U080	Methane, dichloro-
U075	Methane, dichlorodifluoro-
U138	Methane, iodo-
U119	Methanesulfonic acid, ethyl ester
U211	Methane, tetrachloro-
U121	Methane, trichlorofluoro-
U153	Methanethiol (I,T)
U225	Methane, tribromo-
U044	Methane, trichloro-
U121	Methane, trichlorofluoro-
U123	Methanoic acid (C,T)
U036	4,7 Methanoindan, 1,2,4,5,6,7,8,8-octa chloro-3a,4,7,7a-tetrahydro-
U154	Methanol (I)
U155	Methapyrilene
U247	Methoxychlor.
U154	Methyl alcohol (I)
U029	Methyl bromide
U186	1-Methylbutadiene (I)
U045	Methyl chloride (I,T)
U156	Methyl chlorocarbonate (I,T)
U226	Methylchloroform
U157	3-Methylcholanthrene
U158	4,4'-Methylenebis(2-chloroaniline)
U132	2,2'-Methylenebis(3,4,6-trichlorophenol)
U068	Methylene bromide
U080	Methylene chloride
U122	Methylene oxide
U159	Methyl ethyl ketone (I,T)
U160	Methyl ethyl ketone peroxide (R,T)
U138	Methyl iodide
U161	Methyl isobutyl ketone (I)
U162	Methyl methacrylate (I,T)
U163	N-Methyl-N'-nitro-N-nitrosoguanidine
U161	4-Methyl-2-pentanone (I)
U164	Methylthiouracil
U010	Mitomycin C
U059	5,12 Naphthacenedione, [8S-cis]-8-acetyl-10-[(3-amino-2,3,6-trideoxy-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-
U165	Naphthalene
U047	Naphthalene, 2-chloro-
U166	1,4-Naphthalenedione
U236	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl-[1,1'-biphenyl]-4,4'-diyl)bis(azo)]bis(5-amino-4-hydroxy)-,tetrasodium salt
U166	1,4-Naphthoquinone
U167	1-Naphthylamine
U168	2-Naphthylamine
U167	alpha-Naphthylamine
U168	beta-Naphthylamine

Hazardous Waste No.	Substance
U170	p-Nitrophenol
U171	2-Nitropropane (I)
U172	N-Nitrosodi-n-butylamine
U173	N-Nitrosodiethanolamine
U174	N-Nitrosodiethylamine
U111	N-Nitroso-N-propylamine
U176	N-Nitroso-N-ethylurea
U177	N-Nitroso-N-methylurea
U178	N-Nitroso-N-methylurethane
U179	N-Nitrosopiperidine
U180	N-Nitrosopyrrolidine
U181	5-Nitro-o-toluidine
U193	1,2-Oxathiolane, 2,2-dioxide
U058	2H-1,3,2-Oxazaphosphorine, 2-[bis(2-chloroethyl)amino]tetrahydro-, oxide 2-
U115	Oxirane (I,T)
U041	Oxirane, 2-(chloromethyl)-
U182	Paraldehyde
U183	Pentachlorobenzene
U184	Pentachloroethane
U185	Pentachloronitrobenzene
U242	Pentachlorophenol
U186	1,3-Pentadiene (I)
U187	Phenacetin
U188	Phenol
U048	Phenol, 2-chloro-
U039	Phenol, 4-chloro-3-methyl-
U081	Phenol, 2,4-dichloro-
U082	Phenol, 2,6-dichloro-
U101	Phenol, 2,4-dimethyl-
U170	Phenol, 4-nitro-
U242	Phenol, pentachloro-
U212	Phenol, 2,3,4,6-tetrachloro-
U230	Phenol, 2,4,5-trichloro-
U231	Phenol, 2,4,6-trichloro-
U137	1,10-(1,2-phenylene)pyrene
U145	Phosphoric acid, Lead salt
U087	Phosphorodithioic acid, 0,0-diethyl-, S-methyl ester
U189	Phosphorous sulfide (R)
U190	Phthalic anhydride
U191	2-Picoline
U192	Pronamide
U194	1-Propanamine (I,T)
U110	1-Propanamine, N-propyl- (I)
U066	Propane, 1,2-dibromo-3-chloro-
U140	Propanenitrile
U171	Propane, 2-nitro- (I)
U027	Propane, 2,2'-oxybis[2-chloro-
U193	1,3-Propane sultone
U235	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U126	1-Propanol, 2,3-epoxy-
U140	1-Propanol, 2-methyl- (I,T)
U002	2-Propanone (I)
U007	2-Propenamide
U084	Propene, 1,3-dichloro-
U243	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	2-Propenenitrile
U152	2-Propenenitrile, 2-methyl- (I,T)
U008	2-Propenoic acid (I)
U113	2-Propenoic acid, ethyl ester (I)
U118	2-Propenoic acid, 2-methyl-, ethyl ester
U162	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U233	Propionic acid, 2-(2,4,5-trichlorophenoxy)-
U194	n-Propylamine (I,T)
U083	Propylene dichloride
U196	Pyridine
U191	Pyridine, 2-[(2-(dimethylamino)-2-thenylamino)-

Hazardous Waste No.	Substance
U164	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	Pyrrole, tetrahydro-N-nitroso-
U200	Reserpine
U201	Resorcinol
U202	Saccharin and salts
U203	Safrole
U204	Selenious acid
U204	Selenium dioxide
U205	Selenium disulfide (R,T)
U015	L-Serine, diazoacetate (ester)
U233	Silvex
U006	4,4'-Stilbenediol, alpha,alpha'-diethyl-
U206	Streptozotocin
U135	Sulfur hydride
U103	Sulfuric acid, dimethyl ester
U189	Sulfur phosphide (R)
U205	Sulfur selenide (R,T)
U232	2,4,5-T
U207	1,2,4,5-Tetrachlorobenzene
U208	1,1,1,2-Tetrachloroethane
U209	1,1,2,2-Tetrachloroethane
U210	Tetrachloroethylene
U212	2,3,4,6-Tetrachlorophenol
U213	Tetrahydrofuran (I)
U214	Thallium(I) acetate
U215	Thallium(I) carbonate
U216	Thallium(I) chloride
U217	Thallium(I) nitrate
U218	Thioacetamide
U153	Thiomethanol (I,T)
U219	Thiourea
U244	Thiram
U220	Toluene
U221	Toluenediamine
U223	Toluene diisocyanate (R,T)
U222	O-Toluidine hydrochloride
U011	1H-1,2,4-Triazol-3-amine
U226	1,1,1-Trichloroethane
U227	1,1,2-Trichloroethane
U228	Trichloroethene
U228	Trichloroethylene
U121	Trichloromonofluoromethane
U230	2,4,5-Trichlorophenol
U231	2,4,6-Trichlorophenol
U232	2,4,5-Trichlorophenoxyacetic acid
U234	sym-Trinitrobenzene (R,T)
U182	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	Tris(2,3-dibromopropyl) phosphate
U236	Trypan blue
U237	Uracil, 5[bis(2-chloroethyl)amino]-
U237	Uracil mustard
U043	Vinyl chloride
U239	Xylene (I)
U200	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester.

APPENDIX A FIGURE 2
CERCLA LIST

CERCLA List

Note: The following listing fulfills the requirement of Section 306(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), that all "hazardous substances," as defined in that Act, shall be listed as hazardous materials under the Hazardous Materials Transportation Act. That definition includes substances listed under Section 311(b)(2)(A) of the Federal Water Pollution Control Act (FWPCA). Those materials have already been listed as hazardous substances in the Hazardous Materials Table of this section, and that listing is not repeated here. The definition of "hazardous substance" in CERCLA also includes substances designated under Section 307(a) of the FWPCA, Section 3001 of the Solid Waste Disposal Act, and Section 112 of the Clean Air Act. The following listing consists of materials designated under those authorities. Materials indicated in the listing by an asterisk (*) are also listed in the Hazardous Materials Table as hazardous substances. With respect to other materials in the following listing, those that are not forbidden materials or fall within a hazard class are not subject to the requirements of this Subchapter.

It should be noted that Section 306(b) of CERCLA provides that common and contract carriers may be held liable under that Act for the release of a "hazardous substance" as defined in that Act, after the effective date of the listing of that substance as a hazardous material under the Hazardous Materials Transportation Act.

Specific Chemical Wastes

EPA hazardous waste No.	Substance
U001	*Acetaldehyde (I)
U004	Acetaldehyde, trichloro-
U187	Acetamide, N-(4-ethoxyphenyl)-
U005	Acetamide, N-9H-fluoren-2-yl-
U113	Acetic acid, ethyl ester (I)
U144	*Acetic acid, lead salt
U214	Acetic acid, thallium (I) salt
U002	Acetone (I)
U003	Acetonitrile (I,T)
U004	Acetophenone
U005	2-Acetylaminofluorene
U006	*Acetyl Chloride (C,R,T)
U007	Acrylamide
U008	Acrylic acid (I)
U009	*Acrylonitrile
U150	Alanine, 3-[p-bis(2-chloroethyl)amino]phenyl-, L-
U011	Amitrole

Specific Chemical Wastes—Continued

EPA hazardous waste No.	Substance
U010	Azirino(2',3':3,4)pyrrolo(1,2-a)indole-4,7-dione,6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-
U157	Benz[j]aceanthrylene,1,2-dihydro-3-methyl-
U016	Benz[c]acridine
U018	3,4-Benzacridine
U017	Benzalchloride
U018	Benz[a]anthracene
U018	1,2-Benzanthracene
U094	1,2-Benzanthracene,7,12-dimethyl-
U012	*Benzenamine (I,T)
U014	Benzenamine, 4,4-carbonimidoylbis(N,N-dimethyl-
U049	Benzenamine, 4-chloro-2-methyl-
U093	Benzenamine, N,N-dimethyl-4-phenylazo-
U158	Benzenamine, 4,4'-methylenebis(2-chloro-
U222	Benzenamine, 2-methyl-, hydrochloride
U181	Benzenamine, 2-methyl-5-nitro-
U019	*Benzene (I,T)
U038	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	Benzene, 1-bromo-4-phenoxy-
U037	*Benzene, chloro-
U190	1,2-Benzenedicarboxylic acid anhydride
U028	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	*1,2-Benzenedicarboxylic acid, dibutyl ester
U088	1,2-Benzenedicarboxylic acid, diethyl ester
U102	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	1,2-Benzenedicarboxylic acid, di-n-octyl ester
U070	*Benzene, 1,2-dichloro-
U071	*Benzene, 1,3-dichloro-
U072	*Benzene, 1,4-dichloro-
U017	Benzene, (dichloromethyl)-
U223	Benzene, 1,3-diisocyanatomethyl-(R,T)
U239	*Benzene, dimethyl-(I,T)
U201	*1,3-Benzenediol
U127	Benzene, hexachloro-
U056	*Benzene, hexahydro-(I)
U188	*Benzene, hydroxy-
U220	*Benzene, methyl-
U105	*Benzene, 1-methyl-2,4-dinitro-
U106	*Benzene, 1-methyl-2,6-dinitro-
U203	Benzene, 1,2-methylenedioxy-4-allyl-
U141	Benzene, 1,2-methylenedioxy-4-propenyl-
U090	Benzene, 1,2-methylenedioxy-4-propyl-
U055	Benzene, (1-methylethyl)-(I)
U169	*Benzene, nitro-(I,T)
U183	Benzene, pentachloro-
U185	Benzene, pentachloro-nitro-
U020	Benzenesulfonic acid chloride (C,R)
U020	Benzenesulfonyl chloride (C,R)
U207	Benzene, 1,2,4,5-Tetrachloro-
U023	Benzene, (trichloromethyl)-(C,R,T)
U234	Benzene, 1,3,5-trinitro-(R,T)
U021	Benzidine
U202	1,2-Benzisothiazolin-3-one, 1,1-dioxide
U120	Benzo[j,k] fluorene
U022	Benzo[a]pyrene
U022	3,4-Benzopyrene
U197	p-Benzoquinone
U023	Benzotrichloride (C,R,T)
U050	1,2-Benzphenanthrene
U085	2,2'-Bioxirane (I,T)

Specific Chemical Wastes—Continued

EPA hazardous waste No.	Substance
U095	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
U073	Bis(2-chloroethoxy) methane
U027	Bis(2-chloroisopropyl) ether
U074	Bis(dimethylthiocarbamoyl) disulfide
U028	Bis(2-ethylhexyl) phthalate
U064	Bromine cyanide
U225	Bromoform
U030	4-Bromophenyl phenyl ether
U128	1,3-Butadiene, 1,1,2,3,4,4,-hexachloro-
U172	1-Butanamine, N-butyl-N-nitroso-
U035	Butanoic acid, 4-[bis(2-chloroethyl) amino] benzene-
U031	1-Butanol (I)
U159	2-Butanone (I,T)
U160	2-Butanone peroxide (R,T)
U053	*2-Butenal
U074	2-Butene, 1,4,-dichloro-(I,T)
U031	n-Butyl alcohol (I)
U136	Cacodylic acid
U032	*Calcium chromate
U238	Carbamic acid, ethyl ester
U178	Carbamic acid, methylnitroso-, ethyl ester
U176	Carbamide, N-ethyl-N-nitroso-
U177	Carbamide, N-methyl-N-nitroso-
U119	Carbamide, thio-
U097	Carbamoyl chloride, dimethyl-
U215	Carbonic acid, dithallium(I) salt
U156	Carbonochloridic acid, methyl ester (I,T)
U033	Carbon oxyfluoride (R,T)
U211	*Carbon tetrachloride
U033	Carbonyl fluoride (R,T)
U034	Chloral
U035	Chlorambucil
U036	*Chlordane, technical
U026	Chlornaphazine
U037	*Chlorobenzene
U245	1-(p-Chlorobenzoyl)-5-methoxy-2-methylindole-3-acetic acid
U039	4-Chloro-m-cresol
U041	1-Chloro-2,3-epoxypropane
U042	2-Chloroethyl vinyl ether
U044	*Chloroform
U046	Chloromethyl methyl ether
U047	beta-Chloronaphthalene
U048	o-Chlorophenol
U049	4-Chloro-o-toluidine, hydrochloride
U032	*Chromic acid, calcium salt
U050	Chrysene
U051	Creosote
U052	*Cresols
U052	Cresylic acid
U053	*Crotonaldehyde
U055	Cumene (I)
U246	Cyanogen bromide
U197	1,4-Cyclohexadienedione
U056	*Cyclohexane (I)
U057	Cyclohexanone (I)
U130	*1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	Cyclophosphamide
U240	*2,4-D, salts and esters
U059	Daunomycin
U060	*DDD
U061	*DDT
U142	*Decachlorooctahydro-1,3,4-methano-2H-cyclobuta [c,d]-pentalen-2-one
U062	Diallate

