ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
EPA-330/9-74-002-B

N E I C

SAFETY MANUAL

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
DENVER, COLORADO

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I. INTRODUCTION

A. GENERAL

This manual is intended to provide the basis for comprehensive safety programs in each NEIC activity consistent with the Occupational Safety and Health Act requirements. Obviously, every safety hazard cannot be anticipated. Thus, rules cannot be developed for every contingency that could arise. Consequently, a practical safety program consists partly of rules and adherence thereto and partly of common sense, judgment, and experience. All employees are, therefore, required to enforce and adhere to the published rules, but, more importantly, are required to maintain a high level of safety consciousness. The latter involves constant vigilance for unsafe or potentially hazardous practices and immediate corrective action as necessary to ameliorate the condition.

Branch chiefs are responsible for the execution or incorporation of any changes or amendments made to this manual as the need is perceived. Requests are to be submitted, in writing, to the Safety Officer.

In all considerations related to the safety, two aspects transcend all others:

1. Safety consciousness is paramount to all other considerations in the course of job-related activities at NEIC. When in doubt regarding the safety aspects of a particular task or activity

and when competent advice is not immediately available, it is mandatory to follow the safest course of action.

2. Our human resources are our most priceless asset. The prevention of loss of life, injury, or health hazard is the greatest responsibility that we share.

B. IMPLEMENTATION RESPONSIBILITIES

Responsibilities are assigned for implementation of the safety requirements set forth in this manual. A description of each individual's responsibilities is presented.

Director, NEIC

The Director is responsible for the overall effectiveness of the NEIC Safety Program. Working through the Center Safety Officer he ensures that all NEIC employees are working in the safest possible environment.

Center Safety Officer

The Center Safety Officer is responsible for the overall coordination of the Safety Program. In cooperation with the Center Laboratory Safety Coordinators, Field Safety Coordinator, and with Branch Chiefs, he coordinates and maintains a safety program to identify possible hazards, disseminates information on known hazards, follows up on corrective action recommended, and coordinates the NEIC safety training program.

Laboratory Safety Coordinators and Field Safety Coordinator

These people are responsible for identifying possible hazards and recommending corrective action to be taken by Branch Chief or first line Supervisors. They hold periodic safety training sessions for Branch personnel, disseminate safety information on new safety procedures, equipment, etc., routinely inspect laboratories, review field safety procedures, and follow up to ensure that recommendations are implemented.

Branch Chiefs

Branch Chiefs are responsible as line managers for the safety and security of employees, equipment, and areas assigned to them, ensuring that proper safety equipment is provided where needed. Working through direct supervision and through first-line supervisors, the Branch Chiefs ensure that all aspects of the Safety Program are being carried out in their branch.

First Line Supervisors

First line supervisors are responsible for ensuring that the day-to-day work being carried out under their supervision in the laboratories and in the field is accomplished in accordance with established NEIC safety rules and policy. They are responsible for insuring that employees perform their jobs in a safe manner and for initiating immediate corrective action as soon as an unsafe situation or procedure is observed.

NEIC Safety Committee

The Safety Committee is made up of the Center Safety Officer, Field Safety Coordinator, Laboratory Safety Coordinators, and Branch Chiefs. The committee is responsible for reviewing and/or investigating serious accidents and recommending corrective action.

II. GENERAL SAFETY PRECAUTIONS

A. All employees are directed to bring to the attention of the most readily accessible supervisor any condition, practice, or circumstance that could result in health hazard, injury, or death to any employee. When imminent hazards exist, any employee on the scene must take steps to eliminate the hazard. Follow-up consultation with Branch Chiefs or Management should be carried out at the first opportunity. In cases where the hazard is not of an imminent nature the supervisor or employee is expected to consult Branch Chief or Management regarding appropriate corrective measures. Application of this rule requires the exercise of good judgment and common sense by all employees.

B. Protective headwear, eyewear, footwear, clothing, and accessories are available for all foreseeable circumstances; their use, as appropriate, is mandatory. If in doubt, act on the part of safety.

C. Branch Chiefs are authorized and directed to counsel individual employees about any work habits and practices that could be a hazard to the individual employee or fellow employees. Continued or repetitive failure to heed such counseling will be construed to be uncooperative conduct and may lead to appropriate administrative action.

D. Supervisory and Management personnel are required to familiarize themselves with the regulations promulgated pursuant to the Occupational Safety and Health Act of 1970. The latest regulations, set forth in the Federal Register, are available through the Safety Officer.

E. The following practices are expressly forbidden:

- use of explosives (as defined by 49 Chapter I) for any purpose whatsoever, except with the specific written approval of the Director.
- ignition of flammable liquids within, on, or through improvised heating devices (barrels) etc., space heaters not having Underwriters Laboratories' approval.
- entry -- in the absence of clear evidence that such entry can be accomplished safely, into areas or spaces wherein toxic or explosive concentrations of gases or dust may exist.

F. Visitors to all work areas other than offices shall be escorted by an employee. The escorting employee is responsible for the safety of the visitor until relieved of the responsibility by a supervisor, Branch Chief, or Management personnel, or until the visitor departs the work area.

G. All employees having duties that could require prolonged exposure to cold weather are directed to become thoroughly familiar with the contents of the publication "Survive in Winter," appended to this manual [Appendix A].

H. All employees whose duties could cause them to undertake field work are encouraged to avail themselves of immunization for typhoid fever, tetanus, Rocky Mountain spotted fever and polio.

I. All employees will receive basic first aid training. Such training will be provided by NEIC at the earliest opportunity.

III. OFFICE SAFETY RULES

A. The Safety Officer will prepare and post, prominently throughout the building, an evacuation plan for all of the area in Building 53 occupied by NEIC. Employees are directed to familiarize themselves with the plan and to be prepared to execute the plan at any time. An evacuation drill will be scheduled periodically.

B. All employees are cautioned to wipe feet when entering the building and to clean up spilled liquids promptly.

C. The Xerox machine is both a shock and burn hazard to persons not trained in the proper maintenance procedures. The practice of wedging or jamming control buttons is particularly hazardous and is not permitted. A Key Operator is to be called in the case of any machine malfunction. In the event of a fire in the machine, an attempt should be made to unplug the machine. The door of the Xerox room should then be closed and the fire department called.

D. All electrical devices, except clocks (and laboratory equipment - discussed elsewhere herein) are to be turned off when not in use. Coffee pots must be unplugged at the close of business each day.

E. When an electrical circuit breaker is tripped, the cause should be traced and checked for fire or electrical shock hazard and remedied before the circuit is reactivated.

F. Bookcases stacked four units or higher shall be attached to the wall.

IV. LABORATORY* SAFETY RULES

A. GENERAL SAFETY PRACTICES

1. Bottle carriers should be used when transporting glass bottles containing hazardous chemicals (acids or other corrosive liquids), flammable liquids, or any large glass bottles (distilled water bottles).
2. All containers of chemicals and samples shall be labeled clearly and correctly. All unlabeled materials must be discarded under the direction of a supervisor.
3. Chemicals are not to be pipetted by mouth.
4. All gas cylinders must be firmly secured individually by means of safety clamps and straps or chains.
5. All electrical equipment should be properly grounded, and electrical cords inspected periodically to ensure that they are in good working condition.
6. Damaged glassware should never be used in the laboratory. Cracks or jagged edges are a serious hazard. All such items should be set aside to be repaired if they are worth salvaging.

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* For purposes of this manual the same procedures will generally apply to both mobile- and main-laboratory spaces.

If not, they should be discarded in such a way that people removing waste material will not be injured.

7. Joints, stopcocks, etc., are not leak proof, and provisions should be included for catching any material that could leak out. This is particularly true when leaving a reaction unattended.
8. Where possible, heating mantles are preferred over open flames or hot plates.
9. Warning signs meeting OSHA specifications shall be used as required. They should be removed when the hazard has been corrected or no longer exists.
10. Floors and surface working areas (benches, tables, etc.) are to be kept clean, dry, and free from corrosive chemicals. Spills of any liquid, powdered or granular material must be cleaned up immediately.
11. Instruments, glassware, equipment, reagents, and unused containers must be stored in designated areas when not in use. Aisles, hallways, and walkways are to be kept clear and well-lighted.
12. Initiation of a laboratory analysis or experiment, not fully described in Standard Methods, AQC Manual, or other authoritative

procedural source, must be preceded by a survey of existing literature. The toxicity and other hazards connected with the reactants and products should be investigated thoroughly before starting any laboratory reaction. The effects of impurities on the safety aspects of the proposed reaction should be considered.

13. The safety of other personnel in the laboratory must be considered as well as the safety of the person running the reaction. Before undertaking any non-standard analytical procedures, other personnel must be made cognizant of the nature of the analysis to be carried out.

14. Prior to relinquishing control of a non-standard or otherwise hazardous analysis, the employee assuming control must be thoroughly instructed in the potential hazards and methods of counteracting such hazards.

15. Any analysis not completely described in the reference literature must be run on a small scale before attempting full-laboratory scale reaction. During this phase of the experimentation, the analysis should be presumed hazardous and the pertinent items of individual safety equipment used until the reaction is demonstrated to be non-hazardous.

16. Equipment for the analysis must be chosen with the chemistry and physics of the reaction in mind, e.g., fluorination in

glass equipment is inherently dangerous as is the use of flat-bottomed equipment in pressure and vacuum reactions.

17. Glass equipment should be assembled carefully to avoid strains brought about by increased temperature and vibrations. Ball joints give greater freedom of movement than do standard tapered joints.

18. Any vacuum, pressure, or high-temperature distillation should be considered potentially hazardous, and the proper safety equipment such as safety shields should be used.

19. Sufficient free-board should be allowed when sizing equipment to allow for liquid expansion due to increased temperature. This is particularly true in non-glass equipment when the volume of the reactants cannot be observed during all phases of the reaction.

20. It should be remembered that the high-boiling components tend to concentrate in the still pot, and many substances which are non-hazardous in a dilute concentration can be very hazardous in concentrated forms.

21. With temperature-sensitive material, it should be remembered that when adding heat to a reaction the temperature of the surface of the vessel may be considerably higher than the temperature of the reaction mass in which case it may be advisable to use a controlled temperature bath or a heating mantle.

B. PERSONAL SAFETY RULES - LABORATORY

1. Always use rubber gloves and face mask when transferring large amounts (1 liter or more) of corrosive liquids.

2. Safety glasses are mandatory for employees and visitors in all laboratory areas so designated.
3. Face shields, rubber and asbestos gloves, aprons and smocks are to be worn when appropriate.

4. Safety shoes are required for employees who work in areas where large or heavy equipment and containers are used. Branch Chiefs will prescribe personnel and areas to which this rule applies.
5. All employees using illuminated microscopes must be properly trained in the use of filters for eye protection.

6. Employees using UV disinfection devices shall wear proper eye protection.
7. All employees required to use equipment producing steam or hot water (i.e., water still, dishwasher, autoclave, etc.) will be properly trained.

8. Heavy leather-faced gloves or other approved hand protection shall be used to free stuck stoppers, caps, or lids from glass containers and when inserting or removing glass tubing from rubber stoppers.

9. All personnel shall be instructed, as required, on the location and use of first-aid kits, fire extinguishers, safety showers, eye baths, fire blankets, and emergency oxygen equipment. Operational readiness of all such equipment shall be ascertained by inspection; then equipment shall be certified, in writing, as operationally ready, by the NEIC Safety Officer or his designee.

10. Consumption of food and beverages and smoking in laboratories is prohibited.

11. Every employee shall be instructed regarding the following:

a. Location of fire alarms;

b. Telephone numbers of the Denver Federal Center Fire Department and Ambulance Service, immediate supervisor, Branch Chief, Assistant Directors, and Director;

c. Notifications to be made in the event of emergencies;

d. Other safety precautions as warranted.

C. USE AND HANDLING OF HAZARDOUS MATERIALS

1. Compressed Gases

a. Classifications

Compressed gases are classified in four groups. While "non-toxic" is part of two of these classifications, it must be remembered that such gases act as simple asphyxiants when they reduce the oxygen concentrations below safe levels.

(1) Group I -- Non-Flammable, Non-Toxic Gases

Genetrons* except 142B, 151A, 1132A (flammable)
Carbon Dioxide
Nitrogen
Nitrous Oxide
Inert Gases (Helium, Neon, etc.)
Oxygen - no limit consistent with usage. Oxygen should be stored away from readily oxidized materials.

* Brand name of liquified fluorinated hydrocarbons manufactured by Specialty Chemicals Division, Allied Chemical Corp.

(2) Group II -- Non-Flammable, Toxic Gases

Boron Trichloride
Boron Trifluoride
Chlorine
Fluorine
Hydrogen Chloride
Hydrogen Fluoride
Nitrogen Tetroxide
Phosgene
Sulfur Dioxide

Group-II gases can be expected to cause serious effects on human beings in relatively small concentrations. While these gases are not flammable, most cylinders are equipped with fusable plugs operating at 160-165°F. Exposure to fire could cause release of gases. Cylinders should be stored under sprinkler protection, and cylinder size should be No. 3 or smaller when used in the laboratories. Cylinders within laboratories should be kept within hoods with the exhaust running at all times. Unless gas has some distinctive warning odor within a safe concentration, suitable leakage detectors must be employed.

(3) Group III -- Flammable, Toxic Gases

Ammonia
Carbon Monoxide
Dimethylamine
Ethylene Oxide
Hydrogen Sulfide
Methyl Chloride
Trimethylamine

In addition to the toxic properties exhibited by the gases in Group II, these gases are flammable. Precautions as outlined for the Group-II gases should be followed and, in addition, gases inside laboratories should be restricted to those areas where Class I, Division I, electrical equipment is provided. Open flames and other sources of ignition must be avoided. Electric heating mantles within hoods may be used provided controls are located outside the hooded area.

(4) Group IV -- Flammable, Non-Toxic Gases

Acetylene
Alkanes, Methane, Ethane, Propane, Butane
Alkenes, Ethylene, Propylene, Butylenes, etc.
Butadiene
Ethyl Chloride
Hydrogen
Vinyl Chloride

Cylinder size for Group-IV gases should be No. 2 or smaller. Cylinders should be stored under sprinkler protection, and electrical equipment should be suitable for Class I, Division I, locations. For larger usages, see comments under Group II and III.

b. Procedures

Regulators designed for the particular gas are required for most materials. Some cylinders in which liquified contents have vapor pressures under 15 psig at 68°F can be equipped with needle valves to regulate the flow.

Cocks, gate, or globe valves must be avoided. For high-pressure gases, two-stage regulators should be used when delivery pressures below 5 psig are required

Connecting hose, tubing, etc., must be suitable for use with the gas involved and are to be protected from impact or mechanical damage.

Since compressed gases vary widely in their physical characteristics, chemical activity, toxicity, flammability, etc., the foregoing should be considered a general guide. Each gas must be evaluated on its own merits, and a safe-handling procedure followed. A valuable source of information is the Matheson Gas Data Book available from the Matheson Company, Inc., East Rutherford, New Jersey.

When not in use, valves must be closed and caps replaced. All cylinders, active or inactive, must be properly supported to prevent toppling or falling.

Insofar as is possible, only one cylinder of either Group II, III, or IV should be placed in any one hood.

Oxidizing and flammable gases shall be separated in storage. Incompatible materials shall not be placed in close proximity to one another [see Appendix B].

Venting of gas cylinders is prohibited -- no exceptions.

All cylinders not in use shall bear a tag or label showing status (full, partially used, depleted, etc.).

Cylinders may be moved only with the approved cylinder cart. Tie-down straps or chains must be used to secure the cylinder to the cart.

Empty and full cylinders shall not be stored together.

Expended cylinders shall be removed from service with positive pressure remaining.

Cylinders must be off at the close of each day, except when expressly authorized by a branch chief or supervisor.

Cylinders of compressed gases must be stored valve end up in racks to prevent falling.

Cylinders should always be kept away from sources of heat such as steam lines, radiators, or direct rays of the sun.

Only the cylinders required for immediate use are to remain in the laboratory work area. All cylinders not in use must be moved to a separate storage area promptly following use.

c. Care and handling of Compressed Gas Regulators

In the use of gas regulators there are specific rules that must be followed because of the potential danger associated with the high pressures involved. The following section covers general information and the proper procedures for using regulators:

(1) There are two common kinds of regulators, single stage and two stage. The two-stage regulator is recommended for several reasons. These regulators deliver a constant pressure over the whole range of cylinder pressure, and an added safety feature assures longer diaphragm life because of a preset safety that prevents overloading of the first stage.

(2) Gas cylinder regulators are manufactured with different limits on the diaphragms for low-pressure delivery. Delivery pressure is approximately half of the low-pressure gauge maximum.

(3) Regulators are equipped with specific fittings prescribed by the Cylinder Gas Association, and progress has been made in recent years to standardize the kind of fitting used for each

type of gas. Different fittings are still used by different vendors. Therefore, the operator must be familiar with the type of CGA fitting being used by the vendor supplying him with gas. The following CGA fittings are used by NEIC's current vendor for the common gases:

Gas	Kind of Fitting
Nitrogen, Helium	CGA-580
Air (breathing)	CGA-1340
Hydrogen, P-5, P-10	CGA-350
Oxygen	CGA-540
Acetylene	CGA-510
Nitrous Oxide	CGA-1320

(4) No sort of sealing compound or teflon tape should be used to stop leaks at the cylinder valve connection. If a leak persists at the valve, the cylinder valve seat is probably at fault. The cylinder should be returned to the vendor.

(5) The following step-by-step procedure should always be followed when shutting off a cylinder for any purpose:

a) Close cylinder valve completely.

b) Allow gas to flow through the regulator until both high- and low-pressure gauges register zero;

c) Turn the regulator-adjusting screw counterclockwise until the screw is loose; and

d) Close the regulator needle valve. (Most, but not all, regulators are equipped with needle valves.)

(6) The following step-by-step procedure should always be followed when turning on a cylinder:

a) Check to make sure the needle valve is closed.

b) Check the regulator-adjusting screw to make sure it is turned counter-clockwise until loose;

c) Slowly and carefully open the cylinder valve until the full pressure is registered on the high pressure gauge;

d) Then open the valve completely;

e) Open the needle valve;

f) Turn the pressure-adjusting screw clockwise slowly until the desired pressure is registered on the low-pressure gauge.

(7) The pressurized system should always be checked for leaks, particularly the high-pressure side. This can be done quickly by turning the regulator adjusting screw counterclockwise and the cylinder valve off. The pressure should remain constant; a rapid drop in pressure indicates a substantial leak. An alternative method is the use of an inert liquid leak detector, such as "Snoop," which discovers small leaks and does not require the interruption of the gas flow.

(8) No oil or lubricant should be used on any regulator especially one in oxygen service.

(9) All metal lines connected to regulators must be disconnected before changing cylinders.

(10) No connection from a gas cylinder to the high-pressure side of

a regulator should ever be made employing metal or flexible tubing, unless the connecting material is approved for high pressures.

(11) The cylinder valve seat should always be checked for cleanliness before installing a regulator and, if dirty, should be wiped with a dry tissue.

(12) Regulators have both left- and right-handed threads for connections, but it is easy to differentiate between them. The left-handed thread will always have a V-shaped notch in the metal connecting nut.

(13) Adaptors are readily available to change the usage of a regulator from one gas to another, but this is not recommended. This practice introduces an additional connection where another failure or leak could occur. Another and more serious possibility is subjecting a regulator to contact with a corrosive gas when the regulator is designed only for inert gas.

2. Flammable Liquids

a. Classification

Class I Closed cup flash point below 43°C (110°F)

Class II Closed cup flash point of 43°C (110°F) and higher*

b. Procedures

Flammable liquids must never be handled in the vicinity of

* See Appendix B for flash points of some common materials.

open flames or sparking electrical equipment. Air currents could blow a stream of vapors to the flame, resulting in a flashback followed by fire or explosion. Diethyl ether and carbon disulfide are particularly dangerous in this respect. The latter is so highly flammable that it may catch fire upon contact with hot water or a steam radiator. Ether will ignite in contact with a hot plate. In a distillation always use a water bath,for these liquids must never be distilled over an open flame.

Toluene, acetone, benzene, petroleum ether, alcohols, and many other flammable solvents must be handled with caution and at a safe distance from open flames and open electrical equipment.

Materials containing flammable solvents must not be dried in an electrically heated oven except those expressly designed to be explosion-proof.

In dispensing flammable liquids from a drum, a hand pump is preferred. If dispensing from a rack with the drum on its side, a self-closing valve must be provided. Flame-arresting bung vents and ground wires shall be used when dispensing from drums.

Compressed air should never be used to dispense flammable liquids.

Analyses or reactions involving more than one liter of Class-I material at higher than room temperatures must be done in a laboratory hood.

No more than five liters of Class I materials can be used in analyses or reactions in hoods.

Use of Class-II materials within 4.4°C of the flash point of the material must be in laboratory hoods if the quantity of material being handled exceeds one liter.

Transportation of flammable materials in excess of one liter is to be in safety cans only.

Transfer of flammable liquids must be carried out in well ventilated areas -- a fume hood is preferable.

Grounding straps shall be used to ground metal containers when transferring flammable liquids from one metal container to another. During such transfer, only metal funnels shall be used.

Flammable liquids in use in open containers shall be kept in fume hoods wherever possible.

c. Storage (Class I and II materials)

Safety cans up to one-gal. capacity should be stored in OSHA-approved flammable storage cabinets.

No more than five one-liter containers of Class I and II material should be stored in glass in the laboratory areas. Open areas include open reagent shelves and bench tops. Storage should be distributed throughout the lab with no more than two one-liter containers on each side of any lab module.

Bulk storage of flammable liquids is permitted only in the hazardous storage locker.

Bulk storage is permissible in drums or in safety cans up to five-gal. capacity.

Drums are to be stored in the upright position except when equipped with self-closing valves.

All drums for dispensing must be grounded, and containers also must be grounded to the drum when being filled.

3. Mercury

Mercury is not to be left in open containers, in sinks, on bench tops or on the floor if and when spilled. While the vapor pressure of mercury is relatively low at room temperature, mercury is cumulative and, as such, is an insidious and dangerous poison. Avoid splashing mercury on hot surfaces as the resultant higher vapor pressure increases the hazard.

Mercury spilled in lead-lined sinks and left there will quickly form a lead amalgam that is acid soluble; a leak will soon develop.

After cleaning up as much mercury with a vacuum jet or sponge as possible, one should then dust the residual amounts with powdered sulfur.

