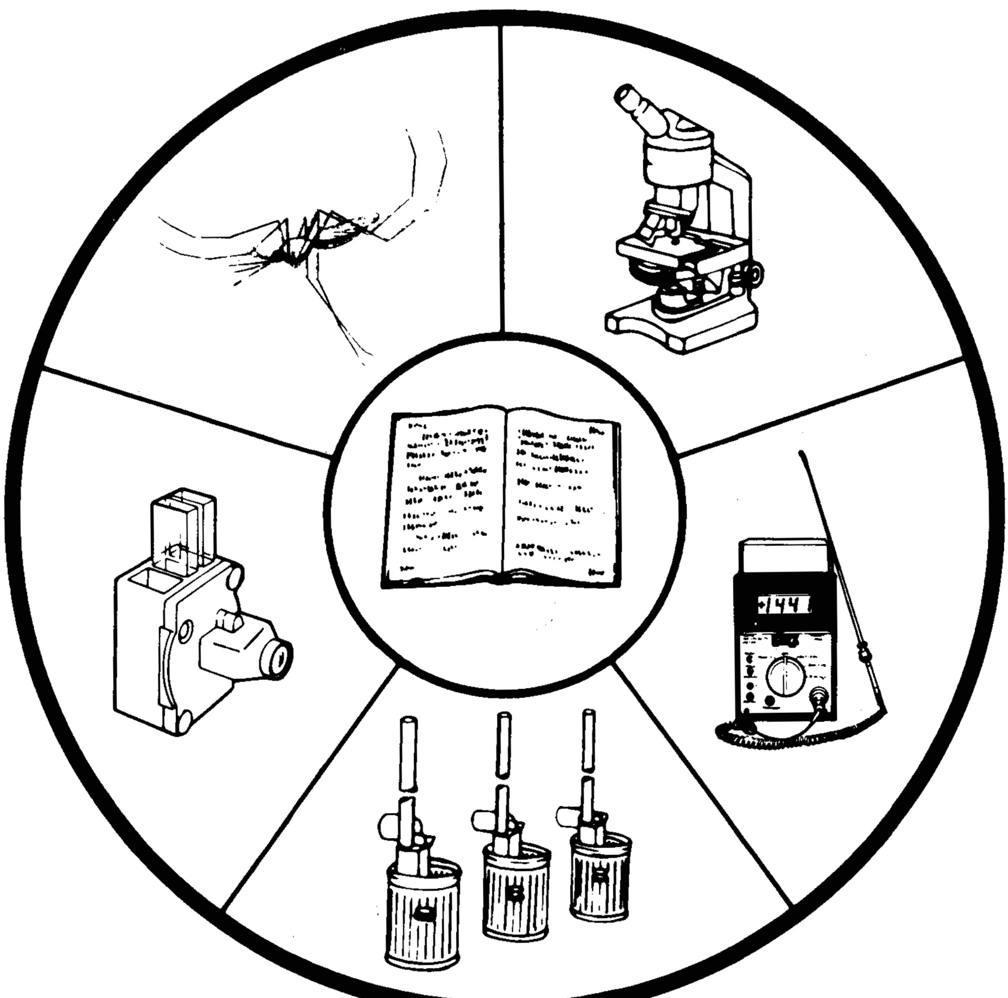
FM 8-250

FIELD MANUAL

PREVENTIVE MEDICINE SPECIALIST



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Preventive Medicine Specialist

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HEADQUARTERS
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PREVENTIVE MEDICINE SPECIALIST

PREFACE

Purpose and Scope

This manual is a reference handbook for the preventive medicine (Pvnt med) specialist (skill levels 1 through 5) engaged throughout the world in preventive medicine (PVNTMED) surveillance and control activities in combat zones, occupied areas, training situations, and installations. It provides guidance needed by these specialists to resolve routine problems encountered in the conduct of a preventive medicine program. This manual serves as the basic reference in the development of the Military Occupation Specialty (MOS) 91S skill qualification test and as the primary source to be employed by an individual in preparing for the test. It may be used as a textbook in formal courses of instruction and in on-the-job training programs for the Pvnt med specialist.

Users Comments

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Standardization Agreements

This manual is in consonance with the following International Standardization Agreements.

Title	NATO STANAG	QSTAG
Minimum Requirements of Water Potability for Short Term Issue..........	2136	
Minimum Requirements for Water Potability (Short and Long Term Use) Amendment No. 1.......		245

When used in this publication, "he," "him," "his," and "men," represent both the masculine and feminine gender unless otherwise stated.

*This publication supersedes TM 8-250, 31 July 1974.

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CHAPTER 1

PREVENTIVE MEDICINE PROGRAM AND ORGANIZATION

Section I. ORIENTATION TO THE PREVENTIVE MEDICINE PROGRAM

1-1. General

The mission of preventive medicine (PVNTMED), as well as the mission of the entire Army Medical Department (AMEDD), is to conserve the fighting strength of the Army. Generally stated, the PVNTMED mission is "to combat the medical threat to enable commanders to keep their troops well enough to fight and win." This mission is accomplished through the development and execution of a program of PVNTMED services directed towards the preservation of health and the prevention of disease and nonbattle injuries.

1-2. Preventive Medicine Program

a. The Army Preventive Medicine Program, as stated in AR 40-5, "is a comprehensive program, ranging from simple field sanitation procedures to extensive and complicated monitoring techniques necessary for the protection of health and environment of Army personnel. The program is designed to promote and maintain the fighting force at maximum effective strength and to maintain the physical well-being of all personnel for which the Army is responsible." Effective execution of this program can be the most profitable activity of a commander, as disease, nonbattle injury, or environmental factors can rapidly deplete a command's ability to complete its mission.

b. The commander's chief adviser in maintaining the health of his command is the surgeon/installation medical authority (IMA). The surgeon ensures effective services for both prevention and treatment of disease and nonbattle injury. Army Medical Department personnel, called the preventive medicine service (paragraph 1-3 through 1-9), serve as technical experts in the development and execution of the preventive medicine program.

c. An effective preventive medicine program is designed to meet the particular needs of a specific command. It includes courses of action that eliminate cause of possible problems. It is sufficiently flexible to permit immediate action to solve problems when they occur. Furthermore, it must be supported by the commissioned and noncommissioned officer and by each soldier. All officers and noncommissioned officers in the command must understand and apply the principles of preventive medicine. The support and cooperation of each individual in the command is as essential to the prevention of disease and nonbattle injury as is the timely application of scientific knowledge.

d. The coordinated efforts by all elements of a command can be broken into two areas:

- *Unit and Direct Preventive Medicine Support Services.* The responsibility for this area of the preventive medicine program is that of the commander. The commander at each level has personnel to assist him in carrying out this responsibility. The field sanitation teams at the company level and the organic medical personnel are engaged in carrying out the primary preventive medicine programs. This program includes training the individual soldiers in proper application of PVNTMED measures. Failure of the soldier to apply these measures can result in mission failure. When the commander and his organic medical personnel cannot accomplish a preventive medicine function, assistance must be requested.

- *General Preventive Medicine Support Services.* General preventive medicine support is those services which may require technical support normally beyond the capabilities of the unit or higher level commander. Primarily these services are provided by preventive medicine personnel (paragraph 1-3 through 1-12). General support may also include professional support from medical laboratories, veterinary, and dental units.

Section II. PREVENTIVE MEDICINE PERSONNEL

1-3. General

Preventive medicine personnel are a specialized group of people who work together in support of the commander. They are directly responsible for preservation of health through the prevention of disease and nonbattle injury. These personnel include preventive medicine officers, occupational medicine officers, sanitary engineers, entomologists, nuclear medical science officers, community health nurses, environmental science officers, preventive medicine specialists, health physics technicians, and other persons as the situation requires. These personnel functions are described in paragraph 1-4 through 1-11.

1-4. Preventive Medicine Officer, MC (SSI 60C)

The preventive medicine officer functions as the leader/medical advisor of the preventive medicine service. He supervises, coordinates, and evaluates the activities of the various branches of preventive medicine, including epidemiology, environmental engineering, environmental sanitation, tropical disease medicine, entomology, nutrition, industrial hygiene and occupational health, and health education. He formulates and recommends preventive medicine programs and courses of action designed to meet the needs revealed through survey and evaluation processes. He directs and evaluates the preventive medicine program as to its effectiveness in maintaining health physical fitness, prevention of disease and injury, and recommends actions to correct deficiencies. The preventive medicine officer maintains liaison with medical personnel of other military services, allied military forces, and civilian agencies. As a civil affairs health officer, he directs the civilian public health program for the area subject to military control and coordinates this program with the military program. He also advises military officials on public health matters.

1-5. Occupational Medicine Officer, MC (SSI 60D)

The occupational medicine officer functions in the planning, directing, and supervising of the DA Occupational Health Program (OHP) as it relates to both military and civilian employees. He is primarily responsible for determining the scope, policies, objectives, and specific goals of the OHP in accordance with regulatory and legal requirements and the particular needs and resources of the installation. To qualify for this position, the occupational medicine officer must be residency trained in occupational health either through the US Army Environmental Hygiene Agency two-year program or have acquired equivalent civilian certification, training, and experience.

1-6. Sanitary Engineer, MS (SSI 68P)

The sanitary engineer manages, supervises, advises on, or performs professional services in the environmental engineering aspects of the preventive medicine program. These aspects include water supply, wastewater and wastewater treatment, health aspects of design review, recreational facilities, waste disposal and industrial hygiene, and occupational health. The sanitary engineer reviews health engineering aspects of military construction and furnishes technical advice on design and construction factors which affect health. He inspects the operation of facilities which can affect health, reports deficiencies, and makes recommendations for correction. He also maintains liaison with representatives of civilian and government agencies concerning environmental pollution and other environmental engineering programs.

1-7. Entomologist, MS (SSI 68G)

This officer provides professional advice and services in fulfillment of the entomological aspects of the preventive medicine program. He plans, initiates, and supervises activities for control of animal reservoirs and vectors of disease. These activities include research, surveys, investigations, and training of preventive medicine specialists and other military personnel. He serves in a staff capacity in laboratories and preventive medicine units. He also maintains liaison with military services and other agencies regarding existing or potential entomological and related preventive medicine problems.

1-8. Community Health Nurse, AN (SSI 66B)

The community health nurse provides professional advice and services in the fulfillment of the health nursing aspects of the preventive medicine program. Under the supervision of the preventive medicine officer or another designated medical officer, the community health nurse plans and develops a community health nursing program which meets the needs of the military community. He works in close coordination with other officers of the Army Medical Department, explaining the health nursing needs and promoting the family-centered health service. He maintains liaison and works closely with personnel of the nursing department/service and other departments of the medical treatment facility as well as schools, community and social agencies, and accepting and making referrals as appropriate. This coordination of efforts provides continuity in medical care and other services which promote good health. The community health nurse assists in the prevention and control of communicable diseases; prevention of disease complications; improvements in maternal, infant, and child health; and prevention of problems which could be encountered with exceptional, retarded, and emotionally immature children. The community health nurse also maintains liaison with local civilian health and welfare agencies, coordinating the military and civilian programs which best benefit military families.

1-9. Environmental Science Officer, MS (SSI 68N)

This officer provides assistance to the preventive medicine program in areas of sanitary and public health sciences. He manages, supervises, advises on, or performs professional and scientific work in preventive medicine or industrial hygiene activities. These activities include inspections, investigations, and surveys to determine compliance with existing occupational and sanitation directives, regulations for living quarters, food service facilities, water and wastewater systems, refuse disposal facilities, bivouac areas, barber and beauty shops, and other installations or facilities used by military personnel. He also maintains liaison with representatives of civilian and governmental agencies concerning public health matters.

1-10. Nuclear Medical Science Officer, MS (SSI 68B)

The Nuclear Medical Science Officer (NMSO) provides health physics/radiation safety support to the AMEDD facility. Frequently the NMSO will be appointed the command Radiation Protection Officer (RPO). The RPO is responsible for monitoring all uses of radiation at the facility. He evaluates radiation exposure and contamination hazards, administers the Personnel Dosimetry Program, conducts radiation safety training, offers consultation to the staff on radiological health issues, and investigates suspected overexposures. The RPO acts as executive agent for any Nuclear Regulatory Commission licenses held by the facility, and ensures compliance with license conditions.

1-11. Preventive Medicine Specialist (MOS 91S)

The preventive medicine (Pvnt med) specialist as stated in AR 611-201 participates in all aspects of the preventive medicine programs. At small installations and separate organizations which are authorized limited preventive medicine services, they may assist the commander or IMA in the formulation, execution, and evaluation of the preventive medicine program, obtaining technical information as required. They also serve as technical specialists with the US Army Environmental Hygiene Agency, Army medical laboratories, preventive medicine detachments, Army area IMA sections, and other TOE and TDA organizations such as Military Assistant Advisor Group, Civil Affairs units, Special Operations, Medical Intelligence, and Civilian Action Teams. Specifically, the Pvnt med specialist performs the following functions:

a. The preventive medicine specialist conducts preventive medicine surveys and inspections of areas which may affect health to detect deviations from prescribed standards of sanitation; collects various types of samples and specimens and submits them to laboratories for processing; and reports discrepancies with recommended remedial actions. Areas of special concern include food service establishments, beauty and barber shops, swimming pools and beaches, living quarters, troop bivouac areas, mobile home areas, industrial operations water and wastewater systems, incinerators, and sanitary landfills.

b. The specialist conducts disease vector and reservoir surveys to determine actual and potential health hazards and collects data needed to evaluate the impact of these hazards on military operations. This data is also used in the selection of bivouac areas and field water sources. The specialist collects and identifies arthropods, rodents, and other animals of medical importance. As required, he establishes and maintains laboratory colonies of medically important arthropods and prepares and ships entomological specimens for study purposes. He plans, conducts, and evaluates methods and measures for the control of animal reservoirs and vectors of disease. These include the calculation, preparation, use and safe storage of insecticide and rodenticide formulations; the operation, maintenance, and minor repair of pest control equipment; and the conduct of tests for insecticide resistance.

c. He surveys conditions, collects and evaluates data, and makes recommendations pertaining to the health aspects of such areas as water points, field water treatment facilities, wastewater treatment facilities, field waste disposal devices and field shower points. He performs special procedures and techniques such as: determining chlorine content, physical and organic chemical characteristics, and bacteriological contamination of water or ice; determining Wet Bulb Globe Temperature (WBGT) indices; monitoring windchill and measuring man-made and natural environmental hazards.

d. He participates in other aspects of the preventive medicine program such as personal hygiene; immunization policies and procedures; prevention and control of sexually transmitted diseases; data-gathering for preventive medicine studies, research, and medical intelligence; investigates disease outbreaks and injuries; and inspects for the proper use of physical protective devices, including those used against x-ray. He also assists the community health nurse in family-centered health nursing programs.

e. He plans, prepares materials, conducts orientation and training for other preventive medicine specialists and field sanitation teams, and evaluates the training. He supervises other Pvnt med specialists, performing all personnel management functions of a supervisor. He also provides technical supervision for labor details engaged in environmental control operations.

f. Training for the Pvnt med specialist is conducted by the Preventive Medicine Division, Academy of Health Sciences, US Army, Fort Sam Houston, Texas 78234. The course is entitled The Preventive Medicine Specialists Course, 322-91S10.

1-12. Health Physics Specialist (MOS 91X)

The health physics specialist assists the NMSO/RPO in operating the radiation protection program. The health physics specialist conducts radiation health and safety surveys of nuclear medicine clinics and researches laboratories. He expends considerable effort in surveying diagnostic x-ray machines for compliance with federal and Army regulations, and in consulting with x-ray operators on quality control procedures. He collects, classifies, and packs radioactive waste for appropriate disposal. In the health physics laboratory he analyzes radioactive samples and maintains a quality control program for analytical equipment. He also assists the NMSO/RPO in radiation safety training and administration of the Personnel Dosimetry Program.

Section III. ORGANIZATIONS IN WHICH PREVENTIVE MEDICINE PERSONNEL FUNCTION

1-13. General

The composition of a preventive medicine service and the responsibilities of its members vary, depending upon the mission of the particular organization to which the service is assigned. The organizations in which a preventive medicine service functions may be under the command jurisdiction of the Commander, US Army Health Services Command (HSC); Commander, US Army Forces Command (FORSCOM); Commander, US Army Materiel Command (AMC); or the commander of other major United States Army commands.

1-14. Office of The Surgeon General

The Surgeon General (TSG) is responsible for the overall development of DA policy and programs for the Armywide Preventive Medicine Program (AR 40-5). The Preventive Medicine Consultants Division of TSG formulates policies, standards, regulations, and directives to conserve, improve effectiveness, and enhance the environment of Army personnel and their families.

1-15. Organization Under the US Army Health Services Command

a. General.

(1) The Commander, US Army Health Services Command (HSC), commands the CONUS medical treatment facilities and services. This command encompasses the bulk of the AMEDD troop strength within the United States. Its headquarters is located at Fort Sam Houston, Texas.

(2) The HSC resources are divided into eight health service regions (Figure 1-1). Each region is further divided into two or more health service areas (HSA). An HSA is a geographical area for which a single US Army Medical Department Activity (MEDDAC), or Army Medical Center (MEDCEN), has the responsibility of furnishing designated health care support to authorized personnel. Included in the support are preventive medicine services.

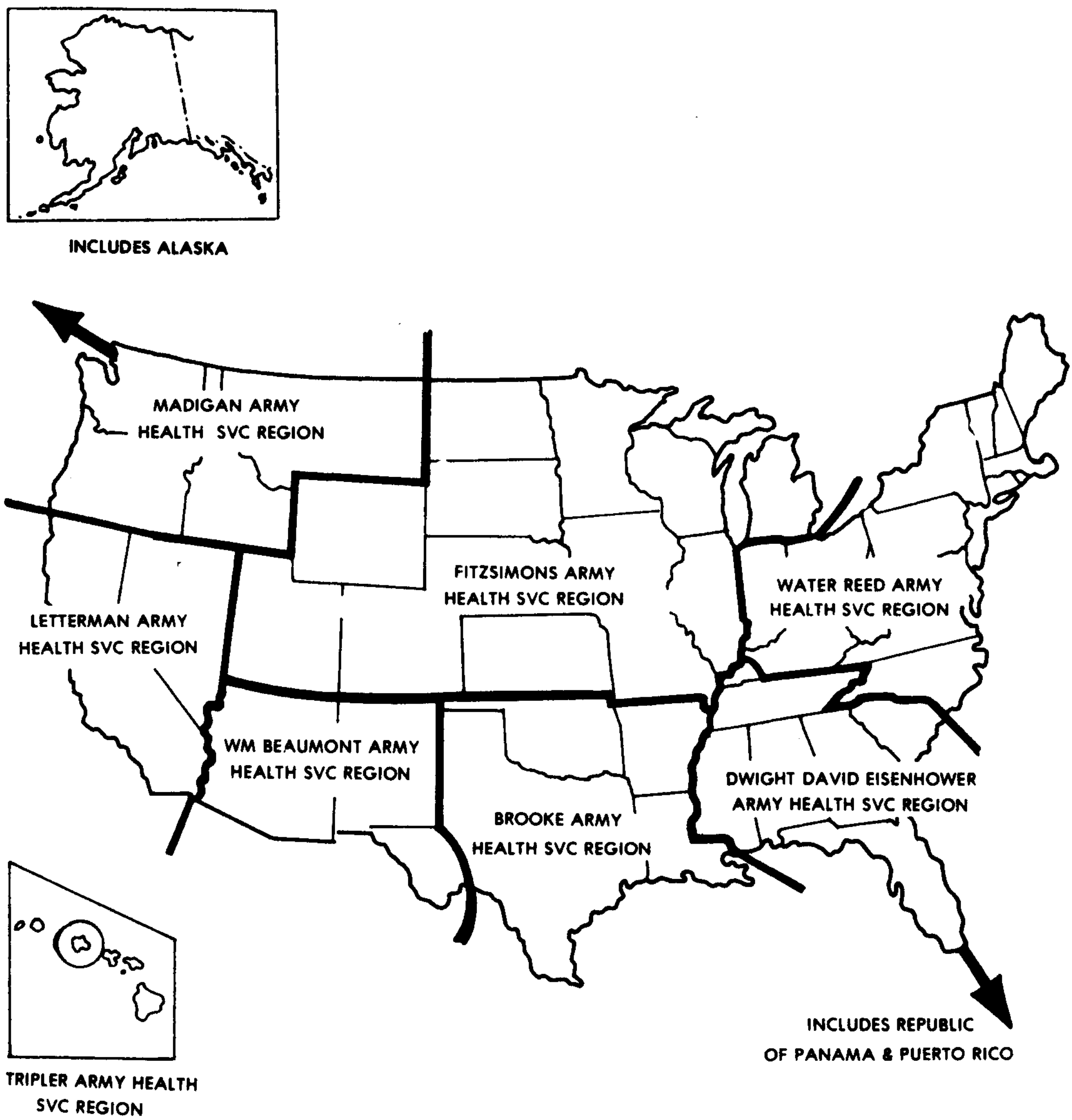


Figure 1-1. HSC support regions.

b. United States Army Environmental Hygiene Agency.

(1) The mission of the United States Army Environmental Hygiene Agency (USAEHA) is to support the Army preventive medicine program through services, investigations, and training in environmental hygiene to include sanitary engineering, medical entomology, industrial hygiene and occupational health, and radiological hygiene (AR 40-4).