Specific Chemical Wastes—Continued

EPA hazardous waste No.	Substance
U063	1,2:5,6-Dibenzanthracene
U064	1,2:7,8-Dibenzopyrene
U064	Dibenz [a,i] pyrene
U066	1,2-Dibromo-3-chloropropane
U069	*Dibutyl phthalate
U062	S-(2,3-Dichloroallyl) diisopropylthiocarbamate
U070	*o-Dichlorobenzene
U071	*m-Dichlorobenzene
U072	*p-Dichlorobenzene
U073	3,3'-Dichlorobenzidine
U074	1,4-Dichloro-2-butene (I,T)
U075	Dichlorodifluoromethane
U192	3,5-Dichloro-N-(1,1-dimethyl-2-propynyl) benzamide
U060	*Dichloro diphenyl dichloroethane
U061	*Dichloro diphenyl trichloroethane
U078	*1,1-Dichloroethylene
U079	1,2-Dichloroethylene
U025	Dichloroethyl ether
U081	2,4-Dichlorophenol
U082	2,6-Dichlorophenol
U240	*2,4-Dichlorophenoxyacetic acid, salts and esters
U083	*1,2-Dichloropropane
U084	*1,3-Dichloropropene
U085	1,2:3,4-Diepoxybutane (I,T)
U108	1,4-Diethylene dioxide
U086	N,N-Diethylhydrazine
U087	O,O-Diethyl-S-methyl-dithiophosphate
U088	Diethyl phthalate
U089	Diethylstilbestrol
U148	1,2-Dihydro-3,6-pyridazinedione
U090	Dihydrosafrole
U091	3,3'-Dimethoxybenzidine
U092	*Dimethylamine (I)
U093	Dimethylaminoazobenzene
U094	7,12-Dimethylbenz[a] anthracene
U095	3,3'-Dimethylbenzidine
U096	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	Dimethylcarbamoyl chloride
U098	1,1-Dimethylhydrazine
U099	1,2-Dimethylhydrazine
U101	*2,4-Dimethylphenol
U102	Dimethyl phthalate
U103	Dimethyl sulfate
U105	*2,4-Dinitrotoluene
U106	*2,6-Dinitrotoluene
U107	Di-n-octyl phthalate
U108	1,4-Dioxane
U109	1,2-Diphenylhydrazine
U110	Dipropylamine (I)
U111	Di-n-propylnitrosamine
U001	*Ethanol (I)
U174	Ethanamine, N-ethyl-N-nitroso-
U067	*Ethane, 1,2-dibromo-
U076	Ethane, 1,1-dichloro-
U077	*Ethane, 1,2-dichloro-
U114	1,2-Ethanediylbiscarbamodithioic acid
U131	Ethane, 1,1,1,2,2,2-hexachloro-
U024	Ethane, 1,1'-[methylenebis(oxy)]bis [2-chloro-
U003	*Ethanenitrile (I,T)
U117	Ethane, 1,1'-oxybis-(I)
U025	Ethane, 1,1'-oxybis [2-chloro-
U184	Ethane, pentachloro-
U208	Ethane, 1,1,1,2-tetrachloro-

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
U043	Ethene, chloro-
U042	Ethene, 2-chloroethoxy-
U078	*Ethene, 1,1-dichloro-
U079	Ethene, trans-1,2-dichloro-
U210	Ethene, 1,1,2,2-tetrachloro-
U173	Ethanol, 2,2'-(nitrosoimino)bis-
U004	Ethanone, 1-phenyl-
U006	*Ethanoyl chloride (C,R,T)
U112	Ethyl acetate (I)
U113	Ethyl acrylate (I)
U238	Ethyl carbamate (urethane)
U038	Ethyl 4,4'-dichlorobenzilate
U114	Ethylenebis(dithiocarbamic acid)
U067	*Ethylene dibromide
U077	*Ethylene dichloride
U115	Ethylene oxide (I,T)
U116	Ethylene thiourea
U117	Ethyl ether (I)
U076	Ethylidene dichloride
U118	Ethyl methacrylate
U119	Ethyl methanesulfonate
U120	Fluoranthene
U122	*Formaldehyde
U123	*Formic acid (C,T)
U124	Furan (I)
U125	*2-Furancarboxaldehyde (I)
U147	*2,5-furandione
U213	Furan, tetrahydro- (I)
U125	*Furfural (I)
U124	Furfuran (I)
U206	D-Glucopyranose, 2-deoxy-2(3-methyl-3-nitrosoureido)-
U126	Glycidylaldehyde
U163	Guanidine, N-nitroso-N-methyl-N'-nitro-
U127	Hexachlorobenzene
U128	Hexachlorobutadiene
U129	*Hexachlorocyclohexane (gamma isomer)
U130	*Hexachlorocyclopentadiene
U131	Hexachloroethane
U132	Hexachlorophene
U243	Hexachloropropene
U133	Hydrazine (R,T)
U086	Hydrazine, 1,2-diethyl-
U098	Hydrazine, 1,1-dimethyl-
U099	Hydrazine, 1,2-dimethyl-
U109	Hydrazine, 1,2-diphenyl-
U134	*Hydrofluoric acid (C,T)
U134	*Hydrogen fluoride (C,T)
U135	Hydrogen sulfide
U096	Hydroperoxide, 1-methyl-1-phenylethyl- (R)
U136	Hydroxydimethylarsine oxide
U116	2-Imidazolidinethione
U137	Indeno (1,2,3-cd) pyrene
U245	Iodomethacin
U139	Iron dextran
U140	*Isobutyl alcohol (I,T)
U141	Isosafrole
U142	*Kepone
U143	Lasiocarpine
U144	*Lead acetate
U145	Lead phosphate
U146	Lead subacetate
U128	*Lindane
U147	*Maleic anhydride
U148	Maleic hydrazide
U149	Malononitrile
U150	Melphalan

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
U152	Methacrylonitrile (I,T)
U092	*Methanamine, N-methyl-(I)
U029	Methane, bromo-
U045	Methane, chloro-(I,T)
U046	Methane, chloromethoxy-
U068	Methane, dibromo-
U080	Methane, dichloro-
U075	Methane, dichlorodifluoro-
U138	Methane, iodo-
U119	Methanesulfonic acid, ethyl ester
U211	*Methane, tetrachloro-
U153	Methanethiol (I,T)
U225	Methane, tribromo-
U044	*Methane, trichloro-
U121	Methane, trichlorofluoro-
U123	*Methanoic acid (C,T)
U036	*4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,-7,7a-tetrahydro-
U154	Methanol (I)
U155	Methapyrilene
U154	Methyl alcohol (I)
U029	Methyl bromide
U186	1-Methylbutadiene (I)
U045	Methyl chloride (I,T)
U156	Methyl chlorocarbonate (I,T)
U226	Methyl chloroform
U157	3-Methylcholanthrene
U158	4,4'-Methylenebis(2-chloroaniline)
U132	2,2'-Methylenebis(3,4,6-trichlorophenol)
U068	Methylene bromide
U080	Methylene chloride
U122	*Methylene oxide
U159	Methyl ethyl ketone (I,T)
U160	Methyl ethyl ketone peroxide (R,T)
U138	Methyl iodide
U161	Methyl isobutyl ketone (I)
U162	*Methyl methacrylate (I,T)
U163	N-Methyl-N'-nitro-N-nitrosoguanidine
U161	4-Methyl-2-pentanone (I)
U164	Methylthiouracil
U010	Mitomycin C
U059	5,12-Naphthacenedione, (8S-cis)-8-acetyl-10-[(3-amino-2,3,-6-trideoxy-alpha-L-lyxo-hexopyranosyl) oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-
U165	*Naphthalene
U047	Naphthalene, 2-chloro-
U166	1,4-Naphthalenedione
U236	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl-(1,1'-biphenyl)-4,4'-diyl)]-bis(azo)bis(5-amino-4-hydroxy)-, tetrasodium salt
U166	1,4-Naphthoquinone
U167	1-Naphthylamine
U168	2-Naphthylamine
U167	alpha-Naphthylamine
U168	beta-Naphthylamine
U026	2-Naphthylamine, N,N'-bis(2-chloroethyl)-
U169	*Nitrobenzene (I,T)
U170	*p-Nitrophenol
U171	2-Nitropropane (I)
U172	N-Nitrosodi-n-butylamine
U173	N-Nitrosodiethanolamine
U174	N-Nitrosodiethylamine
U111	N-Nitrosodi-n-propylamine
U176	N-Nitroso-N-ethylurea
U177	N-Nitroso-N-methylurea
U178	N-Nitroso-N-methylurethane

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
U179	N-Nitrosopyrrolidine
U181	5-Nitro-o-toluidine
U193	1,2-Oxathiolane, 2,2-dioxide
U058	2H-1,3,2-Oxazaphosphorine, 2-[bis(2-chloroethyl) amino] tetrahydro-2-oxide
U115	Oxirane (I,T)
U041	*Oxirane, 2-(chloromethyl)-
U182	Paraldehyde
U183	Pentachlorobenzene
U184	Pentachloroethane
U185	Pentachloronitrobenzene
U242	*Pentachlorophenol
U186	1,3-Pentadiene (I)
U187	Phenacetin
U188	*Phenol
U048	Phenol, 2-chloro-
U039	Phenol, 4-chloro-3-methyl-
U081	Phenol, 2,4-dichloro-
U082	Phenol, 2,6-dichloro-
U101	*Phenol, 2,4-dimethyl-
U170	*Phenol, 4-nitro-
U242	*Phenol, pentachloro-
U212	Phenol, 2,3,4,6-tetrachloro-
U230	*Phenol, 2,4,5-trichloro-
U231	*Phenol, 2,4,6-trichloro-
U137	1,10-(1,2-Phenylene)pyrene
U145	Phosphoric acid, lead salt
U087	Phosphorodithioic acid, O,O-diethyl-, S-methyl ester
U189	Phosphorous sulfide (R)
U190	Phthalic anhydride
U191	2-Picoline
U192	Pronamide
U194	1-Propanamine (I,T)
U110	1-Propanamine, N-propyl-(I)
U066	Propane, 1,2-dibromo-3-chloro-
U149	Propanedinitrile
U171	Propane, 2-nitro-(I)
U027	Propane, 2,2'-oxybis(2-chloro-
U193	1,3-Propane sultone
U235	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U126	1-Propanol, 2,3-epoxy-
U140	1-Propanol, 2-methyl-(I,T)
U002	2-Propanone (I)
U007	2-Propenamide
U084	*Propene, 1,3-dichloro-
U243	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	*2-Propenenitrile
U152	2-Propenenitrile, 2-methyl-(I,T)
U008	2-Propenoic acid (I)
U113	2-Propenoic acid, ethyl ester (I)
U118	2-Propenoic acid, 2-methyl-, ethyl ester
U162	*2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U233	*Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U194	n-Propylamine (I,T)
U083	*Propylene dichloride
U196	Pyridine
U155	Pyridine, 2-[(2-dimethylamino)ethyl]-2-thenylamino)-
U179	Pyridine, hexahydro-N-nitroso-
U191	Pyridine, 2-methyl-
U184	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	Pyrrole, tetrahydro-N-nitroso-
U200	Reserpine
U201	*Resorcinol
U202	Saccharin and salts

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
U204	Selenious acid
U204	*Selenium dioxide
U205	Selenium disulfide (R,T)
U015	L-Serine, diazoacetate (ester)
U233	*Silvex
U089	4,4'-Stilbenediol, alpha, alpha'-diethyl-
U206	Streptozotocin
U135	Sulfur hydride
U103	Sulfuric acid, dimethyl ester
U189	Sulfur phosphide (R)
U205	Sulfur selenide (R,T)
U232	*2,4,5-T
U207	1,2,4,5-Tetrachlorobenzene
U208	1,1,1,2-Tetrachloroethane
U209	1,1,2,2-Tetrachloroethane
U210	Tetrachloroethylene
U212	2,3,4,6-Tetrachlorophenol
U213	Tetrahydrofuran (I)
U214	Thallium(I) acetate
U215	Thallium(I) carbonate
U216	Thallium(I) chloride
U217	Thallium(I) nitrate
U218	Thioacetamide
U153	Thiomethanol (I,T)
U219	Thiourea
U244	Thiram
U220	Toluene
U221	Toluenediamine
U223	Toluene diisocyanate (R,T)
U222	o-Toluidine hydrochloride
U011	1H-1,2,4-Triazol-3-amine
U226	1,1,1-Trichloroethane
U227	1,1,2-Trichloroethane
U228	*Trichloroethene
U228	*Trichloroethylene
U121	Trichloromonofluoromethane
U230	*2,4,5-Trichlorophenol
U231	*2,4,6-Trichlorophenol
U233	*2,4,5-Trichlorophenoxyacetic acid
U234	sym-Trinitrobenzene (R,T)
U182	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	Tris(2,3-dibromopropyl) phosphate
U236	Trypan blue
U237	Uracil, 6[bis(2-chloroethyl)amino]-
U237	Uracil mustard
U043	Vinyl chloride
U239	*Xylene (I)
U200	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methylester
P012	*Arsenic(III) oxide
P011	*Arsenic pentoxide
P011	*Arsenic(V) oxide
P012	*Arsenic trioxide
P038	Arsine, diethyl-
P054	Aziridine
P013	*Barium cyanide
P024	Benzenamine, 4-chloro-
P077	Benzenamine, 4-nitro-
P028	*Benzene, (chloromethyl)-
P042	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino) ethyl]-
P014	Benzenethiol
P028	*Benzyl chloride
P015	Beryllium dust
P016	Bis(chloromethyl) ether
P017	Bromoacetone
P018	Brucine