4. Corrosive Materials

Severe burns can easily result from contact of strong acids, alkalies, and other chemicals with the skin; Protective clothing, such as aprons, full face shield, rubber gloves, etc., is to be worn when handling large quantities of

such items as sodium hydroxide, sulfuric acid, nitric acid, perchloric acid, hydrochloric acid, glacial acetic acid, bromine, etc;

Extreme care must be exercised to avoid splattering. Large quantities of water should always be applied at once to skin surfaces exposed to such burns;

Transfer of the strong chemicals shall be in or near sinks where an adequate flow of water is running for rinsing spills off hands, clothing, and equipment;

When diluting acids, the preferred method is to pour the acid into water, slowly while stirring -- in order to dissipate the heat. Never dilute acids by pouring water into concentrated solutions. The heat generated could result in violent splattering. This is especially true when using concentrated sulfuric acid. In diluting any concentrated acids the mixing vessel should be in the sink or other confining container -- in order to prevent injury to the employee in the case of breakage.

Concentrated acids shall not be stored in the cabinet where concentrated bases are kept.

Storage of concentrated acids and bases is to be kept to a minimum. Except when approved by the lab supervisor, two gallons per cabinet is the maximum which can be kept on hand.

Chromic acid shall not be stored or used in pipet washer jars or other plastic containers.

Perchloric acid is to be handled with extreme care because it inflicts a particularly painful, deep, and slow-healing burn. Perchloric acid shall be stored and used only in a perchloric acid hood. The hood shall be washed down after each use. *A dangerous explosion can result from failure to observe established practices in handling perchloric acid.*

All reagent bottles are to be rinsed thoroughly before being discarded.

Containers are provided for carrying bottles that contain strong acid or alkali.

Bottles or carboys of five-gal. capacity must be handled and stored in properly designed crates or other containers. Such use will minimize breakage and also afford protection to personnel.

5. Metallic Sodium and Potassium

Metallic sodium and potassium must be stored under kerosene

or petrolatum in tin cans. The cans should be inspected periodically and replaced if evidence of leaks or rusting is found.

Scrap bits of metallic sodium and potassium should never be discarded in the sink or thrown into the waste cans; reaction with moisture will cause a fire, and violent splattering takes place. These metals should be added carefully, in small pieces, to cold alcohol. Wait until all gas evolution has stopped and solution is complete before adding more metal. This alcoholate can then be discarded safely in the sink if followed by washing with a generous flow of water.

6. Toxic Inorganic Substances

Inorganic solid materials seldom present a danger by inhalation unless dusts are formed during operations with the materials; therefore, these substances need not be handled in fume hoods. If, however, dusts are formed or the materials fume upon heating, the operations should be performed in a hood. Where there is a possibility of breathing dusts, suitable dust masks shall be worn.

The most common route of ingestion of inorganic toxic chemicals is through the mouth. The habit of using gloves and washing

hands with soap and water should preclude any possibility of transferring materials from the hands to the mouth.

All spilled materials should be immediately cleaned up.

Inorganic toxic liquids or solutions should be treated the same as toxic organic liquids or solutions.

Some inorganic poisons are:

Cyanides	Mercury, or its salts
Lead salts	Silver nitrate
Selenium salts	Ammonia
Arsenic compounds	Fluorides
Halogens	Beryllium, and its salts

Persons working with toxic inorganic compounds should familiarize themselves with the dangers of the material and proper methods of handling through searching the available literature and consulting the laboratory supervisor or laboratory safety coordinator.

Hoods shall be used for any operation which could give off obnoxious odors or hazardous amounts of poisonous vapors. This includes ash determinations, wet digestions with nitric acid, boiling solutions of all volatile acids and ammonia, and operations in which any of the aforementioned poisonous gases are used or produced. Hoods will be used for any operations which give off a hazardous amount of flammable vapors.

7. Toxic Organic Compounds

Some organic compounds are highly toxic and dangerous because of the many routes of incorporation into the body. Routes of incorporation to guard against include: oral; inhalation; skin absorption; and eye absorption.

The number of potentially dangerous organic compounds is so great that the safest rule to follow is to consider all such materials to be dangerous. Some classes of organic compounds, however, deserve particular attention:

Esters of Phosphoric Acids -- this group includes many highly dangerous insecticides such as TEPP, Perathion, Phosdrin, Azodrin, and Thimet. Also included in this group is tricresyl phosphate, a gasoline additive. Most of these compounds are liquids and are readily absorbed through unbroken skin. Many also have sufficiently high vapor pressure to pose a serious danger because inhalation of vapors at normal temperatures is likely.

Chlorinated alkanes and chlorinated aromatics -- this group also includes many insecticide materials. Simple chlorinated alkanes such as dichloromethane and chloroform are not highly toxic, but prolonged exposure can lead to liver damage. Carbon tetrachloride is highly dangerous to the liver, kidneys, and lungs.

Carbamates (urethanes) -- most compounds in this group are insecticides and should be considered highly toxic.

Nitro Compounds -- all organic nitro compounds are potentially explosive, and many have severe physiological effects. Many of the highly toxic nitro compounds (e.g. nitroanilines) are rapidly absorbed through the intact skin. They are also highly volatile and present a danger because of being easily absorbed into the body by inhalation.

Amines -- many amines, particularly aromatic amines, form methemoglobin in the blood and thus reduce the blood's ability to carry oxygen. Some amines (e.g. napthylamine) are carcinogenic.

Nitriles -- these compounds, of which acetonitrite is the most familiar, have toxicological action similar to, but less severe than, cyanide gas. When strongly heated these compounds decompose to gaseous hydrocyanic acid.

Safety precautions required when using organic compounds should include guarding against all routes of incorporation. Eye protection should be worn at all times during handling of organic compounds because absorption through the mucous membranes in the eye is extremely rapid, and a small quantity is immediately presented to the brain. Safety glasses should be considered minimum protection when handling highly toxic materials.

In order to protect against ingestion, mouth pipetting of organic materials is forbidden. Also care should be exercised to avoid the splashing of concentrated solutions.

The best protection against inhalation of volatile toxic substances is to perform all operations with those substances in a fume hood. Weighing of pure or concentrated pesticides must also be performed in a hood.

Skin absorption usually occurs through contact with the hands: therefore, the use of protective gloves is required when handling toxic compounds as the pure materials or as concentrated solutions. When gloves have been used they should be immediately washed with soap and water or discarded in waste receptacles provided. Contaminated gloves shall not be left unattended. Other protective aids against skin absorption include full-face shields and protective aprons.

Before operations with unfamiliar compounds are initiated all available literature should be checked to assess the possible hazards, and preparation should be made accordingly.

Vessels containing highly toxic substances shall be kept in beakers or similar containers to preclude the escape of leaking material.

8. Chemical Carcinogens

These procedures shall apply for all chemical carcinogens regulated by the Department of Labor and will also be implemented for all other known or suspected chemical carcinogens. The control practices include work procedures, environmental control techniques and a health surveillance program. They are specifically designed for work with chemical carcinogens, which are both long-term hazards and immediate hazards, and supplement conventional safety practices such as accident and fire prevention included elsewhere in this manual.

The procedures set forth general safety principles to be followed in the handling, storage and disposal of chemical carcinogens. These standards have been prepared to minimize hazards and to protect all persons in the laboratory area, and to insure the safety of the surrounding community.

The National Cancer Institute, Department of Health, Education and Welfare is preparing and publishing a series of Carcinogen Safety Monographs for 65 individual chemicals. DHEW reports that 18 monographs addressing 65 compounds will be completed at the rate of one per month between January 1977 and June 1978. The monographs will provide detailed technical and safety information which will assist the laboratory and field worker in implementing the standards presented in this section.

a. Regulated Chemical Carcinogens

The standards shall apply to the following chemical carcinogens for which Federal Standards have been promulgated by the Department of Labor:

(1) Low Molecular Weight Aliphatic Derivatives

		Chemical Abstract Number	Maximum allowable Concentration for work in unregulated areas, % by weight or volume
(a)	Ethylenimine	151564	1.0
(b)	Beta-Propiolactone	57578	1.0
(c)	Vinyl chloride	75015	*
(d)	Bis (chloromethyl) ether	542881	0.1
(e)	Chloromethyl methyl ether	107302	0.1

*special precautions are to be used for work with vinyl chloride in accordance with OSHA 1910, 1017.

(2) Aliphatic Nitrosamine Derivatives

(a)	N-Nitrosodimethylamine	62759	1.0

(3) Aromatic Amine Derivatives

(a)	4-Aminodiphyl	92671	0.1
(b)	4-Nitrobiphenyl	92933	0.1
(c)	Benzidine	92875	0.1
(d)	3,3-Dichlorobenzidine	91941	1.0
(e)	Alpha-Naphthylamine	134327	1.0
(f)	Beta-Naphthylamine	91598	0.1

(g) 2-Acetylaminofluorene 53963 1.0

(4) Aromatic Azo Derivatives

(a) 4-Dimethylaminoazobenzene 60117 1.0

(5) Known or Suspected Carcinogens

Whenever known or suspected chemical carcinogens are being used in an area, the same precautions will be observed as with the regulated chemical carcinogens. Operations involving solid or liquid mixtures containing more than 1.0 by weight or volume will be performed in a regulated area.

b. Medical Surveillance

(1) Preassignment Examinations - An appropriate preassignment physical examination shall be provided each person planning to work with carcinogenic chemicals. The purpose of this examination is to establish a base level against which physiological changes can be measured and to determine whether there exists any medical or other conditions that may lead to increased risk in the work situation.

(2) Periodic Examinations - All employees working with carcinogenic chemicals shall be provided periodic physical examinations. The purpose of the periodic examination is to determine whether a change has occurred in the medical state or in other relevant conditions which might lead to increased risk in the work

situation. The examination shall be annual unless work circumstances or the general health of the employee require more frequent attention.

(3) Records - Medical records shall be maintained by the personnel office for the duration of the employee's assignment at NEIC. Upon termination, transfer, retirement or death, the medical records or copies thereof, shall be transmitted to the appropriate records holding facility where the records will be maintained for an extended period of time in a manner that will insure ready access.

c. Personnel Practices

(1) Laboratory Personnel

Protective clothing such as a fully fastened long-sleeved laboratory coat shall be worn in any regulated area where chemical carcinogens are being used. Gloves which are appropriate to the specific situation shall be used when handling chemical carcinogens. Clean protective clothing shall be provided daily and shall not be worn outside the regulated area once the regulated area has been entered. Clothing contaminated by chemical carcinogens shall be decontaminated or disposed of immediately after an overt exposure. Clothing contaminated with chemical carcinogens shall not be sent out for laundering until decontaminated.

(2) Protective Equipment

Personnel engaged in procedures where exposure to airborne particulates contaminated with chemical carcinogens could occur shall wear an appropriate face mask and respirator. The selection of an appropriate face mask and respirator shall be made according to the guidance of the Safety Officer. The face mask and respirator shall not be worn outside the regulated area. Used filters shall be decontaminated or disposed of daily. Safety glasses shall be worn during all phases of carcinogen testing and cleanup of equipment. Contact lenses shall not be worn while personnel are working in a regulated area.

(3) Personal Hygiene

All personnel shall wash their hands immediately after completion of any procedures in which chemical carcinogens have been used. All personnel shall shower immediately after any overt exposure to a chemical carcinogen.

d. Operating Practices

(1) Regulated Area Identification - Entrances to all regulated and storage areas where chemical carcinogens are present shall be posted with signs bearing the legend:

DANGER -- CHEMICAL CARCINOGEN

Authorized Personnel Only

(2) Access Control - Regulated and storage areas where chemical carcinogens are present shall be entered only by personnel authorized by the Laboratory Supervisor. Access procedures shall be prominently displayed at points of access. Employees entering regulated areas shall sign a daily roster established and maintained for that purpose. The rosters or a summary of the rosters shall be retained for a period of 20 years.

(3) Work Surfaces - All work surfaces (bench tops, hood floors, etc.) on which chemical carcinogens are used shall be covered with stainless steel or plastic trays, uncracked glass plates, dry absorbent plastic backed paper or other impervious material. The protective surfaces shall be examined for possible contamination immediately after the procedure involving the chemical carcinogen has been completed. The contaminated surface shall be decontaminated or disposed of as is appropriate.

(4) Use of Laboratory-Type Hoods - Procedures that involve the use of chemical carcinogens shall be conducted in a laboratory-type hood or other suitable containment device designed for this purpose when: (1) the procedure involves the use of volatile chemical carcinogens, or (2) the procedure results in the generation of aerosols such as from the opening of closed vessels, transfer operations, and weighing. When flammable materials are used procedures shall be conducted in an explosion-proof hood. Each laboratory-type hood or containment device

used for containment of chemical carcinogens shall display a label bearing the legend:

DANGER -- CHEMICAL CARCINOGEN

Laboratory-type hoods include both open-faced hoods and laminar flow biological safety cabinets. An open-faced hood is a device enclosed on three sides and the top and bottom, which is designed and maintained so as to draw air inward at an average linear face velocity of 100 feet per minute and a minimum air velocity of 85 feet per minute at any point in the face of the fully opened hood and which is designed, constructed and maintained in such a way that an operation involving a chemical carcinogen within the hood does not require the insertion of any portion of a worker's body other than his hands and arms.

A laminar flow biological safety cabinet is a ventilated containment device which provides both personnel protection and a contamination-free work environment. Personnel protection is provided by an inflow of room air at the work opening where it is quickly entrained in a recirculating air stream and removed through an exhaust grill at the leading edge of the work area. A contamination-free work zone is provided by supplying air through High Efficiency Particulate Air (HEPA) Filters downward towards the work surface at a uniform velocity. Air flow equal to the inflow of room

air is exhausted through HEPA filters incorporated in the cabinet or the exhaust system.

Laminar flow biological safety cabinets may be used for the containment of *in vitro* procedures involving use of chemical carcinogens providing that (1) the exhaust air flow is sufficient to provide an inward air flow at the face opening of the cabinet equal to 100 feet per minute times the face opening area, (2) contaminated air plenums that are under positive air pressure are leak-tight, and (3) the cabinet exhaust air is discharged outdoors.

(5) Working Quantities - Only minimum working quantities of chemical carcinogens shall be present in a regulated area.

(6) Identification, Storage and Inventory

Labeling - Storage vessels containing chemical carcinogens shall be labeled:

DANGER -- CHEMICAL CARCINOGEN

Storage - Stock quantities of chemical carcinogens shall be properly labeled, catalogued and stored in a specific storage area that is properly vented and secured at all times.

Inventory - An inventory of all chemical carcinogens shall be maintained by the Laboratory Supervisor. The inventory records shall include the quantities of chemical carcinogens acquired, dates of acquisition and disposition. A copy of the inventory records shall be furnished to the Safety Officer on a semi-annual basis.

(7) Laboratory Transport

Stock Quantities of Chemical Carcinogens - An unbreakable outer container shall be used to transport chemical carcinogens. Materials contaminated with chemical carcinogens which are transferred from regulated areas to disposal areas shall be placed into separate plastic bags or other suitable impermeable containers, sealed and labeled with both the name of the carcinogen and DANGER -- CHEMICAL CARCINOGEN before being transported.

(8) Housekeeping - General housekeeping procedures which suppress the formation of aerosols such as the use of a wet mop or a vacuum cleaner equipped with a HEPA filter* on the exhaust shall be used. Dry sweeping and dry mopping are prohibited because of the hazard of aerosol formation. In those instances where a chemical-containing material is spilled, special procedures shall be followed.

(9) Protection of Vacuum Lines - Each vacuum service shall be protected with a disposable HEPA filter and liquid trap to prevent entry of any chemical carcinogen into the vacuum system. When using a volatile carcinogen a separate vacuum pump or other device shall be used in conjunction with an appropriate laboratory-type hood or other containment device approved by the Safety Officer.

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* A High-Efficiency Particulate Air Filter which is capable of retaining 99.97% of a mono disperse aerosol of 0.3 μm particles.

(10) Packaging and Shipping - The packaging and shipping methods established by the Department of Health, Education and Welfare for the transportation of etiologic agents (42 CFR 72.25, 1972) shall be applied to the shipment of all stable chemical carcinogens. For chemical carcinogens which are physically or chemically unstable (e.g., corrosive, explosive or flammable) the procedures established by the Department of Transportation for handling of such materials (49 CFR 173, 1973) shall be followed.

(11) Decontamination and Disposal

Contaminated materials including bacteriological culture media shall be decontaminated by procedures that either inactivate the carcinogens or remove them for subsequent disposal. Contaminated wastes and cleaning devices shall be collected in impermeable containers which are closed prior to removal from the regulated area and disposed of by appropriate methods as approved by the Laboratory Supervisor. Chemical carcinogens which have spilled out of a primary container so as to constitute a hazard shall be inactivated *in situ* or shall be absorbed by appropriate means for subsequent disposal.

e. Exhaust Air Treatment

(1) Exhaust Air Treatment - The exhaust air from laboratory-type hoods and other ventilated containment devices shall be appropriately treated such as by filtration, reaction,

absorption, adsorption, incineration or combination of chemical carcinogens in the final effluent which is discharged outdoors shall not exceed 1 µg/1 or natural background levels, whichever is greater. Removal of chemical carcinogens from the exhaust air by collection mechanisms such as filtration, absorption and adsorption shall be accomplished in a manner that permits maintenance while avoiding direct contact with the collection medium.

(2) Performance Certification - Performance of laboratory-type hoods and exhaust air treatment systems shall be checked at least annually.

f. Facilities

(1) General Ventilation Control

General Exhaust Air - The general exhaust air from regulated areas in which chemical carcinogens are used shall be discharged outdoors and dispersed to the atmosphere so as to prevent re-entry into the facility. No recirculation of exhaust air from regulated areas is permitted.

Air Pressure - Regulated areas in which chemical carcinogens are used shall be kept under negative air pressure with respect to the access corridor. For facilities where regulated areas have "clean" access corridors and "dirty" egress corridors, the "dirty" egress corridor shall be kept under negative air pressure with respect to the regulated area.

D. WASTE DISPOSAL

Waste disposal is a part of the job that requires individual thought, cooperation, and effort to get the task done safely. Following is a brief discussion of the types of waste and mode of disposal. If in doubt, ask your supervisor or Branch Chief.

1. Waste paper is disposed of via waste baskets.
2. Broken glass, bottles, and non-toxic/non-flammable solids are disposed of via the special containers present in each laboratory area.
3. Water-soluble, non-hazardous materials should be flushed down the sewers via the drains.
4. Acids or corrosive materials can be flushed to the sewers via the drains with a 50-to-1 dilution with water. Special precautions must be taken with strong acids such as perchloric acid.
5. Non-toxic, water miscible liquids such as acetone and ethanol can be flushed to the sewer via the drains with a 50-to-1 dilution with water. Large quantities of these materials should be disposed of via the waste-solvent drums described in the following paragraph.
6. Waste solvents (water-immiscible organic solvents) are disposed of via the waste-solvent cans and waste-solvent drums. Waste-solvent cans must be clearly marked safety cans. A waste-solvent drum is located in the hazardous-materials storage area and must be used for no other purpose.

7. Any employee having a toxic waste for disposal must consult with the appropriate supervisor or Branch Chief before proceeding with a disposal procedure.
8. Pyrophoric materials or active metals will be handled in the same manner as toxic wastes.
9. All toxic or obnoxious gases must be exhausted through hoods. If possible, these should be destroyed, at the source, by scrubbing, adsorption, reaction, or burning.

E. EMERGENCY PROCEDURES

Although most emergencies can be avoided by following the proper measures in carrying out the usual type of work performed in the laboratory, it is mandatory that laboratory personnel know what steps and action to take in case an emergency occurs.

The laboratory Safety coordinator will periodically conduct a safety refresher for all laboratory personnel. Attendance by all employees, normally engaged in laboratory work, is mandatory.

Emergencies most likely to occur in the laboratory and the steps and actions to be followed in such emergencies are discussed herein.

1. Fires

a. What to do in case of fire:

Every employee must know the location of the fire extinguishers and fire blankets. Each new worker is to be given training in the use of all types of fire extinguishers available in the laboratory. He or she must be familiar with the fire-alarm system. The first person to see the fire should sound the alarm immediately. Small fires can be extinguished with carbon dioxide, dry powder, foam, or soda extinguishers. In case of a large fire, the building should be evacuated.

Each employee should also know the location of the safety shower and fire blanket to be used in the event their clothing catches fire.

The following table classifies types of extinguishers and the kinds of fires on which they should be used.

	Class A Rags, Wood, and Paper	Class B Oils and Solvents	Class C Electrical	Class C Auto-oxidizing Combustibles*
Carbon dioxide	NO	YES	YES	NO
Dry powder agents	YES	YES	YES	NO
Foam	YES	YES	NO	NO
Water	YES	NO	NO	YES
Class ABC Dry Chemicals	YES	YES	YES	NO

* Such as nitrocellulose.

In general, dry chemical is preferred for solvent fires and CO_2 is preferred for electrical fires. Water is preferred for fires in which combustion is supported by the oxygen contained in the material, such as nitrocellulose. In this case, rapid cooling of the material affords the best means of fire control. Foam is effective against liquid petroleum fires but is usually not more effective than CO_2, and the latter eliminates the cleaning problem after use.

b. Solvent Fires

Solvent fires can usually be extinguished by the proper use of dry chemical or carbon dioxide. Foam-type extinguishing agents are effective on some types of solvent fires; however, their use is not recommended on high vapor-pressure, chlorinated, or water-soluble solvents.

In many cases of fire in small containers of solvents, the fire can be snuffed out by placing the lid on the container tightly enough to exclude air. If a lid is not available, a piece of sheet metal, asbestos board, or other similar non-combustible material will suffice.

c. Gas Fires

The surest and most effective means of extinguishing a

gas fire is by closing a valve in the gas supply line thereby shutting off the fuel supply. However, gas fires can be extinguished by the proper use of carbon dioxide or dry chemical extinguishers.

Serious consideration should be given to allowing gas fires to burn until the source of gas can be stopped to prevent possible explosions.

d. Chemical Fires

Chemical fires can be of many different sorts, and often special methods of fire fighting must be used. For example, a sodium fire should be smothered with sand, never with water. All laboratory workers must be taught the particular methods of handling these unusual kinds of fires. Often, if the fire is small and does not endanger other combustibles, it is best to let it burn itself out.

e. Electrical Fires

If possible, first turn off the power to the motor or other electrical equipment. Use carbon dioxide or dry

powder on electrical equipment, never water. Electrical equipment involved in fire should not be placed in operation until inspected and repaired.