(2) The services of USAEHA are available worldwide to Army commands, installations, and activities by request through command channels to HQDA (DASG-PSP), Washington, DC 20310. The regional divisions of USAEHA are authorized to communicate directly with the Commander, USAEHA, on technical matters related to PVNTMED.

c. *Installation Medical Authority.* Each installation has a medical officer designated as the installation medical authority (IMA). If a hospital is located on the installation to provide medical support, the hospital commander also serves as the installation surgeon. At installations where a medical center or medical activity (TDA) or a numbered general hospital (TOE) is located thereon or immediately adjacent thereto, the center or hospital commander serves as the IMA. At other installations not having a hospital located thereon, the senior physician serves as the IMA. The preventive medicine service normally operates under the IMA. In the preventive medicine service, preventive medicine specialists are used to the fullest extent within CONUS. At the installation level all aspects of preventive medicine can be applied in the prevention of disease and nonbattle injury and the preservation of health.

(1) The preventive medicine officer, as chief of the preventive medicine service, is a Medical Corps officer selected by the IMA. Generally, the preventive medicine officer will be a specialist in preventive medicine (residency trained) or will be a graduate of a preventive medicine short course conducted at the Academy of Health Sciences, United States Army. At posts where residency training programs are conducted for medical officers specializing in preventive medicine (SSI 60C or 60D), the preventive medicine officer will be a senior officer with considerable experience in the field. Also, a sanitary engineer or environmental science officer and a community health nurse may also be assigned to his staff.

(2) The preventive medicine officer and other officer personnel direct the functions of the preventive medicine service. The rank of the preventive medicine NCOIC will depend upon the number of Pvnt med specialists supervised or the level of organization to which he is assigned; the number of specialists assigned depends, in turn, upon the work load/task of PVNTMED service. However, regardless of his rank, the effectiveness with which the NCO accomplishes his responsibilities has a far-reaching effect upon the health of the command. Most preventive medicine functions at the installation level to be accomplished in the implementation of the preventive medicine program are within the realm of the NCO's responsibility.

(a) The NCO supervises and coordinates the activities of all assigned Pvnt med specialists in implementing the many aspects of the preventive medicine program. He provides on-the-job training (OJT) programs for preventive medicine specialists, as well as other training as needed to maintain the technical competence of all assigned personnel. He also participates in the installation training program, providing instructional material and instruction for developing a field sanitation team and for teaching troops environmental sanitation and personal hygiene.

(b) The NCO maintains close coordination with other installation personnel engaged in the promotion of health, such as those responsible for food service, insect and rodent control, and safety. He also maintains liaison with local public health authorities in accomplishing those functions directed toward the promotion and preservation of health in both the military and civilian communities.

(c) The NCO reviews and edits reports rendered by subordinates and recommends actions to correct health hazards. He assembles data and drafts reports, such as those submitted to the command and the Army Medical Department. He tabulates and computes incidence rates for disease and nonbattle injury and prepares and maintains statistical charts required by AR 40-418. He maintains a current inventory of occupational hazards and measures for their control. To accomplish his many responsibilities effectively, the NCO must carefully plan and schedule the preventive medicine operations.

1-16. Units Within Combat Zone

a. The Corps commander within the combat zone has a senior medical commander designated as the surgeon (special staff officer). He has access to the Corps commander on matters affecting the health of the command and medical aspects of combat effectiveness. The preventive medicine officer on the surgeon's staff develops, prepares, and coordinates the combat zone preventive medicine program.

b. The preventive medicine role is to reduce noneffectiveness resulting from disease and nonbattle injury. Timely accomplishment of this mission is paramount in the field where combat effectiveness means success in battle. The preventive medicine staff planner at this level anticipates preventive medicine problem areas and recommends programs which assure minimal impact of health problems on combat operations. The current and valid information required by the planner must be provided by personnel specifically trained in gathering and evaluating such information. Such personnel are found in the preventive medicine teams (TOE's 8-600 and 8-620) assigned to the medical brigade which is a part of the corps support command (COSCOM). The assigned preventive medicine teams are the only corps resources applied full time to preventive medicine activities. They, therefore, constitute the principal resources for supporting preventive medicine in the combat zone.

c. There are six types of preventive medicine teams. The AM team, headquarters, preventive medicine detachment, is part of TOE 8-600. The other five teams are a part of TOE 8-620. The LA team, entomology service detachment is commanded by an entomologist, has its own administrative and vehicle support elements. The LB team, environmental sanitation detachment, is commanded by an environmental science officer and is assigned to a command on the basis of one team per division. The LC team, environmental engineering service detachment, is commanded by a sanitary engineer. The LD team, epidemiology service detachment, is commanded by a preventive medicine officer, MD. The LE team, entomology laboratory detachment, is capable of providing entomological laboratory support, such as arthropod identification to between one and three LA teams. The AM, LA, LB, LC, and LD teams each have their own professional and transportation capabilities. These teams are designed to support an independent task force.

1-17. Units in Support of Theater of Operations

a. A theater of operations is composed of a combat zone and a communications zone operated by the Theater Army (TA). The medical component of TA is the Medical Command (MEDCOM). The assigned AM, LA, LB, LC, LD, and LE preventive medicine teams are the sole resources within the communications zone for full-time preventive medicine activities. They, therefore, constitute the principal resources for PVNTMED support.

b. The preventive medicine teams are organized and operated similarly to the teams in the combat zone. However, the teams support the area support commands into which the communications zone is divided instead of the corps support command areas.

CHAPTER 2

INTRODUCTION TO MEDICAL STATISTICS AND PATIENT RATE COMPUTATIONS

2-1. General

As used in military medicine, the term rate is a numerical expression of the number of times a particular event occurs in a specified population during a given period of time. Types of rates determined are admission rates, mortality rates, incidence rates (specific diseases), prevalence rates, medical noneffective rates, and case fatality rates. Through the use of rates, it is possible to make direct, ready, and meaningful comparisons of events related to different time periods and/or different populations.

2-2. Formula

a. The following formula is used to calculate a rate.

$$\frac{x}{y} \times k$$

Where:

x = number of times an event has occurred during a specific period of time.

y = number of persons exposed to the risk of the event during the same interval.

k = some round number, such as 100; 1,000; 10,000; or 100,000; or base, depending upon the relative magnitude of x and y.

2-3. Rates

a. Admission. Admissions represent a general class of which there are many subclasses. Thus, in terms of the reason for admission to medical treatment, the rates may be based only on admissions due to (1) disease (disease admission rate), (2) nonbattle injury, (3) the combination of disease and nonbattle injury (all nonbattle causes admission rate), (4) battle injury and wound, or (5) a combination of all the foregoing causes (all causes admission rate). Similarly, an admission rate maybe computed for the admissions due to a particular cause such as some specific disease.

b. Mortality. The mortality, or death, rate differs from the admission rate only in that the event which it measures is the number of deaths, rather than the number of patient admissions. Since the magnitude of the frequencies is less, a large standard unit of population *k* is used (10,000 or 100,000) more frequently than in the case of admission rates. The standard time period will usually be a year.

c. Incidence. In an incidence rate, the event which is counted is the occurrence of a disease in a population free of the disease during a specific time span. The frequency of incidence here may differ from the frequency of admission due to this same disease since some cases so diagnosed may come from patients whose admission to a MTF is due to some other condition.

d. Prevalence. Prevalence rates measure the number of cases of a specified disease among a designated population at a particular time. They express the number of such cases per standard unit of population, usually per 1,000. They differ from the rates previously discussed in that the events so related are not occurring *over a period of time* but rather the number of cases *at one time*. In actual practice, all of the observations on which a prevalence rate is based will sometimes not be made at one time or on the same day. The following formula is used in calculating the prevalence rate per 1,000.

$$\text{prevalence rate} = \frac{f \times k}{y}$$

where:

- f = The number of cases of the specified kind.
- y = the observed strength or population.
- k = The standard population (1,000).

e. Medical noneffective. The noneffective rate, a measure very frequently used in military medicine, may be regarded as a special case of the prevalence rate discussed in above subparagraph. This rate measures the prevalence of noneffectiveness with noneffectiveness being defined as "excused from duty for medical reasons." This rate does not generally include time off for clinic visits and days off, other than hospitalization, for illness.

(1) The noneffective rate may be computed for all patients excused from duty for all causes, or it may be computed for particular groups such as all cases excused from duty due to disease (disease noneffective rate).

(2) The noneffective rate may be computed by using the same formula as shown for computing the prevalence rate but where *f* stands for the number of persons noneffective in the particular group being studied.

(3) An alternate method of computation is frequently used. It is based on the number of noneffectives on the average day during a particular period rather than on a count of the number of noneffectives as of one particular day.

(a) When the number of days lost in the period is used rather than the number of patients on the average day of the period, the following formula will be used.

$$\text{Noneffective rate} = \frac{\text{days lost} \times 1{,}000}{\text{days in the period} \times \text{average strength}}$$

(b) The following relationship is another method to determine the noneffective rate.

Noneffective rate = daily admission rate x average days per patient

f. *Case fatality.* The case fatality rate is also called the case fatality ratio. It is a measure of mortality for a particular disease, injury, condition, or group of conditions. It shows the relationship of the number of deaths due to a particular cause to the number of cases of that particular condition among which the deaths occurred. This rate is ordinarily expressed as a percentage, that is, the number of deaths per 100 such cases.

(1) The following formula is used in calculating the case fatality rate.

$$\text{case fatality rate} = \frac{f \times k}{c}$$

where:

- c = The number of cases of the kind studied.
- f = The number of these cases that resulted in death.
- k = The standard population (100).

(2) Case fatality rates may be computed for groups of conditions in the same manner as for specific diseases. One such frequently used measure is the case fatality rate for wounded- or injured-in-action cases. This measure indicates the chances of survival among those casualties who reach medical treatment.

2-4. Statistical Data Sources

The frequency (f) and strength (S) data required in computing rates are obtained from regulated reports.

a. Frequency data are obtained from the Medical Summary Report (DA Form 2789-R).

b. Strength data are obtained from —

(1) SIDPER C-61 Report (Daily Strength Summary).

(2) SIDPER C-27 Zero Balance Reports.

(3) SIDPER PO-1, Personnel Transaction Register by unit.

2-5. Graphic Presentation of Statistical Data

Statistical data may be presented in various graphic forms for purposes of analysis, such as in tables and in line, bar, or circle graphs.

a. Table. A table (Figure 2-1) is used primarily to present an orderly arrangement of raw data for comparison purposes.

(1) *Title.* The title of the table contains the nature of the data (WHAT), the geographical location (WHERE), and the period covered (WHEN).

(2) *Boxhead.* The type of information to be entered in each column is clearly identified in a boxhead below the title.

(3) *Stub.* Each horizontal line (row) is clearly identified in the stub which is actually the first column.

(4) *Body.* The columns in which the information is entered are the body of the table.

(5) *Totals.* If totals are known, the column totals are placed at the bottom or top and the row totals are placed at the extreme right.

(6) *Footnotes.* Footnotes are placed at the bottom of the table to identify the source of data and to explain entries in the table.

Title:

NUMBER AND PERCENTAGE OF STUDENT DROPOUTS

Preventive Medicine Field Exercises, FY 1985 [1]

Boxhead / Stub / Body:

Field Exercises	Number of Dropouts [2]	Percentage of Dropouts [2]
1	20	20%
2	18	15%
3	30	17%
4	25	25%
5	20	20%
6	5	8%

Footnotes:

1 PVNTMED Div, Fort Salado, Texas

2 From all causes

Figure 2-1. Statistics presented in a table.

b. Line Graph. A line graph (Figure 2-2) is used to show the trend of a series of observations.

(1) *Title.* The title placed above the graph contains the WHAT, WHERE, and WHEN (paragraph 2-4*a*(1) above).

(2) *Scales and captions.* The left side (vertical) and bottom (horizontal) of the graph paper are labeled and scaled to indicate the meaning of the data and the size of the variations. The horizontal scale is called the X-axis, and the vertical scale is called the Y-axis.

(3) *Body.* The data as indicated by the captions are plotted on the graph paper with dots at the points where the vertical and horizontal lines cross; these dots are connected by straight lines.

(4) *Legend.* When several types of data are plotted with lines of different colors or designs, the meaning of each color or design is explained in a legend placed at the bottom of the graph.

(5) *Footnote.* The source of the data is provided in a footnote placed at the bottom of the graph.

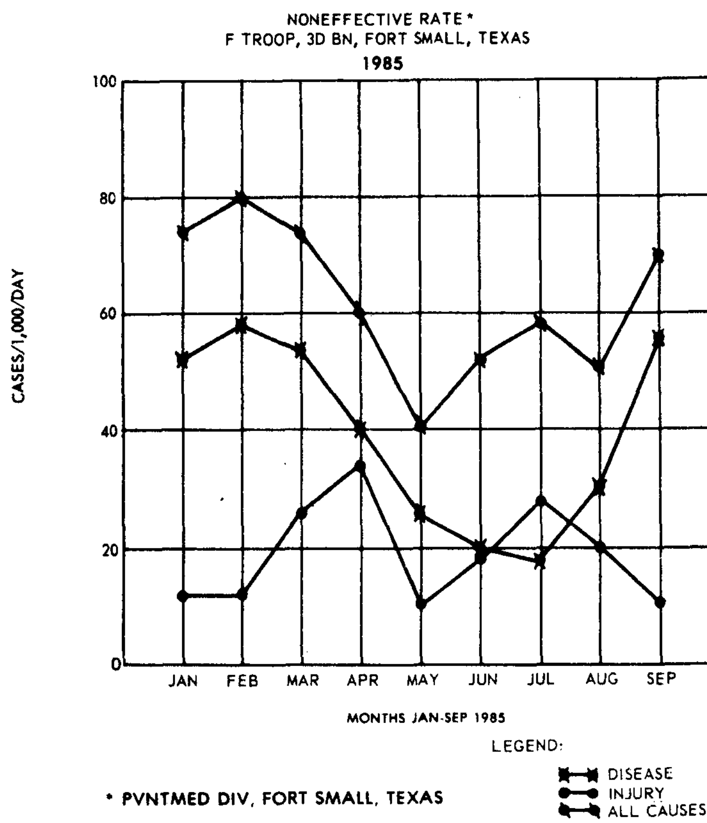


Figure 2-2. Line graph.

c. Bar Graph. A bar graph (Figure 2-3) is used to show comparisons of magnitude in a series of related events.

(1) *Title.* The title placed above the graph contains the WHAT, WHERE, and WHEN (paragraph 2-4a(1) above).

(2) *Scales and captions.* The left side (vertical) and bottom (horizontal) of the graph paper are labeled and scaled to indicate the meaning of the data and the size of variations.

(3) *Body.* The data as indicated by the captions are shown with bars. All bars are the same width and distance apart. They may be drawn on the graph paper horizontally or vertically.

(4) *Legend.* When bars are subdivided by color or design to indicate additional data, the meaning of each color or design is explained in a legend placed at the bottom of the graph.

(5) *Footnote.* The source of the data is provided in a footnote placed at the bottom of the graph.

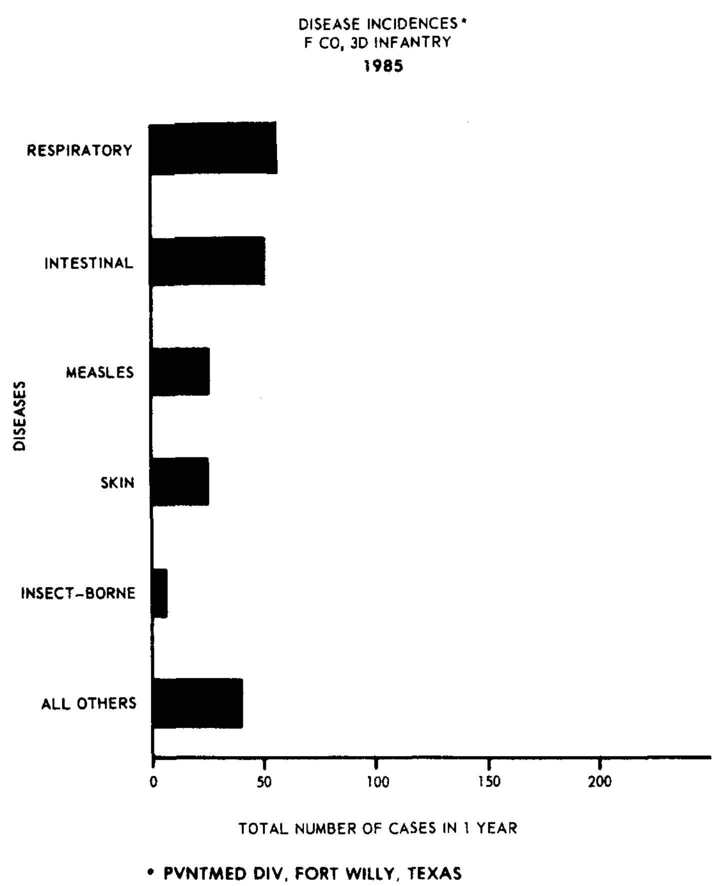


Figure 2-3. Bar graph.

d. *Circle Graph.* A circle graph (Figure 2-4) which shows comparisons is designed primarily for general display purposes.

(1) *Title.* The title at the top of the graph contains the WHAT, WHERE, and WHEN (paragraph 2-4a(1) above).

(2) *Circle.* The circle represents 100 percent or 360°. One percent equals 3.6 degrees (360° ÷ 100 = 3.6°). The circle is divided into sections (degrees) of proportionate sizes to represent the data expressed in percentages. Each section is then labeled to show what it represents and the percentage of the circle it represents. These captions are recorded horizontally so they can be read easily. If the captions cannot be placed within the sections of the circle, they are placed outside the circle with arrows pointing to the appropriate sections. Colors and designs explained in a legend may also be used to identify the sections.

(3) *Footnote.* The source of the data is provided in a footnote placed below the circle.

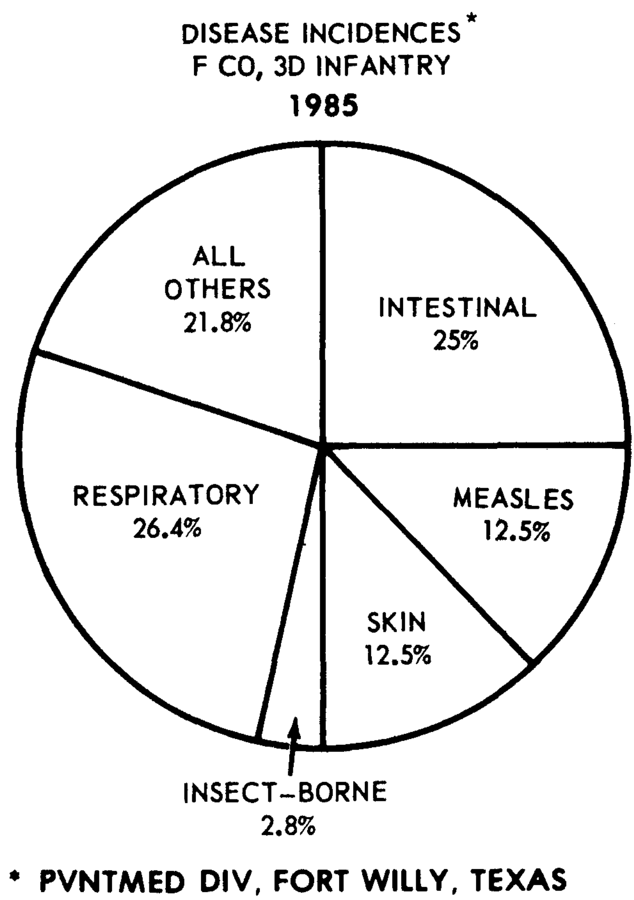


Figure 2-4. Circle graph.

PERCENTAGES CONVERTED TO DEGREES:

DISEASE	DATA (CASES)	PERCENTAGE OF TOTAL	DEGREES
INTESTINAL	50	25.0%	90°
MEASLES	24	12.5%	45°
SKIN	24	12.5%	45°
INSECT-BORNE	6	2.8%	10°
RESPIRATORY	53	26.4%	95°
ALL OTHERS	43	21.8%	75°
TOTAL	200	100.0%	360°

Figure 2-4. Circle graph, continued

CHAPTER 3

REPORTS

3-1. General

Preparing and forwarding reports is an activity that the Pvnt med specialist is involved with, no matter where he is stationed. In many instances, the Pvnt med specialist is responsible for only the collection of data. These data are then evaluated by the IMA/PVNTMED officer and his staff; reports, based on the evaluation, are prepared and forwarded by the IMA/PVNTMED officer. In many instances, however, the specialist is required to collect and evaluate data, then prepare reports for the signature of the IMA/PVNTMED officer. The specialist must be able to assist in the preparation of several recurring reports, but most of his work in regard to reports is preparing and forwarding various environmental sanitation reports.

3-2. Command Health Report

a. General. The Command Health Report is one of the most important reports submitted by the Army Medical Department (AR 40-5). Preparing and submitting the report is a responsibility of the IMA. Because of his many other responsibilities, he often delegates preparation of the report to the preventive medicine officer on his staff. The preventive medicine officer, also burdened with many responsibilities, must depend upon members of his team, both officer and enlisted, to gather and evaluate data and prepare the report. If the report meets the approval of the preventive medicine officer, he presents it to the IMA for his approval and signature.

b. Purpose and Scope. The purpose of the Command Health Report is to periodically report on matters and activities relating to the prevention of disease and the preservation of health. Installation and unit reports are designed to:

(1) Inform commanders of health conditions within their commands and recommend measures to improve them.