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
P123	Camphene, octachloro-
P103	Carbamimidoselenoic acid
P022	*Carbon bisulfide
P022	*Carbon disulfide
P095	*Carbonyl chloride
P033	*Chlorine cyanide
P023	Chloroacetaldehyde
P024	p-Chloroaniline
P026	1 (o-Chlorophenyl)thiourea
P027	3-Chloropropionitrile
P029	Copper cyanides
P030	Cyanides (soluble cyanide salts), not elsewhere specified
P031	Cyanogen
P033	*Cyanogen chloride
P036	Dichlorophenylarsine
P037	*Dieldrin
P038	Diethylarsine
P039	*O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate
P041	Diethyl-p-nitrophenyl phosphate
P040	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	Diisopropyl fluorophosphate
P044	Dimethoate
P045	3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methyl-amino)carbonyl] oxime
P071	*O,O-Dimethyl O-p-nitrophenyl phosphorothioate
P082	Dimethylnitrosamine
P046	alpha,alpha-Dimethylphenethylamine
P047	4,6-Dinitro-o-cresol and salts
P034	4,6-Dinitro-o-cyclohexylphenol
P048	*2,4-Dinitrophenol
P020	Dinoseb
P085	Diphosphoramide, octamethyl-
P039	*Disulfoton
P049	2,4-Dithiobiuret
P109	Dithiopyrophosphonic acid, tetraethyl ester
P050	*Endosulfan
P088	Endothall
P051	*Endrin
P042	Epinephrine
P046	Ethanamine,1,1-dimethyl-2-phenyl-
P084	Ethanamine,N-methyl-N-nitroso-
P101	Ethyl cyanide
P054	Ethylenimine
P097	Famphur
P056	Fluorine
P057	Fluoroacetamide
P058	Fluoroacetic acid, sodium salt
P065	Fulminic acid, mercury (II) salt (R,T)
P059	*Heptachlor
P051	*1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4,5,8-dimethanonaphthalene
P037	*1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,exo-1,4,5,8-dimethanonaphthalene
P060	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo,endo-dimethanonaphthalene
P004	*1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo,exo-dimethanonaphthalene
P060	Hexachlorohexahydro-methanoindene

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
P063	*Hydrocyanic acid
P063	*Hydrogen cyanide
P096	Hydrogen phosphide
P064	Isocyanic acid, methyl ester
P007	3(2H)-Isoxazolone,5-(aminomethyl)-
P092	Mercury,(acetato-O)phenyl-
P065	Mercury fulminate (R,T)
P016	Methane,oxybis(chloro-
P112	Methane,tetranitro-(R)
P118	Methanethiol, trichloro-
P050	*1,4,7,Methano-1H-indene,1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P066	Methomyl
P067	2-Methylaziridine
P068	Methyl hydrazine
P064	Methyl isocyanate
P069	*2-Methylactonitrile
P071	*Methyl parathion
P072	alpha-Naphthylthiourea
P073	Nickel carbonyl
P074	Nickel cyanide
P074	Nickel(II) cyanide
P073	Nickel tetracarbonyl
P075	Nicotine and salts
P076	Nitric oxide
P077	p-Nitroaniline
P078	*Nitrogen dioxide
P076	Nitrogen(II) oxide
P078	*Nitrogen(IV) oxide
P081	Nitroglycerine (R)
P082	N-Nitrosodimethylamine
P084	N-Nitrosomethylvinylamine
P050	*5-Norbornene-2,3-dimethanol, 1,4,5,6,7,7-Hexachloro cyclic sulfite
P085	Octamethylpyrophosphoramide
P087	Osmium oxide
P087	Osmium tetroxide
P088	7-Oxabicyclo[2.2.1] heptane-2,3-dicarboxylic acid
P089	*Parathion
P034	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	*Phenol, 2,4-dinitro-
P047	Phenol, 2,4-dinitro-6-methyl-
P020	Phenol, 2,4-dinitro-6-(1-methylpropyl)-
P009	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P036	Phenyl dichloroarsine
P092	Phenylmercuric acetate
P093	N-Phenylthiourea
P094	Phorate
P095	*Phosgene
P096	Phosphine
P041	Phosphoric acid, diethyl p-nitrophenyl ester
P044	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	Phosphorofluoric acid, bis(1-methylethyl) ester
P094	Phosphorothioic acid, O,O-diethyl S-(ethylthio)methyl ester
P089	*Phosphorothioic acid, O,O-diethyl O-(p-nitrophenyl) ester
P040	Phosphorothioic acid, O-O-diethyl O-pyrazinyl ester
P097	Phosphorothioic acid, O,O-dimethyl O-[p-(dimethylamino)-sulfonyl]phenyl] ester
P110	*Plumbane, tetraethyl-
P098	*Potassium cyanide

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
P027	Propanenitrile, 3-chloro-
P069	*Propanenitrile, 2-hydroxy-2-methyl-
P081	1,2,3-Propanetriol, trinitrate (R)
P017	2-Propanone, 1-bromo-
P102	Propargyl alcohol
P003	*2-Propenal
P005	*2-Propen-1-ol
P067	1,2-Propylenimine
P102	2-Propyn-1-ol
P008	4-Pyridinamine
P075	Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts
P111	*Pyrophosphoric acid, tetraethyl ester
P103	Selenourea
P104	Silver cyanide
P105	Sodium azide
P106	*Sodium cyanide
P107	Strontium sulfide
P108	*Strychnidin-10-one, and salts
P018	Strychnidin-10-one, 2,3-dimethoxy-
P108	Strychnine and salts
P115	*Sulfuric acid, thallium(I) salt
P109	Tetraethyldithiopyrophosphate
P110	*Tetraethyl lead
P111	*Tetraethylpyrophosphate
P112	Tetranitromethane (R)
P062	Tetraphosphoric acid, hexaethyl ester
P113	Thallic oxide
P113	Thallium(III) oxide
P114	Thallium(I) selenite
P115	*Thallium(I) sulfate
P045	Thiofanox
P049	Thiomidodicarbonic diamide
P014	Thiophenol
P116	Thiosemicarbazide
P026	Thiourea, (2-chlorophenyl)-
P072	Thiourea, 1-naphthalenyl-
P093	Thiourea, phenyl-
P123	*Toxaphene
P118	Trichloromethanethiol
P119	Vanadic acid, ammonium salt
P120	*Vanadium pentoxide
P120	*Vanadium(V) oxide
P001	Warfarin
P121	*Zinc cyanide
P122	*Zinc phosphide (R,T)
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons, and sludges from the recovery of these solvents in degreasing operations
F002	The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, orthodichlorobenzene and trichlorofluoromethane, and the still bottoms from the recovery of these solvents.
F003	The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
F004	The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents.
F005	The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; and the still bottoms from the recovery of these solvents.
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.
F019	Wastewater treatment sludges for the chemical conversion coating of aluminum.
F007	Spent cyanide plating bath solutions from electroplating operations (except for precious metals electroplating spent cyanide plating bath solutions).
F008	Plating bath sludges from the bottom of plating baths from electroplating operations where cyanides are used in the process (except for precious metals electroplating plating bath sludges).
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent stripping and cleaning bath solutions).
F010	Quenching bath sludge from oil baths from metal heat treating operations where cyanides are used in the process (except for precious metals heat-treating quenching bath sludges).
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations (except for precious metals heat treating spent cyanide solutions from salt bath pot cleaning).
F012	Quenching wastewater treatment sludge from metal heat treating operations where cyanides are used in the process (except for precious metals heat treating quenching wastewater treatment sludges).
F013	Spent cyanide bath solutions from mine metals recovery operations.
K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments.
K003	Wastewater treatment sludge from the production of molybdate orange pigments.
K004	Wastewater treatment sludge from the production of zinc yellow pigments.
K005	Wastewater treatment sludge from the

SPECIFIC CHEMICAL WASTES—Continued

EPA hazardous waste No.	Substance
K007	Wastewater treatment sludge from the production of iron blue pigments.
K008	Oven residue from the production of chrome oxide green pigments.
K009	Distillation bottoms from the production of acetaldehyde from ethylene.
K010	Distillation side cuts from the production of acetaldehyde from ethylene.
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile.
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile.
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile.
K015	Still bottoms from the distillation of benzyl chloride.
K016	Heavy ends or distillation residues from the production of carbon tetrachloride.
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.
K018	Heavy ends from the fractionation column in ethyl chloride production.
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.
K020	Heavy ends from the distillation of vinyl dichloride in vinyl chloride monomer production.
K021	Aqueous spent antimony catalyst waste from fluoromethanes production.
K022	Distillation bottom tars from the production of phenol/acetone from cumene.
K023	Distillation light ends from the production of phthalic anhydride from naphthalene.
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene.
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene.
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene.
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene.
K026	Stripping still tails from the production of methyl ethyl pyridines.
K027	Centrifuge and distillation residues from toluene diisocyanate production.
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane.
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane.
K095	Distillation bottoms from the production of 1,1,1-trichloroethane.
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane.
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.
K083	Distillation bottoms from aniline production.
K103	Process residues from aniline extraction from the production of aniline.
K104	Combined wastewater streams generated from nitrobenzene/aniline production.
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes.
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes.

SPECIFIC CHE WASTES—Continued

EPA hazardous waste No.	Substance
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used.
K073	Chlorinated hydrocarbon waste from the purification step of the diaphram cell process using graphite anodes in chlorine production.
K106	Wastewater treatment sludge from the mercury cell process in chlorine production.
K031	By-product salts generated in the production of MSMA and cacodylic acid.
K032	Wastewater treatment sludge from the production of chlordane.
K033	Wastewater and scrub water and scrub water from the chlorination of cyclopentadiene in the production of chlordane.
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane.
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane.
K035	Wastewater treatment sludges generated in the production of creosote.
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton.
K037	Wastewater treatment sludges from the production of disulfoton.
K038	Wastewater from the washing and stripping of phorate production.
K039	Filter cake from filtration of diethylphosphorodithioic acid in the production of phorate.
K040	Wastewater treatment sludge from the production of phorate.
K041	Wastewater treatment sludge from the production of toxaphene.
K098	Untreated process wastewater from the production of toxaphene.
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T.
K043	2,6-Dichlorophenol waste from the production of 2,4-D
K099	Untreated wastewater from the production of 2,4-D.
K044	Wastewater treatment sludges from the manufacturing and processing of explosives.
K045	Spent carbon from the treatment of wastewater containing explosives.
K046	Wastewater treatment sludges from the manufacturing, formulation and loading of lead-based initiating compounds.
K047	Pink/red water from TNT operations.
K048	Dissolved air flotation (DAF) float from the petroleum refining industry.
K049	Slop oil emulsion solids from the petroleum refining industry.
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry
K051	API separator sludge from the petroleum refining industry.
K052	Tank bottoms (leaded) from the petroleum refining industry.
K061	Emission control dust/sludge from the primary production of steel in electric furnaces
K062	Spent pickle liquor from steel finishing operations.

PECIFIC CHEMICAL WASTES—Continued

PA ardous te No.	Substance
	Emission control dust/sludge from secondary lead smelting.
	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting.
	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead.
	Ammonia still lime sludge from coking operations.
	Decanter tank tar sludge from coking operations.

APPENDIX A FIGURE 3
TOXIC POLLUTANTS

TABLE 1.—SECTION 307—TOXIC POLLUTANTS

Acenaphthene
Acrolein
Acrylonitrile
Aldrin/Dieldrin
Antimony and compounds*
Arsenic and compounds
Asbestos
Benzene
Benzidine
Beryllium and compounds
Cadmium and compounds
Carbon tetrachloride
Chlordane (technical mixture and metabolites)
Chlorinated benzenes (other than dichlorobenzenes)
Chlorinated ethanes (including 1,2-dichloroethane, 1,1,1-trichloroethane, and hexachloroethane)
Chloroalkyl ethers (chloromethyl, chloroethyl, and mixed ethers)
Chlorinated naphthalene
Chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols)
Chloroform
2-chlorophenol
Chromium and compounds
Copper and compounds
Cyanides
DDT and metabolites
Dichlorobenzenes (1,2-, 1,3-, and 1,4-dichlorobenzenes)
Dichlorobenzidine

Dichloroethylenes (1,1- and 1,2-dichloroethylene)
2,4-dichlorophenol
Dichloropropane and dichloropropene
2,4-dimethylphenol
Dinitrotoluene
Diphenylhydrazine
Endosulfan and metabolites
Endrin and metabolites
Ethylbenzene
Fluoranthene
Haloethers (other than those listed elsewhere; includes chlorophenylphenyl ethers, bromophenylphenyl ether, bis(dischloroisopropyl) ether, bis-(chloroethoxy) methane and polychlorinated diphenyl ethers)
Halomethanes (other than those listed elsewhere; includes methylene chlorid methylchloride, methylbromide, bromoform, dichlorobromomethane, trichlorofluoromethane, dichlorodifluoromethane)
Heptachlor and metabolites
Hexachlorobutadiene
Hexachlorocyclohexane (all isomers)
Hexachlorocyclopentadiene
Isophorone
Lead and compounds
Mercury and compounds
Naphthalene
Nickel and compounds
Nitrobenzene
Nitrophenols (including 2,4-dinitrophenol) dinitrocresol)
Nitrosamines
Pentachlorophenol
Phenol
Phthalate esters
Polychlorinated biphenyls (PCSs)
Polynuclear aromatic hydrocarbons (including benzanthracenes, benzopyrenes, benzofluoranthene, chrysenes, dibenzanthracenes, and indenopyrenes)
Selenium and compounds
Silver and compounds
2,3,7,8- Tetrachlorodibenzo-p-dioxin (TCDD)
Tetrachloroethylene
Thallium and compounds
Toluene
Toxaphene
Trichloroethylene
Vinyl chloride
Zinc and compounds

* The term "compounds" shall include organic and inorganic compounds.