Special procedures are necessary to accomplish emergency shutdown of the gas chromatograph-mass spectrometer. These procedures are posted on the equipment.

2. Spills

a. Flammable Liquids

Leave the immediate vicinity as soon as possible.

Analyze the situation before attempting to take further steps. If possible, shut off all sources of fuel and remove potential sources of ignition by using outside valves and switches, and circuit breakers. Electrical hot plates and the open type of electric motors should be turned off. If clothing is wet with flammable materials, consider the immediate use of a safety shower; otherwise the clothing should be changed as soon as possible, and the affected parts of the body washed with soap and water.

b. Strong Acids and Caustics

In the case of acid or caustic spills on the body, wash the affected portions with a large volume of water then report to the nearest physician. Remove the affected clothing immediately.

If these materials are spilled on a bench top or floor, dilute them with a large volume of water and then neutralize.

In case of a chemical burn of the eye, flush it with clear water at the nearest eye bath and then report to the nearest physician.

c. Other Chemicals

Many hydrocarbons and chlorinated hydrocarbons give off toxic vapors. In case any of these materials are spilled, stay out of the vicinity until the fumes have cleared away. If it is necessary to enter this vicinity, the proper type of air mask must be worn. Entry will be initiated only upon approval by the supervisor or the Branch Chief. If toxic materials are

spilled on the body, wash them off immediately with soap and water. Laboratory employees should be familiar with the gases that they are likely to come in contact with and keep out of any area where they have been released accidentally.

d. Contaminated Clothing

Clothing or shoes that have been contaminated with corrosive or toxic materials, such as acids or benzene, should not be worn again until properly laundered, steamed, or aired.

3. Rupture of Flammable Solvent Containers

In case of rupture of a flammable solvent container, remove all sources of ignition, and remove the container if possible, without hazard to a safe location. Evacuate the area immediately.

4. Failure of Laboratory Service Utilities

A variety of emergency conditions can arise because of the failure of various service utilities such as steam,

electricity, compressed air, etc. The Laboratory Safety Coordinator will prepare and periodically update a detailed list of things to be done in any type of utility failure. The list will be posted in each laboratory module.

5. Asphyxiation and Injury

a. Each laboratory employee will render first aid to a fellow employee who is asphyxiated, shocked, or injured to the extent possible by the training provided.

b. In the event of asphyxiation or serious injury call the Denver Federal Center Fire Department ambulance immediately.

F. RADIOACTIVE MATERIAL

1. General Conditions

a. Only personnel trained in the safe handling of radioisotopes or persons under the direct supervision of such trained personnel shall be permitted to receive, transfer, handle, or dispose of radioactive materials obtained through the Nuclear Regulatory Commission (NRC) license issued to the NEIC. Such trained personnel shall be specifically named in the license.

b. Personnel protection standards shall comply with US NRC Rules and Regulations, 10CFR20.

c. Part 30 of these rules shall apply concerning exempt quantities, records, inspections, tests, and other provisions.

d. Employees working with radioisotopes shall read and have available to them copies of 10CFR20 and 10CFR30 for reference.

2. Personnel Safety

a. Employees shall wear film badges while working in the hot lab. Pocket dosimeters shall also be worn when working with gamma-emitting radionuclides.

b. Disposable gloves shall be worn when transferring or otherwise manipulating high concentrations of unsealed radioactive materials. Remote handling devices should be used when required.

c. Food and beverages shall not be consumed in the hot lab or other laboratory areas. Smoking in the laboratories is also prohibited. Placing anything in or near the mouth may result in ingestion of radioactive materials and, therefore, is not allowed in radiation areas.

d. Mouth pipetting of radioactive materials is prohibited.

e. Radioactive-materials containers shall be appropriately labelled as to quantities, isotopes, and chemical forms.

3. Isotope-handling procedures

a. Absorbent paper, trays, and other containers should be used under unsealed radioactive materials in order to prevent contamination of the laboratory area.

b. High-activity standards and reagents shall be prepared only in the hot lab.

c. Following manipulative procedures, laboratory surfaces shall be monitored with a survey meter designed for the type of radiation concerned.

d. Wipe tests of laboratory surfaces shall be performed on a routine basis, the frequency of which shall be determined by the radiation-safety officer.

4. Disposal of Radioactive wastes

a. Disposal into sanitary drains shall be in accordance with 10CFR20 section 20.303.

b. Contaminated glassware, paper, gloves, and other solid material shall be disposed of in the plastic-bag-lined waste barrels provided.

c. Radioactive liquid wastes shall be disposed of in plastic-bag-lined waste barrels containing absorbent material such as vermiculite or "oil-dry" floor sweeping compound.

d. Full, sealed barrels of liquid or solid radioactive wastes shall be transferred to NRC-licensed government agencies, waste-disposal contractors, or NRC installations participating in waste-disposal programs.

e. Waste drums or barrels shall be Department of Transportation approved and shall be labelled as to radioactive contents.

5. Record Keeping

   a. The Radiation-Safety Officer shall establish record-keeping procedures for receipt, transfer, handling, and disposal of radioactive materials.

   b. Quantities of materials on hand including wastes shall not exceed quantities listed in the license.

6. Sealed-Source Leak Tests

   a. Sealed radioactive sources such as electron-capture, gas-chromatograph detectors shall be tested for leaking of radioactive material at intervals not to exceed six months. Conditions for testing as given in the NRC license and established procedures shall be followed.

   b. Sealed sources failing to pass leak tests shall be repaired, decontaminated, or disposed of.

REFERENCES

1. Matheson Gas Data Book, Matheson Co. Inc., East Rutherford, N. J.

2. Matheson Gas Products, Catalog 28, Matheson Co., Inc. East Rutherford, N. J.

V. FIELD SAFETY RULES

A. AUTOMOTIVE SAFETY

1. All employees must hold valid GSA and State driver licenses to operate GSA or EPA vehicles. Completion of the Defensive Driver training course, within six months after assignment to NEIC, is required for employees whose assignment includes driving.

2. Continuous on-the-job driving in excess of ten hours, or twelve hours combined work and driving of which no more than ten hours shall be driving will not be permitted unless conditions exist which would present a hazard if the vehicle was stopped at the end of the allowed driving time. At least 8 consecutive hours will be allowed for rest after driving ten hours.

3. General automotive safety rules, to be followed by all employees are:

   All vehicles will be operated in a manner consistent with prescribed laws of the locality and the GSA Motor Pool.

   When driving conditions warrant, or an inherent danger exists due to type of terrain, or when other hazards are present, mobile laboratories will be provided with a "co-driver" in addition to a regular driver.

Drivers are responsible for ensuring that assigned motor vehicles receive the prescribed preventive maintenance, and that the GSA Motor Pool is informed of any unsafe condition.

Seat belts and shoulder harnesses, where provided, will be worn by drivers and passengers when vehicles are in motion.

Drivers are responsible for ensuring that permanently assigned vehicles are equipped with fire extinguishers, flares, reflectors, and first-aid kits.

Safety screens are to be installed in the carryall and van-type of vehicles so as to separate the cargo and passenger compartments. If safety screens are not available, cargo will not be stacked higher than the back of the seat.

Vehicles used in areas where pedestrian traffic is heavy and the view behind the vehicle is limited due to loading or vehicle design will be equipped with an audio alarm device to warn foot traffic and other vehicles when the vehicle is being backed.

According to GSA Motor Regulations, operation of the truck mobile laboratory requires a special operator's permit.

All vehicles used to tow any kind of trailer must be equipped with adequate mirrors and the necessary connections for trailer signal, tail lights, brakes, and safety chains.

Any boat transported on a motor vehicle without a trailer will be secured by an approved carrying device.

Any employee required to tow a trailer will be instructed in the proper handling of the equipment involved.

Vehicles used in snow country will be provided with adequate snow tires or chains.

When backing a vehicle with a trailer in tow, there is to be a second party outside the vehicle to properly assist or direct the driver.

Any employee observing the unsafe driving habits or practices of any other employee will call the unsafe condition to the offender's attention and, if the practice continues, will promptly report the matter to his supervisor, Branch Chief, or a Management employee.

B. BOAT SAFETY

1. Government-owned and leased or rented watercraft in use by NEIC will be operated only by employees certified by Branch Chiefs as qualified operators.
2. General boating-safety rules, applicable to all employees, are:

The boat operator is responsible for the safety of all persons on board and for the integrity of all equipment on board.

A boat-safety briefing, by the boat operator, must be provided for all occupants of the boat prior to leaving the dock, pad, etc.

Government-owned, leased, or rented boats are not to be boarded by unauthorized (family, dependent, friends) or non-essential persons.

Boat operators must complete emergency first-aid training.

Boats are to be occupied, during operations, by not less than one qualified operator plus one additional employee.

During boat operation life jackets are to be worn at all times by all occupants. Divers will be permitted to wear wet suits in lieu of life jackets. Fire extinguishers, and first-aid kits must be on board on all boats during operation. At least the minimum safety equipment as prescribed by the U.S. Coast Guard will be on board at all times.

Boats with marine radios will monitor distress frequency except when transmitting.

Boat operators can initiate operations on estuaries, large lakes, and large rivers only after acquiring a current and reliable weather forecast. Operation of boats will not be initiated during marginal weather, including moderate-to-severe electrical storms. Common sense must prevail -- when in doubt, the safe course of action is required.

Night lights must be installed and operated according to established practice for night operations.

Auxiliary fuel will be stored in safety cans, secured to prevent spillage, away from heat and spark sources.

All boats and boat trailers are to receive the prescribed preventive maintenance at the prescribed intervals.

Boats must be equipped with non-slip floor boards. Employees must wear non-skid, soft-soled footwear while on board.

Excess equipment is to be minimized and that which remains on board will be stowed such that walkways are kept clear and fire hazards are avoided.

Refresher classes in boat operation, boat safety, and emergency first aid are to be conducted periodically for all boat operators, as appropriate.

All boats operated in estuaries or open seas should be equipped with two-way radios adequate to communicate with at least one shore station and with depth-finding instruments and proper navigational aids.

Maximum load limits and horsepower ratings of boats must be properly displayed.

3. Safety Rules for Fueling Boats

Fueling is to be completed prior to the onset of darkness, except in emergencies or at well-lighted marinas.

Whenever a boat is moored at a fueling dock, do not smoke, strike matches, or throw switches. All engines, motors, fans, and devices that can produce sparks must be stopped. Lights and heating devices must be turned off.

Before initiating fueling operations, boat must be securely moored. Conditions of fuel-tank vents, connections, and flame screens must be checked. Amount of fuel needed to fill tanks must be determined in advance in order to minimize chances of overflow spillage.

During fueling, nozzle must be kept in contact with fill opening to prevent static sparks.

After fueling, fill openings are to be closed immediately. Spilled fuel must be cleaned up; all hatches, windows, doors,

and covers are to be opened for five minutes to ensure adequate ventilation. Operator must ascertain that no gasoline odor is present in boat prior to initiating starting procedures.

If equipped with exhaust blowers they must be operated for at least five minutes prior to starting the engines.

Exhaust blowers are not substitutes for seaworthy fuel systems. Leaks in tanks and fuel lines must be corrected immediately upon discovery.

C. SAFETY PROCEDURES FOR ELECTRO-SHOCKING

1. When electro-shocking from a boat, the following rules are to be observed.

No employee will operate electro-fishing equipment without being trained in the handling of such equipment.

Railings in the bow of the boat must be secured in place during boom-shocking operations.

Boom-shocking equipment must include a foot-pedal operated, dead man's switch to deactivate or activate electrodes.

Data-recording personnel must be seated during electro-fishing operations.

Before leaving the dock, a briefing is to be held for all boat passengers unfamiliar with electro-shocking procedures.

2. When electro-shocking without a boat, the following rules apply:

Applicable are the same general safety rules that are in effect for boat shocking.

All employees involved in stream shocking must wear reinforced sole rubber boots and long-sleeve, water-tight rubber gloves.

Dip nets with non-conductive handles will be used.

One person must attend the pulsator at all times during the electro-fishing activity.

D. SAFETY PROCEDURES FOR SAMPLING AND FLOW-MEASUREMENT OPERATIONS

1. Survey coordinators will brief all employees regarding safety rules in force within industrial sites. All employees must conform to industry rules while on-site.

2. Approved safety glasses, safety shoes, hard hats, compressed air respirators, gas masks, and ear-protection devices are to be worn, as appropriate, in hazardous areas.

3. Fluorescent vests or jackets are to be worn while sampling from roadways, bridges or near railroad tracks. During sampling a yellow flasher is to be posted on approaches to each end of the bridge. On heavily traveled roads flagmen or warning devices must be posted at each end of bridges lacking at least 24-in. walkways. Such sampling points should be avoided where possible.

4. **Sampling from railroad bridges is not permitted, unless an adequate walkway is present, or the railroad dispatcher has been contacted, and it has been positively determined that no trains will run during sampling period.**

5. **Vehicles will not be parked on bridges for the purpose of sample collection.**

6. **All vehicles used for sampling and associated work will be equipped with amber rotary caution lights. Such lights are to be operated during all operations wherein vehicles are driven slowly on roadways or where parked near roadways.**

7. **All electrical apparatus employed in field operations must be properly grounded.**

8. Wet-cell batteries are to be moved or handled only with the use of a battery strap.

9. Gaging crews, night sampling crews, and crews working in hazardous areas will consist of not less than two persons.

10. Work gloves are to be provided to all personnel engaged in sampling and are to be worn when handling sampling equipment. Disinfectant is to be provided and is to be used for cleaning hands immediately after handling sewage samples and equipment used for sampling sewage. Rubber gloves must be worn while handling samples that could contain toxic or corrosive materials.

11. Rules applicable to operations in, and in close proximity to, manholes are:

    Barricades will be erected around manholes where samples are being collected.

    Manholes will not be left uncovered while unattended or unbarricaded.

    Safety lines, handled by not less than two persons outside of manhole, must be worn when entering manhole. Safety lines are to be kept taut at all times. The maximum time allowed in manhole is 15 minutes. A vehicle must be immediately at hand in case of emergency.

Manholes are not to be entered until cleared, using a blower for at least five minutes. A respirator must be worn when entering manhole.

Under no circumstances are sewer lines to be entered by any employee for any reason.

12. Rules applicable to operations in, and in close proximity to, open channels and streams are:

When sampling fast-moving channels or streams from shore, walkway, etc., the person sampling must work from behind a barricade or wear safety line to secure object. The same rule applies to any open channel when footing is questionable, i.e., snow, steep bank, etc.

Lines attached to sampling devices will not be secured bodily to sampling personnel.

Streams may be waded to knee-depth in swift water, or to hip-depth in placid water. In all work involving wading in fast moving water, a minimum of two persons must be present.

13. Rules applicable to sampling and gaging under ice are:

A minimum crew for operations involving ice cover will be two persons. One person to remain on solid footing until thickness of ice has been determined.

If ice thickness is found to be less than 4 in., operations on the ice will cease.

E. SAFETY PROCEDURES FOR FIELD ACTIVITIES INVOLVING PESTICIDES AND OTHER HIGHLY TOXIC MATERIALS

1. General

At all times, field personnel must take extreme precautions to avoid contact with pesticides. Although the toxicity of pesticides varies from compound to compound, all pesticides (insecticides, herbicides, desiccants, rodenticides, etc.) must be considered extremely toxic. Pesticide poisoning may be induced by inhalation, ingestion, contact with mucous membranes, or absorption through unbroken skin. The toxicity of many other chemicals, not classified as pesticides, is high; safety precautions to prevent exposure to these chemicals are identical to those used for pesticides. If there is doubt concerning the toxicity or concentration of a pesticide or other toxic chemical, the employee will act conservatively in favor of safety.

2. Sampling of Pesticide Formulations and Mixtures

Sampling of pesticide formualtions and mixtures requires extreme caution because pesticide concentraitons are high and chances of exposure from spillage or by other means are great. Care must be taken to insure that there is no skin contact with sampling devices or other contaminated surfaces during or after sampling. Pesticide samples will be removed from their containers through plastic tubing.

Suction will be applied to the tubing by collapsing, then releasing a plastic bottle attached to the tubing; suction by mouth is not permitted. Sample bottles containing pesticides or other highly toxic chemicals shall be clearly marked with individual labels identifying hazardous contents.

3. Decontamination and Disposal of Sampling Equipment

On completion of sampling, the plastic tubing will be cut into small pieces and the plastic bottle will be cut into two pieces. Sampling devices will be placed in a plastic bag and disposed of by appropriate methods as approved by the Laboratory or Field Supervisor. The knife or scissors used to destroy the tubing and plastic bottle will be washed after use.

4. Protective Clothing for Formulation and Mixture Sampling

Protective Clothing, to be worn during all phases of formulation and mixture sampling or observation, consists of the following:

A. Head Cover
B. Face Shield or Goggles
C. Respirator
D. Long-sleeved Coveralls
E. Waterproof Apron
F. Heavy Rubber Gloves
G. Rubber Boots

Whenever there is the possibility that the employee may be sprayed by a pesticide, such as during close observation of applications, the following items of protective clothing will be worn:

A. Head Cover
B. Face Shield or Goggles
C. Respirator
D. Long-sleeved Coveralls
E. Hand Covers
F. Rubber Boots

Unless another entry time is specified on the pesticide label, protective clothing to be worn when entering a field within 48 hours after pesticide application will be:

A. Head Cover
B. Respirator
C. Long-sleeved Coveralls
D. Hand Covers
E. Rubber Boots

Long-sleeved coveralls and hand covers must be worn when handling objects that may have contacted pesticide spray or drift.

5. Decontamination and Disposal of Protective Clothing

After use of protective clothing to prevent pesticide contact, head coverings, coveralls, aprons and gloves should be folded or turned inside-out, then placed in a plastic bag, and sealed. Subsequently, these items shall be disposed of or washed. Face Shields, goggles, respirators, rubber gloves and boots should be washed between uses.

Protective clothing upon which pesticides have been spilled or splashed should be removed (taking care to avoid skin contact), placed in a plastic bag, and disposed of by appropriate methods as approved by the Laboratory or Field Supervisor.

F. SAFETY PROCEDURES FOR AIR POLLUTION SOURCE TESTING

1. Personnel will strictly adhere to all Company safety rules applicable to the source being sampled. They shall familiarize themselves with all warning signals in use at the facility and procedures to follow when these signals are sounded.
2. All ladders, scaffolds, platforms and railings will conform to O.S.H.A. regulations.
3. O.S.H.A. approved ladder fall devices will be worn by personnel using uncaged ladders more than 20 feet high and/or not provided with rest platforms at minimum 20-foot intervals.
4. Safety lines will be worn on all work platforms more than six feet above ground level during high wind conditions, when work platofrms are slick, or when safety rails are not available.
5. Asbestos gloves will be worn when handling hot objects.
6. All electrical equipment will be suitably grounded.
7. Where the potential exists for the presence of toxic gases, detection tests shall be run prior to source testing personnel entering the area.

8. Protective gear such as respirator, goggles, safety glasses, safety shoes, ear plugs and hard hats will at all times be in the possession of persons conducting source tests and will be worn when appropriate. Protective masks or goggles and respirators will be worn when in the vicinity of toxic gases.

G. SAFETY PROCEDURES FOR UNDERWATER DIVING OPERATIONS

1. General

Safety will be the prime consideration in conducting underwater pollution control activities. All underwater activities must be approved in advance by the Center Director or his designee. NEIC employees may participate only if they are in good physical condition, have successfully completed the necessary training, and are properly equipped.

2. Individual Diver Responsibilities

a. Each NEIC diver is responsible for maintaining good physical condition and a high level of diving proficiency.

b. Each diver must conduct diving activities in the safest manner possible.

c. Each diver is expected to exercise good judgement and refuse to dive if conditions are unfavorable or unsafe. A diver who does not feel in proper physical or mental condition or who in diving would violate these regulations or the dictates of diver training must not dive.

d. Each diver must maintain an up-to-date log of all diving activities and have it available to the Center Diving Officer after each diving activity.

3. Certification

a. Center Diving Officer - The Center Diving Officer shall

establish the criteria for evaluating qualifications and shall issue certifications for diver trainee, divers and diving supervisors authorizing the diver to engage in the types of diving operations for which he is qualified. The Diving Officer is responsible for the implementation of Agency diving safety policies, review of operating procedures, investigation and reporting of any diving accidents, and recommendation of any needed changes. In addition, the Diving Officer conducts certification and refresher training programs and maintains an up-to-date file on each diver, including certification, diving logs, physical examinations and training completed.

b. Basic Training - Each NEIC diver must successfully complete a basic SCUBA training course approved by the Center Diving Officer.

c. Medical Examination - Each diver must pass a medical examination by a licensed physician who will attest to the applicant's physical fitness for diving.

d. Diver Trainee - A diver trainee is eligible to participate only in closely supervised dives under conditions of limited hazards.

e. Diver - A diver becomes fully certified and eligible to engage in all NEIC diving activities after logging

at least 50 dives, three of which must have been with the Center Diving Officer.

f. Diving Supervisor - A diving supervisor must have logged at least 100 dives, three of which must have been with the Center Diving Officer. In addition, a diving supervisor must have completed an advanced diving training course approved by the Center Diving Officer. A diving supervisor performs as the diving leader responsible for preparation of the dive plan and coordination of divers at the dive site.

g. Certification Maintenance - Certification will remain in effect provided that divers successfully complete a thorough annual physical examination and log an average of two dives per month during the year. If more than six weeks elapse without a dive, the diver must complete a "check out" specified by the Center Diving Officer before resuming work dives. Certification may be revoked by the Center Diving Officer with concurrence of the Director for violation of the safety regulations or for any act endangering the diver or other diving personnel.