(2) Provide commanders with an opportunity to record actions taken to improve conditions, to conserve manpower, and to inform higher headquarters of support required to implement recommendations.

(3) Serve as feeder reports for the preparation of consolidated command health reports.

(4) Provide information on unsolved problems, new developments, and other matters relating to health effectiveness of the command.

(5) Provide information for the assessment of the preventive medicine program in maintaining a high level of health within the command.

c. Preparing Agencies. Reports for units and installations having assigned IMAs are prepared and signed by the IMA and addressed to the commander of the unit or installation to which the IMA is assigned. Reports for installations without assigned IMAs are prepared by the IMA rendering primary medical services and addressed to the commander of the supported installation. IMAs providing primary medical services to separate units having no assigned IMA prepare the unit Command Health Report and address it to the next higher command of the supported unit. Installations or activities located at civilian facilities not under Army control, such as separate recruiting offices, Military Entrance Processing Stations, ROTC units, off-post Class II activities, and government-owned contractor-operated installations, are not required to submit command health reports.

d. Form and Frequency of Report. This report is prepared in narrative form as described in AR 40-5. Unit and installation IMA/surgeons prepare their command health reports as of the last day of each calendar month. Consolidated reports for major Army commands and Army components of unified commands are prepared as of the last day of each calendar quarter.

e. Command Action and Routing. The Command Health Report is dispatched in time to meet the due date for feeder reports of the consolidated report. The report is addressed to the commander of the unit to which the IMA is assigned. The commander then endorses the report, as originally submitted by the IMA, through command channels, noting approval or disapproval and actions taken to improve conditions and to correct reported deficiencies. Commanders of major Army commands and Army components of unified commands establish the internal routing and consolidation of the command health reports within their command. Each echelon of command screens incoming reports and uses the data contained in them as a basis for comments to be submitted to the next higher command. Commanders of installations and activities forward the original of the report through command channels to The Surgeon General and provide an action copy through appropriate channels to the Commanding General, Military District of Washington, or other appropriate Army commander exercising supervision over the medical resources of the installation or activity. Isolated oversea activities with an assigned IMA and under direct control of a DA agency route the original report to the major oversea commander, who provides technical medical support and furnishes a copy to the DA agency exercising command jurisdiction.

f. Consolidated Reports. The IMA of each major Army command and Army component of unified commands prepares and dispatches a quarterly Consolidated Command Health Report through the major commander to The Surgeon General not later than 30 working days following the end of the report period. This report is based on information obtained from original and information copies of reports received from units or installations, inspections, or other sources within the command, but it is not a compilation or consolidation of detailed material contained in these reports. The report is narrative in nature and contains information on unsolved problems, new developments, or other subjects concerned with the health of the command.

g. Preparation Instructions. Designated headings listed in AR 40-5 are used in preparation of the Command Health Report. Included are statements pertaining to such current preventive medicine and sanitary matters as the IMA deems worthy of reporting, stating the nature of the conditions and other data pertinent to a clear understanding of the subject. Outstanding accomplishments, new developments, and progress, as well as adverse or unsatisfactory conditions, are recorded. If unsatisfactory conditions are reported, corrective measures must be recommended. The report is not intended to convey routine or repetitious information regarding satisfactory conditions. Any item under the suggested list of headings in AR 40-5 which is deemed satisfactory, or where adequate corrective action is being accomplished, need not be reported unless the information is controversial in nature or of sufficient importance to warrant transmission to higher authority. If no comment is required under a particular heading, the heading is omitted; negative comments are not required. The headings listed in AR 40-5 which provide uniformity in reporting must be used. Detailed instructions for preparation of the report are contained in AR 40-5, and no person should attempt to prepare the report unless a copy of this regulation is readily available as a guide.

h. Special Command Health Notification. These reports deal with special situations and are submitted by the IMA in written form as the necessity arises. Their purpose is to place immediately before the commander information regarding serious sanitary defects, environmental hazards, actual or potential epidemic conditions, or other serious situations which may affect the health of the command. Appropriate recommendations are made. These reports are forwarded to the commander of the unit to which the IMA is assigned, and information copies are forwarded to HQDA (DASG-PSP), Washington, DC 20310-2300 or Cdr, HSC, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000, as appropriate.

3-3. Army Medical Department Activities Report

a. General. Normally, the preventive medicine specialist is involved in the preparation of this report only to the extent of collecting data to be included in the preventive medicine section of the report dealing with significant factors affecting the health of the command. He collects data on subjects, including incidence, epidemiology, and control of infectious diseases; environmental hygiene; occupational health service and nutrition; community health nursing programs and activities; and, where indicated, medical and health problems of the civilian or allied military population in the area.

b. Purpose. The Army Medical Department Activities Report (AR 40-226) provides the Department of the Army with annual reports of administrative, professional, and operational activities of the Army Medical Department.

3-4. Army Occupational Health Report

a. General. The Pvnt med specialist is involved in the preparation of this report only to the extent of collecting data to be included in certain sections of the report.

b. Purpose and Scope. This report provides essential information to enable The Surgeon General to discharge his staff responsibilities for planning, directing, and supervising health services in the occupational health program for the Department of the Army as required by AR 10-5.

c. Preparing Agencies. Each Army medical treatment facility located in the United States (including Alaska, Hawaii, and Puerto Rico) that is responsible for providing occupational health services to federal civilian employees prepare this report. Oversea commands in other areas are exempt but may establish a reporting system compatible with their needs.

d. Report Forms, Frequency, and Reporting Period. Reports are prepared on DA Form 3076. The report is prepared semiannually for the periods January through June, and July through December.

e. Routing, Due Dates, and Copies. Individual facility reports are submitted to The Surgeon General through the MEDDAC or hospital to which assigned. A copy of reports pertaining to AMC installations is forwarded through command channels to the Surgeon, AMC. Commanders establish necessary due dates for individual reports in order to dispatch reports in duplicate to The Surgeon General not later than the 17th working day following the end of the report period. An information copy of this report is provided to USAEHA and other major commands as directed by SOP.

f. Review by Major Commanders. Facility reports are reviewed at major commands. Specific recommendations, comments, or supplementary information concerning installation occupational health activities are contained in the letter of transmittal to The Surgeon General.

g. Preparation Instructions. The report is completed by the medical officer or civilian physician-in-charge. If there is no medical officer or civilian physician, the senior nurse prepares the report. Complete detailed instructions for preparation of the report are contained in AR 40-5, and a copy of this regulation should be readily available to persons engaged in preparation of this report.

3-5. Preventive Medicine Survey and Inspection Reports

a. General. The Pvnt med specialist is required to conduct PVNTMED inspections and surveys; and prepare reports with recommendations. Normally, he will spend more time preparing PVNTMED reports than all other types of reports.

b. The Preventive Medicine Survey. A PVNTMED survey uses both administrative and technical procedures to acquire data to assist in the determination of potential health threats or hazards for a specific area of operations. The survey normally lists recommendations to eliminate the threat or hazard. Examples of preventive medicine surveys may include the areas of: industrial hygiene; environmental stress; and medical entomology.

c. The Preventive Medicine Inspection. A PVNTMED inspection is an examination much like the PVNTMED survey. It uses the survey techniques to acquire data on a specific area and also may provide recommendations for corrective actions. Its main difference from the standard survey is that it is used primarily to determine compliance with prescribed sanitation standards. Examples of areas to be inspected may include: troop and family living quarters; food handling establishments; and water facilities and supplies.

d. Types of Preventive Medicine Inspections/Surveys. Preventive medicine inspections/surveys are normally performed as either general or limited inspections/surveys.

(1) *General.* The General Sanitary Survey is broad in scope and is conducted to determine the nature of potential health hazards in a geographic area, on a whole military installation, in a foreign country, or in the civilian environment surrounding an existing or proposed military installation.

(2) *Limited.* The Limited Sanitary Survey is conducted to evaluate specific, usually single insanitary, unhealthful, or potentially dangerous conditions. The limited sanitary survey is, by far, the type that the preventive medicine specialist most often conducts. Conducting limited sanitary surveys the most productive method for discovering defects in environmental sanitation and for evaluating the potential effects of adverse environmental sanitation on the health and welfare of military personnel.

e. Preparation of Reports (Sequence of Events). In conducting environmental sanitation inspections, preparing and forwarding reports, a very definite sequence must be followed. First, the inspection must be conducted to collect data; second, data must be evaluated to determine what is wrong and what should be done about it; and finally, an accurate, valid report is prepared and forwarded.

f. Types of Reports. Many formats are used, ranging from long, military letters to short, simple checklists.

(1) *Military Letter Report.* The military letter report is acceptable in most commands. It is prepared on ordinary bond paper. Sufficient copies are prepared to furnish the original and one courtesy copy to the unit or facility inspected and one copy to each headquarters in the chain of command through which it is forwarded. The format and preparation instructions for the military letter are contained in AR 340-15.

(2) *Checklist.* The checklist is the most common format used, and is favored by many inspectors as a timesaving expedient that ensures a comprehensive look at all major areas of concern. It normally includes an outline format of all major areas requiring inspection, allows for comments and finally identifies whether the inspected facility passed or failed.

g. Content of Reports. In addition all reports should contain the letterhead, office symbol, date, subject, and address, the title of the facility or unit inspected/surveyed; the name and grade of the inspector and what headquarters the inspector represents; the date the inspection was conducted; a list of the deficiencies noted; a list of recommendations for corrective action for the listed deficiencies; and the authorized signature.

h. Deficiencies, Recommendations, and Comments. All major deficiencies noted during the inspection should be listed in the report. Reporting minor deficiencies, for which "on-the-spot" recommendations for correction were made, is usually governed by local or command policy. A recommendation must be submitted for the correction of each reported deficiency. Provide a reference source to an official publication for each recommendation submitted. Above all, recommendations must be sensible, and valid. Comments may be used for various purposes, such as mentioning minor deficiencies where "on-the-spot" corrections were made; giving praise to personnel for maintaining outstanding sanitary standards; and commending personnel on outstanding accomplishments.

CHAPTER 4

GENERAL PREVENTION AND CONTROL OF DISEASES

Section I. IMMUNIZATIONS AND IMMUNOLOGY

4-1. General

One of the keystones for communicable disease control is the use of immunizations. Immunizations change an individual who is susceptible to a certain disease into one who is relatively nonsusceptible. The use of immunizations has spared many people serious illness and death as a result of diseases, such as smallpox, polio, typhoid, tetanus, and diphtheria.

a. The Pvnt med specialist may be called upon to survey immunization programs in dispensaries, hospitals, or clinics to ensure the correctness of procedures used. The quality of the Army immunization program is ensured by continual surveillance.

b. Many subject areas must be considered to evaluate an immunization program. Why are immunizations given? How do they protect the individual from disease? What are the hazards and complications of immunizations? How do you decide which immunizations are required for an individual? What are the important techniques which must be checked? What are the important immunization records? These are some of the areas that will be discussed in this section.

c. The body's defense against infectious disease can be divided into two major types: nonspecific and specific. The nonspecific barriers operate against all the infectious agents indiscriminately. Specific barriers act only upon certain disease-causing agents. The study of the specific methods of disease protection is called immunology.

4-2. Nonspecific Barriers

There are three nonspecific barriers against disease. The first is the *skin and mucous membranes*. The intact healthy skin is an excellent barrier against the entrance of disease-causing agents into the body. The mucous membranes of the nose and respiratory tract are sticky and thus trap some inhaled bacteria and viruses. Those bacteria, viruses, and other infectious agents caught in the mucous of the nose are swept back into the throat, swallowed, and then destroyed by the acid in the stomach. The second nonspecific barrier is the *white blood cells*. These cells circulate in the blood stream and engulf, digest, and destroy any infectious agents they encounter. The third barrier is the *reticuloendothelial system*. This refers to cells found inside lymph nodes, the liver, and the spleen which can engulf and destroy disease-causing agents brought to them by the bloodstream. These three barriers react to all disease challenges. It makes no difference if the threat is the smallpox virus, the plague bacillus, or the cholera bacillus.

4-3. Specific Barriers (Immunology)

Immunity includes all those specific factors by which the individual protects himself against specific communicable diseases. This protection usually involves chemical substances called antibodies. Antibody production is stimulated by disease-causing agents or by vaccines. Antibodies are specific for one disease only. Hence, typhoid antibodies work only against the typhoid bacillus and not against the cholera bacillus.

4-4. Immunity

Inherited immunity is resistance transmitted from parents through the germ cells. It is poorly understood. It has nothing to do with antibodies and is the explanation given for differences in disease susceptibilities among different animals. For example, birds are *not* susceptible to human tuberculosis, and humans are not susceptible to bird tuberculosis. *Acquired immunity* is of more practical concern.

a. Classification of Acquired Immunity. The immunity (the antibodies) we acquire during our lifetime is of two major types — the actively acquired and the passively acquired. Actively acquired immunity refers to antibodies made by the individual himself. It is much superior to passively acquired immunity.

(1) There are two kinds of *actively acquired immunity.*

(a) The first is *naturally acquired active immunity* and refers to the immunity which naturally develops upon recovery from many communicable diseases. For example, recovery from chickenpox usually provides the patient with a lifelong naturally acquired active immunity. Almost all of the infectious agents can stimulate antibody production which will continue for months, years, or even the person's lifetime.

(b) It is for serious infectious diseases that we attempt to provide an *artifically acquired active immunity*. This is done in the laboratory by killing or weakening the disease-causing agent, so that it will still stimulate immunity but can no longer cause the disease. Artificially acquired active immunity is very important, since it is the type of immunity an immunization program hopes to attain.

(2) For *passively acquired immunity*, the individual receives antibodies manufactured by another man or animal. A passively acquired immunity can occur in two ways.

(a) The infant passively receives antibodies in a natural way from its mother. This occurs through the bloodstream while the baby is still in the womb, and after birth, by antibodies contained in breast milk. Like all passive antibodies, these last for a few months only. This is all that is needed, however, since at about 3 months of age, the infant can actively make its own antibodies.

(b) It is possible to artificially transfer antibodies. Blood is drawn from individuals or animals known to have antibodies for a certain disease, for example, rabies. These rabies antibodies are then separated from the donor blood and injected into the patient with needle and syringe.

b. Antigen. An antigen is a foreign substance which stimulates the body to produce specific antibodies. From this discussion, it is evident that there are good and bad antigens. The bad antigen is the disease-causing agent which stimulates antibodies, but may also cause disease or death. The good antigens are changed infectious disease agents which we use as immunizing agents. Antigens stimulate the production of *specific* protective antibodies. Thus, the plague antigen (vaccine) stimulates the body to produce only plague antibodies.

c. Antibody. An antibody is a chemical substance produced by the body which reacts specifically with the antigen that stimulated its production and destroys the antigen. The desired chain of events is as follows: the susceptible individual is injected with the plague vaccine (antigen); his body is stimulated to make plague antibodies; at some later date the plague bacillus enters his body, is attacked by the plague antibody, and is destroyed.

d. Immunizing Antigens. The antigens used to produce an artificial active acquired immunity are of three types:

(1) *Live vaccines.* Live vaccines produce the best and longest lasting immunity. The commonly used vaccines in this category are smallpox, yellow fever, measles, and polio. These viruses are attenuated (weakened) in the laboratory so they do not produce disease but do stimulate antibody production.

(2) *Killed vaccines.* Many vaccines are composed of killed organisms because there is no known way of producing a safe live vaccine. The killed vaccines do not produce as good or as long-lasting an immunity, thus boosters are required more frequently. Examples are the typhoid, influenza, plague, and cholera vaccines.

(3) *Toxoids.* For some infectious disease agents, it is not the organism itself which is harmful but a poison, or toxin, which it produces. The toxin is altered in the laboratory to remove its poisonous properties (but not its antigenic properties), and the resultant toxoid is used as an immunizing agent. The two commonly used vaccines which are toxoids are tetanus and diphtheria. They are often combined.

4-5. Basic Series and Boosters

a. In general, the immunizing schedule for a certain vaccine calls for a basic series and then boosters at scheduled intervals. Regardless of the details, the principles are the same. The antibody response to active artificial immunization with tetanus toxoid is shown in Figure 4-1.

(1) The first dose is 0.5 cc of the antigen, tetanus toxoid, given subcutaneously. The second injection is given at least 4 weeks later. As seen on the curve, the antibody level after just one injection is very low. Antibody production is poor initially because of the body's inefficiency. The body must first recognize the presence of the foreign substance (antigen), and then some of the body's white blood cells must begin to make antibodies against the foreign substance. Experiments have shown that time is crucial. The body must have time to begin antibody production. This is why immunization schedules specifically state a *minimum time interval* between injections in the basic series. Thus, for tetanus toxoid, 4 weeks after receiving the first dose, or

later, a second injection of 0.5 cc is given, again subcutaneously. As seen in Figure 4-1, this time the body is more efficient and produces a greater amount of antibody in a shorter time. The amount of antibody produced is still not enough to provide long-term protection against tetanus toxin; however, these first two shots have stimulated and sensitized the body to the antigen and established the body's antibody production for tetanus toxoid. These first two shots are called the basic series.

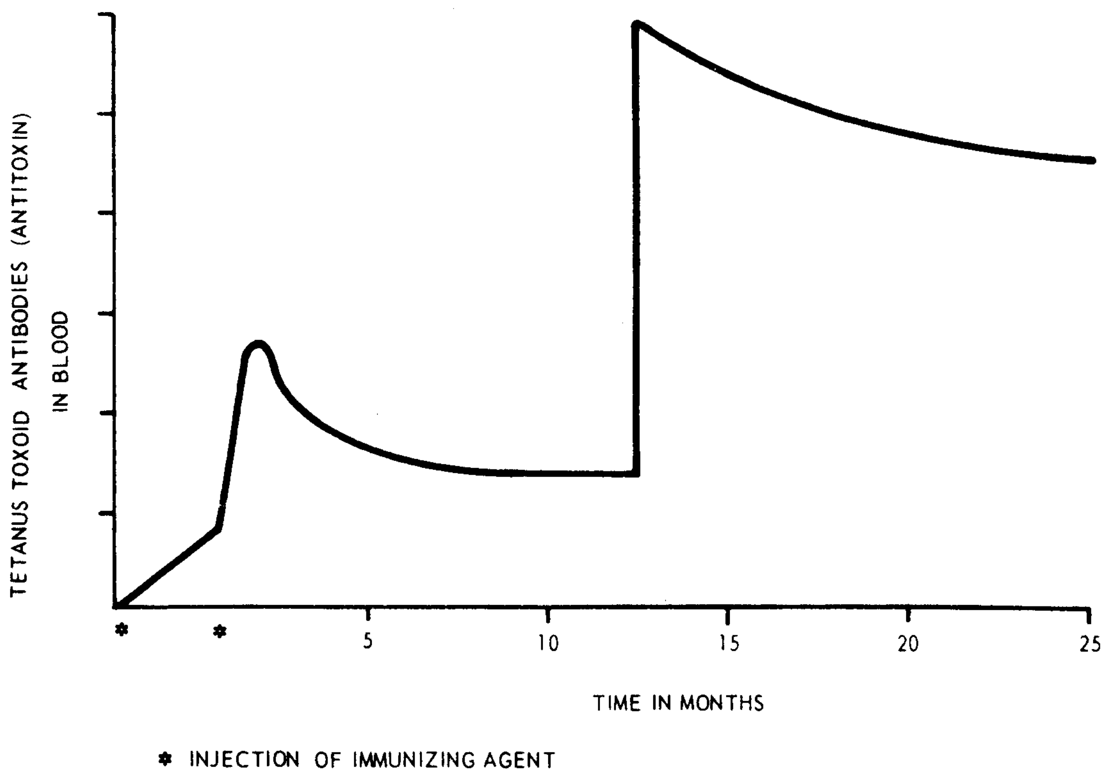


Figure 4-1. Antibody response to active artificial immunization with tetanus toxoid.

(2) At a specific time after the basic series (1 year for tetanus toxoid) the booster dose is given. As seen in the curve, the antibody response is immediate and massive. Following the peak of a booster reaction, the antibody level gradually falls off over a period of many years. In the case of tetanus immunization, exposure to the toxoid (antigen) any time during the next 10 to 20 years will result in a booster reaction. To ensure a good booster response, active duty personnel receive boosters every 10 years.

(3) The curve for tetanus toxoid immunization illustrates the advantage of an active artificially acquired immunity. The individual who has completed the basic series can receive nearly immediate protection by the administration of a booster. In contrast, what happens to tetanus toxoid anti-

bodies (antitoxin) produced in another human when given to a patient? As seen by the line in Figure 4-2, these antibodies disappear very rapidly. They do *not* act as antigens (stimulators of antibodies) for the disease organism or toxin. Passive immunization provides protection for a short time only. For long-term protection an individual must be stimulated to make his own antibodies (active immunization). Antibody from a horse or other animal source is foreign to the body and serves as an antigen. The body produces antihorse antibodies and rapidly destroys the animal antibody. Thus this passive protection lasts for 2 to 3 weeks only.