APPENDIX A FIGURE 4
BASIS FOR LISTING HAZARDOUS WASTE

EPA hazardous waste No.	Hazardous constituents for which listed
F001	Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, chlorinated fluorocarbons.
F002	Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane.
F003	N.A.
F004	Cresols and cresylic acid, nitrobenzene.
F005	Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine.
F006	Cadmium, hexavalent chromium, nickel, cyanide (complexed).
F007	Cyanide (salts).
F008	Cyanide (salts).
F009	Cyanide (salts).
F010	Cyanide (salts).
F011	Cyanide (salts).
F012	Cyanide (complexed).
F019	Hexavalent chromium, cyanide (complexed).
K001	Pentachlorophenol, phenol, 2-chlorophenol, p-chloro-m-cresol, 2,4-dimethylphenyl, 2,4-dinitrophenol, trichlorophenols, tetrachlorophenols, 2,4-dinitrophenyl, creosote, chrysene, naphthalene, fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benz(a)anthracene, dibenz(a)anthracene, acenaphthalene.
K002	Hexavalent chromium, lead
K003	Hexavalent chromium, lead.
K004	Hexavalent chromium.
K005	Hexavalent chromium lead.
K006	Hexavalent chromium.
K007	Cyanide (complexed), hexavalent chromium.
K008	Hexavalent chromium.
K009	Chloroform, formaldehyde, methylene chloride, methyl chloride, paraldehyde, formic acid.
K010	Chloroform, formaldehyde, methylene chloride, methyl chloride, paraldehyde formic acid, chloroacetaldehyde.
K011	Acrylonitrile, acetonitrile, hydrocyanic acid.
K013	Hydrocyanic acid, acrylonitrile, acetonitrile
K014	Acetonitrile acrylamide
[illegible]	[illegible]
K016	Hexachlorobenzene, hexachlorobutadiene, carbon tetrachloride, hexachloroethane, perchloroethylene
K017	Epichlorohydrin chloroethers [bis(chloromethyl) ether and bis (2-chloroethyl) ethers], trichloropropane dichloropropanols.
K018	1,2-dichloroethane trichloroethylene hexachlorobutadiene, hexachlorobenzene
K019	Ethylene dichloride 1,1,1-trichloroethane 1,1,2 trichloroethane [illegible] and 1,1,1,2 [illegible], carbon tetrachloride, chloroform, vinyl chloride, vinylidene chloride
K083	Aniline, diphenylamine, nitrobenzene phenylenediamine
K084	Arsenic.
K085	Benzene dichlorobenzenes, trichlorobenzenes, tetrachlorobenzenes pentachlorobenzene hexachlorobenzene benzyl chloride
K086	Lead, hexavalent chromium
K087	Phenol, naphthalene
K093	Phthalic anhydride maleic anhydride
K094	Phthalic anhydride
K095	1,1,2 trichloroethane 1,1,1,2 tetrachloroeth-

EPA hazardous waste No.	Hazardous constituents for which listed
K020	Ethylene dichloride, 1,1,1-trichloroethane, 1,1,2-trichloroethane, tetrachloroethanes (1,1,2,2-tetrachloroethane and 1,1,1,2-tetrachloroethane), trichloroethylene tetrachloroethylene, carbon tetrachloride, chloroform, vinyl chloride, vinylidene chloride.
K021	Antimony, carbon tetrachloride, chloroform.
K022	Phenol, tars (polycyclic aromatic hydrocarbons).
K023	Phthalic anhydride, maleic anhydride
K024	Phthalic anhydride, 1,4-naphthoquinone
K025	Meta-dinitrobenzene, 2,4-dinitrotoluene.
K026	Paraldehyde, pyridines, 2-picoline
K027	Toluene diisocyanate toluene-2, 4-diamine
K028	1,1,1- trichloroethane, vinyl chloride
K029	1,2 dichloroethane, 1,1,1 trichloroethane, vinyl chloride, vinylidene chloride chloroform.
K030	Hexachlorobenzene hexachlorobutadiene hexachloroethane 1,1,1,2 tetrachloroethane, 1,1,2,2-tetrachloroethane, ethylene dichloride.
K031	Arsenic.
K032	Hexachlorocyclopentadiene
K033	Hexachlorocyclopentadiene
K034	Hexachlorocyclopentadiene
K035	Creosote chrysene, naphthalene fluoranthene benzo(b) fluoranthene benzo(a)pyrene indeno(1,2,3-cd) pyrene benz(a)anthracene dibenz(a)anthracene acenaphthalene
K036	Toluene, phosphorodithioic and phosphoro-thioic acid esters.
K037	Toluene, phosphorodithioic and phosphoro-thioic acid esters
K038	Phorate, formaldehyde, phosphorodithioic and phosphorothioic acid esters
K039	Phosphorodithioic and phosphorothioic acid esters.
K040	Phorate, formaldehyde, phosphorodithioic and phosphorothioic acid esters
K041	Toxaphene
K042	Hexachlorobenzene ortho-dichlorobenzene.
K043	2,4-dichlorophenol, 2,6-dichlorophenol 2,4,6-trichlorophenol
K044	N.A.
K045	N.A.
K046	Lead
K047	N.A.
K048	Hexavalent chromium lead
K049	Hexavalent chromium lead
[illegible]	[illegible]
K051	Hexavalent chromium lead
K052	Lead
K060	Cyanide naphthalene phenolic compounds arsenic
K061	Hexavalent chromium lead cadmium
K062	Hexavalent chromium lead
K069	Hexavalent chromium lead cadmium
K071	Mercury
K073	Chloroform carbon tetrachloride hexachloroethane trichloroethane tetrachloroethylene dichloromethane 1,1,2,2 tetrachloroethane [illegible]
K096	1,2 [illegible] 1,1,2 trichloroethane
K097	Chlordane heptachlor
K098	Toxaphene
K099	2,4-dichlorophenol 2,4,6-trichlorophenol
K100	Hexavalent chromium lead cadmium
K101	Arsenic.
K102	Arsenic.
K103	Aniline, nitrobenzene phenylenediamine
K104	Aniline benzene, diphenylamine nitrobenzene phenylenediamine
K105	Benzene monochlorobenzene dichlorobenzenes, 2,4,6-trichlorophenol
K106	Mercury

N.A.—Waste is hazardous because it fails the test for the characteristic of ignitability corrosivity or reactivity

APPENDIX A FIGURE 5
HAZARDOUS CONSTITUENTS

Acetonitrile (Ethanenitrile)
Acetophenone (Ethanone, 1-phenyl)
3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts (Warfarin)
2-Acetylaminofluorene (Acetamide, N-(9H-fluoren-2-yl)-)
Acetyl chloride (Ethanoyl chloride)
1-Acetyl-2-thiourea (Acetamide, N-(aminothioxomethyl)-)
Acrolein (2-Propenal)
Acrylamide (2-Propenamide)
Acrylonitrile (2-Propenenitrile)
Aflatoxins
Aldrin (1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a,8b-hexahydro-endo,exo-1,4:5,8-Dimethanonaphthalene)
Allyl alcohol (2-Propen-1-ol)
Aluminum phosphide
4-Aminobiphenyl ([1,1'-Biphenyl]-4-amine)
6-Amino-1,1a,2,8,8a,8b-hexahydro-8-(hydroxymethyl)-8a-methoxy-5-methylcarbamate azirino(2',3':3,4)pyrrolo(1,2-a)indole-4,7-dione, (ester) (Mitomycin C) (Azirino(2'3':3,4)pyrrolo(1,2-a)indole-4,7-dione, 6-amino-8-(((amino-carbonyl)oxy)methyl)-1,1a,2,8,8a,8b-hexahydro-8amethoxy-5-methy-)
5-(Aminomethyl)-3-isoxazolol (3(2H)-Isoxazolone, 5-(aminomethyl)-) 4-Aminopyridine (4-Pyridinamine)
Amitrole (1H-1,2,4-Triazol-3-amine)
Aniline (Benzenamine)
Antimony and compounds, N.O.S.*
Aramite (Sulfurous acid, 2-chloroethyl-, 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester)
Arsenic and compounds, N.O.S.*
Arsenic acid (Orthoarsenic acid)
Arsenic pentoxide (Arsenic (V) oxide)
Arsenic trioxide (Arsenic (III) oxide)
Auramine (Benzenamine, 4,4'-carbonimidoylbis(N,N-Dimethyl-, monohydrochloride)
Azaserine (L-Serine, diazoacetate (ester))
Barium and compounds, N.O.S.*
Barium cyanide
Benz(c)acridine (3,4-Benzacridine)
Benz(a)anthracene (1,2-Benzanthracene)
Benzene (Cyclohexatriene)
Benzenearsonic acid (Arsonic acid, phenyl-)
Benzene, dichloromethyl- (Benzal chloride)
Benzenethiol (Thiophenol)
Benzidine ([1,1'-Biphenyl]-4,4'diamine)
Benzo(b)fluoranthene (2,3-Benzofluoranthene)
Benzo(j)fluoranthene (7,8-Benzofluoranthene)
Benzo(a)pyrene (3,4-Benzopyrene)
p-Benzoquinone (1,4-Cyclohexadienedione)
Benzotrichloride (Benzene, trichloromethyl-)
Benzyl chloride (Benzene, (chloromethyl)-)
Beryllium and compounds, N.O.S.*
Bis(2-chloroethoxy)methane (Ethane, 1,1'-(methylenebis(oxy))bis(2-chloro-))
Bis(2-chloroethyl) ether (Ethane, 1,1'-oxybis(2-chloro-))
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)
Bis(2-chloroisopropyl) ether (Propane, 2,2'-oxybis(2-chloro-))
Bis(chloromethyl) ether (Methane, oxybis(chloro-))
Bis(2-ethylhexyl) phthalate (1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester)
Bromoacetone (2-Propanone, 1-bromo-)
Bromomethane (Methyl bromide)
4-Bromophenyl phenyl ether (Benzene, 1-bromo-4-phenoxy-)
Brucine (Strychnidin-10-one, 2,3-dimethoxy-)
2-Butanone peroxide (Methyl ethyl ketone, peroxide)
Butyl benzyl phthalate (1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester)
2-sec-Butyl-4,6-dinitrophenol (DNBP) (Phenol, 2,4-dinitro-6-(1-methylpropyl)-)
Cadmium and compounds, N.O.S.*
Calcium chromate (Chromic acid, calcium salt)
Calcium cyanide
Carbon disulfide (Carbon bisulfide)
Carbon oxyfluoride (Carbonyl fluoride)
Chloral (Acetaldehyde, trichloro-)
Chlorambucil (Butanoic acid, 4-[bis(2-chloroethyl)amino]benzene-)
Chlordane (alpha and gamma isomers) (4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3,4,7,7a-tetrahydro-) (alpha and gamma isomers)
Chlorinated benzenes, N.O.S.*
Chlorinated ethane, N.O.S.*
Chlorinated fluorocarbons, N.O.S.*
Chlorinated naphthalene, N.O.S.*
Chlorinated phenol, N.O.S.*
Chloroacetaldehyde (Acetaldehyde, chloro-)
Chloroalkyl ethers, N.O.S.*
p-Chloroaniline (Benzenamine, 4-chloro-)
Chlorobenzene (Benzene, chloro-)
Chlorobenzilate (Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester)
p-Chloro-m-cresol (Phenol, 4-chloro-3-methyl)
1-Chloro-2,3-epoxypropane (Oxirane, 2-(chloromethyl)-)
2-Chloroethyl vinyl ether (Ethene, (2-chloroethoxy)-)
Chloroform (Methane, trichloro-)
Chloromethane (Methyl chloride)
Chloromethyl methyl ether (Methane, chloromethoxy-)
2-Chloronaphthalene (Naphthalene, beta-chloro-)
2-Chlorophenol (Phenol, o-chloro-)
1-(o-Chlorophenyl)thiourea (Thiourea, (2-chlorophenyl)-)
3-Chloropropionitrile (Propanenitrile, 3-chloro-)
Chromium and compounds, N.O.S.*
Chrysene (1,2-Benzphenanthrene)
Citrus red No. 2 (2-Naphthol, 1-[(2,5-dimethoxyphenyl)azo]-)
Coal tars
Copper cyanide
Creosote (Creosote, wood)
Cresols (Cresylic acid) (Phenol, methyl-)
Crotonaldehyde (2-Butenal)
Cyanides (soluble salts and complexes), N.O.S.*
Cyanogen (Ethanedinitrile)
Cyanogen bromide (Bromine cyanide)
Cyanogen chloride (Chlorine cyanide)
Cycasin (beta-D-Glucopyranoside, (methylONN-azoxy)methyl-)
2-Cyclohexyl-4,6-dinitrophenol (Phenol, 2-cyclohexyl-4,6-dinitro-)
Cyclophosphamide (2H-1,3,2, Oxazaphosphorine, [bis(2-chloroethyl)amino]-tetrahydro-, 2-oxide)

alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-)
DDD (Dichlorodiphenyldichloroethane) (Ethane, 1,1-dichloro-2,2-bis(p-chlorophenyl)-)
DDE (Ethylene, 1,1-dichloro-2,2-bis(4-chlorophenyl)-)
DDT (Dichlorodiphenyltrichloroethane) (Ethane, 1,1,1-trichloro-2,2-bis(p-chlorophenyl)-)
Diallate (S-(2,3-dichloroallyl) diisopropylthiocarbamate)
Dibenz[a,h]acridine (1,2,5,6-Dibenzacridine)
Dibenz[a,j]acridine (1,2,7,8-Dibenzacridine)
Dibenz[a,h]anthracene (1,2,5,6-Dibenzanthracene)
7H-Dibenzo[c,g]carbazole (3,4,5,6-Dibenzcarbazole)
Dibenzo[a,e]pyrene (1,2,4,5-Dibenzpyrene)
Dibenzo[a,h]pyrene (1,2,5,6-Dibenzpyrene)
Dibenzo[a,l]pyrene (1,2,7,8-Dibenzpyrene)
1,2-Dibromo-3-chloropropane (Propane, 1,2-dibromo-3-chloro-)
1,2-Dibromoethane (Ethylene dibromide)
Dibromomethane (Methylene bromide)
Di-n-butyl phthalate (1,2-Benzenedicarboxylic acid, dibutyl ester)
o-Dichlorobenzene (Benzene, 1,2-dichloro-)
m-Dichlorobenzene (Benzene, 1,3-dichloro-)
p-Dichlorobenzene (Benzene, 1,4-dichloro-)
Dichlorobenzene, N.O.S.* (Benzene, dichloro-, N.O.S.*)
3,3'-Dichlorobenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-)
1,4-Dichloro-2-butene (2-Butene, 1,4-dichloro-)
Dichlorodifluoromethane (Methane, dichlorodifluoro-)
1,1-Dichloroethane (Ethylidene dichloride)
1,2-Dichloroethane (Ethylene dichloride)
trans-1,2-Dichloroethene (1,2-Dichloroethylene)
Dichloroethylene, N.O.S.* (Ethene, dichloro-, N.O.S.*)
1,1-Dichloroethylene (Ethene, 1,1-dichloro-)
Dichloromethane (Methylene chloride)
2,4-Dichlorophenol (Phenol, 2,4-dichloro-)
2,6-Dichlorophenol (Phenol, 2,6-dichloro-)
2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters (Acetic acid, 2,4-dichlorophenoxy-, salts and esters)
Dichlorophenylarsine (Phenyl dichloroarsine)
Dichloropropane, N.O.S.* (Propane, dichloro-, N.O.S.*)
1,2-Dichloropropane (Propylene dichloride)
Dichloropropanol, N.O.S.* (Propanol, dichloro-, N.O.S.*)
Dichloropropene, N.O.S.* (Propene, dichloro-, N.O.S.*)
1,3-Dichloropropene (1-Propene, 1,3-dichloro-)
Dieldrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octa-hydro-endo,exo-1,4:5,8-Dimethanonaphthalene)
1,2:3,4-Diepoxybutane (2,2'-Bioxirane)
Diethylarsine (Arsine, diethyl-)

N,N-Diethylhydrazine (Hydrazine, 1,2-diethyl)
O,O-Diethyl S-methyl ester of phosphorodithioic acid (Phosphorodithioic acid, O,O-diethyl S-methyl ester
O,O-Diethylphosphoric acid, O-p-nitrophenyl ester (Phosphoric acid, diethyl p-nitrophenyl ester)
Diethyl phthalate (1,2-Benzenedicarboxylic acid, diethyl ester)
O,O-Diethyl O-2-pyrazinyl phosphorothioate (Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
Diethylstilbesterol (4,4'-Stilbenediol, alpha,alpha-diethyl, bis(dihydrogen phosphate), (E)-)
Dihydrosafrole (Benzene, 1,2-methylenedioxy-4-propyl-)
3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alcohol (1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-)
Diisopropylfluorophosphate (DFP) (Phosphorofluoridic acid, bis(1-methylethyl) ester)
Dimethoate (Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
3,3'-Dimethoxybenzidine ([1,1'-Biphenyl]-4,4'diamine, 3-3'-dimethoxy-)
p-Dimethylaminoazobenzene (Benzenamine, N,N-dimethyl-4-(phenylazo)-)
7,12-Dimethylbenz[a]anthracene (1,2-Benzanthracene, 7,12-dimethyl-)
3,3'-Dimethylbenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-)
Dimethylcarbamoyl chloride (Carbamoyl chloride, dimethyl-)
1,1-Dimethylhydrazine (Hydrazine, 1,1-dimethyl-)
1,2-Dimethylhydrazine (Hydrazine, 1,2-dimethyl-)
3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino) carbonyl]oxime (Thiofanox)
alpha,alpha-Dimethylphenethylamine (Ethanamine, 1,1-dimethyl-2-phenyl-)
2,4-Dimethylphenol (Phenol, 2,4-dimethyl-)
Dimethyl phthalate (1,2-Benzenedicarboxylic acid, dimethyl ester)
Dimethyl sulfate (Sulfuric acid, dimethyl ester)
Dinitrobenzene, N.O.S.* (Benzene, dinitro-, N.O.S.*)
4,6-Dinitro-o-cresol and salts (Phenol, 2,4-dinitro-6-methyl-, and salts)
2,4-Dinitrophenol (Phenol, 2,4-dinitro-)
2,4-Dinitrotoluene (Benzene, 1-methyl-2,4-dinitro-)
2,6-Dinitrotoluene (Benzene, 1-methyl-2,6-dinitro-)
Di-n-octyl phthalate (1,2-Benzenedicarboxylic acid, dioctyl ester)
1,4-Dioxane (1,4-Diethylene oxide)
Diphenylamine (Benzenamine, N-phenyl-)
1,2-Diphenylhydrazine (Hydrazine, 1,2-diphenyl-)
Di-n-propylnitrosamine (N-Nitroso-di-n-propylamine)
Disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate)
2,4-Dithiobiuret (Thioimidodicarbonic diamide)
Endosulfan (5-Norbornene, 2,3-dimethanol, 1,4,5,6,7,7-hexachloro-, cyclic sulfite)
Endrin and metabolites (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalene, and metabolites)
Ethyl carbamate (Urethan) (Carbamic acid, ethyl ester)
Ethyl cyanide (propanenitrile)
Ethylenebisdithiocarbamic acid, salts and esters (1,2-Ethanediylbiscarbamodithioic acid, salts and esters
Ethyleneimine (Aziridine)
Ethylene oxide (Oxirane)
Ethylenethiourea (2-Imidazolidinethione)
Ethyl methacrylate (2-Propenoic acid, 2-methyl-, ethyl ester)
Ethyl methanesulfonate (Methanesulfonic acid, ethyl ester)
Fluoranthene (Benzo[j,k]fluorene)
Fluorine

2-Fluoroacetamide (Acetamide, 2-fluoro-)
Fluoroacetic acid, sodium salt (Acetic acid, fluoro-, sodium salt)
Formaldehyde (Methylene oxide)
Formic acid (Methanoic acid)
Glycidylaldehyde (1-Propanol-2,3-epoxy)
Halomethane, N.O.S.*
Heptachlor (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-)
Heptachlor epoxide (alpha, beta, and gamma isomers) (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a,4,7,7-tetrahydro-, alpha, beta, and gamma isomers)
Hexachlorobenzene (Benzene, hexachloro-)
Hexachlorobutadiene (1,3-Butadiene, 1,1,2,3,4,4-hexachloro-)
Hexachlorocyclohexane (all isomers) (Lindane and isomers)
Hexachlorocyclopentadiene (1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-)
Hexachloroethane (Ethane, 1,1,1,2,2,2-hexachloro-)
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo,endo-dimethanonaphthalene (Hexachlorohexahydro-endo,endo-dimethanonaphthalene)
Hexachlorophene (2,2'-Methylenebis(3,4,6-trichlorophenol))
Hexachloropropene (1-Propene, 1,1,2,3,3,3-hexachloro-)
Hexaethyl tetraphosphate (Tetraphosphoric acid, hexaethyl ester)
Hydrazine (Diamine)
Hydrocyanic acid (Hydrogen cyanide)
Hydrofluoric acid (Hydrogen fluoride)
Hydrogen sulfide (Sulfur hydride)
Hydroxydimethylarsine oxide (Cacodylic acid)
Indeno(1,2,3-cd)pyrene (1,10-(1,2-phenylene)pyrene)
Iodomethane (Methyl iodide)
Iron dextran (Ferric dextran)
Isocyanic acid, methyl ester (Methyl isocyanate)
Isobutyl alcohol (1-Propanol, 2-methyl-)
Isosafrole (Benzene, 1,2-methylenedioxy-4-allyl-)
Kepone (Decachlorooctahydro-1,3,4-Methano-2H-cyclobuta(cd)pentalen-2-one)
Lasiocarpine (2-Butenoic acid, 2-methyl-, 7-[(2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy)methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester)
Lead and compounds, N.O.S.*
Lead acetate (Acetic acid, lead salt)
Lead phosphate (Phosphoric acid, lead salt)
Lead subacetate (Lead, bis(acetato-O)tetrahydroxytri-)
Maleic anhydride (2,5-Furandione)
Maleic hydrazide (1,2-Dihydro-3,6-pyridazinedione)
Malononitrile (Propanedinitrile)
Melphalan (Alanine, 3-[p-bis(2-chloroethyl)amino]phenyl-, L-)
Mercury fulminate (Fulminic acid, mercury salt)
Mercury and compounds, N.O.S.*
Methacrylonitrile (2-Propenenitrile, 2-methyl-)
Methanethiol (Thiomethanol)
Methapyrilene (Pyridine, 2-[(2-dimethylamino)ethyl]-2-thenylamino-)
Methomyl (Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-, methyl ester
Methoxychlor (Ethane, 1,1,1-trichloro-2,2-bis(p-methoxyphenyl)-)
2-Methylaziridine (1,2-Propylenimine)
3-Methylcholanthrene (Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-)
Methyl chlorocarbonate (Carbonochloridic acid, methyl ester)
4,4'-Methylenebis(2-chloroaniline) (Benzenamine, 4,4'-methylenebis-(2-chloro-)
Methyl ethyl ketone (MEK) (2-Butanone)
Methyl hydrazine (Hydrazine, methyl-)
2-Methyllactonitrile (Propanenitrile, 2-hydroxy-2-methyl-)
Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)
Methyl methanesulfonate (Methanesulfonic acid, methyl ester)
2-Methyl-2-(methylthio)propionaldehyde-o-(methylcarbonyl) oxime (Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime)
N-Methyl-N'-nitro-N-nitrosoguanidine (Guanidine, N-nitroso-N-methyl-N'-nitro-)
Methyl parathion (O,O-dimethyl O-(4-nitrophenyl) phosphorothioate)
Methylthiouracil (4-1H-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-)
Mustard gas (Sulfide, bis(2-chloroethyl)-)
Naphthalene
1,4-Naphthoquinone (1,4-Naphthalenedione)
1-Naphthylamine (alpha-Naphthylamine)
2-Naphthylamine (beta-Naphthylamine)
1-Naphthyl-2-thiourea (Thiourea, 1-naphthalenyl-)
Nickel and compounds, N.O.S.*
Nickel carbonyl (Nickel tetracarbonyl)
Nickel cyanide (Nickel (II) cyanide)
Nicotine and salts (Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts)
Nitric oxide (Nitrogen (II) oxide)
p-Nitroaniline (Benzenamine, 4-nitro-)
Nitrobenzine (Benzene, nitro-)
Nitrogen dioxide (Nitrogen (IV) oxide)
Nitrogen mustard and hydrochloride salt (Ethanamine, 2-chloro-, N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
Nitrogen mustard N-Oxide and hydrochloride salt (Ethanamine, 2-chloro-, N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
Nitroglycerine (1,2,3-Propanetriol, trinitrate)
4-Nitrophenol (Phenol, 4-nitro-)
4-Nitroquinoline-1-oxide (Quinoline, 4-nitro-1-oxide-)
Nitrosamine, N.O.S.*
N-Nitrosodi-n-butylamine (1-Butanamine, N-butyl-N-nitroso-)
N-Nitrosodiethanolamine (Ethanol, 2,2'-(nitrosoimino)bis-)
N-Nitrosodiethylamine (Ethanamine, N-ethyl-N-nitroso-)
N-Nitrosodimethylamine (Dimethylnitrosamine)
N-Nitroso-N-ethylurea (Carbamide, N-ethyl-N-nitroso-)
N-Nitrosomethylethylamine (Ethanamine, N-methyl-N-nitroso-)
N-Nitroso-N-methylurea (Carbamide, N-methyl-N-nitroso-)
N-Nitroso-N-methylurethane (Carbamic acid, methylnitroso-, ethyl ester)
N-Nitrosomethylvinylamine (Ethenamine, N-methyl-N-nitroso-)
N-Nitrosomorpholine (Morpholine, N-nitroso-)
N-Nitrosonornicotine (Nornicotine, N-nitroso-)
N-Nitrosopiperidine (Pyridine, hexahydro-N-nitroso-)
Nitrosopyrrolidine (Pyrrole, tetrahydro-, N-nitroso-)
N-Nitrososarcosine (Sarcosine, N-nitroso-)