4. Diving Operations

a. All scuba and other diving equipment and air compressors will be checked, maintained and operated in accordance with appropriate provisions of the U. S. Navy Diving Manual,

NAVSHIPS 250-538, and the equipment manufacturer's instructions. A carbon monoxide test will be made during each air tank filling operation if an internal combustion engine-powered compressor is used. The carbon monoxide test may be waived if the following conditions exist: (1) the inlet air duct is 25 feet away from an internal combusiton engine, and (2) the exhaust is downwind and higher in elevation than the intake.

b. Before any diving operation is undertaken, environmental conditions should be observed for possible danger to divers. Examples are: factory drain pipes, cross-currents, tide conditions, and weather changes.

c. Before any diving operation is undertaken in waters exceeding 33 feet in depth, the diving supervisor shall ascertain the location of the nearest qualified medical and decompression chamber facility and the most expeditious means of summoning emergency assistance, including U.S. Coast Guard or air transportation. All participants in the diving operation shall be provided with this information.

d. A detailed plan of the diving operation shall be submitted by the diving supervisor to the Center Diving Officer before the operation is conducted.

e. The diving depths and the times should be limited so that decompression staging will not be required except as may be necessary for emergency rescue, in which case the U. S. Navy Standard Air Decompression Tables will be adhered to. Decompression tables should not be copied, except by photographic methods which reproduce an exact copy. The maximum depth for dives shall be 130 feet.

f. Divers are required to wear a knife, wrist watch, compass, and depth-indicating device. An inflatable life jacket, equipped with a CO_2 filler or capable of being inflated from the diver's air supply, shall be worn except when using an inflatable or pressurized diving suit. The wrist watch, depth-indicating device, and compass may be omitted in waters not exceeding 15 feet in depth, if in the opinion of the diving supervisor they will not contribute to the safety of the operation. All harness and weight belts must have a quick release, operable by a single motion of either hand.

g. No one will be permitted to dive alone or unattended except as may be required for emergency rescue. Divers will conduct operations in pairs working as a unit under a buddy system with each diver responsible for the

other's safety. When underwater visibility is good, each shall keep the other continuously in sight. When visibility is poor, divers will maintain contact with one another by touch (side-by-side). If contact is lost, both divers will return immediately to the surface.

A diver locator device such as a sonar-pinger should be worn by divers when diving in poor visibility water when the potential exists of a diver being trapped by bottom material or when strong currents are present.

h. A surface tender will be provided for each working unit or buddy pair. It is the surface tender's job to be ready to provide emergency assistance. The surface tender must be a qualified diver equipped and prepared to render immediate emergency assistance. The surface tender may operate on shore or from the deck or a boat as may be appropriate, but in most cases should not be more than 50 feet from the immediate diving area. When operations are conducted from a boat, there shall be a boat operator in addition to the surface tender. The surface tender must always be aware of the diver's location.

i. Underwater time must be monitored closely, either by the surface tender or diving supervisor, to guard against fatigue and over-exposure.

j. A diving flag must be flown while diving in areas where other boats could present hazards.

k. All regulators shall be equipped with an additional second stage and pressure guage, and will be inspected by a certified regulator mechanic at least once per year.

l. Each dive team must have at least one NEIC certified diving supervisor.

m. Each dive will be planned in advance. The diving supervisor will place one of the divers in charge of the dive. Any divergence from the dive plan during a dive must be agreed upon by all divers. There will be no independent action of any diver during a dive (except in an emergency).

n. Oxygen shall be available at each dive site for immediate treatment of decompression sickness.

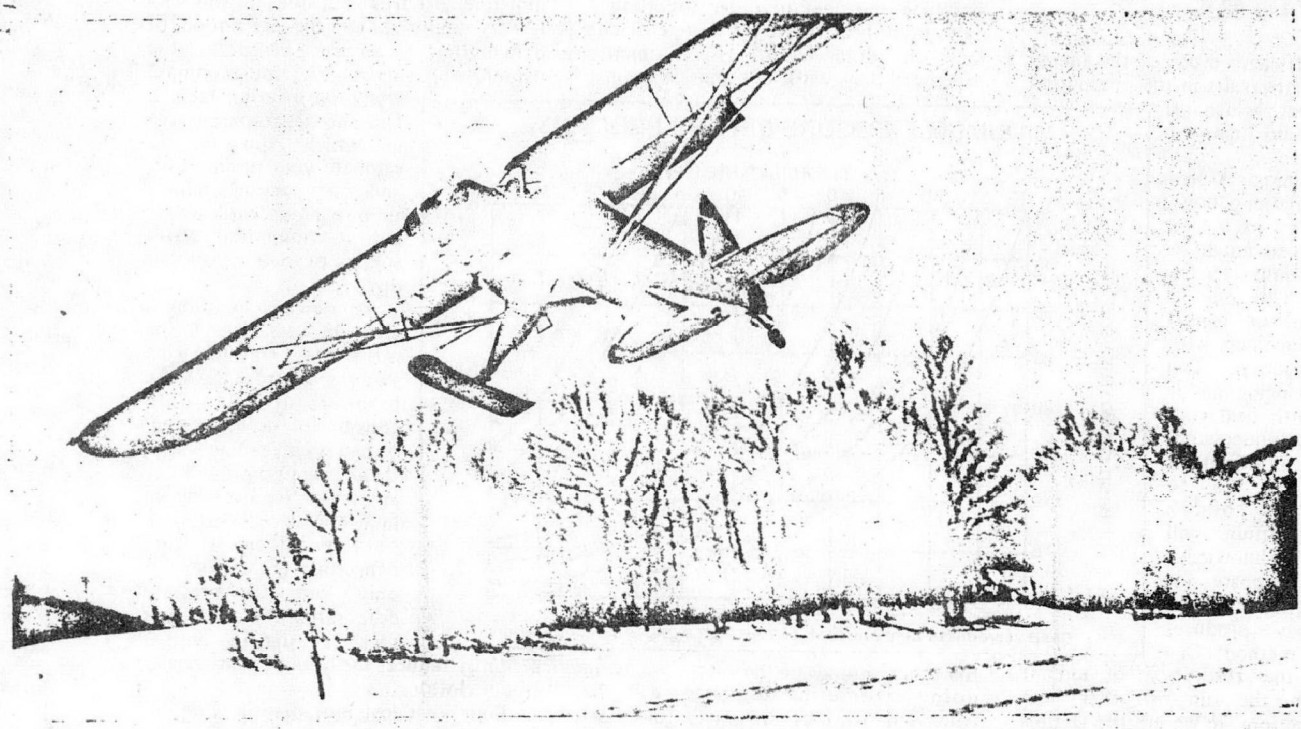
o. All divers will avoid flying for 12 hours after diving, unless being transported to emergency treatment.

p. All divers will be qualified to administer emergency medical treatment, including cardiopulmonary resuscitation.

APPENDIX A

"SURVIVE IN WINTER"

The magazine *Private Pilot* granted NFIC-Denver (Environmental Protection Agency) permission to reprint this article on winter survival.



SURVIVE IN WINTER

by William P. McKay

DO THE WORDS "cold weather survival" mean anything to you? Do they cause you concern?

They should. Your life may one day depend upon your cold weather survival knowledge and preparation.

Despite your most thorough preflight planning and aircraft inspection, you may have to make an emergency landing this winter in some unexpected place. If you do, you'll be intimately concerned with survival.

If you have filed a flight plan, radioed for help, or are equipped with an emergency locator beacon, your encounter with nature may be brief with but temporary inconvenience.

However, what if your rescue takes several hours or even a day or two, and the temperature drops to ten degrees with a 20-mph wind? This temperature and wind combination is equivalent of -25 degrees on your exposed skin. You will be in danger of frostbite or even death.

With the proper knowledge and preparation you have a good chance of surviving, without injury, winter's fury of bitter-cold temperatures and knife-sharp winds.

Rather than delineating dos and don'ts, let's discuss cold weather survival in terms of our body's physiological activities in keeping warm, and the knowledge necessary to prepare for a winter emergency. And, let's outline specific instructions on what to do to avoid serious injury in a survival situation.

The human body has a remarkable physiological mechanism for maintaining its warmth, or temperature. It enables a person to survive a large range of environmental temperatures, but, death will result if a person's actual body temperature varies more than just a few degrees.

The body continuously produces heat. In fact, because the body is only about

SURVIVAL

25 percent efficient, much of the energy in what we eat results in the production of body heat which is transferred, and lost, to the environment.

The physiological process of maintaining body temperature may be compared to an equation of equilibrium, or a teeter-totter. One side of the equation, or teeter-totter, is concerned with heat production. The opposite, balancing side is concerned with heat conservation. Our understanding of this principal of what we can do to maintain our body's thermal-equilibrium will give us the knowledge essential to prepare for and survive winter's cold.

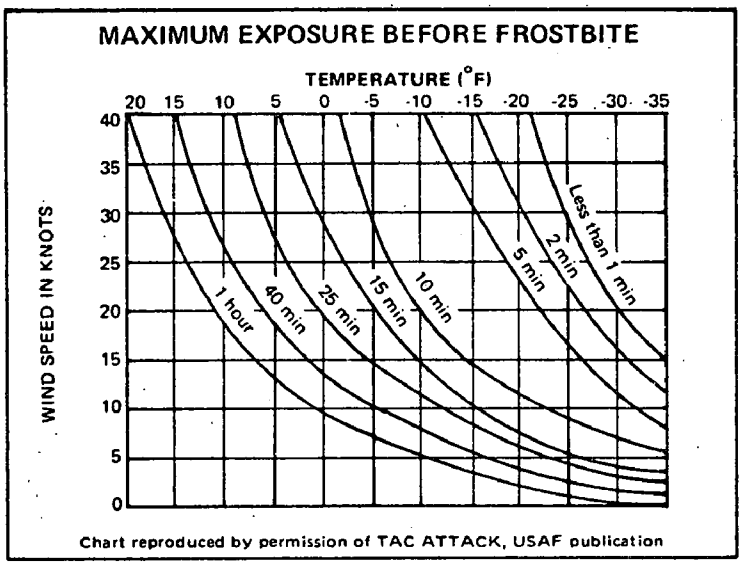
Our body produces heat by two methods. One is through the absorption of radiant energy from the sun or other heat sources. Therefore, if we are the victims of an emergency landing in the winter, we should stay within the sun's rays and, if at all possible, build a fire.

The other and most important method of producing heat is through the body's metabolism. Our metabolic rate (rate of food conversion into heat) can be increased both by what we eat and by physical exercise. Therefore, we should first pay particular attention to our wintertime diet. Our meals should consist of highly nutritional food and be well-balanced in order to provide our digestive systems with a regular source of energy that will in turn be used to maintain our body's heat supply. Then, we can, for brief periods, increase our metabolic rate by eating something with a large sugar content, such as candy. Do not replace a normal food intake with candy, however, because sugar can over-tax the pancreas. But, used judiciously, candy can help us keep warm in an emergency and should be added to our aircraft's survival kit as a wintertime supplement.

Any type of physical exercise will increase our metabolic rate. Beyond the essential activities such as preparing rescue signals or building fires, we shouldn't waste our time and valuable energies by running around in circles or stamping our feet in order to produce more body heat. There is a more efficient way of doing this. Use isometric exercises; they work one muscle against the other, and all of the energy we use in doing isometric exercises will be converted to heat. In fact, for short periods of time, isometric exercises can increase our metabolism over our normal, at-rest rate by several hundred percent.

The body loses heat by five major methods: insensible perspiration, sensible perspiration, radiation, conduction and convection.

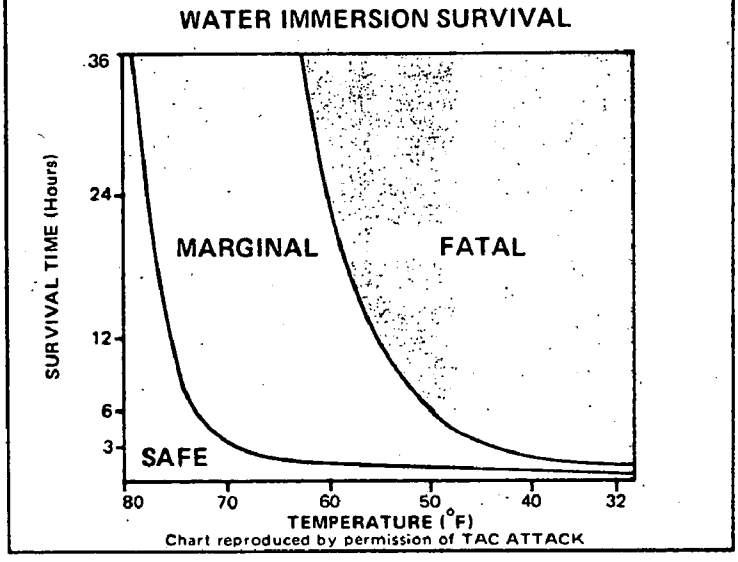
Insensible perspiration is the continual body process of passing moisture through the skin tissue. This moisture does not come from the sweat glands and is produced at a fairly uniform rate regardless of the environment. The amount of body heat used to evaporate this insensible perspiration is small compared to our total heat loss, but the amount of moisture lost from our body in this way is very important to the prevention of dehydration. Therefore, even in the winter, our survival kits must contain water purification tablets. Use the geographical area in which you fly to estimate your rescue time, and carry enough tablets to provide each passenger with a minimum water supply of two quarts per day.



Sensible perspiration is the process of losing moisture through the sweat glands. If the temperature is cold enough for us to be concerned with keeping warm, then there shouldn't be any reason for sweating. In fact, excessive sweating in cold weather is very dangerous. Our bodies not only lose the heat in evaporating the sweat, but the resulting vapor seriously reduces the insulating properties of our clothing.

Body heat lost by radiation is significant only when we are scantily dressed. So, this method of heat loss is minimized by any amount of winter dress. As a result, radiation losses are almost insignificant in the winter.

Heat is lost by conduction whenever any part of the body comes into contact with something cold. Therefore, our feet are normally the first parts of our body to get cold because they usually are in contact with the ground. So, if we sit, lie down, or touch anything cold, our conductive losses increase markedly. Normally, however, the body's conductive loss is minor and can be minimized by avoiding direct contact with cold objects. When we must sit or lie down, we should place some kind of insulating material, such as a blanket, between our bodies and the ground.



Convective heat loss can be quite severe and is the single most important survival problem. It depends not only upon the temperature, but also upon the relative movement of air around our body. For these reasons, the Army assigned Major Paul A. Siple to conduct extensive research into the cooling-power effect of temperature and wind combinations. His research dates back to 1939 and resulted in the origination of the term "wind-chill."

For a period of time, wind-chill was expressed simply as the numerical product of temperature and wind speed. Later, during World War II, Major Siple conducted further research into the wind-chill effect and formulated a more accurate index. His index, which is used today, is expressed by a formula based upon the freezing rate of water. Major Siple developed the formula empirically from voluminous experimental data and took into account such factors as surface area, time, temperature and wind speed.

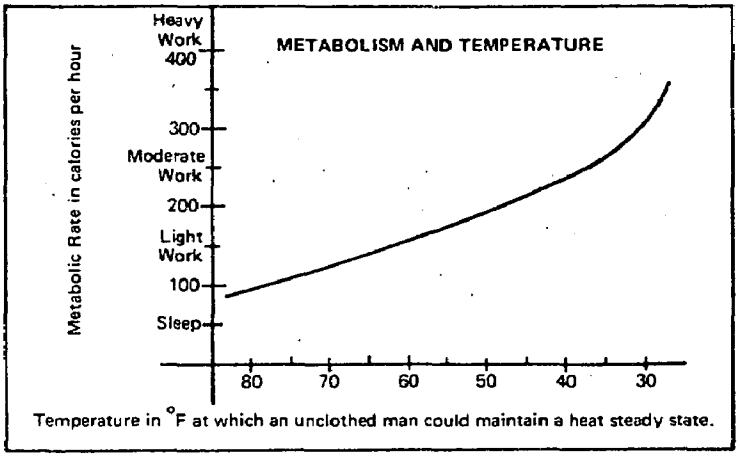
We should always seek shelter from the wind, but the most important way of minimizing our bodies' convective heat loss is through the proper use of clothing. This presents a pilot and his passengers with both a unique and a difficult problem.

If we were going hunting, we would dress properly for the continual exposure to the outside weather. When flying, however, such dress would be far too warm for an airplane's heated cabin. The answer to this problem is a compromise: dress moderately warm and carry additional clothing in the survival kit.

As far as clothing materials are concerned, air is the best insulator. Thus *winter clothing* should consist of several loose layers which will entrap air between them and provide the best possible insulation. Wool is the next best insulator. Also, unlike other clothing materials, wool retains most of its insulating properties when wet.

To take maximum advantage of both these materials, underwear should be made of loosely woven wool (although cotton will do if wool is unavailable or you have an allergy problem). This garment can be of the one or two-piece variety and, like all of our winter clothes, must fit comfortably loose to prevent any restriction of blood circulation. Very light cuffing around the wrists, neck and ankles will maximize heat retention by preventing cold air from getting inside.

The second layer of clothing should be made of a medium-weave, medium-weight material. Wool also would be good here, but to prevent getting too warm, cotton or some similar material will do.



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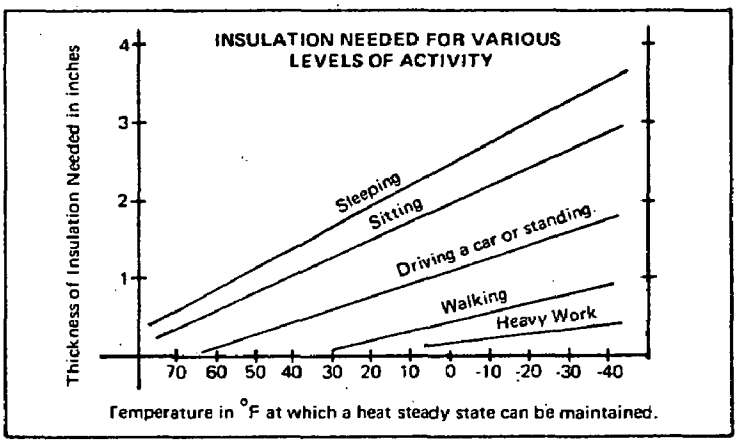

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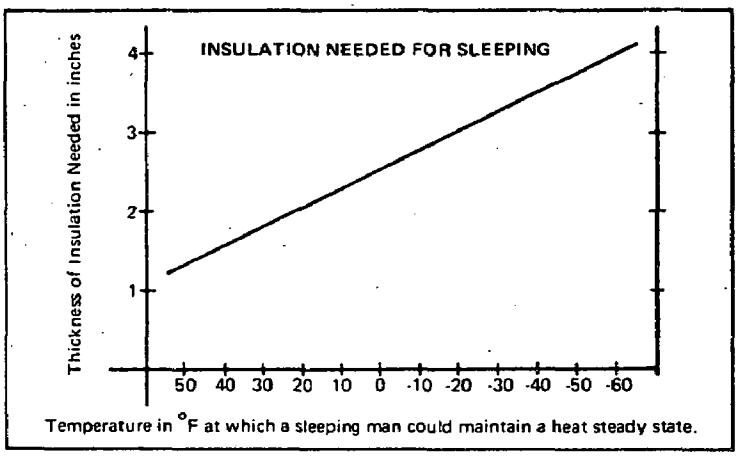


The outer layer of clothing should be a one-piece garment, like a flight suit, and be made from a tight weave, wind resistant material such as nylon.

In addition to this clothing, the winter supplements in our survival kit must include gloves, hats and warm jackets with insulated hoods for each person.

All of these garments must be kept clean and in good repair because insulating properties are greatly reduced if clothing is dirty or torn.

Notice that none of these garments is made from wind or waterproof material. The reason is that clothing must be allowed to breathe. That is, there must be a small amount of air circulation between and through the clothing layers. Otherwise, perspiration would be trapped within the clothing and greatly reduce its insulating properties. This brings up another closely related problem, getting wet.

Getting wet presents a problem similar to that of excessive sweating, but it is far more serious. Because water conducts heat very quickly, getting wet virtually destroys all of clothing's insulating value. Body heat is then immediately conducted to the outside cold air. If one becomes totally immersed in cold water, death can occur within just a few minutes.

In the 70- to 80-degree temperature range, our bodies are in thermal equilibrium. That is, heat production equals heat loss and the thermal teeter-totter is in balance. Below this temperature range, heat losses exceed heat production, thermal equilibrium is lost and we start feeling uncomfortable. Left improperly clothed, our bodies resort to one or more of the following physiological methods of producing and conserving more heat:

1. **Goose pimples**—This erects body hair which in turn increases the thickness of the thin insulating air blanket entrapped within our body hair.

2. **Shivering**—These involuntary muscle extensions and contractions increase our metabolic rate to produce additional heat.

3. **Reduced skin temperature**—This is accomplished by a slight decrease in the

SURVIVAL

Remember, winter's cold can be survived, but survival is a matter of being forewarmed.

COOLING POWER OF WIND ON EXPOSED FLESH

ESTIMATED WIND SPEED (MPH) ↓	ACTUAL THERMOMETER READING (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT TEMPERATURE (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-194	-118	-143
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-148
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
	LITTLE DANGER (for properly clothed person)				INCREASING DANGER			GREAT DANGER				
	DANGER FROM FREEZING OF EXPOSED FLESH											

Trenchfoot and immersion foot may occur at any point on this chart.
Wind speeds greater than 40 mph have little additional effect.

Chart reproduced by permission of TAC ATTACK

blood flow to the skin. The result is a smaller temperature differential between our skin and the surrounding cold air, so less heat is lost.

4. Vaso-constriction—This is an involuntary and sometimes irreversible body process whereby the blood flow to our extremities is decreased significantly or stopped entirely. The one exception is the blood flow to the head. Because life is dependent upon the brain's proper functioning, the head's blood supply is never reduced by vaso-constriction.

These physiological activities also serve another important function. They can be used as warning signals of impending danger. Goose pimples and shivering usually are the first and most obvious signals; they make us feel uncomfortable. But, reduced skin temperature and vaso-constriction are much more subtle. They can begin slowly with a gradual feeling of numbness. However, total loss of feeling follows quickly. If these signals are left unheeded, you can be seriously injured or even die.

Frostbite is the most common type of cold injury and, regardless of the wind-chill index, can only occur when the temperature is below freezing. You can see the effects of frostbite, a grayish or yellow-white spot on the skin, before you can feel the pain.

The affected area must be warmed quickly. Frozen parts should be thawed in water until soft, even though the treatment is painful. This treatment is most effective when the water temperature is exactly 107 degrees, but water either colder or hotter may be used. If warm water is not available, wrap the frozen part in blankets or clothing and apply improvised heat packs. Body heat also can aid thawing. Hold a bare, warm palm against frostbitten ears or parts of the face. Frostbitten hands can be held against the chest, under the armpits or between the legs at the groin.

Never rub a frostbitten area. You may tear frozen tissues and cause further tissue damage. Never apply snow or ice because it increases the cold injury. Do not try to thaw a frozen part by exercising. Exercising of frozen parts will only increase tissue damage and is likely to break the skin.

Hypothermia, lowering of the body's temperature, results from total water immersion or exposure to extreme cold. Symptoms such as shivering, drowsiness, lack of muscular coordination, disinterest in food or water, and total loss of the sense of touch and the sense of pain may be experienced. If hypothermia continues, the body's temperature will drop to 95 degrees with loss of all thermal control. A coma results and death finally occurs when the body's temperature lowers to 79 degrees.