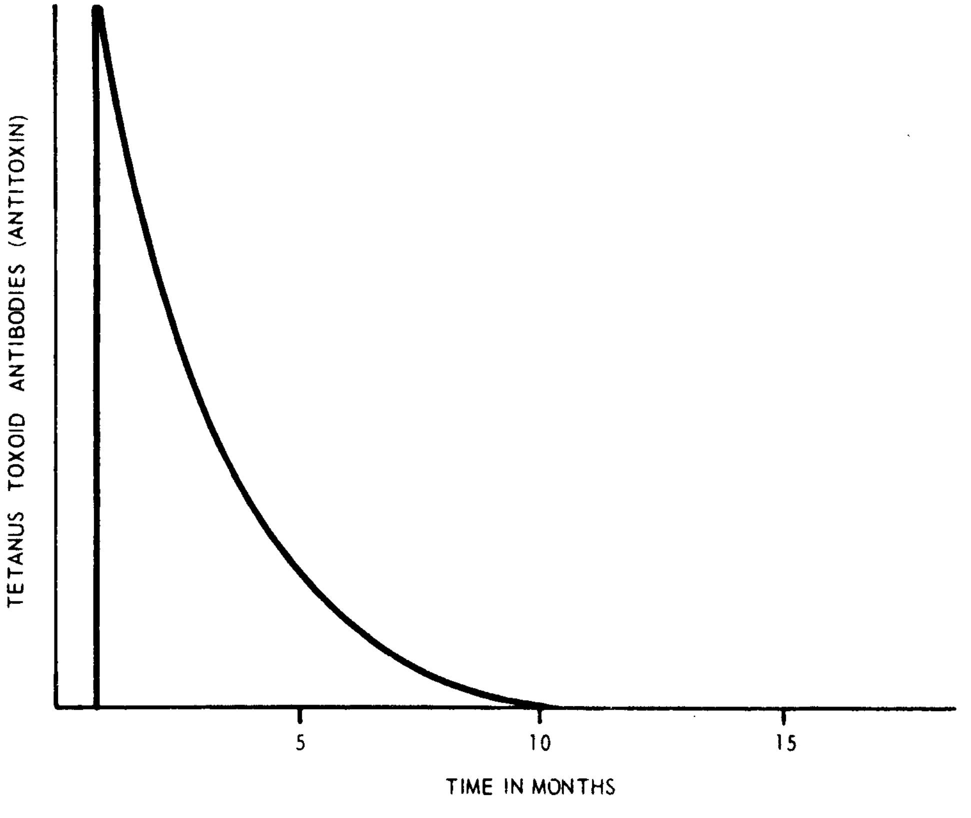


Figure 4-2. Antibody response to passive artificial immunization with tetanus antitoxin.

4-6. Immunization Complications

Every effort must be made to keep the complications of immunization at a minimum. Complications can be grouped into the following three categories.

a. Constitutional (Systemic) Reactions are common complications of immunizations. They include such things as a general feeling of being ill, low grade fever and generalized muscle aches and pains developed after immunizations. A very important type of systemic illness is sometimes seen in the fetus of a pregnant woman when the vaccine involved contains a live, attenuated virus. This illness can be severe. For that reason pregnant females should not receive any live virus vaccine, such as smallpox, yellow fever, measles, or rubella. (Polio vaccine may be given during pregnancy.) If females of child-bearing age are to be immunized, they should be asked about pregnancy before receiving any immunizations.

b. Local Reactions are another common complication of immunizations. These occur at the site of vaccine injection and may be manifested as localized pain, infection, or cyst formation.

c. Allergic Reactions are perhaps the most important complication of immunizations because they can be life-threatening. Severe allergic reactions resulting from immunizations only occur approximately once in every 200,000 injections; however, every effort must be made to keep allergic reactions to a minimum due to their potential severity. This is best done by getting a history of allergies prior to immunization of an individual.

4-7. Prevention of Allergic Reactions

There are several precautions which must be observed whenever immunizations are administered.

a. Allergic History. Every individual is asked about a prior history of allergy to eggs, chicken feathers, or horse serum, or to previous immunizations. A history of allergy to the influenza or yellow fever vaccine is specifically asked. These two vaccines are important because they are the commonly used egg-containing vaccines. In general, the egg-containing vaccines produce the most frequent and most severe allergic reactions. There are other egg-containing vaccines, such as those for measles and Rocky Mountain spotted fever, but these are rarely used for active duty personnel. It is possible to be allergic to the nonegg-containing vaccines, but such allergies are rare. In the event of a definite, or even possible, allergic history, under no circumstances is the vaccine to be administered. The individual is referred to the nearest hospital where allergy tests can be made.

b. Immunization Records. Immunization reactions are to be recorded on SF 601 (Immunization Record), which is kept in the individual's medical folder and on PHS Form 731. These records could supply confirmatory information regarding a previous reaction.

c. Availability of Physician. A physician should be available to those administering immunizations. Whether or not a physician is physically present is established by a local regulation. If a physician is not actually present, he should be at a specific place known to those giving the immunizations and should be available to provide medical care for any reaction which may occur.

d. Observation Period. Individuals who have received immunizations should be kept under the observation of dispensary personnel for at least 10 minutes after injection, and will be no more than 4 or 5 minutes transportation time away from the area during the first 30 minutes after inoculation. Severe reactions may not develop for 15 to 20 minutes after injection.

e. Anaphylactic Tray. Whenever immunizations are given, an emergency anaphylactic tray with at least a tourniquet and a syringe containing 0.5 cc of 1:1000 aqueous epinephrine will be available and ready for immediate use.

4-8. Care and Administration of Vaccines

a. General.

(1) To ensure an effective immunization, a potent vaccine must be used. This material must be given in the proper dosage; the interval between doses must be that which has been found to be most effective by research; and the injection of the material must be accomplished in the proper manner.

(2) All vaccines procured through Army channels must meet rigid specifications and are procured from recognized facilities which maintain high standards in their production. These biologicals must be stored as stated on the package in order to ensure their continued potency.

b. Storage.

(1) Vaccines containing live attenuated organisms, such as yellow fever and oral polio vaccine, must be kept in the freezing compartment of the refrigerator. The temperature must be below freezing. These materials must be kept at this temperature until ready for use.

(2) Yellow fever vaccine remains potent for only 1 hour after thawing. Any vaccine remaining after that time must be discarded.

(3) Oral polio vaccine may be stored at refrigeration temperatures between 35.6° to 46°F (2° to 8°C) for 7 days. It should not be used beyond the 7-day period following thawing or dilution.

(4) Smallpox freeze-dried vaccine should be kept in the coolest available storage space (not freezing). Reconstituted dried vaccine may be kept up to 1 week if stored under normal refrigeration.

(5) All other vaccines are stored at temperatures 35.6° to 46°F (2° to 8°C).

c. Care of Refrigerator. Proper care must be taken of the refrigeration unit to maintain these temperatures. If there is an inch of ice covering the freezing compartment, adequate temperature is not being maintained. The refrigerator must also be cleaned routinely and the material in it arranged in an orderly manner. This refrigerator must not be used for the storage of lunches or snacks.

d. Outdated Vaccines. The supply of vaccines must be checked routinely for outdated materials. The manufacturer has stamped each container with an expiration date. All outdated materials must be removed and disposed of according to instructions from medical supply personnel.

e. Sterilization.

(1) All syringes and needles used must be sterile. The sterilization method of choice for reusable syringes and needles is autoclaving for a 30-minute period under 15 pounds of pressure. Sterilization by boiling will be used only under unusual circumstances where it is impossible to autoclave. When the boiling method is used, each item will be covered with water and boiled for a minimum of 30 minutes. If above sea level the boiling time will be increased 5 minutes for each 1,000 feet in elevation. Needles and syringes must be thoroughly cleaned, making use of stylets, applicators, and detergent solutions, and rinsed thoroughly before they are sterilized.

(2) Another factor which must be considered in the immunization procedure is cleaning the area in which the injection is to be given. The area must be cleaned to remove any material that might enter the injection site and cause an infection. If noticeably dirty, the area should first be cleaned with soap and water and dried thoroughly.

(3) When giving injectable immunizations, the injection site is cleaned with an antiseptic such as alcohol. For smallpox vaccinations, an antiseptic such as ether or acetone must be used. These antiseptics dry quickly. The site *must be* thoroughly dry before applying the smallpox vaccine because of the danger of inactivating the vaccine virus and preventing an effective vaccination.

(4) The rubber stopper of the vial must also be cleaned with alcohol before each withdrawal to avoid contaminating the needle and the material in the vial. Before drawing the immunizing material from the vials, all vials should be shaken vigorously. Some biologicals have material in them that settles out, and, if the vial is not shaken, the potency of the injection may vary from dose to dose.

f. Dosage. Before injecting the immunizing agent the individual giving immunizations, must be positive that he is giving the correct biological in the correct dosage. This necessitates checking the name on the vial and the dosage before withdrawing the material from the vial, again after withdrawing it, and before injecting the material. Correct dosage and the correct interval between injections must be verified. Instructions for the dosage and the schedule of injections for both adults and children are outlined in AR 40-562. The label on the vaccine vial also gives dosage and intervals of vaccination.

g. Method of Administering Vaccines.

(1) *Smallpox.* For smallpox vaccinations, the multiple pressure method is used. The deltoid region of the arm is the usual site. Following preparation of the site, one drop of the reconstituted dried vaccine is expressed on the selected site so as to form one droplet. The needle is held parallel to the skin and the point pressed rapidly through the droplet about 30 times within 5 seconds within an area no greater than 1/8 inch across. Pressure applied in this manner provides optimal depth of penetration. The motion should be perpendicular to the skin and the needle is lifted clear of the skin with each stroke. A properly performed vaccination should not be deep enough to result in bleeding. No dressing should be applied to the vaccinated area. The smallpox vaccination must be read between the seventh and ninth day. An area of active

inflammation (redness) surrounding a central lesion (blister or crust) should be present. All personnel showing little or no reaction should be revaccinated.

(2) *Polio virus vaccine.* Oral poliovirus vaccine will be given in distilled unchlorinated water, in simple syrup, on a sugar cube, or by medicine dropper.

(3) *Other vaccines.* Other vaccines are administered in the prescribed dosage either subcutaneously or intramuscularly. A separate syringe and needle must be used for each injection given. This means not only a separate one for every individual, but a separate one for every vaccine.

(4) *Mixing immunizing agents.* Immunizing agents will not be mixed by the user. Only those which are mixed by the manufacturer are authorized to be used.

(5) *Jet injector device.* The jet injector, when properly used is a safe and effective way of administering large numbers of immunizations very rapidly.

(a) The jet injector has no needles. It is essentially a small hydraulic pump which produces a small stream of immunizing fluid with a velocity of 2800 ft/sec. The immunizing fluid makes a small hole in the skin and then spreads out in the subcutaneous tissue. Generally, the gun is used only for subcutaneous injections, although a special experimental head for intracutaneous smallpox vaccination and tuberculin skin testing has been developed.

(b) Bleeding at the site of skin puncture is uncommon. If bleeding occurs frequently, it is likely that the technique of administration is faulty. A common error is the failure of the operator to have a firm seal or steady pressure of the gun against the patient's skin. A loose seal allows the immunizing fluid to spread out and hence make a larger hole in the patient's skin with a resultant increased likelihood of bleeding. Moving the gun before the injection is completed may lacerate the skin. To avoid this, the operator should count to three after pulling the trigger before moving the gun.

4-9. Army Immunization Program

The Army Immunization Program is established by AR 40-562. Its prime purpose is to prevent disease that might interfere with accomplishment of the military mission.

a. Routine Immunizations. The immunizations required for military personnel (active duty and reserves) and nonmilitary personnel (dependents and civilian employees of the federal government) are outlined in AR 40-562. The requirements vary depending on the assignment of the individual.

b. Special Immunizations. Special immunizations may be required in addition to the routine series. These situations are the geographic area of assignment, the requirements of a specific theater surgeon, and an occupational risk. In determining the immunization requirements of an individual or a group, one first determines the necessary routine immunizations and then decides if any of the special requirements apply.

(1) Outside the United States, Canada, and Greenland certain routine immunizations require more frequent boosters, and additional vaccines may be required. These depend on the endemic disease problems and the requirements of the host country.

(2) Theater surgeons may recommend additional immunizations within their spheres of responsibility if indicated by a particular disease pattern.

(3) Occupational exposure to rabies is a hazard to veterinarians and dog handlers. Because of this risk, it is usually recommended that these personnel receive pre-exposure rabies vaccination.

c. *Exemptions and Waivers.*

(1) *Exemptions* to required immunizations are usually permanent and are always made for medical reasons. For example, if a man has an anaphylactic allergic reaction after receiving a certain immunization, he is made permanently exempt from any future requirements to receive that vaccine. In rare cases, this can interfere with international travel and may place assignment limitations on the individual. Those unable to receive the yellow fever vaccine currently cannot be assigned to areas of the world where yellow fever is known to exist. As mentioned above, pregnant females are given temporary medical exemptions for smallpox, yellow fever, and measles vaccines, if they are required.

(2) *Waivers* are an excuse from immunization requirements for administrative reasons. The usual reason for a temporary waiver is a short tour (less than 30 days) under conditions which make exposure unlikely. The senior command surgeon may grant administrative waivers for required immunizations in such a case, provided none of the waived immunizations are required by the World Health Organization (yellow fever, and cholera). The usual reason for a permanent waiver is religious objections to injection of vaccines into the body. This can only be granted by the Office of The Surgeon General of the Army and is subject to revocation.

d. *Records of Immunization.*

(1) At the time of initial immunization of a person entering military service, SF 601 and PHS Form 731 are initiated. These forms are official Department of Defense records and have corresponding validity.

(2) PHS Form 731 is retained by the individual and is carried by him when traveling overseas. Data may be entered by hand, rubber stamp, or typewriter. The day, month, and year will be entered in the order named. Entries for smallpox, cholera, and yellow fever must be authenticated by the actual signature of the medical officer. Entries for smallpox must cite type of vaccine (liquid or freeze-dried), manufacturer, and lot number. Immunizations other than smallpox, cholera, and yellow fever may be authenticated by initialing.

Section II. CHEMOPROPHYLAXIS

4-10. General

Chemoprophylaxis is defined as the use of drugs in the prevention of disease.

4-11. Malaria Chemoprophylaxis

In malarious areas throughout the world, certain chemoprophylactic drugs are taken in order to suppress the development of malaria. Command emphasis is the key if malaria chemoprophylaxis is to be effective. The pills are usually given by platoon roster under the supervision of an officer or NCO. Malaria chemoprophylaxis, if used correctly, can reduce the incidence of malaria dramatically. Chemoprophylactic drugs are usually continued for varying periods of time after leaving the endemic area. The dosage schedule is dependent on which drug is employed.

4-12. Meningococcal Meningitis

In World War II, during the type A meningococcal meningitis outbreaks, sulfa drugs were widely used as prophylactic treatment of contacts and carriers of the disease. It was effective in removing the reservoir of the infection and halting these outbreaks. Since 1963 most of the outbreaks in military recruits have been caused by type B and C meningococcus, many strains of which are resistant to sulfa drugs (sulfadiazine). The emergence of these resistant strains has limited the use of sulfa prophylaxis. Rifampin, another antibiotic, is now used to prevent meningococcal disease in close contacts of cases. Immunization is now given to all new Army recruits for types A, C, Y, and W135.

4-13. Streptococcal Infections

Penicillin prophylaxis may be indicated for Beta-hemolytic streptococcal infections (strep throat) to prevent rheumatic fever. The decision to institute such a program is made from surveillance activities. The diagnosis of streptococcal sore throats is made by confirming respiratory symptoms with a positive throat culture. By recording the number of cases occurring in each unit on a base, trends showing a serious streptococcal problem that would otherwise go unnoticed may become evident. With this information, the medical officer can apply the use of penicillin prophylaxis to a specific unit or to an entire post. Thus a serious streptococcal problem is recognized and managed before multiple rheumatic fever cases result.

Section III. PERSONAL HYGIENE

4-14. General

Although immunization exists against tetanus, smallpox, polio, typhoid fever, and cholera, there is no guarantee that they will be 100 percent effective. In fact, many diseases such as some colds, diarrhea, skin diseases, and sexually transmitted disease have no immunizations. Preventive measures, such as food sanitation, water purification, arthropod control, isolation and quarantine, surveillance for carriers, and aggressive medical treatment of cases, are important but by themselves offer no foolproof insurance that disease will be controlled. Personal hygiene, in conjunction with the above will markedly decrease the incidence of disease.

4-15. Responsibilities

a. The Commander.

(1) Provides and maintains facilities, equipment, and supplies as necessary for the practice of personal hygiene.

(2) Ensures that instruction in personal hygiene is provided.

(3) Inforces the practice of personal hygiene by inspection.

b. The Medical Department.

(1) Conducts instruction in personal hygiene.

(2) Carries out inspections in regard to personal hygiene.

(3) Recommends corrections and improvements of personal hygiene as it is deemed necessary.

(4) Provides medical therapy as applicable.

c. The Individual.

(1) Must understand and continually apply personal hygiene measures.

(2) Should seek medical attention without delay if he becomes ill.

(3) Must avoid self-treatment or unauthorized treatment.

4-16. Military Health Rules

a. Personal Cleanliness. Plain soap and water prevents many skin problems, such as heat rash, eczema, boils, and impetigo. It is also effective in blocking the fecal-oral spread of hepatitis, salmonellosis, and other gastrointestinal diseases. Cleaning the body daily reduces the risk of louse, tick, and flea infestation. Thereby, helps control related diseases, such as typhus, relapsing fever, and plague. Proper dental care protects against dental caries and numerous gum infections.

b. Proper Wearing of Uniform. Intelligent wearing of the uniform is an effective means of protecting oneself against malaria and other arthropod-borne diseases. As the climate dictates, it is important in preventing heat and cold injury. It is also important that socks be changed and proper foot care be maintained as the primary means of protection against immersion foot and other foot disorders.

c. Personal Protection Devices. Items for use by individuals to provide personal protection against arthropods and arthropod-borne diseases include — insect repellents in the form of DEET (75 percent N, N-diethyl-M-Toluamide) and M-1960, used for clothing impregnation; insecticidical aerosol bombs; bednetting. Condoms are another personal protective device available to all troops, and if used properly, can definitely decrease the incidence of sexually transmitted disease. Another measure that may be included under this heading is the antimalaria pills.

d. Avoidance Techniques. The last of the general health rules relies on a combination of education and common sense. Water discipline is an area of prime importance, and troops must be aware of the dangers of drinking water, ice, and bathing water acting as vehicles of disease. Total avoidance of contacts is also the best prevention against sexaully transmitted disease. Similarly, the best policy is total avoidance of animals and reptiles to prevent rabies and snakebite. When the situation permits, areas known to have large populations of medically important arthropods should be avoided to prevent unnecessary exposure to the diseases they carry. A general awareness of the potential hazards resulting from obtaining food and drinks locally in many foreign lands will lead to the prevention and control of a number of communicable diseases.

Section IV. NUTRITION

4-17. General

a. Good nutrition is essential for good health. Nutrition directly affects growth, development, reproduction, well-being, and the physical and mental condition of the individual. Health depends upon nutrition more than on any other single factor in hygiene.

b. The body requires a certain amount of energy to sustain life. This energy is obtained by the breakdown of foods in the process of digestion and metabolism. The energy provided by the metabolism of food is measured in calories. The important food groups are water, fats, proteins, carbohydrates, minerals, and vitamins. A daily minimum amount of each food group is necessary to maintain health. Also, excessive food intake can cause an impairment of health; overweight soldiers have more of a nutritional problem than underweight troops.

4-18. Responsibilities

a. Army Regulation 40-15 charges the Army Medical Department with the responsibility for —

(1) Establishing appropriate nutritional and dietary standards for the Army.

(2) Making inspections to determine the nutritional adequacy of the ration as prescribed and consumed by the troops.

(3) Reporting deficiencies from prescribed standards to appropriate officers, with recommendations regarding intake levels of specific nutrients and measures necessary to correct such deficiencies.

(4) Supervising studies made for determining the nutritional status of personnel.

(5) Maintaining close liaison with the Army Materiel Command and Quartermaster Corps in an advisory capacity to prevent deficiencies from occurring in the rationing system.

(6) Instructing personnel in the principles of nutrition.

b. Army Regulation 40-5 states that one of the duties of the preventive medicine officer, with the assistance of the preventive medicine specialist and others, is to participate in the development of programs to prevent nutritional deficiencies.

4-19. Nutritional Requirements of Troops

a. General. An adequate ration is one that meets all of the nutritional requirements of troops for the maintenance of health, physical fitness, efficiency, and a feeling of well-being.

b. Effect of Physical Activity on Nutritional Requirements. The only important effect of physical activity on nutritional requirements is on caloric requirement. The greater the physical exertion, the greater the caloric need. The need for protein does not increase with physical activity. Individuals engaged in heavy physical activity, such as airborne trainees, personnel undergoing ranger training, and some combat units, may require as much as 5,000 calories daily in a temperate environment to maintain body weight.

c. Effect of Climate on Nutritional Requirements.

(1) *Cold climates.* Nutritional requirements of troops operating in cold climates are not much different from those stationed in temperate climates. Caloric requirements for inadequately clothed personnel increases as the environmental temperature decreases. Whereas a daily intake of 3,200 calories is sufficient for troops in temperate climates, inadequately clothed troops may require from 5,000 to 5,500 calories a day in extreme cold weather. Normally adequately clothed personnel could exist on the same caloric diet as those in a subtropical environment. However, because of the hobbling effect of arctic clothing as well as the weight of the clothing and equipment, a slightly greater caloric diet is needed. No greater quantities of fat and protein are required in the Arctic than in temperate climates. The slight increase in food requirements may be met by increasing the consumption of all components of the ration. Water requirements are as great, if not greater, in the Arctic than in temperate climates. Troops required to produce their own drinking water often become dehydrated rather than take the trouble to melt ice or snow, this may lead to exhaustion.