5-Nitro-o-toluidine (Benzenamine, 2-methyl-5-nitro-)
Octamethylpyrophosphoramide (Diphosphoramide, octamethyl-)
Osmium tetroxide (Osmium (VIII) oxide)
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid (Endothal)
Paraldehyde (1,3,5-Trioxane, 2,4,6-trimethyl-)
Parathion (Phosphorothioic acid, O,O-diethyl O-(p-nitrophenyl) ester
Pentachlorobenzene (Benzene, pentachloro-)
Pentachloroethane (Ethane, pentachloro-)
Pentachloronitrobenzene (PCNB) (Benzene, pentachloronitro-)
Pentachlorophenol (Phenol, pentachloro-)
Phenacetin (Acetamide, N-(4-ethoxyphenyl)-)
Phenol (Benzene, hydroxy-)
Phenylenediamine (Benzenediamine)
Phenylmercury acetate (Mercury, acetatophenyl-)
N-Phenylthiourea (Thiourea, phenyl-)
Phosgene (Carbonyl chloride)
Phosphine (Hydrogen phosphide)
Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester (Phorate)
Phosphorothioic acid, O,O-dimethyl O-[p-((dimethylamino)sulfonyl)phenyl] ester (Famphur)
Phthalic acid esters, N.O.S.* (Benzene, 1,2-dicarboxylic acid, esters, N.O.S.*)
Phthalic anhydride (1,2-Benzenedicarboxylic acid anhydride)
2-Picoline (Pyridine, 2-methyl-)
Polychlorinated biphenyl, N.O.S.*
Potassium cyanide
Potassium silver cyanide (Argentate(1-), dicyano-, potassium)
Pronamide (3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)benzamide)
1,3-Propane sultone (1,2-Oxathiolane, 2,2-dioxide)
n-Propylamine (1-Propanamine)
Propylthiouracil
(Undecamethylenediamine, N,N'-bis(2-chlorobenzyl)-, dihydrochloride)
2-Propyn-1-ol (Propargyl alcohol)
Pyridine
Reserpine (Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester)
Resorcinol (1,3-Benzenediol)
Saccharin and salts (1,2-Benzoisothiazolin-3-one, 1,1-dioxide, and salts)
Safrole (Benzene, 1,2-methylenedioxy-4-allyl-)
Selenious acid (Selenium dioxide)
Selenium and compounds, N.O.S.*
Selenium sulfide (Sulfur selenide)
Selenourea (Carbamimidoselenoic acid)
Silver and compounds, N.O.S.*
Silver cyanide
Sodium cyanide
Streptozotocin (D-Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-)
Strontium sulfide
Strychnine and salts (Strychnidin-10-one, and salts)
1,2,4,5-Tetrachlorobenzene (Benzene, 1,2,4,5-tetrachloro-)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) (Dibenzo-p-dioxin, 2,3,7,8-tetrachloro-)
Tetrachloroethane, N.O.S.* (Ethane, tetrachloro-, N.O.S.*)

1,1,1,2-Tetrachlorethane (Ethane, 1,1,1,2-tetrachloro-)
1,1,2,2-Tetrachlorethane (Ethane, 1,1,2,2-tetrachloro-)
Tetrachloroethane (Ethene, 1,1,2,2-tetrachloro-)
Tetrachloromethane (Carbon tetrachloride)
2,3,4,6,-Tetrachlorophenol (Phenol, 2,3,4,6-tetrachloro-)
Tetraethyldithiopyrophosphate (Dithiopyrophosphoric acid, tetraethyl-ester)
Tetraethyl lead (Plumbane, tetraethyl-)
Tetraethylpyrophosphate (Pyrophosphoric acide, tetraethyl ester)
Tetranitromethane (Methane, tetranitro-)
Thallium and compounds, N.O.S.*
Thallic oxide (Thallium (III) oxide)
Thallium (I) acetate (Acetic acid, thallium (I) salt)
Thallium (I) carbonate (Carbonic acid, dithallium (I) salt)
Thallium (I) chloride
Thallium (I) nitrate (Nitric acid, thallium (I) salt)
Thallium selenite
Thallium (I) sulfate (Sulfuric acid, thallium (I) salt)
Thioacetamide (Ethanethioamide)
Thiosemicarbazide
(Hydrazinecarbothioamide)
Thiourea (Carbamide thio-)
Thiuram (Bis(dimethylthiocarbamoyl) disulfide)
Toluene (Benzene, methyl-)
Toluenediamine (Diaminotoluene)
o-Toluidine hydrochloride (Benzenamine, 2-methyl-, hydrochloride)
Tolylene diisocyanate (Benzene, 1,3-diisocyanatomethyl-)
Toxaphene (Camphene, octachloro-)
Tribromomethane (Bromoform)
1,2,4-Trichlorobenzene (Benzene, 1,2,4-trichloro-)
1,1,1-Trichloroethane (Methyl chloroform)
1,1,2-Trichloroethane (Ethane, 1,1,2-trichloro-)
Trichloroethene (Trichloroethylene)
Trichloromethanethiol (Methanethiol, trichloro-)
Trichloromonofluoromethane (Methane, trichlorofluoro-)
2,4,5-Trichlorophenol (Phenol, 2,4,5-trichloro-)
2,4,6-Trichlorophenol (Phenol, 2,4,6-trichloro-)
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) (Acetic acid, 2,4,5-trichlorophenoxy-)
2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex) (Propionoic acid, 2-(2,4,5-trichlorophenoxy)-)
Trichloropropane, N.O.S.* (Propane, trichloro-, N.O.S.*)
1,2,3-Trichloropropane (Propane, 1,2,3-trichloro-)
O,O,O-Triethyl phosphorothioate (Phosphorothioic acid, O,O,O-triethyl ester)

sym-Trinitrobenzene (Benzene, 1,3,5-trinitro-)
Tris(1-aziridinyl) phosphine sulfide (Phosphine sulfide, tris(1-aziridinyl-)
Tris(2,3-dibromopropyl) phosphate (1-Propanol, 2,3-dibromo-, phosphate)
Trypan blue (2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl(1,1'-biphenyl)-4,4'-diyl)bis(azo)]bis(5-amino-4-hydroxy-, tetrasodium salt)
Uracil mustard (Uracil 5-[bis(2-chloroethyl)amino]-)
Vanadic acid, ammonium salt (ammonium vanadate)
Vanadium pentoxide (Vanadium (V) oxide)
Vinyl chloride (Ethene, chloro-)
Zinc cyanide
Zinc phosphide

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APPENDIX B
GUIDE TO COMPATIBILITY OF CHEMICALS

GUIDE TO COMPATIBILITY OF CHEMICALS

The Guide is based in part upon information provided to the Coast Guard by the National Academy of Sciences – U.S. Coast Guard Advisory Committee on Hazardous Materials and represents the latest information available to the Coast Guard on chemical compatibility.

The accidental mixing of one chemical cargo with another can in some cases be expected to result in a vigorous and hazardous chemical reaction. The generation of toxic gases, the heating, overflow, and rupture of cargo tanks, and fire and explosion are possible consequences of such reactions.

The purpose of the Compatibility Chart is to show chemical combinations believed to be dangerously reactive in the case of accidental mixing. It should be recognized, however, that the Chart provides a broad grouping of chemicals with an extensive variety of possible binary combinations. Although one group, generally speaking, can be considered dangerously reactive with another group where an "X" appears on the Chart, there may exist between the groups some combinations which would not dangerously react. The Chart should therefore not be used as an infallible guide. It is offered as an aid in the safe loading of bulk chemical cargoes, with the recommendation that proper safeguards be taken to avoid accidental mixing of binary mixtures for which an "X" appears on the Chart Proper safeguards would include consideration of such factors as avoidance of the use of common cargo and vent lines and carriage in adjacent tanks having a common bulkhead.

The following procedure explains how the Guide should be used in determining compatibility information:

(1) Determine the reactivity group of a particular product by referring to the alphabetical list in Table 7.1.

(2) Enter the Chart with the reactivity group. Proceed across the page An "X" indicates a reactivity group that forms an unsafe combination with the product in question.

For example, crotonaldehyde is listed in Table 7.1 as belonging in Group 19 (Aldehydes). The Chart shows that chemicals in this group should be segregated from sulfuric and nitric acids, caustics, ammonia, and all types of amines (aliphatic, alkanol, and aromatic). According to note A, crotonaldehyde is also incompatible with non-oxidizing mineral acids.

It is recognized there are wide variations in the reaction rates of individual chemicals within the broad groupings shown reactive by the Compatibility Chart. Some individual materials in one group will react violently with some of the materials in another group and cause great hazard; others will react slowly, or not at all. Accordingly, a useful addition to the Guide would be the identification of specific binary combinations which are found *not* to be dangerously reactive, even though an "X" appears on the chart for those two chemicals. A few such combinations are listed in Table 7.3; other safe combinations will be listed in subsequent revisions.

COMPATIBILITY CHART

REACTIVE GROUPS / :O GROUPS	1. NON-OXIDIZING MINERAL ACIDS	2. SULFURIC ACID	3. NITRIC ACID	4. ORGANIC ACIDS	5. CAUSTICS	6. AMMONIA	7. ALIPHATIC AMINES	8. ALKANOLAMINES	9. AROMATIC AMINES	10. AMIDES	11. ORGANIC ANHYDRIDES	12. ISOCYANATES	13. VINYL ACETATE	14. ACRYLATES	15. SUBSTITUTED ALLYLS	16. ALKYLENE OXIDES	17. EPICHLOROHYDRIN	18. KETONES	19. ALDEHYDES	20. ALCOHOLS, GLYCOLS	21. PHENOLS, CRESOLS	22. CAPROLACTAM SOLUTION
ON-OXIDIZING MINERAL ACIDS		X			X	X	X	X	X	X	X	X	X			X	X		A	C		
ULFURIC ACID	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITRIC ACID		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
RGANIC ACIDS		X			X	X	X	X	C			X				X	X			F		
AUSTICS	X	X	X	X				X			X	F				X	X		X	X	X	X
MMONIA	X	X	X	X						X	X	X	X			X	X		X			
LIPHATIC AMINES	X	X	X	X							X	X	X	X	X	X	X	X	X	X	X	X
LKANOLAMINES	X	X	X	X	X						X	X	X	X	X	X	X	B	X			
ROMATIC AMINES	X	X	X	C							X	X							X			
MIDES	X	X	X			X						X									X	
RGANIC ANHYDRIDES	X	X	X		X	X	X	X	X													
SOCYANATES	X	X	X	X	X	X	X	X	X	X					O					X		X
INYL ACETATE	X	X	X			X	X	X														
LATES		X	X				X	X														
TITUTED ALLYLS		X	X				X	X				O										
LKYLENE OXIDES	X	X	X	X	X	X	X	X														
PICHLOROHYDRIN	X	X	X	X	X	X	X	X														
ETONES		X	X				X	B														
LDEHYDES	A	X	X		X	X	X	X	X													
LCOHOLS, GLYCOLS	E	X	X	F	X		X					X										
HENOLS, CRESOLS		X	X		X		X			X												
APROLACTAM SOLUTION		X			X		X					X										
										•												
LEFINS		X	X																•			
ARAFFINS																						
ROMATIC HYDROCARBONS			X																			
ISCELLANEOUS HYDROCARBON MIXTURES			X																			
STERS		X	X																			
INYL HALIDES			X																			X
ALOGENATED HYDROCARBONS		G			H		I															
ITRILES		X																				
ARBON DISULFIDE							X	X														
ULFOLANE																						
LYCOL ETHERS		X										X										
THERS		X	X																			
ITROCOMPOUNDS					X	X	X	X	X													
ISCELLANEOUS WATER SOLUTIONS		X										X										
etters refer to notes on following page)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

NOTES TO COMPATIBILITY CHART:
REACTIVITY DIFFERENCES (DEVIATIONS) WITHIN CHEMICAL GROUPS

A Acrolein (19), Crotonaldehyde (19), and 2-Ethyl-3-propyl acrolein (19) are not compatible with Group 1, Non-Oxidizing Mineral Acids.

B Isophorone (18), and Mesityl Oxide (18) are not compatible with Group 8, Alkanolamines.

C Acrylic Acid (4) is not compatible with Group 9, Aromatic Amines.

D Allyl Alcohol (15) is not compatible with Group 12, Isocyanates.

E Furfuryl Alcohol (20) is not compatible with Group 1, Non-oxidizing Mineral Acids.

F Furfuryl Alcohol (20) is not compatible with Group 4, Organic Acids.

G Dichloroethyl Ether (36) is not compatible with Group 2, Sulfuric Acid.

H Trichloroethylene (36) is not compatible with Group 5, Caustics.

I Ethylenediamine (7) is not compatible with Ethylene Dichloride (36).