When any of these symptoms are experienced, the body must be given additional heat immediately. Warm liquids, food, additional clothing or blankets, and a fire will prevent death.

The best drink to carry with you on a winter flight is hot chocolate. Hot chocolate is both warm and nutritional—coffee is only a warm drink and a temporary stimulant. One important thing to remember with regard to eating and drinking, however, is don't eat unless you have enough water to drink. Eating increases thirst. Your will to survive is of paramount importance and with it you can survive several days without eating as long as you have water.

An excellent source of information on building shelters and campfires is U.S. Air Force manual AFM 64-5, *Search and Rescue Survival* (available for $1.00 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402). This manual is the best single source of survival information and is a must for your survival kit.

Maintaining a proper heat balance can be quite a problem. Obviously, when you are wearing enough clothing to keep yourself warm at-rest while awaiting rescue, you will be too warm when exercising. Use your head.

That is, use your head as a heat radiator. Remember, your head's blood circulation is never reduced by vaso-constriction. Therefore, when you must exercise vigorously, remove or vary the amount of insulation around your head. Then your circulating blood will transfer the excess body heat to your head where it can be radiated in place of creating an excessive amount of sweat.

If your hands or feet get too cold, and you're already wearing a hat, pull your jacket's insulated hood over your head. This will cause vaso-dilation of the circulatory system to your extremities. Being unable to radiate heat from your head, your blood will then transfer the heat to your hands and feet.

Remember, winter's cold can be survived, but survival is a matter of being forewarmed.

APPENDIX B

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

APPENDIX B

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Formula	Flash Point °F		Explosive Limits % by Vol. in Air		Specific Gravity (Water = 1.00)	Vapor Density (Air = 1.00)	Boiling Point °F
		Closed Cup	Open Cup	Lower	Upper			
Acetalydehyde	CH_3CHO	-36	...	4.0	57.0	0.783	1.52	70
Acetic Acid (Glacial)	CH_3COOH	104	110	4.0	....	1.05	2.07	245
Acetic Anhydride	$(CH_3CO)_2O$	121	130	2.67	10.13	1.08	3.52	284
Acetone	CH_3COCH_3	0	15	2.15	13.0	0.792	2.00	134
Acetylene	C_2H_2	gas	...	2.5	80.0	....	0.91	-119
Acrylic Acid	C_2H_3COOH	...	...	....	....	1.062	....	285
Acrylonitrile	CH_2CHCH	...	32	3.05	17.0	0.800	1.83	171
Ammonia (anhydrous)	NH_3	gas	...	16.0	25.0	....	0.587	-37
n-Amyl Alcohol-	$CH_3CH_2CH_2CH_2CH_2OH$	91	120	1.2	....	0.817	3.04	280
Amyl Chloride	$CH_3(CH_2)_3CH_2CL$	...	55	1.4	....	0.878	3.67	223
Aniline	$C_6H_5NH_2$	168	...	...	....	1.022	3.22	363
Benzene	C_6H_6	12	...	1.4	8.0	0.88	2.77	176
Benzin	C_nH_{2n+2}	...	<0	1.1	4.8	0.64	4.5	100-160
Benzoic Acid	C_6H_5COOH	250	...	...	....	1.266	4.21	482
Benzoyl Chloride	C_6H_5COCl	215	...	...	....	1.212	4.88	387
Butadiene 1,3	$CH_2:CHCH:CH_2$	May be gas		2.0	11.5	0.621	1.87	24
Butyl Alcohol	$CH_3CH_2CH_2CH_2OH$	84	110	1.7	....	0.806	2.55	243
Chlorobenzene	C_6H_5Cl	90	...	1.8@ 212°F	9.6@ 302°F	1.11	3.88	270
Cocoanut Oil	.....	420	510	...	....	0.91	....	...
p-Cresol	$CH_3C_6H_4OH$	187	...	...	....	1.04	3.72	395
Cyclobutane	C_4H_8	<50	gas	...	....	....	....	55
Cyclohexane	C_6H_{12}	1	...	1.31	8.35	0.779	2.90	176
Cyclohexanol	$C_6H_{11}OH$	154	...	....	....	0.962	3.45	322
Cyclohexanone	$C_6H_{10}O$	147	...	1.1@ 212°F	....	0.947	3.38	313
Denatured Alcohol-95%	.....	60	...	....	....	0.82	1.60	175
o-Dichlorobenzene	$C_6H_4Cl_2$	151	165	....	....	1.325	5.07	354
p-Dichlorobenzene	$C_6H_4Cl_2$	150	165	....	....	1.458	5.07	345
Diethanolamine	$(HOCH_2CH_2)_2NH$	...	280	....	....	1.097	3.65	5.4
Diethylamine	$(C_2H_5)_2NH$	<0	<0	....	....	0.710	2.53	134
Diethylene Glycol	$HOCH_2CH_2OCH_2CH_2OH$	255	290	....	....	1.119	3.66	472
Diethyl Ether	$C_2H_5OC_2H_5$	-20	...	1.7	48.0	0.71	2.55	95
Dimethyl Aniline	$C_6H_5N(CH_3)_2$	145	170	....	....	0.956	4.17	379
Dinitro-Benzene-1,2	$C_6H_4(NO_2)_2$	302	...	....	....	1.59	5.79	605
Dinitro-Toluene-2,4	$(NO_2)_2C_6H_3CH_3$	...	...	....	....	1.52	6.27	572
Diphenylamine	$(C_6H_5)_2NH$	307	...	....	....	1.16	5.82	575

APPENDIX B CONTINUED

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Formula	Flash Point °F		Explosive Limits % by Vol. in Air		Specific Gravity (Water = 1.00)	Vapor Density (Air = 1.00)	Boiling Point °F
		Closed Cup	Open Cup	Lower	Upper			
Ethanolamine	$NH_2CH_2CH_2OH$	....	200	....	....	1.02	2.10	342
Ethyl Alcohol	C_2H_5OH	55	....	3.28	19.0	0.79	1.59	173
Ethylamine - 70% aqueous solution	$C_2H_5NH_2$	....	<0	....	....	0.778-0.802	....	....
Ethylene	C_2H_4	gas	....	3.02	34.0	....	0.975	-155
Ethylene Chlorohydrin	CH_2ClCH_2OH	....	140	....	....	1.213	2.78	264
Ethylene Dichloride	CH_2ClCH_2CL	56	65	6.2	15.9	1.258	3.42	183
Ethylene Glycol	CH_2OHCH_2OH	232	240	3.2	....	1.113	2.14	387
Ethylene Oxide	CH_2OCH_2	<0	....	3.0	80.0	0.887	1.52	51
Gas, Natural	.....	....	....	4.8	13.5	....	....	....
Gasoline	.....	-50	....	1.3	6.0	0.75	3-4	100-400
Glycerine	$HOCH_2CHOHCH_2OH$	320	350	....	....	1.26	3.17	554
n-Hexane	$CH_3(CH_2)_4CH_3$	-7	....	1.25	6.9	0.661	2.97	156
Hexane-iso	C_6H_{14}	<-20	....	1.0	7.0	0.669	3.0	130
Hydrocyanic Acid	HCN	0	gas	5.6	40.0	0.697	0.932	79
Hydrogen	H_2	gas	....	4.1	74.2	....	0.069	-442
Hydrogen Sulfide	H_2S	gas	....	4.3	45.5	....	1.18	-76
Hydroxylamine	NH_2OH	Explodes at 265	....	....	....	1.227	....	158
Isobutane	$(CH_3)_2CHCH_3$	gas	....	1.8	8.4	....	2.08	10
Isobutylene	.....	....	....	....	....	0.600	....	19.6
Isoprene	$CH_2=C(CH_3)CH=CH_2$	-65.2	....	....	....	0.679	2.35	93
Kerosene	.....	110-165	....	1.16	6.0	<1	4.5	....
Maleic Anhydride	$CHCO_2O$	218	240	....	....	1.305	3.38	396
Methane	CH_4	gas	....	5.3	13.9	....	0.554	-258
Methyl Alcohol	CH_3OH	54	60	6.0	36.5	0.792	1.11	147
Methyl Cellosolve	$CH_3OCH_2CH_2OH$	107	115	....	....	0.966	2.62	255
Methyl Chloride	CH_3Cl	gas	....	8.1	17.2	0.92	1.78	-11
Methyl Ethyl Ether	$CH_3OC_2H_5$	135	....	2.0	10.1	0.697	2.07	50
Methyl Ethyl Ketone	$CH_3COC_2H_5$	30	....	1.81	11.5	0.805	2.48	176
Methyl Salicylate	$HOC_6H_4COOCH_3$	214	225	....	....	1.182	5.2	432
Mineral Spirits	.....	85	110	0.77 @212°F	....	0.80	3.9	300
Monofluorodichloromethane	$(CHFCl_2)$	Practically nonflammable	....	....	....	....	....	....
Monofluorotrichloromethane	CCl_3F	Nonflammable	....	....	....	....	....	....
Naptha, Safety Solvent	.....	100-110	....	1.1	6.0	0.03	....	300-400
p-Nitroaniline	$(NO_2)\ (NH_2)\ C_6H_4$	390	....	....	....	1.437	....	<545
Nitrobenzene	$C_6H_5NO_2$	190	....	1.8@ 200°F	....	1.2	4.25	4.2

APPENDIX B CONTINUED

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Formula	Flash Point °F		Explosive Limits % by Vol. in Air		Specific Gravity (Water = 1.00)	Vapor Density (Air = 1.00)	Boiling Point °F
		Closed Cup	Open Cup	Lower	Upper			
Paraformaldehyde	$HO(CH_2O)_nH$	158	200	....	....	....	....	...
n-Pentane	$CH_3CH_2CH_2CH_2CH_3$	<-40	....	1.4	8.0	0.631	2.43	97
Petroleum Ether	.....	-50	....	1.4	5.9	0.63-0.66	2.50	100-160
Phenol	C_6H_5OH	175	185	....	....	1.07	3.24	358
Phthalic Anhydride	$C_6H_4(CO)_2O$	305	330	....	....	1.527	5.10	543
iso-Propyl Alcohol	$CH_2CHOHCH_3$	53	60	2.5	....	0.789	2,07	181
Propylene	C_3H_6	gas	....	2.0	11.1	....	1.49	-58
Sodium*	Na	....	....	....	....	0.97	....	1612
Styrene	$C_6H_5CHCH_2$	90	....	1.1	6.1	0.907	3.60	295
Sulfur	S	405	440	....	....	2.046	....	832
Toluene	$C_6H_5CH_3$	40	45	1.27	7.0	0.866	3.14	232
Trichloroethylene	$CHClCCl_2$	Practically non-flammable		....	....	1.47	4.53	189
Turpentine	.....	95	....	0.8	....	<1	4.84	300
Vinyl Acetate	$CH_3COOCHOH$	18	30	....	....	....	....	161
Vinyl Chloride	CH_2CHCl	gas	<0	4.0	22.0	0.97	2.15	7

* An asterisk following the name of a metal indicates that hydrogen will be liberated when the metal is in contact with water. With the exception of potassium and sodium, hydrogen will be liberated in hazardous quantities only if the metal is in finely divided form.

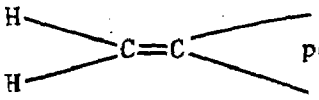
APPENDIX C

HAZARDOUS

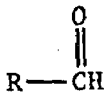
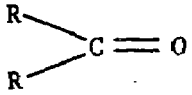
CHEMICALS

I. Reactive and Hazardous Chemicals

A. A *reactive* chemical is a material that will react vigorously with itself by polymerizing or condensing.

Vinyl Compounds  polymerize.

Carbonyl compounds form condensation products

Aldehydes  Ketones 

or react with themselves in the presence of a trace amount of some other substance, such as a contaminant or catalyst,

Conjugated unsaturates such as butadiene, acrolein and styrene

C = C—C = R

To prevent reactions, inhibit with proper chemicals to neutralize the effect or refrigerate.

or react violently with water.

Water is always present It is used in cleaning equipment, for cooling and condensing, in dissolving other chemicals, in diluting other solutions, and in the atmosphere.

Many materials react vigorously with water to give off large amounts of heat, or generate high pressures from the large volumes of gases produced. Anhydrides react to form the corresponding acids and can cause vigorous boiling of the mixtures if sufficient cooling is not applied. Alkali metals react vigorously with water to form hydrogen gas and hydroxides; cause heat-producing boiling of mixtures. Metals and oxides react similarly with alcohols, organic acids, and amines. Concentrated inorganic acids and bases produce high heat of solution. Dilute carefully. Always add the chemical to the water.

or spontaneously decompose	Peroxides, acetylene, acetylides, ethylene oxide, and products of similar properties spontaneously decompose. Avoid forming peroxides by the strict exclusion of all oxygen. Acetylides must be handled under wet conditions at all times.
or react spontaneously with air	Phosphine, phosphorus, metallic sodium and potassium, and products of similar properties will ignite spontaneously in the presence of air without a source of ignition. They should be handled and stored with air excluded. For example, store the alkali metals in kerosene.
	Sodium sorbate, linseed oil, hexaldehyde, butyraldehyde, and products of similar properties will oxidize on contact with air under proper conditions. Care should be exercised to avoid spilling on contact insulation around steam lines. Do not use rags to mop them up. On oxidation, these materials release heat that, in turn, raises the temperature of the rag material to its fire point.

B. A *hazardous* chemical is one that does not qualify as a *reactive* chemical but which is hazardous from the standpoint of Health, Fire, or Reactivity with other chemicals. Some chemicals, reactive in the usual sense of the word, do not fall within the strict definition of a *Reactive* chemical. For example, neither ethylene nor chlorine reacts with itself under usual conditions. Each is a *hazardous* chemical. The two react together vigorously to form ethylene dichloride, a reaction that could get out of control.

C. The following system can be used to indicate the degree of Health, Fire, and Reactivity of chemicals:

Health Hazards Rating	Fire Hazard Rating	Reactivity Rating
1. No residual injury expected	0. Non-flammable	1. Normally stable
2. Minor residual injury possible	1. Flash point above 60°C (140°F)	2. Reactive with water
3. Major residual injury if not treated	2. Flash point from 38-60°C (100 to 140°F)	3. Self-reactive with contaminants; temperature sensitive.
4. Major residual injury; prompt treatment required.	3. Flash point from 23-38°C (73 to 100°F)	4. Self-reactive with contaminants; temperature and shock sensitive.

The following table can be used to determine whether a chemical is reactive or hazardous:

H (Health)	F (Flammability)	R (Reactivity)
	0	
1	1	1
2	2 *Hazardous* chemical	2 *Reactive*
3 *Hazardous* chemical	3 unless designated as	3 chemical
4 unless designated as reactive in R column.	4 reactive in R column.	4

These classifications are based on physical and chemical properties and do not include conditions of exposure or handling such as pressure, weight, velocity, or volume. Signals should be revised by the user to represent the hazard under conditions of actual use.

D. [See pages following in this appendix for a list of chemicals that are rated numerically for their Health, Fire, and Reactivity Hazards, as classified by these tables. Additional information concerning these areas is included in Appendix D, Incompatible Chemicals, and Appendix B, Properties of Flammable Liquids, Gases, and Solids.]

E. Because of the wide range of hazards involved it is not practical to list all the necessary precautions in this manual. However, it is felt that some discussion of the hazards and precautions is necessary, at least to the extent of citing examples.

Toxicity and Health Hazards -- The newer chemicals are toxic in varying degrees and much in the same manner as the older, well-known chemicals; by inhalation, ingestion, absorption and contact.

The toxicity resulting from the inhalation of the chlorinated hydrocarbons has already been mentioned. In other chlorinated compounds, absorption through the skin, in addition to inhalation, can be a problem. In fact, any heavily chlorinated compound in liquid or solution form or any used at elevated temperatures should be handled cautiously.

The isocyanates, exemplified by toluene diisocyanate (TDI), are among the most toxic, from repeated contacts, of the modern industrial organic chemicals. Isocyanates, particularly those in liquid form and those used at elevated temperatures, should be handled with suitable precautions.

While it has been known for many years, epichlorohydrin is an organic chemical finding increasing use in the rubber and plastics industry. This compound and some of its derivatives are toxic in much the same manner as are the isocyanates and should be treated similarly. Furthermore, epichlorohydrin slowly penetrates rubber so that rubber clothing that has been in contact with the liquid should be discarded.

The amines, particularly the liquid ones and those used in solution form, frequently cause problems with dermatitis, throat irritations, conjunctivitis, etc., unless handled with suitable protective equipment.

Fire and Explosion Hazards -- Many modern industrial chemicals are extremely fire and explosion hazardous. The hazards arise from many causes, some of which are: Loss of inhibitor, exposure to oxygen (air), shock, sensitivity, friction, thermal changes, contamination by metals and their salts or oxides, etc. Some specific examples are given.

Equipment should be well designed and suitable for the type of reactions involved with peroxides.

The peroxide to be used should be carefully selected. Whenever possible, particularly if there is a choice, the less hazardous one should be chosen. Dilution with a compatible material is advisable whenever possible.

Only the quantities immediately needed should be stored in the laboratory. All storage and handling should preclude the possibility of contamination of the peroxide or the contamination of other materials by the peroxide. It is suggested that the weight of actual peroxide in storage be limited as follows:

Peroxide Hazard Classification	Cutoff Area Unopened Containers	Detached Area Unopened Containers	Laboratories per 5,000 ft^2 floor space
I	20 lb	1,000 lb	2 lb
II	100 lb	5,000 lb	10 lb
III	500 lb	25,000 lb	50 lb

Many purified chemicals are susceptible to oxidation and rapidly form potentially explosive peroxides after the container has been opened and the substance exposed to air. A typical example is purified tetrohydrofuran (THF). Precautions include:

use of inhibited materials whenever possible;

buying in minimum practical-sized containers and immediately discarding any unused remainder in a container;

dating containers with the date received, followed by a strict rotation of stock; dating the containers with the date opened and discarding if not used within a prescribed time limit;

the addition of suitable inhibitors that will not interfere withe the intended use of the remainder.

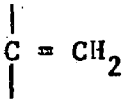
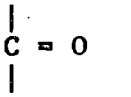
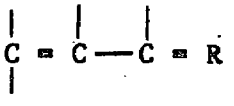
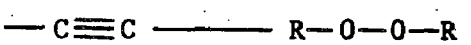
Hydrazine is a dangerously *reactive* chemical that, with some of its derivatives, is finding increasing use in syntheses in the chemical and plastics industries. It is a highly active reducing agent and reacts with many organic and inorganic chemicals. Anhydrous hydrazine and unsymmetrical dimethyl hydrazine are such unstable compounds that they were earlier used as monopropellants and are considered as explosive substances. Other derivatives are considered flammable liquids having very low ignition temperatures and high chemical reactivity.

Decomposition can be initiated by heat, electrical sparks and arcs, by the catalytic action of oxygen, and by contaminants such as the oxides of heavy metals.

The usual properties relating to flammable liquids are not always fully indicative of the major hazards involved although some of these properties confirm the unstable nature of hydrazine. As an example, anhydrous hydrazine has a reported upper explosive limit (U.E.L.) of 100 percent vapor, by volume, which indicates that oxygen (air) is not necessary to produce an explosive type reaction. Such explosions can be initiated in closed containers, pipes, etc., by outside sources of heat, by internal catalytic influences, and by reaction with contaminants.

The precautions for these compounds follow closely those required by the organic peroxides: limitations on quantities, rigid standards on shelf-life, disposal of residues, protection from heat, isolation to prevent contamination, strict control of ignition sources, and others.