(2) *Hot climates.*

(a) The nutritional requirements (amount of protein, vitamins, and minerals) of troops stationed in hot climates are not fundamentally different from those of troops stationed in temperate climates.

(b) The caloric requirement of troops in hot climates is usually somewhat lower than in temperate climates due partly to lowered physical activity. However, when personnel are required to perform the same amount of work in a hot environment as in a temperate environment, their caloric expenditure will be increased. This increase in the caloric requirement is related to increased activity of the circulatory system for heat transport, the increased activity of the sweat glands, the increased caloric loss due to sweat vaporization, and altered body mechanisms due to heat retention. Hence, men performing work similar to that performed in a temperate climate may require a 4 percent increase in the caloric allowance for every degree of rise in ambient temperature between 86°F and 104°F.

(c) The most important nutritional consideration in the tropics is the prevention of physical deterioration due to a caloric deficit caused by a lack of appetite. Lack of appetite is most noticeable in the initial bodily adjustment to a warm climate and may persist throughout the soldier's stay in the tropics. To combat this lack of appetite, mealtimes may be changed to the cooler hours of the day. Cool drinks should be provided with meals. Provision should also be made for ice to cool food and drinks.

(d) Of primary importance in maintaining physical fitness and efficiency in tropical or desert areas is the ingestion of adequate amounts of water and salt. See Chapter 6 for a discussion on heat injury.

d. United States Army Rations (TB MED 141).

(1) A ration is an allowance of food for the subsistence of one person for 1 day.

(a) Field ration A is the basic ration of the Army and is prescribed for troops in the zone of interior. It normally contains a maximum of fresh food items, and conforms to the average dietary pattern of the civilian population of the United States.

(b) Ration, operational B, corresponds as nearly as possible to field ration A but incorporates nonperishable processed and canned foods instead of perishable items like fresh meat and vegetables. It is designed for use in oversea theaters where food must be supplied from the zone of interior. It furnishes approximately 3,950 calories and is nutritionally adequate when properly prepared.

(c) Meal, ready to eat, was designed for issue as the practical situation dictates, either in individual units as a meal or in multiples of three as a complete ration. Each meal furnishes approximately one third of the minimum nutrient intake prescribed by Army Regulations. One meal furnishes approximately 1,185 calories, three meals 3,555 calories. Although nutritionally adequate, it should not be used in excess of 10 consecutive days.

(d) The food packet, long-range patrol, is designed for use by troops in operations precluding resupply for periods up to 10 days. The main item can be rehydrated in hot or cold water or eaten dry like popcorn. When three packets are consumed in 1 day, the requirements for all nutrients with the possible exception of calories are met, but continuous use is limited to not more than 10 days. Some soldiers have complained that the rehydrated food packet contains more food than can be comfortably eaten at one sitting. Once the food packet has been rehydrated, it should be consumed within a reasonable period of time and should not be saved for later consumption because of possible bacteria growth.

(2) *Limitations of rations.* Operational rations are nutritionally adequate as packaged, but there are limitations to their use. They become monotonous when consumed as the sole diet for long periods of time. Under such conditions, the troops may restrict their food intake voluntarily, and their caloric intake may be decreased to the extent that it lowers their operational efficiency. Experience has shown that supplementing operational field ration B with fresh foods will improve the acceptability of the ration, increase food consumption, and thereby improve the health of the troops. It is desirable as soon as practicable to supplement the ration with fresh meats and produce. Prior to being sent into combat areas or into assault operations, troops should be given a liberal ration to minimize the effects of eating packaged rations.

(3) *Storage of rations.* Although the components of the field ration B and packaged rations are referred to as nonperishable, many of the components undergo deterioration when stored at high temperatures, such as occur in the tropics or desert areas. Deterioration adversely affects the palatability and acceptability of the ration and reduces its nutritive value. Powdered whole milk, powdered eggs, canned bread, and powdered cream substitutes are particularly susceptible to deterioration even though they are vacuum-packed. If at all possible, they should be treated as perishable products and stored at a temperature below 70°F.

(4) *The use of multivitamin tablets.* Rations provided for the troops are nutritionally adequate and only under exceptional circumstances is there need to supplement the ration with multivitamin tablets. These may occur when logistical support of the troops fails and only portions of the B ration are available, or when troops are isolated and forced to subsist for excessively long periods of time on the packaged rations. Only after all efforts to correct the deficiency by normal means have failed should multivitamin tablets be issued as a supplement to the ration.

CHAPTER 5

PREVENTION AND CONTROL OF COMMUNICABLE DISEASES

Section I. EPIDEMIOLOGY

5-1. General

a. Epidemiology is that field of medical science which is concerned with the relationship of factors and conditions which affect the health of the people in a community. Various terms describe the prevalence of communicable disease in a community. A disease constantly present in a community is said to be endemic. An unusual occurrence of a disease affecting many people is said to be an epidemic.

b. Epidemiological methods are not restricted to infectious diseases alone. These methods have been employed in the past to investigate pellagra, endemic goiter, and tooth decay, as well as occupational exposures such as lead or carbon monoxide poisoning. The problem of smoking and lung cancer, as well as accidents, especially those caused by automobiles, are all within the scope of epidemiological investigation.

c. The unit of study in epidemiology is a group of individuals, as contrasted to the single individual studied by the clinician. Epidemiological data are obtained from each individual in the group,the data are collected and analyzed, and then certain facts applicable to the group as a whole are found. Examples of data collected are age, sex, occupation, health status, ethnic background, and state of immunity.

d. Epidemiology is not a "pure" science. It is the result of detailed individual facts, clinical facts, mortality and morbidity facts, as well as statistical tabulations.

e. The actual investigation of an outbreak involves many considerations. First, the nature of the disease causing the outbreak is determined, if possible. Second, the investigator must verify that the disease under consideration is occurring in epidemic proportions. The date of onset, the number of persons sick, and the rapidity of onset are all determined. House-to-house visits may be necessary to uncover more cases and contacts. Then, after appropriate planning, a detailed study is made. This must include characterization of the disease, getting incidence figures, and drawing epidemic curves, as well as finding out as much as possible about the agent of disease and its mode of spread. Once data are gathered, they must be analyzed. From analysis, conclusions must be drawn and appropriate preventive measures instituted. The aims of an epidemiologic investigation are thus to search for causes of disease in a community, to determine the methods of spread of the disease, to gather information on the number and distribution of cases, and to recommend control and preventive measures.

5-2. Categories of Disease

a. Communicable Disease.

(1) Communicable disease is an illness which is due to an infectious agent which can be passed from an infected person or animal (the reservoir) to another person (a susceptible individual). This can occur directly or indirectly. For example, hepatitis is spread from person to person directly or indirectly by way of contaminated food and water.

(2) The chain of infection is defined as having three links: the source or reservoir of infection, the means of transmission, and the susceptible individual. Disease control aims at breaking any or all the links in the chain of infection.

(a) The source or reservoir can be controlled by personal hygiene, isolation, quarantine, treatment, and medical surveillance.

(b) Transmission can be reduced or eliminated by personal hygiene, avoidance of overcrowding, and by good ventilation, water purification, good food sanitation, proper preparation of food, sanitary disposal of waste and insect control.

(c) Control measures applicable to the susceptible individual include personal hygiene, immunizations, and suppressive drugs.

(3) At times the body has enough immunity to prevent recognizable disease and become a carrier. A carrier can transmit disease in the same way as someone with the same infection.

b. Noncommunicable Disease. A noncommunicable disease is an illness which afflicts an individual but which cannot be passed from one person to another. Heat exhaustion is an example.

Section II. RESPIRATORY INFECTIONS

5-3. General

a. Definition. Respiratory infections are diseases transmitted from person-to-person by discharges from the respiratory tract of the infected person. Some respiratory infections may result from inhalation of infectious material from other sources; for example, inhaling dust shaken from blankets may lead to streptococcal disease.

b. Signs and Symptoms. The symptoms of most respiratory infections are localized to the respiratory system. Exceptions to this include meningococcal meningitis, which usually produces central nervous system symptoms, and smallpox, which is manifested by deep-seated skin lesions.

c. Agents and Reservoir.

(1) The causative agents of respiratory infections are viruses, bacteria, fungi, and rickettsia. The viral and bacterial respiratory infections are the most important in military populations. The reservoir (source) of these agents is man. A person who is ill with respiratory infection is called a *case* and is a potential source of infection. A person who harbors agents of respiratory infections, but who is not ill, is called a *carrier*. Such a person is also an important source of infection, since he can spread the agents of respiratory infections without even suspecting his own infectivity.

(2) A few agents of respiratory infections arise from reservoirs other than man. The rickettsia of Q-fever, for example, its natural reservoir is certain wild and domestic animals.

d. Transmission. The spread of respiratory infections from person-to-person occurs by several methods.

(1) *Droplet transmission.* In the normal course of breathing or talking, a person exhales droplets of moisture which can carry disease agents from the respiratory tract if the person is infected. The droplets which are about 50 microns (1 micron = 1/1000 of a millimeter) in size are termed large droplets, even though at this size they cannot be seen with the naked eye. These droplets usually travel about 4 or 5 feet horizontally from their point of release in air before rapidly falling downward because of their weight. If forcibly expelled, as in coughing and sneezing, they travel much farther.

(2) *Droplet nuclei.* Droplet nuclei are the residue of dried-out respiratory discharge droplets. They are about 1 to 5 microns in size and consist of infectious agents plus organic matter remaining after the moisture originally in the droplet has evaporated. These nuclei do not fall rapidly because they are very light in weight. They remain in the air for long periods of time traveling with the air currents. When disease agents in the droplet nuclei are drawn into the respiratory tract of a susceptible person, transmission occurs without direct contact with the disease source.

(3) *Fomites.* Fomites is a term used to refer to contaminated objects which can transmit disease. The bedding, clothing, and personal articles of a case or carrier of respiratory infection are considered fomites, since they are contaminated by respiratory discharges from the infected person. Mutual use of these contaminated articles results in direct transmission of disease agents to susceptible persons. Also infectious agents in droplets can be resuspended in the air when these articles are shaken or dusted. Thus infectious materials get another chance to be inhaled and cause disease.

(4) *Direct transmission.* Direct transmission of respiratory infections refers to person-to-person spread of the oral-pharyngeal (mouth and throat) route. This is probably the method of transmission of the virus-causing infectious mononucleosis, which has accordingly been called the "kissing disease" by some people. Direct transmission of tuberculosis and meningococcal infections have resulted from mouth-to-mouth breathing instituted by medical personnel to save the lives of patients severely overcome with these infections.

e. Susceptible Host. The transmission of a respiratory infection agent to a new host, that is, a person lacking resistance to the particular agent, completes the chain of infection. This new person becomes a case or carrier of the infection. An individual's resistance to respiratory diseases is related to immunity or previous exposure to the disease; however, several factors in particular predispose to respiratory disease epidemics in military populations.

(1) *Overcrowding.* In the military, the population tends to be crowded. As members of a military unit, people are housed, fed, drilled, and trained as a group. Various studies of barracks and wards have shown that the number of bacterial and viral agents in the air increases as the number of people in the area increases. Opportunities for transmission of agents causing respiratory infection are thus enhanced.

(2) *Susceptibility of recruits.* Epidemiological studies have shown that recruits, compared with "seasoned" soldiers, have a much higher susceptibility to respiratory infections. New recruits are brought together from all walks of life and from all parts of the country and formed into military units. They arrive as carriers or mild cases of the respiratory infections endemic to their own particular area of the country and are housed in close contact with susceptibles from other parts of the country. Also they may go to a recruit training center where additional, new respiratory infections are endemic. As a result, recruits have a much higher prevalence of respiratory infections than do other military groups who are more "seasoned."

(3) *Lowered resistance in recruits.* The fatigue and physical exhaustion found in recruits in the early training program seems to be important in leading to respiratory disease. Also, during this time emotional stress is high in the trainee. All of these factors tend to lower the recruit's resistance to respiratory infections. This is particularly true for the common respiratory disease, the causative virus can remain in a latent (inactive) state in the nose and throat, becoming active and causing disease only during periods of lowered resistance.

5-4. Acute Respiratory Disease

Acute respiratory disease (ARD) refers to a specific illness which occurs regularly in epidemic proportions among recruits.

a. Typically symptoms are fever, chills, muscular aches, sore throat, and cough. It may be incapacitating in its severity. At recruit centers, the illness is sometimes referred to as "viral pharyngitis." The virus responsible is nearly always the adenovirus.

b. The reservoir for the adenovirus is man, and transmission occurs by direct contact — droplets or fomites.

c. Treatment is symptomatic and consists of bed rest and aspirin. Antibiotics are not used unless bacterial complications occur. Hospitalization is required in about 10 percent of the cases. Recruits are never put "on quarters" for respiratory disease; they are either returned to duty or hospitalized.

5-5. Primary Atypical Pneumonia

The term Primary Atypical Pneumonia (PAP) was originally adopted to describe cases of pneumonia for which no bacterial cause could be found and which did not respond to sulfa or penicillin treatment. This type of pneumonia accounts for about 90 percent of the pneumonia seen in military populations. Studies in military recruits have shown that about one-third of these pneumonias are due to the adenoviruses, one-third to the *Mycoplasma pneumonia* organism, and one-third to unknown agents. The illnesses caused by these agents are similar clinically. Usually high fever, incapacitating weakness, cough, and chest pain occur. The illness lasts from 1 to 3 weeks and usually requires hospitalization.

5-6. Influenza

Though adenovirus and mycoplasma organisms attack military personnel at greater frequency than civilian personnel, influenza attacks both populations equally. The seasoned troop or civilian dependent is as likely to be involved in an influenza epidemic as is the recruit. Since symptoms of influenza are practically indistinguishable from those of adenovirus-caused acute respiratory disease, epidemiological behavior may serve to distinguish the two diseases. For example, an epidemic of acute, febrile respiratory illness occurring among civilians and nonrecruit military personnel, as well as recruits, is likely to be influenza. Epidemics of respiratory illness limited to recruits would probably be caused by adenovirus. On an individual basis, however, serologic tests must be used to differentiate the two diseases. Influenza epidemics occur infrequently in the Army, because vaccine (which has been demonstrated to be 60 to 90 percent effective in reducing disease incidence) is administered yearly. Because new strains of influenza virus develop about every 2 to 3 years, new vaccines must be produced at these intervals. There will always be some lag in availability of vaccine for new strains of influenza.

5-7. Bacterial Pneumonia

These pneumonias are usually sporadic in distribution and only rarely epidemic among military personnel. Only 5 to 10 percent of all pneumonias seen in the military are bacterial in nature. A rising incidence commonly accompanies epidemics of viral respiratory disease, especially influenza. Conditions of physical and mental fatigue and alcohol abuse may contribute to lowered resistance. The onset of pneumonococcal pneumonia is characterized by chills, fever, cough, chest pain, and difficulty in breathing. Antibiotics are usually very effective. The prevention of pneumonococcal pneumonia primarily depends upon emphasis, by commanders, on general respiratory preventive measures.

5-8. Smallpox

The last case of smallpox in the world was in East Africa in 1977. However, because of its potential as a biological agent, the Army continues to vaccinate all soldiers with a primary vaccination (if necessary) and a booster every 5 years.

5-9. Meningococcal Meningitis

The military importance of this disease lies in its high case fatality rate (5 to 10 percent even with treatment) and its panic producing effect on populations.

a. The causative agent, *Neisseria meningitides*, is transmitted by respiratory discharges from infected persons, usually asymptomatic carriers. Very few persons who acquire the organism become noticeably ill, and only about 1 in 1,000 develop meningitis.

b. Meningococcal meningitis is a disease having an acute onset with fever, chills, headache, and weakness. The illness is often preceded by symptoms of an upper respiratory infection. Small hemorrhages in the skin, called petechiae, may be found. This combination of findings should be considered a meningococcal infection until proven otherwise. Later in the disease, symptoms of nervous system involvement (stiff neck, confusion, coma) may appear. Spinal fluid and blood examination confirm the diagnosis.

c. Prior to 1950, most epidemics, including military outbreaks, were due to *N. meningitides*, Group A, organisms which were sensitive to sulfa drugs. In the spring of 1963, Group B organisms resistant to sulfa were recognized as the cause of outbreaks in US recruits. Since that time the administration of sulfa drugs to carriers has not been of value in most recruit outbreaks. Prevention and control measures are currently aimed at reducing the spread of the organisms by preventing overcrowding and reducing stress and fatigue in recruits. Also of vital importance in preventing meningococcal disease is to immunize all recruits for meningococcal strains A, C, Y, and W135. However, because these measures will not entirely eliminate the problem, early diagnosis and treatment of cases is essential in preventing mortality.

5-10. Streptococcal Infections

Among the streptococci that cause disease in man, Group A (Beta hemolytic) streptococci have the most importance for the military. The chief clinical disease produced by these infections is streptococcal sore throat.

a. The infections are transmitted when in direct contact with an infected person, by contaminated fomites, and by droplets. Symptoms of the illness include fever, severe sore throat, difficult swallowing, headache, and tender cervical lymph nodes. Throat cultures should be done in all suspected cases.

b. Rheumatic fever may follow untreated or incorrectly treated streptococcal sore throat. In epidemics this occurs in 1 to 2 percent of the cases. An inflammation of the kidney called glomerulonephritis may result from some strains of streptococcal infections. These diseases can usually be prevented by treatment with penicillin during the active streptococcal infection.

c. Prevention of hemolytic streptococcal infections depends on educating personnel in the importance of good personal hygiene and environmental sanitation. Personnel must be trained to report to the dispensary if the slightest symptom of respiratory disease occurs, so that effective treatment can be administered rapidly. Prophylactic penicillin may be given to all members of a unit under epidemic conditions. Fortunately, epidemics rarely happen in the US Army today.

5-11. Tuberculosis

Tuberculosis (TB) is a chronic respiratory disease that is present in nearly every community, including the military community. In underdeveloped countries, it is a major cause of morbidity and mortality.

a. Tuberculosis is caused by *Mycobacterium tuberculosis*. The disease is transmitted by droplet nuclei generated by the tuberculous patient in coughing, sneezing, or talking. The primary or initial infection usually goes unnoticed and heals by itself, leaving only a positive TB skin test. Occasionally, it leads to widespread disease throughout the body many months to years after the initial infection. Pulmonary tuberculosis generally has a chronic and variable course and may produce no noticeable symptoms until late in the disease. In advanced stages, cough, fever, weight loss, chest pain, and coughing up blood may occur. Diagnosis is by chest x-ray and laboratory examination of respiratory discharges. The tuberculin skin test is positive in infected persons or those with active disease.

b. Prevention and control of this disease depends on early diagnosis and close follow-up on contacts of new cases. Periodic chest x-rays and tuberculin skin test surveys are the foundation of the control program. All personnel entering the US Army are skin tested. Positive reactors should be carefully examined to determine if they have active disease. If not, they should be advised of the signs and symptoms of TB. Annual chest x-rays are not of value. Immunization with attenuated tubercle bacilli (BCG vaccine) gives protection but is not currently recommended for use in the US except in special circumstances. Educating the patient with tuberculosis to cover his mouth when coughing or sneezing will greatly reduce the spread of infectious droplet nuclei. Masks worn by attendants are not effective protection.

5-12. Measures of Control

It is more difficult to control outbreaks of respiratory infections than many other types of communicable diseases. In general, control efforts are based on improving personal hygiene, avoiding contacts with patients and carriers, controlling dust and aerial contamination, preventing overcrowding and fatigue, and immunizing when applicable.

a. Avoidance of Direct Contact.

(1) Patients with respiratory disease must be diagnosed, isolated, and treated as soon as possible. This is not possible with all respiratory infections; however, patients with mild respiratory infections should learn and practice personal hygiene measures, such as covering the mouth when coughing or sneezing.

(2) A minimum of 72 square feet of floor space per man is required for basic trainee housing. Storage space, closets, hallways, and latrines are not included in the calculation. Other personnel may, if the situation requires, be

housed with less floor space per man. Reducing the floor space must be a command decision. Reducing floor space often leads to an increase in respiratory disease.

(3) Bed staggering and head-to-foot sleeping arrangements may also afford some protection.

(4) Overcrowding should also be avoided in classrooms and dayrooms. This may be accomplished during periods of respiratory infection epidemics by using alternate seating arrangements. In addition, maximum use of outdoor training is encouraged when weather permits.