ALPHABETICAL LISTING OF COMPOUNDS

Name	Group No.
Acetaldehyde	19
Acetic Acid	4
Acetic Anhydride	11
Acetone	18
Acetonitrile	37
Acrolein (inhibited)	19
Acrylic Acid (inhibited)	4
Acrylonitrile (inhibited)	15
Adiponitrile	37
Allyl Alcohol	15
Allyl Chloride	15
Aminoethylethanolamine	8
Ammonia, Anhydrous	6
Ammonium Hydroxide (28% or less)	6
Ammonium Nitrate, Urea, Water Solutions (containing Ammonia)	6
Ammonium Nitrate, Urea, Water Solutions (not containing Ammonia)	43
Amyl Acetate	34
Amyl Alcohol	20
Amyl Tallate	34
Aniline	9
Asphalt	33
Asphalt Blending Stocks:	
Roofers Flux	33
Straight Run Residue	33
Benzene	32
Benzene, Toluene Xylene (crude)	32
Butadiene (inhibited)	30
Butane	31
Butyl Acrylate (inhibited)	14
Butyl Acetate	34
Butyl Alcohol	20
Butylamine	7
Butyl Benzyl Phthalate	34
Butylene	30
1,3-Butylene Glycol	20
Butylene Oxide	16
Butyl Ether	41
Butyl Methacrylate (inhibited)	14
Butyraldehyde	19
Butyric Acid	4
Camphor Oil (light)	18
Caprolactam Solution	22
Carbolic Oil	21
Carbon Disulfide	38
Carbon Tetrachloride	36
Caustic Potash Solution	5
Caustic Soda Solution	5
Chlorine	*
Chlorobenzene	36
Chloroform	36
Chlorosulfonic Acid	*
Corn Syrup	43
Creosote, Coal Tar	21
Cresols	21
Cresylate Spent Caustic Solution	5
Crotonaldehyde	19
Cumene	32
Cycloaliphatic Resins	31
Cyclohexane	31
Cyclohexanol	20
Cyclohexanone	18
Cyclohexylamine	7
Cymene	32
Decaldehyde	19
Decane	31
Decene	30
Decyl Alcohol	20
Decyl Acrylate (inhibited)	14

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

Polybutene	30
Polyethylene Glycols	40
Polymethylene Polyphenyl-isocyanate	12
Polypropylene	30
Polypropylene Glycol Methyl Ether	40
Polypropylene Glycols	40
Propane	31
Propanolamine	8
Propionaldehyde	19
Propionic Acid	4
Propionic Anhydride	11
Propyl Acetate	34
Propyl Alcohol	20
Propylamine	7
Propylene	30
Propylene Butylene Polymer	30
Propylene Glycol	20
Propylene Oxide	16
Propylene Tetramer	30
Propyl Ether	41
Pyridine	9
Sodium Hydrosulfide Solution (45% or less)	5
Sorbitol	20
Styrene (inhibited)	30
Sulfolane	39
Sulfur (molten)	*
Sulfuric Acid	2
Sulfuric Acid, Spent	2
Tallow	34
Tallow Fatty Alcohol	20
1,1,2,2-Tetrachloroethane	36
Tetradecanol	20
Tetradecene	30
Tetradecylbenzene	32
Tetraethylene Glycol	40
Tetraethylenepentamine	7
Tetrahydrofuran	41
Tetrahydronaphthalene	32
Tetrasodium Salt of EDTA Solution	43
Toluene	32
Toluene Diisocyanate	12
1,2,4-Trichlorobenzene	36
Trichloroethylene	36
Tridecanol	20
Tridecene	30
Tridecylbenzene	32
Triethanolamine	8
Triethylamine	7
Triethyl Benzene	32
Triethylene Glycol	40
Triethylenetetramine	7
Tripropylene Glycol	40
Turpentine	30
Undecanol	20
Undecene	30
Undecylbenzene	32
Valeraldehyde	19
Vinyl Acetate (inhibited)	13
Vinyl Chloride (inhibited)	35
Vinylidene Chloride (inhibited)	35
Vinyl Toluene (inhibited)	30
Xylene	32

* Because of very high reactivity or unusual conditions of carriage, this product is not included in the Compatibility Chart. If compatibility information is needed for a shipment, contact Commandant (G-MHM-1/83), U.S. Coast Guard, 400 Seventh Street, S.W., Washington, D. C. 20590.

REACTIVITY GROUPS

1. Non-Oxidizing Mineral Acids

Hydrochloric Acid
Hydrofluoric Acid
Phosphoric Acid

2. Sulfuric Acids

Spent Sulfuric Acid
Sulfuric Acid (98% or less)

3. Nitric Acid

Nitric Acid (70% or less)

4. Organic Acids

Acetic Acid
Butyric Acid
Formic Acid
Propionic Acid
Acrylic Acid (inhibited)

5. Caustics

Caustic Potash Solution
Caustic Soda Solution
Cresylate Spent Caustic Solution
Sodium Hydrosulfide Solution
(45% or less)

6. Ammonia

Ammonia, Anhydrous
Ammonium Hydroxide (28% or less)
Ammonium Nitrate, Urea, Water
Solutions (containing Ammonia)

7. Aliphatic Amines

Butylamine
Cyclohexylamine
Dibutylamine
Diethylamine
Diethylenetriamine
Diisopropylamine
Dimethylamine
Di-n-propylamine
Ethylamine
Ethylenediamine
Hexamethyleneimine
Methylamine
Morpholine
Propylamine
Tetraethylenepentamine
Triethylamine
Triethylenetetramine

8. Alkanolamines

Aminoethylethanolamine
Diethanolamine
Diethylethanolamine
Diisopropanolamine
Dimethylethanolamine
Ethanolamine
Propanolamine
Triethanolamine

9. Aromatic Amines

Aniline
Pyridine
2-Methyl-5-Ethylpyridine

10. Amides

Dimethylformamide

11. Organic Anhydrides

Acetic Anhydride
Phthalic Anhydride
Propionic Anhydride

12. Isocyanates

Diphenylmethane Diisocyanate
Polyphenyl Polymethylene-isocyanate
Toluene Diisocyanate

13. Vinyl Acetate

Vinyl Acetate (inhibited)

14. Acrylates

Butyl Acrylate (inhibited)
Butyl Methacrylate (inhibited)
Decyl Acrylate (inhibited)
Ethyl Acrylate (inhibited)
2-Ethylhexyl Acrylate (inhibited)
Ethyl Methacrylate (inhibited)
Methyl Acrylate (inhibited)
Methyl Methacrylate (inhibited)

15. Substituted Allyls

Acrylonitrile (inhibited)
Allyl Alcohol
Allyl Chloride
1,3-Dichloropropene

16. Alkylene Oxides

Propylene Oxide
Butylene Oxide

17. Epichlorohydrin

Epichlorohydrin

18. Ketones

Acetone
Camphor Oil
Cyclohexanone
Diisobutyl Ketone
Isophorone
Mesityl Oxide
Methyl Ethyl Ketone
Methyl Isobutyl Ketone

19. Aldehydes

Acetaldehyde
Acrolein (inhibited)
Butyraldehyde
Decaldehyde
Ethylhexaldehyde
Formaldehyde
Glutaraldehyde Solution
Glyoxal Solution
Methylbutyraldehyde
Octyl Aldehyde
Pentyl Aldehyde
Propionaldehyde
Valeraldehyde

20. Alcohols, Glycols

Amyl Alcohol
Butyl Alcohol
1,3-Butylene Glycol
Cyclohexanol
Decyl Alcohol
Diacetone Alcohol
Diisobutyl Carbinol
Dodecanol
Ethanol
Ethoxylated Alcohols C_{11}-C_{15}

Ethyl Alcohol
Ethylbutanol
Ethylene Chlorohydrin
Ethylene Cyanohydrin
Ethylene Glycol
2-Ethyl Hexanol
Furfuryl Alcohol
Glycerin
Hexanol
Hexylene Glycol
Methanol
Methyl Alcohol
Methylamyl Alcohol
Methylisobutyl Carbinol
Octyl Alcohol
Nonyl Alcohol
Pentadecanol
Propyl Alcohol
Propylene Glycol
Sorbitol
Tallow Fatty Alcohol
Tetradecanol
Tridecanol
Undecanol

21. Phenols and Cresols

Carbolic Oil
Creosote, Coal Tar
Cresols
Nonyl Phenol
Phenol

22. Caprolactam Solution

Caprolactam Solution

23 - 29. Unassigned

30. Olefins

Butadiene (inhibited)
Butene
Butylene
Decene
Dicyclopentadiene
Diisobutylene
Dodecene
Ethylene
Hexene
Isoprene (inhibited)
Methyl Acetylene, Propadiene Mixture (stabilized)
(alpha-) Methyl Styrene (inhibited)
Nonene
Octene
Pentene
Polybutene
Polypropylene
Propylene
Propylene Butylene Polymer
Propylene Tetramer
Styrene (inhibited)
Vinyl Toluene (inhibited)
Tetradecene
Tridecene
Turpentine
Undecene

31. Paraffins

Butane
Cycloaliphatic Resins
Cyclohexane
Decane
Dodecane
Ethane
Heptane
Hexane
Methane
Nonane
Octane
Pentane
Propane

32. Aromatic Hydrocarbons

Benzene
Benzene, Toluene, Xylene (crude)
Cumene
Cymene
Decylbenzene
Diethylbenzene
Dodecylbenzene
Ethylbenzene
Naphthalene
Tetradecylbenzene
Tetrahydronaphthalene
Toluene
Tridecylbenzene
Triethylbenzene
Undecylbenzene
Xylene

33. Misc. Hydrocarbon Mixtures

Asphalt
Asphalt Blending Stocks
Diphenyl - Diphenyl Oxide
Distillates
Gas Oil, Cracked
Gasoline Blending Stocks
Gasolines
Jet Fuels
Kerosene
Mineral Spirits
Naphtha
Oils, Crude
Oils, Diesel
Oils, Coal
Oils, Fuel (No. 1 thru No. 6)
Oils, Residual
Oils, Road
Oils, Transformer
Petrolatum
Petroleum Naphtha

34. Esters

Amyl Acetate
Amyl Tallate
Butyl Acetate
Butyl Benzyl Phthalate
Castor Oil
Coconut Oil
Cottonseed Oil
Dibutyl Phthalate
Diethylene Glycol Monobutyl Ether Acetate
Diheptyl Phthalate
Diisodecyl Phthalate
Dinonyl Phthalate
Dioctyl Phthalate
Diundecyl Phthalate
Ethyl Acetate
Ethylene Glycol Monobutyl Ether Acetate
Ethylene Glycol Monoethyl Ether Acetate
Ethylhexyl Tallate
Fish Oil
Glycol Diacetate
Lard
Methyl Acetate
Methyl Amyl Acetate
Octyl Epoxy Tallate
Olive Oil
Palm Oil
Peanut Oil
Propyl Acetate
Safflower Oil
Soybean Oil
Tallow
Tucum Oil
Vegetable Oil

35. Vinyl Halides

Vinyl Chloride (inhibited)
Vinylidene Chloride (inhibited)

36. Halogenated Hydrocarbons

Carbon Tetrachloride
Chlorobenzene

Chloroform
Dichlorobenzene
1,1-Dichloroethane
Dichloroethyl Ether
Dichloromethane
1,1-Dichloropropane
1,2-Dichloropropane
Ethyl Chloride
Ethylene Dibromide
Ethylene Dichloride
Methyl Bromide
Methyl Chloride
Pentachloroethane
Perchloroethylene
1,1,2,2-Tetrachloroethane
1,2,4-Trichlorobenzene
Trichloroethylene

37. Nitriles

Acetonitrile
Adiponitrile

38. Carbon Disulfide

39. Sulfolane

40. Glycol Ethers

Diethylene Glycol
Diethylene Glycol Monobutyl Ether
Diethylene Glycol Monoethyl Ether
Diethylene Glycol Monomethyl Ether
Dipropylene Glycol
Ethoxy Triglycol
Ethylene Glycol Monobutyl Ether
Ethylene Glycol Monethyl Ether
Ethylene Glycol Monomethyl Ether
Nonylphenol, Ethoxylated
Polyethylene Glycols
Polypropylene Glycols
Polypropylene Glycol Methyl Ether
Soybean Oil, Epoxidized
Tetraethylene Glycol
Triethylene Glycol
Tripropylene Glycol

41. Ethers

Butyl Ether
1,4-Dioxane
Ethyl Ether
Methyl Formal (Dimethyl Formal)
Propyl Ether
Tetrahydrofuran

42. Nitrocompounds

(mono-) Nitrobenzene
1- or 2-Nitropropane
Nitrotoluene

43. Miscellaneous Water Solutions

Ammonium Nitrate, Urea, Water Solutions (not containing Ammonia)
Corn Syrup
Dextrose Solution
Latex Solutions
Tetrasodium Salt of EDTA Solution

APPENDIX C
MATERIAL SAFETY DATA SHEET

Environmental Protection Agency

BASIC FIELD ACTIVITIES SAFETY TRAINING

Post Test

1-1. The basic level of field training consists of all the following except:

a. 24 hours of classroom training
b. 36 hours of field training with experienced employee
c. 8 hours of respiratory and protective gear training
d. All of the above

1-2. Employee reports of hazardous work conditions must be investigated within:

a. 24 hours for imminent dangers
b. One week if potentially serious
c. 30 days for other conditions
d. None of the above

2-1. Which is the best procedure when preparing to visit a site for the first time:

a. Let the highest ranking person take charge; others listen and obey.
b. Let the person with the most experience at similar sites take charge; others listen and obey.
c. Let one person record every team member's suggestions. Then consider the task <u>as a team</u> and make your plans jointly.

3-1. Treat third degree burns and "burn shock" by _____ and other appropriate procedures)

a. Use of ice
b. Giving fluids to drink (if patient is conscious)
c. Removing all burned, hot clothing, with any adhering skin
d. All of the above

3-2. Which CPR technique should not be <u>practiced</u> on a classroom volunteer?

a. Mouth-to-mouth resuscitation
b. Opening and clearing the airway
c. Feeling for pulse at the carotid artery
d. Cardiac compression

4-1. Your team will be working in the sun, in 95° F heat, in encapsulating suites, without cooling vests. Work periods should last not longer than:

a. 15 minutes
b. 30 minutes
c. 60 minutes
d. 2 hours

4-2. Normal activities will be disrupted if the internal temperature drops only _____.

a. 2 degrees F
b. 5 degrees F
c. 10 degrees F
d. 19.6 degrees to 80 degrees F

4-3. Heat cramps are caused by _____.

a. Insufficient sweating
b. Loss of electrolytes
c. Erratic blood pressure and pulse
d. Hard work in hot sun

4-4. When heat stress is anticipated, which fluids are recommended:

a. White wine
b. Gatorade
c. Weak salt solution
d. Sweetened, hot coffee
e. b and c
f. a and d

5-1. A spilled substance with a specific gravity of 0.80 and a vapor pressure of 600 mm/hg at ambient air temperature _____.

a. Would evaporate readily
b. Sink to the bottom of a pond
c. Be found in high concentration in low lying areas
d. Would likely be very flammable

5-2. Which of the following is not a characteristic of a hazardous waste?

a. combustible liquid
b. Corrosivity
c. Reactivity
d. E.P. toxicity
e. None of the above

6-1. Acute dosage tests are preferred to chronic tests because:

a. They are cheaper
b. The are faster
c. They have an easily recognizable endpoint
d. None of the above
e. a, b, c

6-2. The potency of a poison is determined by _____.

a. A select committee of OSHA
b. The design of the experiments used to determine it
c. The use of standard white mice
d. All of the above
e. None of the above

6-3. The common mechanism linking cancer, mutation, and teratogenic effects is _____.

a. Modification of NDA
b. Modification of tRNA
c. Modification of mRNA
d. Sister chromatid exchange

7-1. An allergy is _____.

a. A kind of chronic toxic effect.
b. A kind of acute toxic effect.
c. A malfunction of the immune system.
d. A product of the imagination, without physical cause.