II. Key to Type of Linkage or Structure Contributing to Reactivity

Type	Name	
A	Vinyl	
B	Carbonyl	
C	Conjugated, unsaturated	
D	Self-reactants	
E	Acetylenic and peroxide	

Listing of Reactive Chemicals

Compound	Hazard Classification H	F	R	Type of Structure	Type of Reactivity
Acetaldehyde	4	4	3	B	Alkali-catalyzed condensation
Acetylene	3	4	4	E	Explosive decomposition
Acrolein	4	4	3	C	Vinyl polymerization and aldol condensation
Acrolein Dimer	4	2	3	B	Aldol polymerization, acid-catalyzed polymerization
Acrylic Acid	4	2	3	C	Vinyl polymerization
Acrylonitrile	4	4	3	C	Vinyl polymerization
Allyl Chloride	4	4	3	A	Vinyl polymerization
Allyl Cyanide	4	3	1	C	Vinyl polymerization
Butadiene	2	4	3	C	Vinyl polymerization
Butyl Acetate	2	3	1	C	Vinyl polymerization
Butyraldehyde	4	4	3	B	Aldol condensation
Chlorotrifluoroethylene	4	4	3	A	Vinyl polymerization
Copper Acetylide	3	4	4	E	Explosive decomposition
Crotonaldehyde	4	4	3	C	Aldol condensation

	Hazard Classification H	F	R	Type of Structure	Type of Reactivity
Croton Oil	4	4	3	B	Possible aldol condensation
1,3-Cyclopentadiene	3	4	3	A	Vinyl polymerization
Decyl Acrylate	3	1	3	A	Vinyl polymerization
Diacetylene	3	4	4	E	Explosive decomposition
Diacetyl Peroxide	4	2	4	E	Explosive decomposition
Diallyl Maleate	3	2	3	A,C	Vinyl polymerization
Dibenzoyl Peroxide	4	4	4	E	Mild explosive decomposition
Dibutyl Ether Peroxide	4	4	4	E	Explosive decomposition
Diethyl Ether Peroxide	4	4	4	E	Detonation
Diketene	4	2	3	C	Violent polymerization, hydrolysis
Di-isopropyl Ether Peroxide	4	4	4	E	Detonation
Dialauroyl Peroxide	4	3	4	E	Explosive decomposition
Di-t-Butyl Peroxide	2	4	4	E	Explosive decomposition
Divinyl Sulfone	4	1	3	A	Vinyl polymerization
Ethyl Acrylate	3	4	3	C	Vinyl polymerization
Ethylene Oxide	4	4	4	D	Hydrolysis, polymerization, isomerization to acetaldehyde
2-Ethylhexaldehyde	3	2	-	B	Spontaneous ignition in air
2-Ethylhexyl Acrylate	3	1	3	C	Vinyl polymerization
Ethyl-1-Propenyl Ether	3	4	3	A	Ionic-catalyzed vinyl polymerization
Formaldehyde	4	4	3	B	Condensation and polymerization
Glutaraldehyde (25% in water)	4	0	3	B	Aldol condensation and polymerization
Glyoxal (30% in water)	2	0	3	B	Condensation and polymerization
2,4-Hexadienal	4	1	3	C	Vinyl polymerization, aldol condensation
Hexaldehyde	2	3	3	B	Aldol condensation
Hydrazine	4	2	4	-	Explosive decomposition
Hydrogen Peroxide	4	0	4	E	Decomposition
2-Hydroxyadipaldehyde (25% in water)	1	0	1	B	Aldol condensation
Isoctyl Aldehyde	2	2	3	B	Aldol condensation
Isoprene	3	4	3	C	Vinyl polymerization
Isopropenyl Acetate	3	4	3	A,B	Vinyl polymerization
Ketene	4	4	3	D	Polymerization, hydration
Methacrolein	4	4	3	C	Vinyl polymerization
Methacrylic Acid	4	-	3	C	Vinyl polymerization

	Hazard Classification H	F	R	Type of Structure	Type of Reactivity
1-Methoxy-1,3-Butadiene	4	4	-	C	Vinyl polymerization. ionic catalyzed polymerization
Methylacetylene	3	4	4	E	Explosive decomposition
2-Methylpentaldehyde	2	4	3	B	Condensation
Nitro compounds	-	-	-	-	Explosive decomposition
Peracetic Acid	4	4	4	B	Explosive decomposition
Perchloric Acid	4	0	3	-	Explosive decomposition
Piperylene	3	-	3	C	Vinyl polymerization
Propadiene (allene)	3	4	3	A	Vinyl polymerization
Propionaldehyde	4	4	3	B	Aldol condensation
Pyruvaldehyde (40% in water)	2	0	3	C	Polymerization
Silver Acetylide	3	4	4	E	Explosive decomposition
Sodium Perchlorate	3	-	4	-	Explosive decomposition
Sodium Sorbate	2	1	3	C	Vinyl polymerization
Sorbic Acid	4	1	1	C	Vinyl polymerization
Styrene	2	3	3	A	Vinyl polymerization
Succinaldehyde	4	-	3	B	Aldol condensation
t-Butylhydroperoxide	4	4	4	E	Explosive decomposition
Tolylene Diisocyanate	4	1	2	-	-
Tributyl Phosphine	4	4	-	-	Spontaneous ignition in air
Tridecyl Aldehyde	2	1	3	B	Spontaneous ignition in air
n-Valeraldehyde	4	4	3	B	Aldol condensation
Vinyl Acetate	3	4	3	A,B	Vinyl polymerization
Vinyl Acetylene	3	4	4	C	Vinyl polymerization explosive decomposition
Vinyl Acrylate	2	-	3	A,C	Vinyl polymerization
Vinyl Allyl Ether	4	4	3	A	Vinyl polymerization, ionic-catalyzed polymerization
Vinyl Buty Ether	4	4	3	A	Ionic-catalyzed polymerization
Vinyl Butyrate	3	3	3	A,B	Vinyl polymerization
Vinyl Chloride	3	4	3	A	Vinyl polymerization
Vinyl 2-Chloroethyl Ether	4	3	3	A	Ionic-catalyzed polymerization
Vinyl Crotonate	2	3	3	A,C	Ionic-catalyzed polymerization
Vinyl 2-Ethylhexoate	3	1	3	A,B	Vinyl polymerization
2-Vinyl-5-Ethyl Pyridine	4	1	3	A	Vinyl polymerization
Vinyl Formate	4	4	3	A,B	Vinyl polymerization
Vinyl Isobutyl Ether	4	4	3	A	Ionic-catalyzed polymerization
Vinyl Propionate	3	4	3	A,B	Vinyl polymerization
White Phosphorus	4	4	3	-	Spontaneous ignition in air

Compound	Hazard Classification H	F	R	Type of Reactivity
Compounds Reacting With Water				
Acetic Anhydride	4	1	2	Hydrolyzes
Acetyl Chloride	4	4	2	Hydrolyzes violently
Aluminum Alkyle	4	-	2	Hydrolyzes explosively
Aluminum Chloride	4	0	2	Hydrolyzes
Butyl Magnesium Chloride	3	-	2	Hydrolyzes violently
Calcium Carbide	4	0	2	Hydrolyzes exothermically
Calcium Oxide	4	0	2	Hydrolyzes exothermically
Chlorosulfonic Acid	4	0	2	Hydrolyzes violently
Diethyl Sulfate	4	1	2	Hydrolyzes
Diisobutyl Aluminum Chloride	4	4	2	Hydrolyzes violently
Epichlorhydrin	4	2	1	Hydrolyzes
Isopropyl Titanate (IV)	3	1	2	Hydrolyzes
Maleic Anhydride	4	1	3	Hydrolyzes
Phosphoric Acid	4	0	2	Heat of solution
Phosphorus Oxychloride	4	0	2	Hydrolyzes violently
Phosphorus Pentoxide	-	-	-	Hydrates violently
Phosphorus Tetraoxide	-	-	-	Hydrates violently
Phosphorus Trichloride	3	0	2	Hydrolyzes violently
Phosphorus Trioxide	-	-	-	Hydrates violently
Propylene Oxide	3	4	3	Hydrolyzes
Silicon Tetrachloride	4	0	2	Hydrolyzes violently
Sodium Metal	4	4	2	Hydrolyzes violently
Sodium Methylate	4	4	2	Hydrolyzes
Sulfuric Acid	4	0	2	Reacts violently
Titanium Tetrachloride	4	0	2	Hydrolyzes violently
Triisobutyl Aluminum	4	4	2	Hydrolyzes violently

APPENDIX D

ADDITIONAL REFERENCES

CONCERNING SAFETY

ADDITIONAL REFERENCES CONCERNING SAFETY

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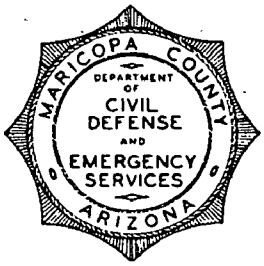
APPENDIX E

DESERT SURVIVAL



INFORMATION FOR ANYONE TRAVELING IN THE DESERT SOUTHWEST

MARICOPA COUNTY DEPARTMENT OF
CIVIL DEFENSE AND EMERGENCY SERVICES
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MARICOPA COUNTY DEPARTMENT OF
CIVIL DEFENSE AND EMERGENCY SERVICES
WILLIAM G. ELDRIDGE, COLONEL, USA, RET., DIRECTOR

(For mail requests: Third class postage for two ounces requested)

TEN SAFETY RULES FOR SURVIVAL IN THE DESERT

1. Never go into the desert without first informing someone as to your destination, your route and when you will return. STICK TO YOUR PLAN.
2. Carry at least one gallon of water per person per day of your trip. (Plastic gallon jugs are handy and portable.)
3. Be sure your vehicle is in good condition with good hoses, spare tire, spare fan belts, necessary tools, and reserve gasoline and oil.
4. KEEP AN EYE ON THE SKY. Flash floods may occur any time "thunderheads" are in sight, even though it may not rain where you are.
5. If your vehicle breaks down, stay near it. Your emergency supplies are here. Raise hood and trunk lid to denote "Help Needed."
6. If you are POSITIVE of the route to help, and must leave your vehicle, leave a note for rescuers as to when you left and the direction you are taking.
7. If you have water—DRINK IT. Do not ration it.
8. If water is limited—KEEP YOUR MOUTH SHUT. Do not talk, do not eat, do not smoke, do not drink alcohol, do not take salt.
9. Do not sit or lie DIRECTLY on the ground. It may be 30 degrees or more hotter than the air.
10. A roadway is a sign of civilization. IF YOU FIND A ROAD, STAY ON IT. (Other people use it, too.)

A WORD OF CAUTION: The desert is beautiful and deadly. Danger is always present once you leave well-traveled roads. Not only strangers and Sunday sightseers have found this to be true. Many native-born Arizonans have been careless and suffered the consequences. The information in this manual may save your life.

ANOTHER WORD: In case of a nuclear disaster do not attempt to avoid radioactive fallout by evacuation to the desert unless you have a fallout shelter at your destination. **Radioactive Fallout** will be in the form of fine sand or dust, and its area of descent cannot be predetermined. **RADIATION** cannot be seen, tasted or felt. Its presence can be determined only by special instruments. Learn about your Community Shelter Program, and how to take advantage of your immediate surroundings if a community shelter is not available.

GENERAL

The Desert Southwest is characterized generally by brilliant sunshine, a wide temperature range, sparse vegetation, a scarcity of water, a high rate of evaporation and low annual rainfall. Some areas are flat and sandy, some mountainous and rocky, and others may be salt marsh or dunes. As opposed to the normally thought of summer conditions of extreme heat and severely parched character, the balance of the year affords usually moderate temperatures, and especially in the spring, a surprising amount of life and color. The desert supports a large variety of animal and plant life, although for the most part it is diminutive in size or modified due to its adaptation to the environment.

TRAVEL

Travel in the desert can be an interesting and enjoyable experience or it can be a fatal or near fatal nightmare. The contents of this small manual can give only a few of the many details necessary for full enjoyment of our desert out-of-doors. Much more must be learned of the basic principles of outdoorsmanship and self-reliance, and there are many sources waiting to be tapped for their information. The Boy Scouts of America, The Girl Scouts, Camp Fire Girls, The American Red Cross, The National Rifle Association, The National Field Archery Association, The Arizona Game and Fish Department, The Phoenix Desert Botanical Gardens, and many more, offer information or services which will be useful to you. Unlimited satisfaction awaits the person who is willing to take advantage of the desert and **who prepares himself** for this unusual environment.

ALWAYS BEFORE GOING INTO THE DESERT, INFORM A RELATIVE OR NEIGHBOR EXACTLY WHERE YOU ARE GOING AND WHEN YOU WILL RETURN.

Pathfinding: When you plan on going into strange country obtain a map beforehand and study the terrain features, the road structure (do the roads run mainly north and south, or east and west?), the directions to the nearest habitation, location of water, etc. When you arrive at your campsite, recheck your map, look for landmarks and orient yourself with the prominent ones. As you move through the country check your back trail often, making mental pictures of the land behind you — this is what you will be looking for when you return to camp. Take into consideration the position of the sun and shadows, and where they will be at the time you expect to return. Stay on established trails, if possible, or mark your route by blazes or other marks. Make a blaze by a single downward chop with a hatchet or heavy knife on a thin-barked tree or by one downward and one upward stroke on a thick-barked tree to expose the light wood. Make bush marks by breaking over the top leaving it attached by the bark. Make

other marks by aligning stones to form arrow shapes, or by slanting sticks into the ground in the direction that you are going. Travel from one prominent point to the next, making a direction mark at every stop.

If you think you are lost do not panic. Sit down for awhile, survey the area and take stock of the situation. Try to remember how long it has been since you knew where you were. Decide on a course of action. It may be best to stay right where you are and let your companions or rescuers look for you. This is especially true if there is water and fuel nearby, or in winter, if there is some means of shelter. Once you decide to remain **do not move.** Make a fire — a smoky one for daytime and a bright one for the night. Other signals may be used, but fire is by far the best.

If you feel, after thinking the situation over, that you can retrace your course, do so. Mark your spot or leave a note before moving on. Look for tracks, you may be able to back-track and find your way to familiar ground. Do not try to take shortcuts as this may tend to further confuse you. If possible, climb a tree or a high point and make a sketch of the area before moving. Always move down stream or down country, but travel the ridges instead of the washes or valleys. Make marks as you go. Travel by landmarks or compass and do not try to move too fast.

REMEMBER, MOVE WITH A PURPOSE, NEVER START OUT AND WANDER AIMLESSLY.

Walking: There are special rules and techniques for walking in the desert. By walking slowly and resting about 10 minutes per hour a man in good physical condition can cover at the outset about 12-18 miles per day — less after he becomes fatigued or lacks sufficient water or food. Consider walking at night. It is cooler and if lack of water is a problem you will dehydrate less. You can navigate by the stars. The disadvantages are that you cannot see well and may stumble, or you might overlook water and food sources and indications of habitation. On the hot desert it is best to travel early morning or late evening, spending midday in whatever shade may be available. The position of the sun early and late in the day will give a better sense of direction. In walking, pick the easiest and safest way. Go around obstacles, not over them. Instead of going up or down steep slopes, zigzag to prevent undue exertion. Go around gullies and canyons instead of through them. Use a steady easy step. When going down hill, bend the knees considerably. When climbing, place the whole foot on the ground at one time, not the heel alone. When walking in sand, lean well forward, keeping the knees bent. On walks of long duration do not swing the arms, but grasp the shoulder straps of your pack or the shirt at the shoulder seams to prevent the hands and lower arms from swelling, and creating undue fatigue. When

walking with companions, adjust the rate to the slowest man. Keep together but allow about 10 feet between members.

At rest stops, if you can sit down in the shade and prop your feet up high, remove your shoes and change socks, or straighten out the ones you are wearing. If the ground is too hot to sit on, no shade is available, and you cannot raise your feet, do not remove your shoes as you may not be able to get them back onto swollen feet. However, unlace boots, adjust socks and relace.

Automobile Driving: Cross country driving or driving on little used trail roads is hazardous, but can be done successfully if a few simple rules are followed. Move slowly. If in doubt of the terrain, dismount and check it out first on foot. Do not attempt to negotiate washes without first checking the footing and the clearances. High centers may rupture the oil pan. Overhang may cause the driving wheels to become suspended above the ground. In marsh or sand, the wheels may sink in resulting in a high center and loss of traction. Do not spin wheels in an attempt to gain motion, but apply power very slowly to prevent wheel spin and subsequent digging in. When driving in sand or snow, traction can be increased by partially deflating tires. Drive slowly on low tires. Do not remove so much air that the tire may slip on the rim. Start, stop and turn gradually, as sudden motions cause wheels to dig in. If you plan on driving in the desert, practice "difficult traction" in a dry wash with another car standing by to tow you out if you become stuck. Experiment with the various footings. There are certain tool and equipment requirements if you intend to drive off the main roads: one or more shovels, a pick-mattock, a tow chain or cable, at least 50 feet of strong tow rope, tire pump, axe, water cans, gas cans (both **filled**), and of course, your regular spare parts and auto tools. For rope, consider nylon rather than manila. It costs more, but has twice the strength, will last much longer, and its elasticity is highly beneficial in extracting stuck vehicles. ¾" nylon has a working strength of 2,000 pounds and a breaking strength of about 10,000 pounds. Be sure that your car is in sound condition with a full gas tank, a filled clean radiator, a filled battery and new (and extra) fan belts. If you become stuck or your car breaks down, RAISE THE HOOD and STAY WITH THE CAR.

Aviators: File a flight plan before flying cross-country. When flying across the desert be sure that you have a survival kit and clothing suitable for ground conditions. If you have difficulty, a crash landing is preferable to parachuting, as you may have trouble locating the plane later. Land before you are completely out of gasoline — dead stick landings in desert terrain are dangerous. Also you will have gasoline with which to start signal fires. Build fires well away from the plane — remember the gusty desert winds. It may be best to remain at the plane instead of trying to walk out. You can survive longer without water in the

shade of the plane's wing than you can by exhausting yourself walking. Walk out only if you are sure you can reach help easily, and are absolutely sure that you have enough water to make it. If you decide to walk, make a careful plan, and follow the path-finding instructions.

Direction Finding: Haven't you awakened in a strange area to find that you are "turned around"? The sun rises in the east and sets in the west regardless of your first impressions. Stand with your right hand to the morning sun or your left hand to the evening sun and you will face North. When first arriving in new country look around, study the land masses, and fix the directions well in your mind. When moving through new country continue the practice of fixing direction and of looking all around you. A slow, careful trip out will assure a rapid and safe return.

Use of the Compass: A good compass, (one with a protected face is best) is a must for traveling in strange country. Check it out at the same time you are making your mental notes of direction and prominent land features. To orient the compass, hold it horizontally so that the needle swings freely. When the needle comes to rest, rotate the compass so that the needle on the dial and North coincide. Remember that this direction is Magnetic North and may vary from true North by an appreciable degree. Compare the needle direction with the North Star to learn the difference, or you can determine this "declination constant" from a map of the area. This deviation varies with location. Avoid orienting your compass near any iron or steel as these will cause swinging of the needle and incorrect readings. To use the compass, orient it, then determine the reading to a distant land mark in the direction you want to go. To return, orient the compass, subtract 180° from the outgoing reading, and move in the direction of the calculated "back sight". This will not necessarily return you to your exact original location, but if you have made your mental notes before leaving, have kept some idea of how far and how fast you have traveled out, you will be on familiar ground in due course upon returning.

Determining Direction Using a Watch: The watch must tell nearly correct sun time, not daylight savings time. Hold the watch horizontally, point the hour hand at the sun. **South** will be midway in the smallest angle between the hour hand and the symbol 12. On cloudy days a stick held upright on the center of the watch will cast a faint shadow. Align the shadow over the hour hand, then **North** will be half way through the small angle between the shadow and the symbol 12.

Determining Direction From the Stars: The only star which appears stationary is Polaris, the North Star. Learn to recognize it, and the Pointers and other star arrangements which will guide

the eye to the North Star. Examine the sky each night for some time before going into the field. This acquaintance will give one a sense of confidence for night travel if it becomes necessary. Take into account that the night sky, at a given hour each night, will have shifted a little, as well as appearing to rotate during the night. When traveling use a star close to the horizon as a guide, but remember that the earth rotates 15 degrees every hour, so that you must adjust or use a new guide every 10 minutes or so in order to maintain an intended direction.

Determining Direction from Shadow: Select an object at least three feet high which casts a shadow with a well defined projection. Mark the shadow tip — wait 10 to 15 minutes and again mark the shadow tip. A line drawn from the first mark through the second mark will point **East.** Effective from about 9 a.m. to 3 p.m.

Determining Direction From Nature: Trees may have moss which will be predominantly on the north and northeast sides of the trunks. Check a number of trees to get a good average direction reading. The tips of evergreens generally point toward the rising sun, approximately east. The plane on top of the barrel cactus slants usually toward the southwest. A noon-day shadow points north.

Navigational Hazards: The heat and high evaporation rate of the desert cause a phenomenon known as "mirage". The varying density distribution of the layers of hot air, usually close to the earth's surface, causes light rays to reach the observer along several paths causing distorted, multiple or sometimes inverted images. These "heat waves" hamper your vision, making it difficult to determine distance or objects. It may cause objects or land marks to change shape, disappear or cause them all to appear alike. Another type of mirage is the false dawn of the desert, which seems to make the sun rise in the west. Ground haze is a layer of warm, dusty air close to the ground which hampers and distorts vision.

SIGNALS: The best signals are fire — a huge bright one at night, a smoky one by day, black smoke if the country is light colored, white smoke if the country is dark. Maintain a good supply of fuel to give the appropriate signal. Build your signal fire on the highest point near to your shade or shelter. If fuel is plentiful two fires some distance apart are better than one, and three fires in a triangle denote "HELP!"

The **signal mirror** is an excellent device for attracting attention, particularly of aircraft. They can be obtained at military or camping equipment stores, and the directions are included. It is a 2-faced metallic mirror with a hole in the center. You can improvise one from a can lid which is shiny on both sides. To use, hold the mirror about three inches in front of your face, and

sight through the hole on the object you are trying to signal. Move the mirror so that the light spot on your face, which you can see in reflection, disappears in the hole in the mirror while still maintaining sight of the plane, etc., through the hole. On a clear day ground signals may be transmitted for 10 miles, signals to aircraft an even greater distance.

Aluminum foil is an excellent signaling material. Signs may be made of piled brush, rocks, tree branches, stomped-down snow, etc. Make large characters running north and south to cast the best shadow. Pilots understand these signals:

I—Need Doctor	↑—Going This Way
II—Need Medicine	LL—All Is Well
X—Unable To Proceed	N—No
F—Need Food-Water	Y—Yes
⩔—Need Firearms	⅃L—Not Understood
K—Which Way	□—Need Map - Compass

Signals made by sound are the least effective. **Three** of whatever sound you can make denotes "Distress." A "thunderer" type whistle is recommended as an easy way to make a lot of noise. Blowing across the mouth of an empty large-caliber cartridge case makes a distinctive sound. If you have a firearm, shoot once, wait 10 seconds and fire twice more about 5 seconds apart. The first will attract attention and the second and third will give direction. If there is no answer save your ammunition. Sound carries best during the early evening quiet just before dark.

CLOTHING AND EQUIPMENT

Clothing: Clothing requirements will vary considerably with the season and the environment. For the hot desert, light weight and light colored clothing which covers the whole body is best. Long trousers and long sleeves protect from the sun, help to prevent dehydration and protect against insects, abrasions and lacerations by rocks and brush and tend to reduce infections caused by these injuries. Headgear should provide all around shade as well as eye shade. Shoes should be light weight but sturdy, and should protect the ankles. Remember thorns and spines make walking a problem. Woolen socks are recommended, and spare socks should always be carried. Gloves are helpful to protect hands from spines and thorns when handling brush and firewood. Winter clothing requirements for the southwest vary with the altitudes in which you are operating. Also in winter, keeping dry is important. The "layer" system is best. Several light garments are easily carried and are more versatile in varying temperatures than are heavier garments, and will prove at least as

warm. They should be selected for size, keeping in mind that other clothing may be placed over or under them. A light weight, water repellent, wind breaker should be available to wear alone or over the layers. A coat style is best as it will protect the hips. Headgear should shade the eyes and some provision should be made to protect the ears. Earflaps in the headgear are probably best and are always available. Footgear should be sturdy, protect the ankles, and be water repellent. Do not grease shoes—it makes them cold, tends to rot the leather, and does not waterproof them. Silicone preparations are excellent, easy to apply, and lasting. Woolen socks are again recommended, and spare socks should always be carried. In winter it is important to keep the feet dry to help prevent "trench foot" and frost bite. Damp socks can be carried inside the shirt front against the body to dry them out.

Equipment: Your method of travel will dictate in large part the equipment to carry. When traveling by auto you will carry "pioneer" gear such as shovels, picks, heavy rope, etc. You must also think about bedding, cooking gear, can opener, eating utensils, flashlight with spare batteries, lantern with fuel, First Aid kit, towels, soap, toilet paper, tissues, paper napkins, old newspapers. These are the same items to be included when setting up the home shelter against disaster. In this section, however, we are primarily interested in those items to be carried by the individual on foot, whether engaged in recreational activity or a survival problem, such as "walking out" from a downed aircraft or disabled vehicle.