(5) New recruits are particularly susceptible to respiratory infections. Effective measures taking this into account have been instituted through the use of the "platoon system." New recruits are placed in small units and separated physically from the rest of the base into their own training area. This cuts down considerably the number of contacts and lessens the risk of spreading respiratory infections from platoon to platoon. It is of particular importance in the early weeks of basic training. The "platoon system" is used throughout basic training.

b. Personal Hygiene. This is one of the most important respiratory disease control measures. This approach is the practice of simple health habits. Covering the nose and mouth when sneezing or coughing, and washing the hands, should be routine practices. Infected cases should avoid contact with healthy persons. Personal articles, such as towels, drinking glasses, and toothbrushes are not shared. Healthful exercise, fresh air, and sunshine should be encouraged.

c. Ventilation, Temperature, and Humidity. The gentle circulation of fresh air at all times, and especially during periods of greatest personnel activity, aids in limiting dust and bacterial contamination of the air. Extremes of humidity and temperature are undesirable. Whenever possible, the barracks temperature should be near 70° F during daylight and slightly cooler at night. Relative humidity of 45 to 60 percent at the suggested temperature is comfortable. Windows are opened to provide ventilation.

d. Dust Control. Dry sweeping should be avoided. Either a sweeping compound or wet mopping should be used.

e. Food Service Sanitation. The early detection of coughs, colds, and sore throats among food handlers is the responsibility of the food service supervisor. He should refer cases to the dispensary. Food service personnel must practice good personal hygiene, because some respiratory diseases, such as streptococcal sore throat, can be transmitted by the food-borne route.

f. Vaccination and Prophylaxis. Progress has been made in the development of prophylactic drugs and vaccines effective against many of the respiratory infections; however, some of the diseases of military importance do not respond to drug prophylaxis, treatment, or vaccines. Vaccination against smallpox, diphtheria, whooping cough (for children under age 5 only), measles, and influenza are available and widely used. A successful program for vaccination against meningococcal disease is currently in progress.

Section III. GASTROINTESTINAL DISEASES

5-13. General

The communicable gastrointestinal diseases are infectious diseases in which either the causative agent enters the body through the gastrointestinal tract, or by some other route, in which case the major disease process still takes place in the gastrointestinal tract. These diseases may be caused by bacteria, by viruses, by one-cell animals (protozoans), or by various worms (helminths). Their primary mode of transmission is by the ingestion of contaminated food or water; however, in some cases they may be spread directly from one person to another. They are divided into three principal types: intoxications, intestinal infections, and helminthic infestations. Chemical food poisoning, caused by the ingestion of numerous chemical substances, is not a communicable disease, but may cause symptoms difficult to distinguish from the communicable infectious diseases mentioned. Some bacteria which may be transmitted to food can produce certain chemicals (toxins). These toxins, if ingested, can cause severe diseases such as staphylococcal food poisoning and botulism.

5-14. Chemical Food Poisoning

a. Chemical food poisoning may result from the accidental ingestion of insecticides, rodenticides, and other poisonous substances which may contaminate food; however, the most common type of chemical food poisoning results from the ingestion of heavy metals, such as zinc, cadmium, and antimony. Zinc is the one most frequently involved. When an acidic food, such as lemonade or grapefruit juice, is placed in a container made of or lined by one of the heavy metals, the acidity of the food causes the metal to go into solution. The food, along with the dissolved metal, is then ingested causing irritation of the gastrointestinal tract.

b. An individual poisoned with chemicals usually experience abdominal cramps, nausea, violent vomiting, and diarrhea, within 5 to 60 minutes after ingesting the food. The individual usually feels extremely ill, but rarely for more than 24 hours. This illness can be prevented if one simply remembers not to place acidic foods in containers either made of or lined with one of the heavy metals, such as galvanized zinc garbage cans. This type of poisoning will not result from allowing food to remain in the original tin can in which it was obtained, once it has been opened. All present-day cans are required to have a lining within them which will resist the action of the acid of any contained food.

5-15. Intoxications

The intoxications are those gastrointestinal diseases which result from the ingestion of a toxin, this toxin being a biologic rather than an inorganic poison. The toxin is produced by a bacterial organism which contaminates food under favorable environmental conditions that enable the organism to multiply. The food is then ingested by man, and it is the ingested toxin, rather than the ingested bacteria, which causes the disease. Toxin production usually ceases at the time the food is eaten.

a. Staphylococcal Intoxication.

(1) *Epidemiology.*

(a) The most frequent intoxication seen in the Army is caused by ingesting food containing a toxin produced by certain strains of staphylococci. These bacteria are very commonly found on man's skin, in boils, and in man's nose and throat. If a food handler has a boil on his hand, he may contaminate the food which he is preparing, or if he has a cold and is coughing or sneezing, the staphylococci from his nose and throat may be disseminated in the air about him and settle on food. Once in food, these organisms begin to multiply and produce a poison (enterotoxin). Within 1 to 6 hours after the enterotoxin has been ingested, the individual may begin to feel nauseated and start to vomit. He usually experiences abdominal cramps, develops diarrhea, and has a headache. The onset of this disease is rapid (within 1 to 6 hours), because the toxin is preformed in the food, and one does not have to wait for bacterial multiplication within man's body before disease results. The duration of this illness is short, roughly one-half day to 3 days. There is no specific treatment for staphylococcal intoxication, and all that can be done from a medical standpoint is to make the individual comfortable until he recovers. This disease is seldom fatal in a young, healthy adult.

(b) Factors helpful in identifying an outbreak of staphylococcal intoxication are:

- The clinical symptoms described above.

- The characteristic incubation period which usually varies from 1 to 6 hours.

- The fact that there are usually multiple cases with everyone becoming ill almost simultaneously. A positive diagnosis can be made only by demonstrating the presence of enterotoxin in the food eaten, but finding food contaminated with staphylococci is good presumptive evidence.

(2) *Prevention and control.*

(a) Staphylococcal intoxication is a disease for which we have little in the way of treatment, but it is a disease that can be easily prevented. Before food handlers begin work, the supervisor should inspect each one for evidence of infected cuts, scratches, boils, or upper respiratory infections. If any of these things are found, the individual should be sent to the dispensary. A medical officer will decide whether it is safe for this individual to work or whether he should be kept out of the kitchen until the condition has been corrected. Before returning to duty, the food handler must again be seen by a medical officer to make certain that his health has returned and that he will not endanger the health of those eating in the dining hall.

(b) The foods which are likely to support the growth of the staphylococci are low acid foods with high moisture and high protein content. Hence, it is rare to find a food such as pickles serving as a media for the growth of the organism, since pickles are too acidic. If the food has less than 30

percent moisture in it, it will not serve as a medium for the growth of the organism. On the other hand, the more moisture that is present above 30 percent, the more rapidly the organism will grow in that particular food. Custards, cream fillings, puddings, and potato salad are well known for causing outbreaks of staphyloccal intoxication.

(c) Food that supports staphylococcal growth should be prepared as close to serving time as possible. This minimizes the amount of time the organism has to multiply in the food, thus limiting the production of the toxin. Foods must not be prepared more than 3 hours in advance of serving time. Refrigerating food below 45°F will inhibit bacterial growth and toxin production, but will not kill the bacteria. Also, if a large quantity of food is to be refrigerated, it is better to place it in multiple small containers than leave it in a single, large one. If left in the latter, it may take 4 to 5 hours for the central portion of the food to cool down to 45°F, this is sufficient time for the staphylococci to multiply. If placed in several small containers, it may cool down to 45°F in less than an hour, and this is insufficient time for the organism to produce enterotoxins.

(d) If food is to be kept warm, such as on a steam table, it must be kept above 140°F. This will also inhibit the growth of the organism. Cooking food, on the other hand, cannot be considered a preventive measure for this type of intoxication. The enterotoxin produced by the staphylococcus is resistant to heat, and will not be destroyed even if the food is boiled for an extended period of time. It is true that the bacterial organisms will be destroyed as a result of cooking, but not the enterotoxin, which produces the disease in man. The enterotoxin is not affected by freezing nor does it have a characteristic smell. It gives food neither a bad taste nor a spoiled appearance. Therefore, it is impossible for man to detect the presence of this toxin in the food by any of his senses prior to the time that the food is ingested.

b. Botulism.

(1) *Epidemiology.*

(a) This disease is an intoxication caused by a bacterial organism, *Clostridium botulinum*. It gets into food and multiplies in much the same way that the staphylococcus does. It is a spore-forming organism and is commonly found in the soil, and on fruits and vegetables. In the process of canning, the spores are often found adhering to foods even after thorough washing. If the temperature of the food in the cans is not raised high enough or held there long enough to kill the organisms, they will grow within the cans and produce a very potent toxin.

(b) Botulinum toxin is the most potent toxin known. If man merely places a small portion of food in his mouth and holds it there for a few seconds, enough toxin is absorbed through the tongue and cheeks to cause death. The toxin is produced only when the organism is in an anaerobic (oxygen free) environment, such as in food that has been either canned or placed in plastic bags from which all of the air has been evacuated. The disease cannot result from eating fresh fruits and vegetables, because ingestion of the organism, in the absence of the toxin, does not produce disease.

(2) *Clinical aspects.* The toxin produces disease by blocking the transmission of nerve impulses to muscles, and only rarely does it cause gastrointestinal symptoms. The incubation period is usually from 18 to 36 hours. One of the first symptoms which an individual may note is that of double vision resulting from paralysis of the extraocular muscles. If the individual has ingested a sufficient amount of toxin, he will develop a progressive paralysis of all body skeletal muscles. This means that he is unable to breathe on his own, as both the diaphragm and intercostal muscles are skeletal muscles. It means that he is unable to swallow his own secretions, since the esophagus is also skeletal muscle, and his arms and legs may be completely paralyzed. The individual, however, notes little loss of sensation. He is able to see that which is directly in front of his eyes, even though he is unable to look about himself. He can feel someone touching him and he can hear what is being said in the room about him, but he is unable to respond in any way. Temperature elevation does not occur. Specific treatment for the patient consists of administering botulinum antitoxin, as well as placing the individual on some type of respirator, aspirating his trachea and bronchial tree and providing adequate nursing care. Botulism carries a case fatality at a rate of 30 to 70 percent, regardless of the type of treatment offered.

(3) *Prevention and control.*

(a) The toxin produced by *Clostridium botulinum* may produce a definite odor, that can serve to warn of its presence. Generally, it will also give the food a spoiled appearance, that is helpful in its identification. Since it is heat labile, thoroughly cooking food prior to ingestion will serve as a good preventive measure. If you suspect the toxin in a given food, do not taste it since that can prove fatal. Another means of detection is inspecting the cans in which food is procured. When this organism multiplies in a can, gas is produced, causing the ends to bulge and the center portion to swell. Cans that show signs of swelling and bulging should be discarded.

(b) Home canned foods are more likely to be poisonous than are commercially canned foods, since the spores of this organism are not easily killed by heat. In an open kettle, canned food must be boiled for a period of 5 1/2 hours to make certain that all spores have been killed. On the other hand, if the food is placed in a pressure cooker, the temperature is raised from 212°F to 250°F and only a 20 minute heating time is required.

c. Clostridium Perfringens. This is the bacterium responsible for gas gangrene. It may also cause food poisoning by producing a toxin. The incubation period ranges from 8 to 24 hours (usually 10 to 14) following ingestion of food heavily contaminated with Clostridium perfringens. Symptoms include sudden onset of abdominal pain and nausea, but rarely are diarrhea and vomiting present. The patient is usually well in 24 hours. The food is generally a meat or gravy dish prepared one day previously and served the following day after short warming. Prevention and control measures are the same as for botulism.

d. Bacillus Cereus. This is a bacterium that produces two toxins. Symptoms seen depend on the type of toxin. One toxin produces a disease much like staphylococcal food poisoning, with a short incubation period, with vomiting as the predominant manifestation. The other produces a mild food poisoning with an incubation period and symptomology resembling *Clostridium perfringens*.

Section IV. INTESTINAL INFECTIONS

5-16. General

Intestinal infections are those diseases caused by the presence and multiplication of living microorganisms within man's body; the major pathology being found in the gastrointestinal tract. There is no toxin produced by the organism in food prior to ingestion.

a. These diseases are spread by the fecal-oral route, that is, the organism leaves man's body in the feces, gets into the environment, food, and water, and then is ingested by another individual. As such, the diseases are referred to as filth diseases.

b. Food and water is contaminated in several ways. Leaky or improperly installed sewer lines in dining facilities or near water sources account for some contamination. Raw feces or improperly treated sewage contaminates water sources. Flies and other arthropods carry infectious agents from sewage, or from dumps, to foods. In many areas of the world human feces are used for fertilizer, foodstuffs are therefore contaminated while in the soil. A common mode of transmission is food contaminated by infected food handlers.

5-17. Salmonellosis

a. Epidemiology. A type of intestinal infection commonly seen in the Army is salmonellosis. This disease is produced by members of the genus *Salmonella*, which contains over 1,000 different types of bacterial organisms, all of which have the capacity for producing gastrointestinal disease in man, some to a greater extent than others. Salmonellosis is characterized by vomiting, diarrhea, abdominal cramps, and fever, which occur roughly 6 to 48 hours after ingesting the contaminated food. The onset is usually explosive and the duration of the disease is from 1 to 3 days. The reservoir for the organism is both man and various animals. Man can become a carrier of the organisms by having the disease or by ingesting a number of organisms without ever becoming clinically ill. The carrier will continue to pass the bacteria in his feces, even though he appears to be well. Hogs and cattle harbor the organism in nature; however, the most frequent food source for man is contaminated poultry. The bacteria enters the gastrointestinal tract of the bird, and from there they invade the bloodstream and are carried to muscle tissue and the oviduct. Eggs laid by a bird with salmonellosis can be contaminated with the organism even though the shells are unbroken. If man ingests such eggs without adequate cooking or if he ingests turkey or chicken or other poultry that is poorly cooked, he is likely to come down with salmonellosis. The disease is rarely fatal, but can produce a great deal of noneffectiveness in the military.

b. Prevention and Control.

(1) Salmonellosis can be prevented by attacking the various links in the chain of infection, namely, the reservoir, the vehicle, and the host. Looking first at the human reservoir, one finds that man spreads the disease primarily through food. A food handler, for example, may be a carrier of the organism. If he goes to the latrine and fails to wash his hands following defecation, he may then go back to work and contaminate any food he prepares. It is also possible for the disease to be spread directly from one person to another, but this is not the most likely mode of transmission.

(2) To make certain that the food handlers working in food service facilities are healthy, they must be inspected every day by the supervisor before starting the day's work. If anyone feels ill or has nausea, vomiting, or diarrhea, he should be sent to the dispensary for medical care. Anyone found with dirty hands, an unclean uniform, or without headgear, must correct the discrepancy before starting to work. Since food handlers may harbor the organism in their gastrointestinal tract and be unaware of this fact, it is of the utmost importance that they be trained to wash their hands thoroughly after using the latrine. If this is done, it is unlikely that they will transmit the disease through food.

(3) Attempts are being made to eradicate the salmonella organism from poultry, hogs, and cattle throughout the United States; however, this has not been completely successful. It must always be assumed that foods of this nature procured by the military will frequently contain this organism.

(4) The incidence of salmonellosis appears to be increasing in the United States at present time, despite a relatively high level of sanitation. One reason for this is the fact that a great deal of the food is now produced in very large quantities. If a single ingredient in a particular lot of food contains the organism, the entire lot of food will subsequently be contaminated.

(5) One of the best preventive measures available for salmonellosis is thoroughly cooking all foods; all organisms within well-cooked food are destroyed. If the food is improperly handled after cooking, however, it can be recontaminated. This occurs when chickens or turkeys, are placed on a worktable or cutting board and the drumsticks removed. They are then put in the oven and heated up to the proper temperature for the required time to destroy the bacteria. These cooked birds are then placed back on the same cutting board or worktable which has not been washed after its previous use. If the birds were contaminated with salmonella when they entered the dining hall, the cutting board or worktable was contaminated and became the source of recontamination. The end result is an outbreak of salmonellosis.

(6) Refrigerating foods is also extremely important in preventing this disease. If food that contains a few salmonellae is promptly refrigerated, the organisms will not multiply, and the men who eat it will receive only a few bacteria. This may be insufficient to produce disease, because man must ingest a great many organisms before clinical disease results.

(7) There is little that can be done to attack the third link in the chain, that is, reducing the susceptibility of the individual. There is not an effective vaccine against salmonellosis; even the immunity produced by the disease itself is very short lived. There are over 1,000 species of salmonella. Since there is no cross immunity between these species, it is possible to become repeatedly infected by the many types of salmonella that may contaminate food.

5-18. Shigellosis

a. Epidemiology. Shigellosis (bacillary dysentery) is an intestinal infection which produces an acute inflammation of the colon, and is caused by members of the genus *Shigella*. These organisms are easily killed by direct sunlight, but they can survive for considerable periods in water, ice, and the mucoid discharges of active cases. The disease occurs worldwide and is likely to occur in military troops when they are out in the field where water is often scarce and personal hygiene is neglected. The primary reservoir is man. It is transmitted directly from one person to another, but can also be spread by means of food and water. When uncontrolled it is a cause of significant disability.

b. Clinical Aspects. Typically, after an incubation period of from 1 to 7 days, the individual may begin to run a fever of up to 104°F. Diarrhea appears early in the course of the disease with the stool containing blood, mucous, and pus. The patient will have on the average, six to ten stools per day. With severe disease, the stools may ultimately consist of nothing more than blood stained mucous, a characteristic cellular exudate, and enormous numbers of pathogenic bacteria. The patient may notice severe abdominal pains. The bowel evacuations may become involuntary and often accompanied by intense tenesmus. Shigellosis, however, is a self-limited disease, usually running its course in approximately 2 weeks. Mild cases are very common. The patient may experience nothing more than a mild headache and generalized malaise. A high percentage of the cases may be completely asymptomatic; this makes it a hard disease to control. These individuals are not aware that they are passing the organisms in their stool, and are thus not as careful about their personal hygiene and hand washing as they would be if they had clinical disease or were aware of the problem. Shigellosis is often confused with amebiasis; they cannot be differentiated on the basis of the clinical picture alone. Cultures of the patient's stool are required to make this differentiation.

c. Prevention and Control. Since shigellosis is often transmitted from person-to-person, good personal hygiene, particularly hand washing, is of the utmost importance in prevention and control. Treatment of both cases and carriers will reduce the frequency of the asymptomatic reservoir. Other preventive measures are discussed in paragraph 5-22.

5-19. Cholera

a. Epidemiology.

(1) Cholera is an acute, bacterial infection of the intestine caused by *Vibrio cholera*. It is endemic in India and Pakistan, and from these areas it

can spread along the routes of trade to almost any area of the world. The reservoir for the disease is man; epidemics usually are due to the widespread consumption of water that is contaminated with the feces of infected individuals, or to bathing in such water. There is very little direct person-to-person spread.

(2) The almost total absence of cholera in American troops during World War II and the Korean conflict can be attributed to the combined effects of both vaccination and good sanitation. The potential danger to our troops, however, is always there when they are stationed in an endemic area. Because of its great epidemic potential, cholera is one of the internationally quarantinable diseases, and contacts should be under medical surveillance for at least 5 days after their last exposure.

b. Clinical Aspects. Cholera is characterized by a sudden onset, following an incubation period, which may vary from a few hours to 7 days. The most pronounced symptom is diarrhea, which initially resembles any other type of loose stool. As the diarrhea worsens, bile pigments disappear, and the stools take on a characteristic "rice water" appearance. They are completely liquid, do not contain blood, and have no foul odor. A patient may lose as much as 30 liters of fluid in a 24-hour period, resulting in rapid dehydration, circulatory collapse, and death. In fact, a person may die within 2 hours after the onset of diarrhea. Effortless vomiting, without nausea, has been described with cholera and may even precede the onset of the diarrhea. The duration of the disease is short, roughly 3 to 5 days and, if untreated, is fatal in as high as 75 percent of the cases.

c. Prevention and Control. Cholera is one of the few intestinal diseases for which an immunization exists; however, it is not completely effective. For this reason, reliance must be placed primarily on good environmental sanitation. With even small improvements in sanitation, one usually sees a marked drop in the incidence of this disease. General sanitary control measures are similar to those for other intestinal infections (paragraph 5-22).

5-20. Typhoid Fever

a. Epidemiology.

(1) Typhoid fever is a systemic infection caused by a bacterial organism, *Salmonella typhi*. Man gets the disease by ingesting either food or water that has been contaminated by the feces of an infected carrier. The bacteria invade the wall of the small bowel and may be found circulating in the bloodstream early in the course of the disease. As the disease progresses, areas of lymphoid tissue in the walls of the small intestine, called Peyer's patches, may ulcerate. When this happens, large numbers of typhoid bacilli are passed in the stool.

(2) Typhoid fever is seen throughout the world. The incidence in the United States has decreased markedly because of the general rise in the level of sanitation and personal hygiene; the availability of effective immunization; and the registration of carriers, who are not allowed to work as food handlers. The disease is still a major problem in other areas of the world.

c. Clinical Aspects. The incubation period is from 5 to 14 days. Clinical signs of the disease include a fever which rises over the course of 5 or 6 days and then remains relatively constant at 104° to 105°F for another 7 or 8 days. It then drops sharply and becomes very erratic during the convalescent phase. The patient may have a markedly enlarged spleen, and rose spots may appear on the trunk of the body. Constipation is more common in typhoid fever than is diarrhea, and the patient usually feels extremely ill. On the average, the duration of the disease is 4 weeks. Man is the only reservoir for the organism.

c. Prevention and Control.

(1) Because the organisms circulate in the bloodstream during the disease, a patient may develop foci of infection in areas of the body far removed from the intestine. They may occur even if adequate antibiotic therapy is administered. One of the most common areas for such localization is the gallbladder. A patient with an infected gallbladder may become a chronic carrier and pass the bacteria in his feces for years. Frequently an individual will need to have his gallbladder removed surgically in order to rid his stool of *Salmonella typhi*, and, on a few rare occasions, an individual may remain a carrier of the organism for the remainder of his life, regardless of what treatment is given.