7-2. The site of action of a toxic chemical is _____.

a. The geographic location where the chemical gets loose.
b. The identity of the chemical process for which the chemical was intended to be used.
c. The target organ or system, within an animal.
d. The molecular structure to which the chemical attaches to effect its detrimental action

7-3. Chronic use of alcohol results in increased biosynthesis of liver alcohol dehydrogenase. This is an example of _____

a. Target organ damage.
b. Drug addiction.
c. An adaptive mechanism.
d. An immune reaction.

8-1. OSHA defines PELs, which are _____.

a. Protective environmental limits
b. Permissible exposure limits
c. Probably endangered lives
d. Protective environmental laws

8-2. TLV-STEL levels are the concentration to which a worker ___.

a. May never be exposed to
b. May be exposed to over 40 hours
c. May be exposed continuously for 15 minutes without harm
d. May be exposed to for a shot term of less than 8 hours

8-3. In which of the following areas are toxic chemicals most easily absorbed:

a. Hands
b. Feet
c. Face
d. Arms

9-1. Many hazards are invisible. Which jet or stream of high pressure gas is easiest to see:

a. Carbon dioxide, from a liquid CO_2 fire extinguisher
b. 600 psig heated steam
c. 100 psi air

10-1. You are preparing to climb a 30 foot ladder, and when you finish climbing, you will need a hammer, chisel, screwdriver, and vice-grip wrench. Which is best?

a. Put them in your pockets or tool vest to keep your hands free
b. Put them in a tool box to be carried in one hand
c. Put them in a back pack
d. Put them in a closed container that will be hoisted up to you after you climb the ladder.

10-2. Scaffolds should be secured at least every _____ feet of elevation

a. 8
b. 12
c. 20
d. 30

10-3. Standard guard rails have top- and mid-rails how high?

a. 54 and 27 inches
b. 42 and 21 inches
c. 36 and 18 inches
d. 30 and 18 inches

11-1. Grit chambers, digesters, and wet wells are places where which hazard may exist?

a. Insufficient oxygen
b. Slippery spills of water, grease and oil
c. Flammable liquids or vapors
d. All of the above

11-2. In these plants, the on-site locations with the highest percentages of accidents are _____.

a. Sludge handling and manholes
b. Maintenance shop and preliminary treatment
c. Pump stations, and wet or dry wells
d. Settling tanks and laboratory

11-3. When chlorine gas leaks out and combines with water, it forms

a. Hydrogen peroxide
b. Sodium hypochlorite
c. Hydrochloric acid
d. Polychlorinated biphenyls

12-1. The list of dangerous gases in a mine is usually headed by ___.

a. Methane
b. Propane
c. Hydrogen
d. Hydrogen sulfide

13-1. If a car going 40 mph can stop in 65 feet on dry concrete, what is the estimated stopping distance at 40 mph in snow?

a. 85 feet
b. 200 feet
c. 275 feet
d. 400 feet

13-2. If a car going 25 mph can stop in 40 feet, after the brakes have been applied, a car going 50 mph can stop in about ____.

a. 65 feet
b. 80 feet
c. 120 feet
d. 160 feet

13-3. The distance between your car and the one in front is _____.

a. Separation
b. Interval
c. Maneuvering space
d. Reaction space

14-1. A storm warning center is displaying a single square red flag with a black center, and the radio says there is a storm warning. What should you do?

a. Proceed cautiously, but not get out of sight or shore, in case a small craft warning is issued.
b. Go shore and stay ashore until the weather clears.
c. Proceed with your mission, but radio the Coast Guard to let them where you are.
d. Don life jackets, but continue sailing if you know how to navigate with a compass.

14-2. You are using a 20-foot cabin cruiser, and there is a fishing boat trawling for fish, on a course that may take it across your bow, but a collision seems likely, or else you may get your propeller fouled in his net. You should _____.

a. Sound your horn repeatedly to tell the fishenman to get out of your way, because you are on government business.
b. Get on the CB radio and try to contact the other boat.
c. Yield the right of way.
d. Make him yield the right of way, because your boat is better.

15-1. You have collected 12 liquid samples of hazardous materials in glass jars. For your return flight with the samples, in your chartered aircraft, what packing and stowing precautions should you observe?

a. None, that's why you used a chartered aircraft.
b. Enclose bottles in plastic bags to contain spills.
c. Observe (b) and stow the case of bottles so it can't slide or overturn.
d. Observe (b) and (c) and stow, as directed by the pilot to maintain proper balance in the aircraft

15-2. You have filed a flight plan, and now your chartered plane develops engine trouble. The pilot glides in, roughly but safely, on a meadow in a wilderness area. The radio is dead. Your estimated time of arrival is 11:00a.m. When will a search for your plane be initiated?

a. at 11:30a.m.
b. at noon
c. at 12:30p.m.
d. When your wife, or boss, or someone else misses you and starts phoning the airport from which you left.
e. Never, unless you took out air search insurance.

16-1. A fire extinguisher has these pictures on it: a flaming waste basket and a bonfire, a container pouring liquid and a fire, and an electrical plug and receptacle with a red slash running diagonally through them. That extinguisher can be used on which fires?

a. Types A, B, and C
b. Types B and C
c. Types A and B
d. Types A and C

16-2. You open the door to see what's in the room, and you discover a brisk fire burning. You should _____.

a. First sound (or shout) the alarm, then call the fire dept
b. Sound the alarm, and use the nearest fire extinguisher
c. Grab the biggest of the 3 fire extinguishers on the wall, and try to put out the fire.

17-1. The flashpoint of a flammable substance is _____.

a. The point of ignition
b. The temperature at which enough vapor is released to allow a flame to propagate in the vapor-air mixture.
c. A guide in choosing a fire extinguisher.

17-2. The UFL is the _____.

a. Upper flammable limit
b. Unidentified flammability level
c. Unrequited flaming love
d. Unignited flammable liquid

17-3. The LEL is the _____.

a. Least explosive level
b. Lowest environmental liability
c. Lower explosive limit
d. Lowest explosive level

17-4. Faulty judgement, poor coordination, and rapid fatigue occurs at what percentage of oxygen?

a. <6%
b. 10 - 14%
c. 16 - 18%
d. 19 - 23%

18-1. Coliwasa stands for _____.

a. Surface water (wasa) contaminated with fecal Escherichia coli
b. Collected, integrated, waste sampler
c. Composite liquid waste sampler
d. Collected liquid waste saver

18-2. A GFCI is a _____.

a. General Fire Containing Inclosure
b. General Flammable Chemical Index
c. Gas Flame Caused Implosion
d. Ground Fault Circuit Interrupter

18-3. Combustible dusts of coal, grain, etc., are what "Class" of flammable material?

a. I b. II c. III

19-1. Rocky Mountain Spotted Fever is caused by bacteria (rickettsia) and transmitted by _____.

a. ticks
b. mosquitoes
c. lice
d. sewage

19-2. Another creature that can cause a life-threatening allergic reaction is the _____.

a. Striped bass
b. Rabid fox
c. Rattlesnake
d. Wasp or bee

19-3. The most poisonous spider venom in the U.S. comes from the _____.

a. Brown recluse spider
b. Black widow spider
c. Tarantula
d. Widow-maker spider

20-1. Which shoe or boot material is almost impossible to decontaminate?

a. Leather
b. Neoprene
c. PVC
d. Butyl rubber

20-2. What material has the greatest resistance to degradation by fuels?

a. Butyl rubber
b. Polyvinyl chloride (PVC)
c. Neoprene
d. Natural rubber

20-3. According to Dept. of Labor stats, what % of work related injuries occur during routine job assignments?

a. [illegible]
b. 75%
c. 60%
d. 45%

20-4. What material has the greatest resistance to mineral acids?

a. Butyl rubber
b. Polyvinyl chloride (PVC)
c. Neoprene
d. Natural rubber

21-1. If [illegible] n atmosphere that is IDLH, you must use

a. A full [illegible], with harness-mounted [illegible] gas [illegible]
b. A SCBA
c. An airline respirator with auxiliary self-contained air supply
d. a, b, or c
e. [illegible] or c
f. [illegible]

21-2. All toxic gases can be detected by

a. Slight color or visible haze
b. Odor
c. Irritation of nose and throat
d. All of the above
e. None of the above

22-1. About 50 unsound drums, mostly with n structural integrity, are sitting close together, outside, in disc lerly rows. There are no labels [illegible] should you sample hem?

a. Move each drum carefully, with a bac[illegible]pe, to a sampling area and puncture over catch basins.
b. Empty the drums with a vacuum system, after digging moats to catch spills
c. Puncture and sample the drums in place, wearing Class A protection.
d. Leave them alone.

22-2. SCBA and Protective Clothing are which level of protection?

a. A b. B c. C D

23-1. The proper shipping name for hazardous material is found in

a. The DOT regulations
b. Beilstein
c. The ACS Official Nomenclature of Chemicals
d. The NIOSH Registry of Hazardous Materials

SECTION VI . REACTIVITY DATA

STABILITY			
	UNSTABLE		
	STABLE	X	Can react vigorously with oxidizing material.

INCOMPATABILITY (materials to avoid)

Carbonates; Hydroxides; many oxides and phosphates, etc.

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION			CONDITIONS TO AVOID
	MAY OCCUR		
	WILL NOT OCCUR	X	

SECTION VII . SPILL AND DISPOSAL PROCEDURES

SPILLS

Eliminate all sources of ignition. Cover contaminated surfaces with soda ash or sodium bicarbonate. Mix and add water if necessary. Scoop up slurry and wash neutral (make litmus test) waste down drain with excess water, if local environmental regulations permit.

DISPOSAL

Dispose through a waste treatment plant if local environmental regulations permit.

SECTION VIII . PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type) Self-contained breathing apparatus

VENTILATION	LOCAL	SPECIAL
	X	
	MECHANICAL (general)	OTHER
	X	

PROTECTIVE GLOVES	EYE PROTECTION
Rubber gloves	Face shield

OTHER PROTECTIVE EQUIPMENT

Approved working clothes

SECTION IX . HANDLING AND STORAGE PRECAUTIONS

STORAGE & HANDLING

Keep away from heat and open flame. Keep in tightly closed container, at a temperature above 17°C. (63°F.). If frozen, thaw by moving closed container to warm area. Loosen closure cautiously.

SECTION X . MISCELLANEOUS INFORMATION

Do not get liquid or vapor in eyes, on skin, on clothing. Avoid breathing vapor. Wash thoroughly after handling.

Date Issued 1/17/78

Approved by B. J. Lambert
Manager, Quality Assurance

6-20

Revision No. & Date Issued

MATERIAL SAFETY DATA SHEET

J.T.Baker CHEMICALS

J. T. Baker Chemical Co., 222 Red School Lane, Phillipsburg, N.J. 08865

SECTION I . IDENTIFICATION OF PRODUCT

CHEMICAL NAME	FORMULA
Acetic Acid, Glacial	CH_3COOH
SYNONYM OR CROSS REFERENCE	**CAS NO:**
Methane carboxylic acid; Ethanoic Acid	**EPA NO:**

SECTION II . HAZARDOUS INGREDIENTS

MATERIAL	NATURE OF HAZARD

SECTION III . PHYSICAL DATA

BOILING POINT	240°C.	MELTING POINT	F.P. 62°F.
VAPOR PRESSURE	@ 20°C. 11.3 mm	SPECIFIC GRAVITY	1.05
VAPOR DENSITY (AIR=1)	2.07	PERCENT VOLATILE BY VOLUME (%)	
WATER SOLUBILITY	Soluble	EVAPORATION RATE (_____=1)	

APPEARANCE: Clear, colorl liquid with strong pungent odor of vinegar.

SECTION IV . FIRE AND EXPLOSION HAZARD DATA

			Lower	Upper
FLASH POINT (method used)	103°F. (cc)	FLAMMABLE LIMITS @ 212°	5.4%	16%

FIRE EXTINGUISHING MEDIA: Water spray, dry chemical or carbon dioxide.

SPECIAL FIRE-FIGHTING PROCEDURES

UNUSUAL FIRE AND EXPLOSION HAZARD: Gives off flammable vapor above its flash point.

SECTION V . HEALTH HAZARD

THRESHOLD LIMIT VALUE: 10 ppm orl-rat LD_{50}: 3310 mg/kg

HEALTH HAZARDS: Causes severe burns. POISON May be fatal if swallowed. Harmful if inhaled.

FIRST AID PROCEDURES 6.19

Call a physician. If swallowed, do not give emetics. Give tap water, milk or milk of magnesia. Give whites of eggs beaten with water. If inhaled, remove to fresh air. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before re-use.