Survival Kit: Kits are outlined in many writings on survival. The following items are listed, we think, in the order of their importance. Detailed use is omitted here, but learn to use and practice with each item BEFORE you need it for survival:

1. **Knife**—a good small one of the "boy scout" variety is best.
2. **Matches**—12 or more, strike anywhere, waterproofed by coating with parafin, beeswax, fingernail polish, etc.
3. A small **magnetic compass.** Learn to use it.
4. **A "thunderer" whistle.** Carry it on a line around the neck.
5. A small metal **signaling mirror.**
6. A small **magnifying lens**—used to start fires, and as aid in removing small spines or splinters.
7. A large-eyed **needle.** For first aid and sewing purposes. Keep from rusting.
8. Cobbler's **linen thread.** A hundred feet or more, 8 strand. Used to set snares, build shelter, repair or improvise clothing, etc.
9. **Nylon chiffon.** A piece about a yard square, bright orange color, to be used for signaling, for straining dirty water, or as a face covering during sand or dust storms.

10. **Aluminum foil.** About five feet of the 12 inch heavy duty type, used for signaling, a reflector for fire or candle, to make a cooking pot or a drinking cup.

11. **Water purification tablets.** 10 or more. Iodine-type tablets are probably best. Seal carefully in plastic foodwrap to keep dry.

12. **Toy balloons.** Three or four of the large, heavy, bright orange-colored ones. Used for emergency water containers or for signaling. Wrap in plastic food wrap to preserve.

13. **Candle stub**—used for light or as an assist in starting fires — helps to conserve matches.

14. A single-edged **razor blade.** A handy first aid tool. Leave in the original package to prevent rusting.

15. **Pencil stub.** Assist rescue parties by leaving notes.

16. **Cigarette papers.** A book of these for writing notes, or to leave as trail markers.

17. **Adhesive tape.** About 2 feet, 1 inch wide, primarily for first aid purposes. Bandaids are handy, too. Replace every few months.

18. **Fish hooks.** Five, assorted sizes. Use a little bait to snare birds, etc.

19. **Box nails.** About five, blunted and bent to hook shape, to be used as snare triggers.

20. **Flint and steel fire starter.** Make by attaching a lighter flint to the end of a small sturdy stick. Wrap a length of cobbler's linen around the stick. To make a fire, fuzz the end of the linen, position the fuzz at the flint and strike against steel. The fuzz will catch the spark and can be blown into a flame. Practice with it. A cigarette lighter will provide sparks. Do not depend on having fluid in it when you need it, and ordinary lighter wick will not flame when dry.

All of the above items can be fitted into a tobacco tin, a band-aid box or a similarly sized plastic box and be ready to go at any time. Check it from time to time and be sure all items are there and in good condition.

Other items that should be carried on the individual are: a sharp belt knife, a good map of the area, thirty or more feet of nylon parachute shroud line, canteen, a watch, a snake bite kit, a firearm and ammunition, and such other items which may be small and useful. Consider carrying your gear in a small rucksack or pack over your shoulders. Weight carried in this manner is less tiring than if carried in pockets or hung on the belt. The pack can be used to sit upon. It also affords a safer method of carrying those things, such as the belt knife, hatchet, etc., which may lend to the chances of injury in case of a fall.

HEALTH HAZARDS

Much thought must be given to protecting your health and well being, and the prevention of fatigue and injury: first, because medical assistance will be some time and distance away; second, because conditions are usually different and distinct from your everyday living. The desert is a usually healthy environment due to dryness, the lack of human and animal wastes, and the sterilizing effect of the hot sun. The higher elevations will also present an environment conducive to good health, since the major part of human disease is transmitted through respiratory action or through contact. Therefore, your immediate bodily needs will be your first consideration.

If you are walking or active, rest 10 minutes each hour. Drink plenty of water, especially early in the morning while the temperature is still low.

While on the desert or in snow, wear sun glasses to protect your eyes from glare. Even though the glare does not seem to bother you, it will impair your distant vision and will retard your adaptation to night conditions. If you have no glasses make an eyeshade by slitting a piece of paper, cardboard or cloth. Applying charcoal or soot around the eyes is also beneficial.

Use chapstick or grease on lips and nostrils. Do not "lick" your lips if they are dry as this will hasten splitting.

Change your socks regularly even though you must change to used socks. Sunning and aeration of socks and underclothing have a marked freshening value.

Do not remove your clothing in an attempt to keep cool. This will only hasten dehydration, as will sitting on the hot ground.

In winter, do not sit down if your clothing is damp or you have been perspiring unless you have additional clothing or a fire. If you have neither, walk slowly around a tree or in a circle where ground is level and footing good until you dry out.

Do not travel in storms. Mark your direction of travel and find shelter. Dust storms can be seen before their arrival. If on foot, lie down with your back to the wind. Cover your head with a cloth to keep dust out of your eyes, nose, mouth and ears. If driving, stop and get off the road as far as possible to avoid collision. Turn out lights and turn on emergency flashers. Back vehicle into the wind to prevent sand pitting of windshield.

In a survival situation everything that you do, each motion that you make, and each step you take must be preceded by the thought: **Am I safe in doing this?**

WATER

WATER REQUIREMENT CHARTS

(from "The Physiology of Man in the Desert"
by Adolph & Associates)

A. Number of Days of Expected Survival in the Desert, No Walking At All:

Available water per man, U. S. Quarts	0	1	2	4	10	20
Max. daily shade temp. F.	Days of expected survival					
120 degrees	2	2	2	2.5	3	4.5
110	3	3	3.5	4	5	7
100	5	5.5	6	7	9.5	13.5
90	7	8	9	10.5	15	23
80	9	10	11	13	19	29
70	10	11	12	14	20.5	32
60	10	11	12	14	21	32
50	10	11	12	14.5	21	32

B. Number of Days of Expected Survival in the Desert, Walking at Night Until Exhausted and Resting Thereafter:

Available water per man. U. S. Quarts	0	1	2	4	10	20
Max. daily shade temp. F.	Days of expected survival					
120 degrees	1	2	2	2.5	3	
110	2	2	2.5	3	3.5	
100	3	3.5	3.5	4.5	5.5	
90	5	5.5	5.5	6.5	8	
80	7	7.5	8	9.5	11.5	
70	7.5	8	9	10.5	13.5	
60	8	8.5	9	11	14	
50	8	8.5	9	11	14	

The importance of temperature reduction to the survivor is highlighted by the following in Chart A: Temperature 120°, water available 2 quarts, days of expected survival 2; reduce the temperature to 100°, and 2 quarts of water will extend your life expectancy THREE TIMES. This importance to a potential "survivor" cannot be overemphasized. Night travel, or better, NO TRAVEL, is stressed.

At equal temperatures, the body requires two to three times as much water to maintain water balance in the desert as it requires in the jungle with its high humidity.

Dehydration: An increase in body temperature of 6 to 8 degrees above normal (98.6) for any extended period causes death.

Body temperature in a healthy person can be raised to the danger point either by absorbing heat or by generating it. The body absorbs heat from the air if the air is above 92 degrees Fahrenheit. Direct sunlight striking the body, will increase temperature even if the air is cool. You can also absorb heat reflected from the ground or absorb it directly from the ground by contact. Any kind of work or exercise increases body heat.

The body gets rid of excess heat and attempts to keep the temperature normal by sweating, but when you sweat the body loses water and dehydration results. It has been proven that you can do twice as much work or walk twice as far with sufficient water and normal temperatures as you can after you lose 1½ quarts of water by sweating under 100 degree temperature.

No permanent harm is done to a man who dehydrates up to 10% of his weight. IF, later he drinks enough water to gain it back. However, 25% dehydration at temperatures in the nineties or above, will probably be fatal. You can drink cool or warm water as fast as you want, but ice cold water may cause distress and cramps.

Symptoms of Dehydration: Only by the ability to recognize the initial symptoms of dehydration can one logically expect to take corrective measures to prevent further (and possibly fatal) dehydration. Learn these symptoms:

Thirst discomfort, slow motion, no appetite, and later nausea, drowsiness, and high temperature. If dehydration is from 6 to 10 per cent, symptoms will be: dizziness, headache, dry mouth, difficulty in breathing, tingling in arms and legs, bluish color, indistinct speech and finally, inability to walk.

Prevention of Dehydration: Thirst is not an indication of the amount of water you need. If you drink only enough to satisfy your thirst, you can still dehydrate. Drink plenty of water, especially at meal times and during the cooler early morning hours.

A pebble or small coin carried in the mouth will alleviate the sensation of thirst, but is not a substitute for water and will not aid in keeping your body temperature normal. Avoid smoking as it encourages oral breathing exposing large areas of mucous membrane to drying influences, thereby increasing the rate of dehydration and need for water. Salt will do you definite harm unless plenty of water is available. Don't worry about salt but do try to keep up the water intake.

Ration Sweat, Not Water: In hot deserts you need about a gallon of water a day. If you walk at night, you may get about 20 miles for that gallon, but if you walk in the daytime heat, you will get less than 10 miles to the gallon.

Keep your clothing on, including shirt and hat. Clothing helps ration your sweat by slowing the evaporation rate and prolong-

ing the cooling effect. It also keeps out the hot desert air and reflects the heat of the sun. Stay in the shade during the day. Sit on something 12 or more inches off the ground, if possible. DO NOT LIE ON THE GROUND as it can be 30 degrees hotter than a foot above the ground. If travel is indicated or necessary, travel slowly and steadily.

Rationing water at high temperatures is actually inviting disaster because small amounts will not prevent dehydration. Loss of efficiency and collapse always follow dehydration. IT IS THE WATER IN YOUR BODY THAT MAINTAINS YOUR LIFE, NOT THE WATER IN YOUR CANTEEN.

KEEP THE MOUTH SHUT and BREATHE THROUGH THE NOSE to reduce water loss and drying of mucous membranes. AVOID CONVERSATION for the same reason. If possible, cover lips with grease or oil. ALCOHOL IN ANY FORM IS TO BE AVOIDED as it will accelerate dehydration. Consider alcohol as food and not as water since additional water is required to assimilate the alcohol. For the same reason, food intake should be kept to a minimum if sufficient water is not available.

Carrying Water: When planning to travel give your water supply extra thought. Carry enough water based on the charted requirements. Do not carry water in glass containers. These may break. Metal insulated containers are good, but heavy. Carry some water in gallon or half-gallon plastic containers similar to those containing bleach. They are unbreakable, light-weight and carrying several will assure a water supply if one is damaged.

Finding Water in the Desert: If you are near water it is best to remain there and prepare signals for your rescuers. If no water is immediately available look for it, following these leads:

Watch for desert trails—following them may lead to water or civilization, particularly if several such trails join and "arrow" downward toward a specific location.

Flocks of birds will circle over water holes. Listen for their chirping in the morning and evening, and you may be able to locate their watering spot. Quail fly toward water in the late afternoon and away in the morning. Doves flock toward watering spots morning and evening. Also look for the diggings and browsings of wild animals as they tend to feed near water.

Water may be found at the base of rock cliffs for some time after a rain. It may be found in the waste rock at the base of cliffs or in the gravel-wash from mountain valleys which get regular seasonal rains. Limestone and lava have more and larger springs than any other type rocks. Springs of cold water are safest. Limestone caverns often have springs, but remain in sight of the entrance as you may get lost. Look for springs along walls of valleys that cross the lava flow. Springs may be found along

valley floors or down along their sloping sides. See if there is seepage where the dry canyon cuts through a layer of porous sandstone. Dry stream beds may have water just below the surface. Look at the lowest point on the outside of a bend in the stream channel. Dig until you hit wet sand. Water will seep out of the sand into the hole. Damp surface sand marks a place to dig a shallow well. Dig at the lowest point and go down 3 to 6 feet. If the sand stays damp, keep digging. Look at hillsides to see where the grass is lush and green. Dig at the base of the green zone and wait for water to seep into the hole. Water is more abundant and easier to find in loose sediment than in rocks. Look for a wet spot on the surface of a clay bluff or at the foot of the bluff and try digging it out.

Look for the "indicator" plants which grow only where there is water: cottonwoods, sycamores, willows, hackberry, saltcedar (tamarisk), cattails and arrow weed. You may have to dig to find this water. Also keep on the lookout for windmills and water tanks built by ranchers. If cactus fruits are ripe eat a lot of them (see section on foods), to help prevent dehydration.

The immature flower stalks of Agave, Yucca and Sotol contain moisture, or if no flower stalks are present the main stalks may be split open and the pith chewed to prevent dehydration. The barrel cactus contains a high degree of moisture, but to press out water is pure myth, as the mucilaginous, acrid juice thickens rapidly. To remove moisture chew on the pith but do not swallow it. Carry chunks of the pith with you to suck on to alleviate thirst. Young plants six to eighteen inches in height, and with a soft green color will have the higher moisture content. The root of the night blooming cereus is also high in moisture.

Methods of Purifying Water: Dirty water should be filtered through several layers of cloth or allowed to settle. This does not purify the water even though it may look clean. Incidentally, radioactive fallout is dirt and most can be removed from water as above. Purification to kill germs must be done by one of the following methods:

1. Water purification tablets are the easiest to use. Get them from the drug store and follow the directions on the label. Not only do you need them in your survival kit and in your car or plane, but you should keep an emergency supply at home. Generally, one tablet is sufficient for one quart of clear water or two tablets for cloudy water. Let stand for thirty minutes.

2. Tincture of Iodine; add three drops per quart of clear water, double for cloudy water. Let stand for thirty minutes.

3. Household bleach (5.25% sodium hypochlorite): 2 drops per quart of clear water, 4 drops per quart of cloudy water. Stir, let stand 30 minutes. Water should have a slight chlorine taste.

4. Boiling for 3 to 5 minutes will purify most water. Add charcoal while boiling to remove disagreeable odors from water. Agitate to aerate and restore taste or add a small pinch of salt.

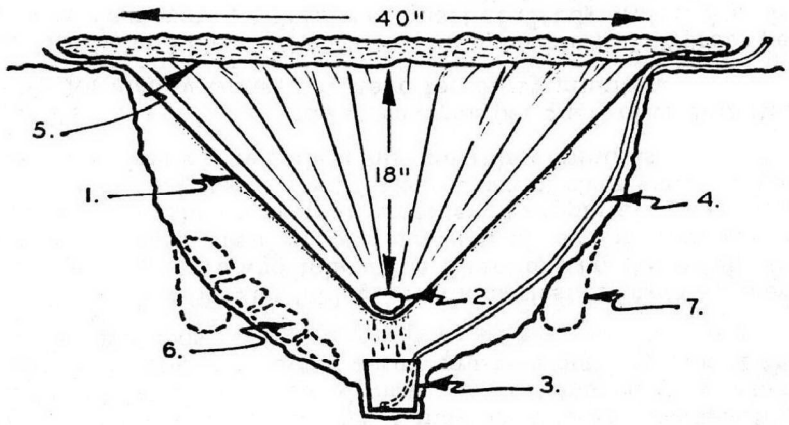
DESERT STILL

An interesting method of acquiring water is through the use of a solar still constructed generally as shown. The sun's rays heat the ground inside the hole, causing evaporation of the soil's moisture, which saturates the air space and condenses on the cooler plastic surface. This method will produce some water in even the driest areas, but by selecting a site where there are indications of moisture—greener or more plant life, loam soil, damp sand, etc. —about two to three pints per day may be obtained. Several such stills would have to be constructed to provide the amount necessary for continued survival. Cacti and other plants which contain moisture may be broken up and placed in the hole to provide a higher water recovery rate. Saguaro, barrel and prickly pear cacti are best for this purpose. Non-potable water may be poured into a trench around the inside of the hole and be distilled, and made safe for drinking by the process. If non-potable water or plant materials are placed in the hole, be sure that they do not come in direct contact with the plastic, as the water forming on it would then be contaminated.

The basic requirement for constructing the still is a six-foot square or circular sheet of "wettable" plastic. The plastic material should be a thin (1 mil), tough, rough-surfaced type, of which duPont's "Tedlar" is an example. Smooth plastics are less "wettable", and the droplets forming will not adhere and run down to the point of the cone before dropping off. If a smooth type must be used, slight abrading with scouring powder, fine sand or sandpaper will improve its wettability. Be sure the roughened side is placed down. A wide-mouth container of some kind is used to collect the distilled water.

The site must be in full sunshine to be efficient, although an established still will produce some water during the night. The hole may be dug with a sharp rock or stick, and soil removed by hand if a shovel is not available. If the container catching the water is non-rigid, the bottom of the hole must be shaped to support the container as it becomes filled.

The still may become a source of food, as lizards, snakes and small animals will fall into the cone and become entrapped.



LEGEND:

1. Sheet of wettable plastic, 6-foot diameter
2. Smooth, fist-sized rock for forming cone of plastic.
3. Pail, jar, can, or cone of foil, plastic or canvas to catch water
4. Drinking tube, ¼ inch plastic, about 5 feet long. Desirable but not necessary
5. Soil to weight plastic sheet and seal space. A good closure is important
6. Line hole with broken cacti or other succulents
7. If non-potable water is available, dig a soaking trough around inside of hole. Carefully fill the trough to prevent impure water from running down and contaminating the water-catching container.

FOOD

You must have water to survive, but you can go without food for some days without harmful effects. In fact, if water is not available do not eat, as food will only increase your need for water. The important thing about locating food in a survival situation is to know what foods are available in the particular environment and how to go about obtaining them. Hawks soaring overhead may mean rabbits or other rodents below; birds flocking may mean not only edible berries but will probably mean water nearby. Game will be found around water holes and in areas that are prominent because of heavier brush growth.

Food List: When planning, include those items which have high energy value, long shelf life and little weight. Generally, meats have higher energy value than vegetables. The dehydrated

foods are excellent and keep well. Candies are OK but cause thirst, so you need a good water supply. The following list, in quantity, represents food for one person for two weeks or two persons for one week, etc. Use this list also for family emergency food stockpile. See USDA Home and Garden Bulletin #77 for additional food information. (Don't forget the can opener!)

1. Canned meats, fish, poultry—8 lbs.
2. Prepared canned foods with meat, fish, poultry (chile, spaghetti, macaroni, beans, etc.)—8 lbs.
3. Canned soups (condensed, containing meats, fish, poultry) 5 lbs. (or equivalent in dehydrated soup products).
4. Canned fruits and vegetables—12 lbs.
5. Canned juices, regular strength—14 - #1 tall cans.
6. Dried fruits—2 lbs.
7. Crackers and cookies—3 lbs.
8. Milk: evaporated—7 - 14½ oz. cans, or powdered—1½ lbs.
9. Cereal, dry, ready to eat—1 lb.
10. Cereal, quick cooking—1 lb.
11. Flour—2 lbs.
12. Flour mixes—1 lb.
13. Fats and oils—1 lb. or 1 pt.
14. Jams, jellies and peanut butter—2 lbs.
15. Sugar and candies—2 lbs.
16. Relish, catsup, mustard, honey, syrup—as required.
17. Coffee, tea, instant cocoa, instant cream, salt, pepper, vinegar, baking soda, bouillon cubes, etc.—as required.

Survival Rations:

Here is a survival ration, originally developed by the late Mr. Lee Kelly, Survival Expert, which is tasty and which will provide enough food for 2 days in an emergency:

- 3 cups cereal—Oatmeal or Barley, Corn or Wheat Flakes
- 2½ cups Powdered Milk
- 1 cup White Sugar
- 3 tablespoons Honey
- 3 tablespoons Water
- ½ package Citrus Flavored Gelatin
- ¼ teaspoon Salt

Place all dry ingredients, except gelatin, in mixing bowl. Combine water and honey and bring to a boil. Dissolve the gelatin in the honey-water mixture, then add to the dry ingredients. Mix well. Add water a teaspoon at a time until mixture is just moist enough to mold. Pack into a refrigerator dish or other mold. This recipe will make 2 bars, 1½ x 2 x 5 inches. The bars may be placed in the oven and dried under very low heat, then

wrapped in foil and stored indefinitely. Each bar will provide about 1,000 calories and is sufficient food for one day. It can be eaten dry or cooked with about 2/3 of a canteen cup of water.

Edible Wildlife: Almost every animal and reptile, and many insects are edible, and many are sources of highly esteemed foods. Learn now to prepare the various things that would be available to you in a survival situation. Avoid any small mammal which appears to be sick as it may have tularemia, a disease transmittible to humans. A spotted liver in the animal is also an indication of this disease. Some animals have scent glands which must be removed before cooking. Do not allow the hair of these animals to come in contact with the flesh as it will give the meat a disagreeable taste.

1. **Jack Rabbit:** A hare, with long ears and legs, sandy color, may weigh up to 8 lbs. Grubs are often found in the hide or flesh but these do not affect the food value.
2. **Cottontail Rabbit:** Small, pale gray with white tail. Active in the early morning and late evening.
3. **Pocket Gopher, Kangaroo Rat, Wood Rat, Pocket Mouse, Grasshopper Mouse:** Active at night.
4. **Ground Squirrel, Tree Squirrel, Chipmunk:** Out during the day.
5. **Porcupine:** Singe the quills, then skin and roast or boil.
6. **Muskrat, Beaver:** Beaver tail is especially delicious, broil it on a stick then remove the skin.
7. **Skunk:** Skin carefully, the meat is excellent. Active at night.
8. **Badger.**
9. **Racoon, Ring-tail Cat, Coati-Mundi.**
10. **Opossum.**
11. **Fox, Coyote, Bear.**
12. **Bobcat, Wildcat, Mountain Lion.**
13. **Mexican Free-Tail Bat.**
14. **Javelina (Collared Peccary):** Dark gray-black, about three feet long, weighing 30-50 pounds with sharp, strong tusks. Has scent glands on the back, over the hind legs. May be dangerous if cornered or wounded.
15. **White Tail Deer, Mule Deer, Elk:** Keep hair off meat.
16. **Prong Horn Antelope:** 60 to 120 pounds. Keep hair off the meat.
17. **Desert Bighorn Sheep:** May weigh over 200 pounds.
18. **Mourning Dove:** Year-round resident, usually found near habitation and water. Sometimes nests in cholla cactus.
19. **White Wing Dove:** Resident, April to October, nests in mesquite and palo verde trees. Usually near water.

20. **Gambel's Quail, Scaled Quail, Mearn's Quail, Dusky Grouse, Pheasant:** The Gambel's is of primary importance in desert and semi-arid areas.

21. **Wild or Merriam's Turkey:** About 8 to 20 pounds. Found in pine and oak areas.