(2) Typhoid fever is much more likely to occur in a population during wars or natural disasters. During such periods, the level of sanitation falls, and food and water are more likely to become contaminated with feces from typhoid carriers. A relatively effective immunization is available for typhoid fever. Immunity to the bacteria, however can be overwhelmed if large numbers of bacteria are ingested; therefore, drinking water must be disinfected with either chlorine or iodine, or, if chlorine or iodine are unavailable, by boiling. All food must be either thoroughly cooked or chemically disinfected, and a high level of sanitation must be maintained in all food serving facilities. The contacts and carriers of cases must be traced and treated. Chronic carriers are not allowed to function as food handlers.

5-21. Amebiasis

a. Epidemiology.

(1) Amebiasis, (amebic dysentery) may present either an acute or chronic infection of the gastrointestinal tract. It is caused by a one-celled animal, *Entamoeba histolytica*. This organism exists in two forms, a cyst form (infective) and a trophozoite form (invasive). The cyst is the one that can remain viable in man's external environment and is primarily responsible for the transmission of the disease. The trophozoite is the motile form and the one that produces acute disease in man.

(2) The disease is transmitted when one ingests food or water contaminated with the cyst-laden feces of an infected person. Once ingested, the cysts pass through the stomach and into the small intestine. Here they rupture and give rise to trophozoites. These are transported into the colon where they invade the bowel wall and produce multiple, pin-point, flask-shaped ulcers. The trophozoites live in these ulcers and ingest red blood cells, bacteria,

and the metabolic products of man's cells. If a trophozoite leaves an ulcer, it forms into a cyst, which is then passed in the feces of the individual which spreads the disease. In some patients, the trophozoites in the intestinal ulcer may enter blood vessels and then migrate to the liver, the lungs, or the brain. Here they may produce amebic abscesses, thus causing serious clinical disease.

b. Clinical Aspects. The incubation period for amebiasis varies from 5 days to several months. An individual may have a mild, chronic form of the disease, in which he experiences vague abdominal pains and alternating diarrhea and constipation. On the other hand, he may have a severe form in which he has marked diarrhea containing blood, mucous, and small amounts of pus. If an abscess develops in the liver, the individual is usually very ill. He has a fever with tenderness and pain over the liver. One need not have severe intestinal disease in order to have extra-intestinal complications, and the latter may appear many years after the former has subsided.

c. Prevention and Control.

(1) Man is the reservoir for amebiasis, and the disease is seen worldwide, but is especially common in the tropics, where personal hygiene is poor and sanitary facilities are primitive. There is no immunity following an acute infection, and one can become infected over and over again. An immunization against the disease is not available.

(2) Mild cases and carriers are common, and these are the people responsible for most of the spread. The person who has severe diarrhea will usually be passing primary trophozoites in the stool. These have a very short life span once outside man's body and even if ingested, most of them are killed in man's stomach. The mild case or carrier who has a well-formed stool, on the other hand, passes primary cysts, the form that can remain viable for long periods in the external environment, and is infectious if ingested.

(3) Disinfecting water is extremely important in limiting the disease transmission, since water is the primary means of spread, the cysts being rapidly killed upon drying. However, the cysts are not readily killed by routine water chlorination. For this reason, a 10 milligram per liter (mg/l) residual of free available chlorine at the end of a 30-minute contact time must be used. The diatomite filter can filter out most of these cysts, but high level chlorination is still required, since all the cysts will not be filtered out. If the troops are using individual canteens, iodine tablets may be used, they will also destroy the cysts. If nothing else is available, the water must be boiled.

(4) All foods should be thoroughly cooked to prevent infection with this organism. Eating fresh foods grown in fields fertilized with night soil is particularly hazardous, and should be avoided.

5-22. General Control Measures

a. General. Intestinal infection control rests on interruption of the "fecal-oral cycle." Some preventive measures attack the source of the disease. Some tend to destroy the vehicle of transmission, and still others are aimed at decreasing the susceptibility of the potential host.

b. Measures Applicable to the Source.

(1) Individuals who are ill with gastrointestinal disease should be seen and treated by a medical officer.

(2) It is the responsibility of the supervisor to inspect all kitchen personnel for signs of any illness and for general cleanliness before starting work each day. He must make on-the-spot corrections and immediately refer anyone who is obviously ill to the medical treatment facility. It is also the supervisors' responsibility to enforce rules of personal hygiene among the food handlers. These rules include thoroughly cleaning fingernails, wearing uniforms that are plain, neat, and sufficient to cover the body, trunk, and armpits, as well as wearing hair restraints. Facilities for hand washing with soap and warm water must be readily available within the dining hall; and each individual must wash his hands after using the latrine and before handling utensils or food. This is one of the most effective general measures for preventing intestinal infections.

c. Measures Applicable to the Vehicle.

(1) *Feces.*

(a) Human feces should be disposed of in a sanitary manner as described in Chapter 18. This is one of the best long-range control measures, since it prevents contamination of the soil and water sources. Human feces should not be used as fertilizer for growing fruits and vegetables, since they may later be eaten raw or only partially cooked. On a post with a sanitary sewage system that includes an adequate sewage treatment plant, excreta containing the most virulent disease agents can be placed directly in the system with complete safety, even without prior disinfection. In the field the proper construction, maintenance, use, and closure of latrines must be enforced.

(b) To make sure that food and water is protected from contamination, latrines should be constructed at least 100 yards from the food service facility and 30 yards from the nearest water source. They should be at least 30 yards from the end of the unit area, but within a reasonable distance for easy access. They should not be dug below the water level, as this may result in contamination of the water supply, and they should not be placed in an area where drainage into a water supply can occur. If the water table is high, burn-out latrines or chemical toilets should be used.

(c) Enough latrines should be provided so that 4 percent of male and 6 percent of female personnel in the unit can be accommodated at one time.

(2) *Fluids.*

(a) Water is one of the main vehicles for spreading gastrointestinal infections. As such, a water source should be at least 30 yards from the nearest latrine and located in an area where fecal material will not drain into it. All water must be treated, as described in Chapter 16.

(b) One must also consider ice as a potentially dangerous vehicle of many gastrointestinal diseases, especially in foreign lands with poor sanitation. *Potable* ice should be used, but if it is unavailable nonpotable ice may be used for cooling beverages, by placing the desired beverage in a container surrounded by ice.

(c) All milk delivered to the food service facility must be kept at a temperature of 50°F or below, but not frozen. Pasteurized milk, if so kept, will keep fresh or sweet for several days. Milk that is served to diners or exposed to the air will not be reused, but will be discarded. Leftover milk in unopened containers can be kept and must be refrigerated.

(3) *Food.*

(a) Gastrointestinal diseases are also transmitted through food. Every effort should be made to keep food from becoming contaminated with pathogenic organisms while being handled. Since most foods contain the essential nutritional elements for bacteria to multiply rapidly within them, the food service supervisor should inspect all food-stuffs arriving at his facility. Any food that appears unwholesome should be examined by veterinary personnel.

(b) Bacterial growth in foods can be markedly inhibited by refrigerating them below 45°F. Emphasis should be placed on the minimum rather than on the maximum time that food may remain out of the refrigerator. Bacterial growth can also be minimized by preparing all foods as close to the serving time as possible. Foods which readily support bacterial growth, such as locally prepared sauces, chicken salad, cream fillings, cream sauces, and custards, must not be prepared more than 3 hours before serving.

(c) One of the best preventive measures for intestinal infections is thoroughly cooking all food. This will destroy all organisms having the capacity to produce this type of disease in man. Care must be taken not to recontaminate food after it has been cooked. It should not be returned to its original container and should be kept away from contaminated working areas, such as cutting boards. If food is to be kept warm while being served, it must be kept above 140°F to prevent bacterial growth.

(d) Foods that are to be eaten raw must be thoroughly washed in potable water. Foods grown in areas where night soil is used should not be eaten raw. If they are to be consumed, and are not to be thoroughly cooked, they should be disinfected by first thoroughly washing them with clean potable water. Then they may be either immersed in water at 160°F for 1 minute or disinfected chemically by washing in a chlorine solution made by dissolving one package of Disinfectant, Chlorine, Food Service, in 20 gallons of water at 100°F. They should then be completely immersed a second time for 30 minutes in a separately prepared solution made by dissolving one package of Disinfectant, Chlorine, Food Service, in 20 gallons of warm water. The fruits or vegetables should be stirred occasionally so that all surfaces become thoroughly wet. After 30 minutes, they should be removed and thoroughly rinsed in potable water. Only use a chlorine solution once. A new batch must be prepared for each use.

(4) *Flies, fomites, and fingers.*

(a) Patients who are ill with intestinal infections should be cared for in areas that are screened against flies and under such conditions of isolation as are warranted by the particular disease. The walls, floors, latrines, and clothing soiled by cases and carriers must be thoroughly disinfected.

(b) Proper screening of latrines is also important. This prevents insects from carrying organisms from the latrine to areas where food is being prepared and eaten. Flies and cockroaches do carry fecal material on their body.

(c) To minimize the transmission of these diseases by means of dishes and silverware, all eating utensils are to be scraped and then prewashed to remove food particles. They are then washed, either manually or with an automatic dishwashing machine. After washing, all dishes are air dried.

(d) Since the gastrointestinal infections can be spread by insects and rodents, food service facilities should be screened and a high level of sanitation maintained. Insecticides and rodenticides may be used, but they are no substitute for sanitation. Garbage cans should be kept covered and cleaned thoroughly after emptying.

(e) Everyone must wash their hands immediately after using the latrine. The commander must ensure that handwashing facilities are readily available.

d. Measures Applicable to the Susceptible Person. Susceptibility to intestinal infections is general. Immunizations exist only for typhoid fever and cholera. Since the immunity afforded by these immunizations can be easily overcome when one ingests a large number of organisms, immunizations should be considered as supplements to, and not substitutes for, good personal hygiene and a high level of sanitation. No effective vaccines exist for any of the other gastrointestinal diseases discussed in this chapter Therefore, good personal hygiene must become a fixed habit. Particularly important measures applicable to the susceptible person are hand washing, drinking potable water only, thoroughly cooking all food, avoiding known sources of disease, and promptly reporting disease symptoms.

Section V. HELMINTHIC INFECTIONS

5-23. General

Helminthic infections are those diseases caused by worms living within the human body. Examples are ascariasis, ancylostomiasis, and trichinosis. These diseases are much more common than generally believed, but the symptoms produced usually are mild and very vague. Severe diseases can be produced, but this is relatively rare.

5-24. Ascariasis

a. Epidemiology.

(1) Ascariasis is a helminthic infection caused by *Ascaris lumbricoides*. The worm is one of the round worms, is white in color, and is roughly a foot long. It is seen throughout the world and is probably the most widespread of any helminthic infections. The eggs of the adult female are passed in the feces of the infected person. Once passed, the eggs must reach the soil and remain there for a period of from 1 to 3 weeks. At the end of this time period, the eggs become infective for man. If ingested immediately after passage in the stool, they are incapable of producing disease. They are very resistant to drying, and, as such, they remain viable on the surface of vegetables or on the surface of the ground for long periods of time, up to 4 years in some cases. They are able to survive over a broad range of temperatures, and they readily resist freezing.

(2) Infection results from eating contaminated foods or drinking contaminated water, the gastric juices being unable to destroy the eggs. From the stomach, the eggs pass into the small intestine where they hatch. The resulting larvae immediately invade the lining of the small intestine and bore their way into the blood vessels of the bowel. They are then transported, by means of the bloodstream, to the liver. They pass through this organ in roughly 2 to 3 days, and are then carried by the bloodstream through the right side of the heart to the lungs. Here the blood vessels narrow down into very fine capillaries to provide a large surface area for the diffusion of oxygen and carbon dioxide. The capillaries are too small to permit the passage of the larvae, which must burrow their way out of the capillaries into the alveoli (air cells) of the lungs. The organisms then migrate toward the bronchi and trachea (bronchial tubes and windpipe). From there they are carried, by the action of cilia, to the throat. They are swallowed once again and pass through the stomach into the small intestine where they grow to sexual maturity. The males and females then mate, and the females begin laying up to 200,000 eggs per day. These appear in the stool of the infected individual roughly 2 months from the time the infectious eggs are ingested.

b. Clinical Aspects. With ascariasis the patient may experience a pneumonia during the time the larvae are migrating through the lungs. Once the worms get into the intestine, they may cause no symptoms; however, in severe infections there may be so many worms they obstruct the bowel. If one of the worms crawls into the appendix, the individual may develop appendicitis. The adult worms in the intestine may actually compete with the infected host for food and other nutrients leading to malnutrition in the host. The duration of the disease, if untreated, is roughly 1 year.

c. Prevention and Control.

(1) The best long-range method for controlling ascariasis is to prevent contamination of the soil with human feces. Indiscriminate defecation should be discouraged, and properly constructed, properly located latrines, as described in Chapter 18, must be employed. Human feces should not be used as fertilizer, as this results in direct contamination of fruits and vegetables

from the contaminated soil. We must, therefore, concentrate on protecting ourselves under these conditions. In any area where night soil is being used, we can be reasonably certain that the ground is contaminated with the eggs of *Ascaris lumbricoides*.

(2) Since the only way that man can develop the disease is by ingesting the eggs of the organism, it is extremely important that he cook all food, since the eggs are readily destroyed by heat. All water should be thoroughly disinfected by using either calcium hypochlorite or iodine tablets, or by boiling it. Fresh fruits and vegetables grown in areas where human excreta is being used as fertilizer may be either immersed in water at 160 °F for 1 minute, or be disinfected chemically placing them in a chlorine solution made by dissolving one package of the Disinfectant, Chlorine, Food Service, in 20 gallons of warm water. The fruits or vegetables should be stirred occasionally so that all surfaces are thoroughly wet. After 30 minutes they are removed and thoroughly rinsed in potable water. Only use the chlorine solution once. A new batch must be prepared for each use.

5-25. Ancylostomiasis

a. Epidemiology.

(1) Ancylostomiasis, (hookworm disease), is a helminthic infection that is seen primarily in tropical and subtropical areas. It is caused by both the Old World hookworm, *Acylostoma duodenal*, and by the New World hookworn *Necator americanus*. The clinical disease produced by these two worms is identical. The worms are about 1 centimeter in length, and the adults reside in the gastrointestinal tract of man. Here the females lay eggs which are passed in the feces of the infected patient. If the feces of such a patient reaches soil which is warm and moist, the eggs will hatch in less than 24 hours, giving rise to rhabditiform larvae. These larvae then migrate down into the soil where they feed on bacteria and grow in size.

(2) After doubling in size, a metamorphosis takes place, producing the infective, filariform (larvae). This nonfeeding form then migrates to the surface of the ground. If they come in contact with the skin of man, such as a barefoot individual, they will penetrate the skin and enter the body. Man need not have sores, cuts, or abrasions of the skin for this to happen, since the filariform larvae have the capacity to penetrate the unbroken skin. Once inside they make their way to the blood or lymphatic vessels just beneath the skin. From here they are carried by the bloodstream, through the right side of the heart, to the lungs.

(3) In the lungs the blood vessels narrow into very fine capillaries, and the larvae are too large to pass through them. As a result they break out of the capillaries and enter the alveoli (air cells) of the lungs. Here they move toward the bronchi and trachea. From there they are carried by cilia action to the throat. They are then swallowed and pass into the intestine where they grow to sexual maturity. They attach themselves to the intestinal lining and live on the host blood. The female worms then lay eggs which are passed in the feces of the infected person. Thus, the life cycle is complete.

b. Clinical Aspects.

(1) When the larvae penetrate the skin, an itchy sensation is usually experienced. By this time, the larvae have penetrated to such a depth that they can no longer be rubbed off. When the larvae are breaking out of the capillaries in the lung and entering the alveoli, the host may experience a pneumonia. In the intestine each hookworm sucks from one half to 1 milliliter of blood each day. When heavily infested the individual will suffer severe anemia. As a result, the individual becomes extremely weak and is unable to perform even very simple tasks without complete exhaustion.

(2) If the disease is left untreated, these symptoms may persist for as long as 7 years, but death is rare.

c. Prevention and Control.

(1) The best long-range method for preventing hookworm disease is to prevent the soil from becoming contaminated with feces from infected individuals. All human feces should be deposited in properly constructed, properly located latrines as described in Chapter 18. Since the reservoir for the organism is man, we are concerned only with human feces.

(2) In many areas of the world, human excreta is used as fertilizer on fruit and vegetable gardens. When US troops are present in such areas, they should take every precaution to prevent exposing their skin to the soil. Shoes should be worn at all times. If anyone plans to rest on the ground, he should first spread his poncho over the area. If soil must be handled with the hands, gloves should be worn. Also, if soil gets on the hands, it should be rubbed off immediately. It takes approximately 3 minutes for the larvae to penetrate the skin, so if you clean or rub the soil off immediately, there is insufficient time for larval penetration.

(3) Although the primary mode of acquiring the disease is penetration of the skin by the larva, hookworm infestation can also be acquired by ingesting the larvae. When larvae are ingested, they pass through the stomach and develop directly into adult hookworms in the intestine without having migrated through the bloodstream and lungs. For man to be completely free from hookworms, it is very important that all food be thoroughly cooked.

(4) A well-balanced diet, high in protein and iron, is also important. This allows the body to compensate for some of the blood loss caused by the worms.

5-26. Trichinosis

a. Epidemiology.

(1) Trichinosis is a helminthic infection caused by the small, round worm, *Trichinella spiralis*. The worm usually varies from 1 to 5 millimeters in length. Man usually acquires the disease by ingesting undercooked pork which contains the encysted larvae. These are not killed in the stomach

and pass on into the small intestine where they grow to sexually mature adults. After mating, the females penetrate the lining of the intestine and deposit living larvae. These larvae circulate in the bloodstream and finally invade the skeletal muscles of the body and encyst. After reaching their final destination in the muscle, the larvae require a minimum of 16 days to complete their development and to become infective. After remaining here for a period of 6 months, they calcify and remain in that condition for the remainder of the host's life. Those that fail to reach skeletal muscle generally die. The females continue to discharge living larvae into the intestinal wall for a period of 3 to 16 weeks, after which they die.

(2) The primary source of human infection is the hog, although many other flesh-eating mammals also serve as reservoirs. Both hogs and rats are cannibalistic, and they may ingest the skeletal muscle of an infected hog who has been slaughtered or who has died of the infection, or they may ingest a rat, dying of trichinosis. In the United States, hogs are infected chiefly from feeding on uncooked garbage containing pork scraps, thus completing a hog-to-hog cycle. Outbreaks of human trichinosis then follow consumption of fresh, insufficiently cooked pork products.

b. Clinical Aspects. Clinically, an individual who has ingested under-cooked pork containing the cysts of *Trichinella spiralis* may experience mild nausea, vomiting, diarrhea, and abdominal pain within 24 hours. This subsides shortly. Approximately 7 days later, at the time the female worms are depositing the larvae in the intestinal wall, the patient experiences fever and severe muscle pains throughout his entire body. He may also have mild edema, particularly around the eyes. After the larvae have encysted in the muscle tissue, all of the above symptoms subside. This disease can prove fatal if many larvae enter a vital organ such as the heart.

c. Prevention and Control. The best preventive measure for trichinosis is to cook all pork thoroughly prior to ingestion. Smoking pork does not destroy the cysts of *Trichinella spiralis*, therefore, smoked pork should also be cooked. Government inspectors make no attempt to check for the encysted larvae when inspecting pork; therefore, just because pork has been inspected does not mean that it is free of the organism. Irradiation of pork or keeping it at a temperature of -22°F for 24 hours will destroy the encysted larvae; however, neither of these methods of prevention are being employed on a wide-scale basis today because they are not economically feasible. All garbage fed to hogs should be throughly cooked to break the hog-to-hog cycle.

Section VI. SEXUALLY TRANSMITTED DISEASES

5-27. General

a. Sexually transmitted diseases (STD) are communicable diseases which are usually contracted through sexual activity with an infected individual. The chances of contracting these diseases increase tremendously when an individual changes sexual partners frequently or when the individual's sexual partner is promiscuous. Except in unusual instances any infected individual can serve as a source of infection for another person if intimate contact occurs, and this infected person remains infectious until he has received proper treatment.

b. Because of ignorance about the cause, effect, and cure of STD, many infected persons are not diagnosed or adequately treated. As a result, many children have been born dead or with the malformations resulting from congenital syphilis. Syphilis still accounts for a significant percentage of hospitalizations for insanity and blindness, especially among the elderly.

c. The incidence of sexually transmitted diseases is increasing. The majority of military cases of STD occurs in individuals between the ages of 18 and 25 years of age.

d. There are many sexually transmitted diseases: gonorrhea, syphilis, nongonococcal urethritis, herpes, venereal warts, trichomoniasis, and hepatitis B being among the most important. The most common of these diseases is gonorrhea.

5-28. Gonorrhea

Gonorrhea, still the most prevalent sexually transmitted disease among military personnel, is caused by a bacterium, *Neisseria gonorrhoeae*, also known as the gonococcus. The incubation period is from 2 to 7 days, but on the average symptoms of this disease develop within 3 to 5 days. The organism grows well in the lining of the urethra in the male, and in the urethra and genital tract of the female. The organism will also thrive in the rectum and oropharynx. The signs and symptoms in the male are usually pain on urination and a purulent discharge from the penis; however, many females carry this infection without ever developing signs or symptoms of the disease. Complications of this disease in the male include inflammation of the prostate and epididymis, and sterility. In the female, complications may result in sterility. The diagnosis of gonorrhea can be made by microscopic examination of pus and by culture of the gonococci on special media.