22. **Ducks, Coot and other Water Fowl.**

23. **Owls, Hawks, Crows, Road Runners, Cactus Wrens,** and various other small birds.

24. **Woodpeckers:** Inhabit the Saguaro Cactus areas.

25. **Vultures and Eagles.**

26. **Birds Eggs:** All are edible.

27. **Fish.**

28. **Bullfrogs:** Skin before cooking.

29. **Snakes:** Most snakes are edible. Rattlesnake is especially good. Remove the head and bury it as a safety precaution. However, leaving the head on is not detrimental to the eating qualities.

30. **Lizards:** Many species, all believed edible, including the poisonous Gila Monster.

31. **Desert Tortoise.**

32. **Lubber Grasshopper:** 2½ inches long. Should be cooked.

33. **Grubs:** Found under bark, in rotten wood or in the ground. Boil or fry.

34. **Hairless Caterpillars:** Hairy ones may be poisonous.

Preserving Surplus Meat: It is surprisingly easy to preserve surplus meats in the desert southwest because of the bright sun and dry heat. You can make **Charqui** (Jerky) from fat free meat of large animals, by slicing it into strips about 1 inch thick by several inches wide, and hanging it in the sun for two or three days until it is completely dry. May be eaten dry or soaked and cooked. Will keep indefinitely. **Sand dried meat** is similarly stripped, then wiped dry, and buried, unsalted in dry sand about 6 inches deep. If kept dry will keep for several years. Eat dry or soak and cook. **Smoke drying** is also simple. Build a lattice about 3 feet above a slow burning fire, lay ¼ inch thick strips of meat on the lattice. Smoke until the meat becomes brittle. Do not let the fire become so hot that the meat cooks or draws juices—the smoke does the trick. Do not use pitchy or oily woods as they will flavor the meat.

Snares, Traps, Deadfalls: Learn to design and use these from books on Woodcraft. Most are simple devices which require only ingenuity, a pocket knife, a bent nail and a piece of string. You will have these things in your survival kit—or you may have to improvise. Snares should be placed after camp is set up but before dark. A twitch-up snare jerks the animal into the air, kills promptly and protects it against other animals. A noose of string

laid around a hole or burrow can be jerked by hand as the animal puts its head out of the hole. Conceal yourself some distance away so that the animal in the hole cannot see you. Deadfalls are traps which allow a heavy object, log or rock to drop on the animal when a trigger is released. Any sized animal may be killed by this method if the trap is large enough. Slings or slingshots may be used to kill birds or small animals. A handful of pea-sized rocks flung by hand may get a bird as a last resort.

Set snares in game trails or frequently used runways which can be recognized by fresh tracks and droppings. The spot used for butchering will attract other animals and will be a good place to watch for a day or so. Use entrails for bait. Place the snare in the narrowest part of the trail, or arrange obstacles to force the animal to pass through the snare. Disturb natural surroundings as little as possible. Be sure the noose is large enough so that the head but not the body of the animal will pass through.

Edible Plants: A visit to the Phoenix Botanical Gardens in Papago Park or similar arboretum will afford you much interesting information regarding desert plants.

The main desert edibles are the fruits of cacti and legumes. All cactus fruits are safe to eat. In the summer the fleshy and thin-walled ripe fruits can be singed over fire to remove spines. Then they can be peeled and eaten. Old cactus fruits contain seeds which can be pounded between two stones into a powder and eaten, or mixed with water into a gruel called pinole. New, young pads of the prickly pear can be singed, peeled and boiled.

The legumes are the bean bearing plants. The main ones are the honey and screwbean mesquites, the palo verde, the tesota (ironwood) and the catclaw acacia. All are small trees with fern-like leaves. The palo verde is recognized by its open growth, greenish bark and feathery leaves. Ironwood has rough, dense growth, and will grow into a large tree under favorable conditions. Catclaw is a small, grayish tree with numerous short curved thorns. All have bean pods which when green and tender can be boiled and eaten. Dry, mature beans, like cactus seeds, are too hard to chew and must be cracked to be digested.

The night blooming cereus looks like a cluster of weather beaten sticks and is found close to trees and bushes; has a large, edible, beet-like root. Slice the root and fry. This root has a very high moisture content, and may be used as a water source.

Other edibles are the fruits of: the tomatillo or squawberry, a stiff thorny bush with small berries which are rather citric-tasting and much liked by birds: the hackberry, a small tree with tiny thick-growing roundish leaves and small red berries; Jojoba (the goatnut or wild hazel) is a smallish shrub, with thick-growing acorn-like nuts which were once a staple food of the Indians. In

less arid areas burdock, cattails, dandelions, dock, lambs-quarters, miner's lettuce, nettles (young), water cress are a few of the more desirable edible plants. Acorns (may be dangerous if eaten in large quantities) pinion nuts, pine kernels, red berries, and the young bark of aspen, cottonwood, pine and spruce are all edible.

Poisonous Plants: The identification of all poisonous plants in Arizona (there are more than 700 in the United States and Canada) is beyond the scope of this small manual. The reader is encouraged to study the matter further based on his degree of interest. There is no pattern of geography, habitat, relationship, seasonal appearance or plant part than can be used successfully to separate poisonous plants from the harmless ones. The poison principals contained are many, and effects (and treatment) varied. A few of those common and important in our Desert Southwest, regardless of their particular environment, are listed:

Cultivated Poisonous Plants Common to Inhabited Areas:

1. **Castor Plant:** A large plant with broad leaves, reddish, burr-like seed pods and vari-colored beans. All parts are toxic (but the oil of the beans is not).

2. **Oleander:** A common large woody hedge shrub with red, pink or white flowers. A single leaf can be lethal to a child. Meat skewered on Oleander branches can kill.

3. **Poinsettia:** The common Christmas plant with red leaves. Contains an acrid, burning, milky juice that may cause severe intestinal injury.

4. **Dumbcane, Caladium and Philodendron:** Decorative plants often seen in lobbies, offices, etc. Contain small needlelike crystals. Biting imbeds the crystals in the tissues of tongue and mouth resulting in intense burning and irritation which is not dangerous in itself. Swelling of tissue at the base of the tongue may cause death through suffocation.

5. **Lantana:** A common decorative shrub with small clusters of red and orange, yellow or lavender flowers and a minty odor. Much planted around shopping centers and commercial buildings. All parts are poisonous.

6. **Privet:** A common hedge plant. The berries, especially, are poisonous.

7. **Larkspur, Monkshood, Delphinium:** Cultivated or wild plants with spikes of attractive blue flowers and milky juice.

8. **Rhubarb:** A common vegetable, the leaf stalk of which is used as food. The leaf blade, however, contains a poisonous acid.

9. **Potatoes:** A close relative to the deadly nightshade. Healthy tubers are harmless, but there is some danger in sprouts, in rotting potatoes, in the green sunburned areas of potatoes grown at the surface of the ground, and in the vines.

Wild Poisonous Plants:

10. **Nightshade (Ground Cherry, Wild Potato, Horsenettle):** A low shrub resembling the potato plant. Has grayish leaves, purple flowers and yellow fruit which turn purple as they ripen. One species is yellow-flowered and fruit and plant are covered with spines giving it the name "Buffalo Bur".

11. **Sacred Datura (Jimson Weed or Thornapple):** Nightshade family. A coarse ground vine with smelly gray-green foliage and large trumpet-shaped white flowers. All parts are poisonous. Children have been poisoned by sucking the nectar from the flowers.

12. **Water Hemlock (Cow Bane):** Found in marshy areas and along stream banks. The base of the stem is swollen and several tuberous roots are attached to it. The fleshy roots have a pleasant taste but are extremely dangerous.

13. **Locowood or Milk Vetch:** Attractive low member of the pea family with colorful purple-white flowers and a disagreeable odor.

14. **Lupine or Bluebonnet:** Also a member of the pea family with blue-purple flowers.

15. **Milkweed:** A rush-like plant up to five feet in height with green-white flowers. Leaves are short-lived. In some species the milky sap contains much rubber. Grows on rocky slopes from sea level to 2,500 foot elevation.

16. **Coral Bean:** Medium-sized shrub recognized in early summer by its leafless branches and bright red flowers; in mid-summer by its small triangular leaves and in late summer and fall by the thick pods (6-10 inches long) with the bright red seeds. Usually found at elevations around 3,000 to 5,000 feet.

17. **Jatropha or Limber Bush:** A low shrub with heart-shaped leaf blades and flexible branches, found on rocky slopes at elevations of 2,000 - 3,000 feet. Sometimes called "Sangre de drago" because of the reddish sap in the roots. The seeds are laxative.

18. **Mushrooms:** Most are edible, but eat only those you can positively identify. Do not eat those which have these characteristics: a veil or fringe around the upper part of the stem; a bag or cup at the base of the stem; a white or green spore deposit which drops out of the gills; scales on the cap.

In a survival situation where use of strange plants for food is indicated, follow these rules: AVOID plants with milky sap. AVOID all red beans. If possible, boil plants which are questionable. Test a cooked plant by holding a small quantity in the mouth for a few moments. If the taste is disagreeable (very bitter, nauseating, burning) do not eat it.

FIRES AND COOKING

Clear an area about 15 feet across, dig a pit or arrange rocks to contain the fire. Make a starting fire of dry grass, small twigs, shavings, under-bark of cottonwoods, etc. Place larger twigs—about pencil size—on top. Have heavier material ready to add, using the smaller pieces first. Place them on the fire in a "tepee" fashion to prevent smothering your starting fire and aid in the formation of an up-draft. After the fire is burning well, continue to use the tepee method for boiling but criss-cross fuel for forming coals for frying or broiling.

Start your fire with a lighter, matches, or a hand lens. If you have time practice the art of making a fire using flint and steel. Remember, do not use up your water-proofed matches unless your return from the field is a guaranteed fact. Here are some hints for expeditious fire building:

Drying Matches: Damp wooden matches can be dried by stroking 20 to 30 times through the dry hair at the side of the head. Be careful to not knock off the chemical head of very wet matches at the start of the procedure.

Tinder: (all these must be **dry**) Under-bark of the cottonwood, cedar bark, dead golden rod tops, cattail floss, charred cloth, bird nests, mouse nests, or any readily flammable material shredded into fine fibers. Fine steel wool makes excellent tinder.

Fuzz-stick: Cut slivers into soft wood sticks so that they adhere to the stick. Arrange them tepee fashion, with the separated ends downward.

Quick, hot fires: Cottonwood, cactus skeletons, creosote-bush, aspen, tamarisk, cedar, pine, spruce, dried animal dung.

Long lasting fires: Mesquite, ironwood, black jack, sage, oak.

Flint and Steel: A practicable method if you practice. Strike steel against flint or agate, so that the sparks hit the tinder. Hold flint against tinder to catch spark, then carefully blow into flame.

Friction Methods: The Navajo hand drill and fire plough methods should be learned, but require proper materials and much practice. Material for Friction Method of Starting Fires: Yucca, cottonwood, tamarisk, cedar, willow, elm, fir.

Gun Powder: Remove bullets from two cartridges. Prepare a hole in the ground about 8 inches deep and 4 inches across. Place tinder in the hole and empty one cartridge case of powder into the tinder. Load the other case into rifle, being careful not to dump the powder out, hold the muzzle about 4 inches from the tinder, and fire the gun. The flame will ignite the powder in the

hole and the tinder. Have all your fuel ready to add. Do not use this method if your cartridges are limited, or you may have fire but go hungry. Do not attempt to start the fire without a suitable hole and tinder as the blast will blow away the material.

REMEMBER, YOU WANT FLAME FOR HEAT, EMBERS FOR COOKING, AND FOR SIGNALS YOU NEED SMOKE IN THE DAYTIME AND BRIGHT FIRE AT NIGHT. BE SURE TO EXTINGUISH YOUR FIRE BEFORE LEAVING IT.

Cooking: The methods of cooking over an open fire are many, the main limitations being available equipment, the available food, and the ability of the cook. All methods of cooking, boiling, frying, broiling, roasting and baking may be employed. The techniques are too lengthy to describe here. The many books on camping are full of suggestions, as are some of the pamphlets on use of aluminum foil. Foil affords as easy way of cooking. Wrap the prepared food inside, double fold the edges leaving some air space inside and place on coals. Meats, vegetables, fish, sandwiches, and other dishes may be cooked or heated in this manner. You can boil water or make soup in a cardboard, bark or other container of flammable material, provided you use a low fire and keep liquid inside of the container. The part of the container above the water line may burn if not kept moist.

POISONOUS CREATURES

There is probably more said and less truth about poisonous creatures than any other subject. These animals and insects are for the most part shy, or due to their nature not often seen. Therefore, any person who has the fortune or misfortune to become acquainted with them becomes an expert, and in due course, the stories told become distorted. Like gossip, the final tale seldom resembles the original fact. Learn the facts about these creatures and you will see that they are not to be feared but only respected. Visit the museums which have displays, dead or alive, of the creatures—avoid the roadside zoos with their sensational imports if you are looking for facts.

Snakes: There are many types of snakes in the southwest but only rattlesnakes and coral snakes are poisonous. (Side-winders are small rattlesnakes which get their name from the peculiar side-looping method used in moving over sandy areas.) Snakes hibernate during the colder months, but will start appearing with the warming trend, sometimes in early February. During the spring and fall months they may be found out in the daytime, but during the summer months they will generally be found out during the night, due to the fact that they cannot stand excessive heat.

Rattlesnakes: These are easily identified by the sandy color, the broad arrow-shaped head, blunt tipped-up nose, and rattles on the tail. Look for them mostly, where food, water, and pro-

tection are available—around abandoned structures, irrigation ditches, water holes, brush and rock piles. They do not always give warning by rattling, nor do they always strike if one is close. Usually they are not aggressive and will not "chase" people. They may attempt to escape from noise and commotion or they may remain quiet and hidden. Rattlesnakes strike by rapidly extending the neck and upper body loops for a distance of one-third to one-half the total length. The poison is injected through two curved hollow fangs which are hinged forward by the wide opening of the mouth. The strike results in immediate pain accompanied by swelling. The venom primarily causes local and internal destruction and nerve damage. Severe infection is a possibilty. About 99% of snake bites are in lower parts of the limbs. If traveling in areas where rattlers are, wear protective footgear and watch where you put your hands and feet. Improvised puttees of corrugated cardboard or thick newspapers underneath trousers provide effective leg protection.

Arizona Coral Snake: A small snake, rarely over 20 inches long with small blunt, black head and tapering tail. Wide red and black bands are separated by narrower yellow bands and all completely encircle the body. They are nocturnal and live under objects, in burrows, and are shy and timid. Corals bite and chew rather than strike, but due to the very small mouth and short (about 0.2 to 0.3 mm) fixed fangs, they are unable to bite any but the smallest extremities. Arizona Coral snakes will bite only under severe provocation. The venom affects the nervous system causing failure of the heart and respiratory muscles.

Treatment of Poisonous Snakebite: If bitten, try to capture the snake as identification will aid in specific medical treatment. GET A DOCTOR! Antivenin kits (Wyeth Corporation) are available. Keep a kit available for administration by your Doctor. In acute emergency Antivenin may be self-administered. If ice is available, use the Stahnke Ligature-Cryotherapy method as follows:

1. **KEEP THE VICTIM QUIET!** Immediately apply a ligature (constricting band) of strong string, shoe lace, or similar between the bite and the body, just above the punctures. Tighten only until first pain is felt. Place a piece of ice on the site. Instead of ice, Frigiderm or other spray refrigerant may be used. Do not spray directly on the skin. Cover the site with a thin wet cloth pad and spray with refrigerant to form ice. Re-spray as required to maintain an effective ice pack.

2. Prepare a suitable vessel of crushed ice and water, and submerge the entire limb to well above the site. USE NO SALT.

3. After about ten minutes remove the ligature. Keep the limb in ice water for at least two hours. Then,

4. Transfer the limb to a vessel of crushed ice (USE NO SALT) for a minimum of 24 hours. Several days treatment may be required for bites of larger snakes. Ice must not be permitted

to melt away from the body surfaces. If the bite is on the torso or at a point of attachment of limb to body, the entire limb and body area well above the point of attachment must be packed in ice.

5. Keep the patient comfortably warm during the first 24 hours. Then, until treatment is discontinued, keep the patient warm to the point of mild perspiration. This is important to prevent tissue deterioration. It is also very important that the patient's fluid intake be greatly increased during treatment.

6. Hypothermia, as this ice treatment is called, must be discontinued gradually. This is best done by again placing the member in ice water from which the ice has been removed, and permitting both to return gradually to room temperature.

Cut and Suck Method: Recent studies of the "cut and suck" method are showing that the technique is of doubtful value. Of about 6,000 persons bitten by poisonous snakes in the U.S. each year only about 12 die and many of the survivors had no first aid treatment whatsoever. So, if ice is not available, follow these simple instructions: **Keep the Victim Quiet!** Immediately apply a ligature as in Step 1 above. Bring the doctor to the patient.

If the "cut and suck" method is deemed necessary, follow the instructions with the snake bite kit or Red Cross Manual. In any event, Step 1 above, is very important. To prevent excessive damage to tissues, nerves, and blood vessels, make the longer, deeper cuts in the direction of the body tissue and the shorter cross incision at right angles. Depth of cuts will depend on the size of the snake and the area bitten. Do not hesitate to suck by mouth. Venom is not a stomach poison, and the amount one would absorb through sores in the mouth would be insignificant. To be effective, the incisions must be made immediately after the bite, and suction applied for an hour or more. C-S employed one-half hour after the bite has little if any value.

Gila Monster: Our only poisonous lizard; due to the small numbers it is protected by law. Seldom over 20 inches long, with a beaded black and coral colored skin. They move sluggishly but can swap ends and snap rapidly. The bite is poisonous (but the breath is not). The neurotoxic venom is carried from glands in the lower jaw by grooved teeth. The poison seems to be an anticoagulant and the wounds bleed freely accompanied by swelling. Death (extremely rare) results from heart and respiratory failure. If bitten, grab the Gila behind the head and yank off. The teeth are not set in sockets and come out readily. Use L-C treatment and call a doctor.

Poisonous Insects and Spiders: The potentially lethal species in this area are the small Rock or Bark Scorpion, the Black Widow Spider and the Honey Bee. The Recluse Spider bite results in serious ulceration. Bites or stings of other species may

be painful, but generally are not dangerous except that **GREAT HAZARD OF INFECTION EXISTS IN ALL CASES.**

Rock or Bark Scorpion: Small, very slim, light straw colored. The stinger in the tip of the "tail" injects a minute amount of powerful venom. Dangerous to small children, the elderly, and those with high blood pressure, heart or respiratory ailments. There will be pain at the site, numbness, restlessness, fever, fast pulse, and breathing difficulty. Healthy adults usually have little serious reaction.

Black Widow Spider: Shiny black with red hour glass marking on the abdomen. Found in the dark corners of sheds and outbuildings, under logs, and in rock piles. Will bite if provoked. Bite can be dangerous to all ages, but is seldom fatal. Pain spreads throughout the body, accompanied by headache, dizziness and nausea. Extremities become cramped, the abdomen becomes rigid, pupils dilate, and spasms may occur after several hours.

Honey Bees: Honey bee "stingers" are barbed at the tip and remain in the victim. The venom sacs are torn from the bee's body and remain attached to the stinger. Pinching the sac will inject additional venom. Therefore, do not try to pull out stingers but scrape them out with a knife or other thin edge. There are more deaths annually from honey bee stings than from all other poisonous creatures combined. Hypersensitive persons or those sensitized by previous stings (anaphylaxis) may have fatal reactions unless promptly treated medically. The application of ice to the site within minutes can prevent serious results. Inform your doctor of your honey bee sting history.

Recluse or Brown Spider: Rare in the desert. Light brown colored, about ½ inch in length, active at night, Easily identified by the violin-shaped marking on the "head" and back. The bite causes local reddening and swelling, and results in an ulcerous wound extremely difficult to heal.

Tarantula, Giant Hairy Scorpion, Desert Centipede: Not dangerous but may inflict a painful bite or sting. Tarantula may produce anaphylaxis. **Ants, Velvet Ants, Wasps, Hornets:** May cause a painful sting, usually not serious. Application of strong household ammonia, Mrs. Stewart's liquid household bluing, or ice is helpful in reducing pain. **Conenose Bugs:** Bloodsuckers may inject disease-producing organisms.

Vinegaroon, Solpugid, Jerusalem Cricket: Not only harmless but beneficial to man.

Prevention and Treatment: In places where venomous species are expected, carefully inspect all clothing and bedding before use, especially items that have been on or near the ground during the night. Dampness seems to attract these creatures. During summer evenings scorpions travel over the desert floor and up

the branches of trees and bushes looking for food. Bedding on the ground will provide them with a hiding place toward morning. If bitten (stung) apply a ligature and ice. DO NOT cut and suck. Remove the ligature after five minutes. Get to a doctor, especially if the victim is a child, is elderly, has a bad heart, or has been bitten several times or on the main part of the body.

QUICKSAND

Quicksand is a deposit of fine sand in combination with water. It may have the appearance of smooth dry sand, but the water underneath lubricates the grains and allows them to flow easily. There is nothing mysterious about quicksand—it acts as any thick liquid would, and if we react sensibly we can escape it. Man is lighter and will float in water, and therefore, quicksand. It has no power to suck down bodies, but frantic struggling to free the feet creates forceful downward movement which causes the sand first to move away, then quickly return to pack around the legs. The result is a firmer and deeper hold on the body. Further struggling repeats the process until the body is engulfed completely. If caught throw yourself flat on your back. You will float. Get rid of extra weight. Throw your gun and pack off quickly. Don't hold up your arms—let them rest spread out on the surface. Roll slowly to firm ground, or turn onto your stomach and do a slow breaststroke. Move slowly and carefully, and you will "swim" to safety. Avoid getting caught—look for quicksand in river beds, washes and run-off areas of recent flash floods.

RABIES (Hydrophobia)

Rabies is a disease of warm-blooded animals. Domestic dogs and cats, and many desert animals (coyotes, foxes, skunks, gophers, rats, bats) can transmit the disease to man by biting. If a person is bitten by any strange animal, it is important to capture and isolate it, if possible. The suspected animal must be kept in isolation for fourteen days unless death intervenes, in which case the undamaged head should be sent to the State Laboratory for examination. The victim should get to a doctor as soon as possible although start of treatment may be delayed for several days without danger. Untreated rabies infection is always fatal. A special warning in regard to bats: Do not pick up or handle bats as they are believed to be the most common carriers and transmitters of the disease.

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