5-29. Syphilis

Syphilis is caused by a bacterium known as a spirochete (a spiral-shaped microorganism), *Treponema pallidum*. If this disease is untreated or inadequately treated, it will usually be characterized by three clinical stages — primary, secondary, and tertiary. These stages may overlap.

a. Primary Syphilis.

(1) The incubation period for primary syphilis is variable (10 to 90 days) but, on the average, signs and symptoms develop at about 21 days. The first sore (chancre) of primary syphilis appears at the site of entrance of the spirochete. This may occur through minute breaks in the skin or through the mucous membranes of the body. The chancre may persist for 1 to 3 weeks and disappear without treatment. Typically, the chancre is a hard and painless ulcer.

(2) Any ulcer of the genitals should be suspected of being syphilis, and the diagnosis can readily be made by a dark-field microscopic examination. Blood tests (serological tests) for syphilis may be negative early in the primary stage, but change to positive with progression of the disease.

b. Secondary Syphilis. The lesions of secondary syphilis usually begin to appear a few weeks after the disappearance of the chancre. This stage is characterized by a spotty rash, ulcers in the mouth, headache, fever, and patchy falling out of hair. During this stage, the blood test is almost always positive for syphilis.

c. Tertiary Syphilis. Tertiary (late) syphilis follows secondary syphilis after a period without symptoms of 5 to 30 years, manifestations of the disease may again appear. These include blindness, insanity, and cardiovascular disease. In many cases a positive blood test will become negative during this stage.

5-30. Herpes Simplex

Herpes simplex viruses types 1 and 2 are capable of causing genital infections (especially type 2) following sexual contact with an infected individual. The incubation period is 2 to 12 days. Herpes is currently epidemic in the United States and many other parts of the world. Infection is characterized by a rash of the involved area that is typically vesicular in nature. (A vesicle is a fluid filled lesion in which the fluid is serous, or watery, in nature.) Pain, itching, and burning commonly accompany the rash. There may be a period of fever and malaise preceding the outbreak of the rash. The acute episode may last days to weeks. A hallmark of herpes infection is the likelihood of recurrences in perhaps 50 percent of infected persons. Recurrences are usually less severe and of shorter duration than the initial attack. There is no curative treatment, as with other viral diseases. Infections of newborns of mothers with active lesions can occur and are often very severe. Herpes infections in females have been associated with an increased risk of cervix cancer.

5-31. Nongonococcal Urethritis

Nongonococcal urethritis is a disease caused by a number of organisms, the most common being bacteria of the *Chlamydia* group. The clinical presentation is essentially the same as that of gonorrhea, due to the fact that infection occurs at the same sites as with *Neisseria gonorrhoeae*. However, clinical manifestations tend to be somewhat milder than those seen with gonococcal infection, for example, the discharge is more watery and less profuse and the burning or pain with urination tends to be less intense. Control measures are identical to those for gonorrhea.

5-32. Sexually Transmitted Disease Control

a. Prevention of Contact with Infected Individuals. The best way to prevent STD is to avoid exposure to infected individuals. An individual who has extramarital sex contacts is in the susceptible population. The following are areas to which efforts are directed.

(1) Armed Forces Disciplinary Control Boards (AFDCB) are established throughout the United States. Through their reasoned judgment and efforts, conditions thought unhealthy are brought to the attention of appropriate individuals and usually corrected. When the power of reason fails, the Board recommends "off limits" to commanders. Placing an establishment "off limits" is a last resort and is a command action. A commander can place an establishment "off limits" to members of his command without an AFDCB recommendation when he sees conditions detrimental to the health and welfare of his command. See AR 190-24 for detailed information.

(2) Suppression of prostitution is an established Department of the Army policy. Prostitution control is the responsibility of civilian law enforcement officers. Military personnel are required to cooperate with these authorities in the suppression of prostitution.

(3) Character guidance programs (AR 600-30) are established to assist the commander in promoting healthy mental, moral, and social attitudes in the personnel under his command.

(4) Education of soldiers through command information programs provides a means of imparting factual material of medical, social, and moral importance. The importance of early medical diagnosis and prompt treatment is also stressed.

b. Prophylaxis.

(1) The condom aids in preventing sexually transmitted disease. They are available for sale at all service exchanges. Personnel are advised to use the condom during intercourse as protection from direct contact with infectious sources. Men should be informed as to the correct use of the condom. The device should be put on before any contact is made, and it should be rolled on, holding a short space at the tip compressed. It should be removed carefully, with one swift motion, turning it inside out as it comes off. Women should insist on their sex partners use of the condom.

(2) After intercourse, urinate and wash the genitalia as soon as possible. Washing the genital area vigorously with soap and water removes many organisms which might lead to infection of the individual. Urination serves to flush out the urethra and eliminate organisms.

(3) The use of oral antibiotics ("No Sweat Pills") for STD prevention is most emphatically discouraged. Chemoprophylaxis for STD does not work; moreover, it only develops drug resistance in the organisms which cause STD.

c. Early Diagnosis and Treatment.

(1) With modern treatment methods administered early in the disease, it is rarely necessary to hospitalize an individual with STD. Complete recovery is almost certain and disability is prevented.

(2) Early treatment also renders the patient noninfectious for other persons with whom he might come into contact. It breaks the chain of infection.

(3) Personnel who are sick or who have skin rashes, genital sores, or a urethral discharge should report to a medical treatment facility as soon as possible.

d. Patient Interviewing.

(1) Every patient diagnosed as having sexually transmitted disease must be interviewed to determine those persons with whom he has had sexual contact during the course of his illness or from whom he could have contracted the disease. Tracing and bringing under treatment the sources and contacts of known cases of sexually transmitted disease is the most effective public health control method.

(2) During the interview the patient is urged to provide information about those persons from whom he could have contracted the disease and persons with whom he has had sexual contact since becoming infected. In the interview he is apprised of the nature of his infection, the manner in which it is transmitted, and the need for his cooperation in curtailing the sexually transmitted disease infection.

(3) The contact interview should cover the time period during which the patient could have contracted the infection and transmitted it to others. Since the incubation periods for each disease varies, it is necessary to cover variable periods of time in seeking out the contacts in each case. From the time the patient's symptoms began, cover the preceding—

- two weeks for gonorrhea.
- three weeks for nongonococcal urethritis.
- three months for syphilis. (In cases of syphilis of less than 2 years' duration, check all contacts. Over 2 years, check only family contacts.)
- at the present time there is no treatment for herpes, therefore, contact interviews are not indicated.

e. When the patient reports a civilian contact, a separate Center for Disease Control (Form 73.2936A) Venereal Disease Epidemiologic Report, is completed on each contact. Submit the report to the health officer of the state in which the contact resides. Speed is essential in tracing contacts; therefore, promptly initiate and transmit the Venereal Disease Epidemiologic Report. This report constitutes a medical record of privileged nature, and the source of the information (patient) is not identified on the forms submitted. Following the investigation and disposition of the contact, the civilian health agency reports its findings to the originating installation through the Army area surgeon. Contact reports of STD received from civilian health agencies of alleged contacts among Army personnel must be handled promptly. All personnel named as contacts must be brought to a medical treatment facility for examination and treatment, if necessary.

CHAPTER 6

PREVENTION AND CONTROL OF HEAT AND COLD INJURIES

Section I. HEAT INJURIES

6-1. General

The human body temperature is regulated within extremely narrow limits, even though there may be marked variations in the environmental temperature. Exposure to high environmental temperature produces stress on the body which may lead to a heat injury. The conditions in the environment which influence the heat equilibrium of the body and its adjustments are the air temperature; the temperature of surrounding objects; the sun's radiant heat; the vapor pressure of the water in the air (relative humidity); the air movement; and the amount and type of clothing worn. Another important factor which influences the heat equilibrium is the metabolic heat produced by the body as a result of physical activity.

a. Heat is lost from the body by several methods. The heat generated by metabolism and muscular activity deep in the body is moved to the cooler body surfaces. This movement is provided by conduction of the heat directly through the tissues from the hotter internal organs to the cooler superficial area and by heating the blood in the deep tissues and the subsequent cooling in the skin. In addition, sweat is produced which causes the loss of heat when it evaporates. Lastly, the body loses some heat by the radiation of heat waves. *It is important to remember that heat in general is transferred from the hotter point to the cooler point.*

b. The body controls its temperature by regulating heat flow (mainly by blood circulation regulation) and by the regulation of sweat gland activity. At air temperatures below 80° F simple conduction of heat away from the body suffices. In the range from 80°F to 92°F, additional heat loss is provided by dilatation of superficial blood vessels resulting in increased peripheral or superficial blood flow. Also, sweating begins in the range from 92°F to 99°F. These mechanisms act in concert, but conduction becomes less effective because the gradient of hot to cold (body environment) is reduced. When the environmental temperature exceeds body temperature, conduction of heat reverses and the body gains heat by conduction. At this point, sweating and subsequent sweat evaporation provide the only method of heat loss.

c. The environment also plays a part in body heat loss.

(1) The rate and direction of heat flow from (or to) the body depends on the *temperature* of the environment. If the temperature of the environment is much below body temperature, then the rate of heat loss is large. This rate falls as the environmental temperature reaches body temperature and stops when these temperatures are equal. As the environmental temperature rises above body temperature, the only way for the body to lose heat is by sweating.

(2) The *wind* is another important environmental factor in heat regulation. As the wind rate increases, the warm air cooled by the body through conduction is blown away and replaced by additional warm air that increases body heat. If the air is warmer than the skin, it may still help cool the body by evaporating sweat. Of course, with a high wind rate, the skin may be injured by mechanical forces (windburn) which will decrease body heat loss.

(3) Air *humidity* is yet another important heat loss factor. The air, at any given temperature, can hold only a certain amount of water vapor. As the environmental humidity (the measure of how much water vapor there is in the air) rises, smaller amounts of sweat can evaporate, and heat loss by evaporation slows. This is the main difference between the heat of the desert (low humidity) and the jungle (high humidity). Because of the limitation of evaporation, heat injuries occur at lower environmental temperatures in the jungle or in any area where the humidity is high. For sweating to be effective, it must evaporate from the skin surface. Sweat that drips or is wiped off does not aid in body heat loss.

(4) Radiant energy (heat waves) is an important environmental factor. If objects, such as tanks, surrounding a human body are hotter than the body, they will radiate heat to the body. In warm weather, and especially outdoors in the sun, the radiant heat load is high, and the body cannot lose heat by radiation. Shade and light colored clothing block absorption of the radiant energy of the sun by the body.

6-2. Types of Heat Injury

Three distinct clinical syndromes of heat injury may occur, depending on the manner of breakdown in the individual's heat adjustment. These syndromes are heat cramps, heat exhaustion, and heatstroke. The three conditions produce distinctive signs and symptoms which should be recognized at once not only by the medical officer, but also by the line officer and other personnel if the casualty is to receive proper care and attention. All military personnel should be familiar with the first aid treatment of these conditions.

NOTE

For heat injury treatment, see FM 8-230.

a. Heat Cramps. Painful cramps of the voluntary muscles may occur following exposure to heat. Heat cramps result primarily from excessive loss of salt from the body. The muscles of the extremities and of the abdominal wall are usually involved and the cramps may be of great severity. Heat cramps can occur alone or in the presence of heat exhaustion. Body temperature is normal unless heat cramps are accompanied by heat exhaustion.

b. Heat Exhaustion. Heat exhaustion occurs as the result of peripheral vascular collapse due to excessive salt depletion and dehydration. This syndrome is characterized by profuse sweating, headache, tingling sensations in the extremities, pallor, dyspnea, palpitations association with gastrointestinal symptoms of anorexia, and occasionally, nausea and vomiting. Neuromuscular disturbances with trembling, weakness, and incoordination coupled with cerebral signs ranging from slight clouding of the sensorium to momentary loss of consciousness complete the classical picture. The skin is cool and moist. The pulse rate is rapid (120 to 200 beats per minute), and the blood pressure may be low. The oral temperature may be subnormal (as in cases where hyperventilation is present) or slightly elevated, but the rectal temperature is usually elevated.

NOTE

For first aid, see FM 21-11 or FM 8-230.

c. Heatstroke. HEATSTROKE IS A MEDICAL EMERGENCY, with a high mortality rate. Whereas heat exhaustion may be regarded as the end result of overactive heat-balance mechanisms that are still functioning, heatstroke results when thermo-regulatory mechanisms are not functional, and the main avenue of heat loss (cooling by evaporation of sweat) is blocked. There may be early signs, such as headache, dizziness, delirium, weakness, nausea, vomiting, and excessive warmth; however, sweating may or may not be absent. Although the patient may first progress through the symptoms of heat cramps or heat exhaustion, the onset of heatstroke may occur with dramatic suddenness with collapse and loss of consciousness. Profound coma is usually present and convulsions may occur. In the early stage, the patient's skin is usually hot, red, and dry. The presence of sweating does not exclude this diagnosis. The best sign of this injury is a high body temperature, in excess of 106°F (41°C). A rectal temperature exceeding 108°F (42°C) is not uncommon and indicates a poor prognosis. The patient's condition deteriorates rapidly; therefore, treatment must begin immediately. One attack of heatstroke predisposes to a second attack, and care should be taken by the individual to avoid a second exposure to the precipitating condition. An alternative view is that the individual is a member of a susceptible population and remains susceptible.

6-3. Predisposing Factors Leading to Heat Injury

a. Several human factors come into play which increase the heat load on the body and make the likelihood of injury more prevalent. Individuals who are unacclimatized are much more likely to be injured. Recruits are particularly vulnerable to heat injury. The individual who has been living in a cool climate does not handle heat stress well. In fact a person who is acclimatized to heat and who moves to a cool area for 1 month loses most of his acclimatization to heat.

b. Overweight and fatigue impair the body's heat losing mechanisms. It takes work on the part of the body to lose heat, and an already tired body cannot perform this function well.

c. Heavy meals and hot foods put unnecessary stress on the body. Hot meals add heat which must be eliminated. Heavy meals direct blood flow to the digestive tract.

d. Use of alcoholic beverages, especially amounts resulting in hangovers, will decrease the ability of the body to deal effectively with heat stress.

e. Fever increases the amount of heat to be dissipated by the body. Fever is usually the result of disease processes, but can also be induced by man. Many of the immunizations which are administered produce fevers. This becomes an important consideration, particularly for the recruit, who is being stressed in other ways as well.

f. Drugs which inhibit sweating such as atropine, scopolamine, antihistamines, some tranquilizers, cold medicines, and some antidiarrheal medications markedly impairs heat loss when temperatures are high.

g. Tight, occlusive clothing is detrimental to heat loss from the body. Clothing should be loose so as not to restrict circulation or impede movement of air over the skin.

6-4. Prevention of Heat Injuries

Successful prevention of adverse effects of heat depends largely on education of personnel, including the personnel exposed to heat, especially those charged with the supervision of such personnel. Specifically, prevention of heat injury involves the development of procedures to alert individuals to the existence of dangerous heat stress levels, the application of measures to reduce both the severity and duration of exposure,and adoption of techniques to increase the resistance of exposed persons. Resistance is increased by gradual acclimatization of individuals to hot environments, or at least graduated introduction of the required work level in a hot environment; by replenishing water and salt losses from the body as they occur; and by the maintenance of the optimum physical condition of personnel. Heat stress is decreased by reducing the workload and by introducing any measure which will protect the individual from the hot environment.

a. Water.

(1) The human body is highly dependent on water to cool itself in a hot environment. By sweating, an individual may lose water in excess of 1 quart per hour. These losses must be replaced; or rapid decrease in the ability to work, a rise in body temperature and heart rate, deterioration of morale, and heat injury will occur. Water loss should be replaced by periodic intake of small amounts of water throughout the work period. Personnel must be encouraged and given time to drink water, since normal thirst does not serve as a true indication of the body's need for water. Table 6-1 may be used as a guide to estimate the drinking water requirements for personnel exposed to heat. This table should be used for planning and procurement purposes only, and should not be used as a yardstick for water intake of any individual.

(2) During the period of moderate activity, with moderate conditions prevailing, water requirement will be 1 pint or more per hour per man. This is best taken at 20- to 30-minute intervals. As activities or conditions become more severe the intake increases accordingly. When water is in short supply, significant water economy may be achieved by limiting physical activity to the early morning, evening, and night hours when the heat load is less and sweating is reduced. The optimum drinking water temperature is between 50°F and 60°F.

(3) The belief that men can be taught to adjust to decreased water intake is incorrect. Man cannot live or work in heat without sufficient water.

(4) Excess intake of salt should be avoided, since it may cause increased thirst and intestinal disturbances.

b. Salt.

(1) In addition to water, sodium chloride is lost in the sweat. The military diet usually provides adequate salt.

(2) A convenient method of providing adequate salt intake is to encourage use of salt added to food at mealtime. This, along with salt in cooking and in bread, coupled with sound training, will meet most usual requirements. Excess intake of salt should be avoided; it may cause increased thirst and intestinal disturbances.

CAUTION

Due to the high salt concentration in field rations, caution must be taken to maintain a high water intake.

Table 6-1. Heat Injury Prevention

*CRITERIA		CONTROLS		
			Physical Activity for Soldiers	
Heat Condition	WBGT Index °F	Mandatory Water Consumption	**Acclimatized Work/Rest	Unacclimatized Soldiers and Trainees
Green	82–84.9	At least 1/2 quart/hour	50/10 minutes	Use discretion in planning heavy exercises.
Yellow	85–87.9	At least 1 quart/hour	45/15 minutes	Suspend strenuous exercise during first three weeks of training. Training activities may be continued on a reduced scale after the second week of training. Avoid activity in direct sun.
Red	88–89.9	At least 1 1/2 quarts/hour	30/30 minutes maximum 6 hrs/day	Curtail strenuous exercise for all personnel with less than 12 weeks of hot weather training.
Black	90 and up	More than 2 quarts/hour	20/40 minutes	Physical training and strenuous exercise is suspended. Essential operational commitments not for training, where risk of heat casualties may be warranted, is excluded from suspension.

*MOPP gear or body armor adds 10°F to the WBGT index.

**An acclimatized soldier is one who has worked in the given heat condition for 10 to 14 days. These work/rest periods do not apply to soldiers in MOPP gear or body armor.

c. Acclimatization.

(1) Training programs for personnel who are climatically and/or physically unseasoned to heat should be limited in intensity and time. A period of approximately 2 weeks should be allowed for acclimatization with progressive degrees of heat exposure and physical exertion (substantial acclimation, about 78 percent). If men are required to perform heavy physical work before being acclimatized, the work is poorly performed, development of the capacity to effective work is retarded, and the risk of heat injury and disability is high. A period of acclimatization is necessary regardless of the individual's physical condition, although the better the physical condition, the quicker acclimatization is completed.

(2) Acclimatization to heat begins with the first exposure, and is usually well developed by the end of the first week. Individuals who are unusually susceptible to heat will require additional time for acclimatization. Full acclimatization (the ability to perform a maximum amount of strenuous work in the heat) is attained most quickly by gradually increasing work in the heat. Resting for 3 or 4 days in the heat, with activity limited to that required for existence, results in only partial acclimatization. Physical work in the heat must be accomplished for development of full acclimatization to that work level in a given hot environment. A day or two of intervening cool weather will not interfere significantly with acclimatization to a hot environment.

(3) A schedule should be established which provides for alternating work and rest periods. Although advantage should be taken of the cooler hours in accomplishing a portion of the work, the schedule should include gradually increasing exposure during the hotter parts of the day rather than complete exclusion of work at that time. Table 6-1 provides work/rest cycles. These cycles may be modified to be consistent with local conditions. The work period should be divided so that a man works and rests in alternating periods. When necessary to accomplish a given task two details can be arranged to work in sequence. The schedule is based on work equal to that of marching with a 20-pound pack at the rate of 2.5 miles per hour. Lighter work may be carried out for longer periods of time, and heavier work for shorter periods. During the midday period the men should rest and keep in the shade as much as possible. Peak wet bulb globe temperature (WBGT) conditions usually occur between 1200 and 1400 hours. Local and regional variations may warrant modifications of the above schedule. Acclimatization schedules for unseasoned individuals, including recruits, should be scaled down to their tolerance.

(4) Adequate water must be provided during the acclimatization period as well as other times.

(5) Once acclimatized, the soldier will retain his adaption for 1 week after leaving the hot environment, but if not exposed to work in high temperatures, the acclimatization will then decrease at a variable rate, the major portion being lost within 1 month.

(6) Acclimatization to a hot, dry (desert) environment markedly increases the ability of men to work in a hot, moist (jungle) environment; however, for proper acclimatization to the latter, residence in such an area

with regulated physical activity is required. Whereas carefully and fully developed acclimatization increases resistance, it does not provide complete protection against ill effects of heat, especially moist heat.

(7) Under conditions of heat stress, meals should be cool rather than hot. The heaviest meal should be served in the evening rather than at noon. An hour of rest following the noon meal is beneficial.

d. Physical Condition. The general physical condition of the individual has a significant bearing on the reaction to heat stress. Individual susceptibility to heat may be enhanced by a large number and variety of conditions. Among these are infections, fevers, immunization reactions, heat rash, sunburn, fatigue, overweight, and previous case of heatstroke. The risk of heat injury is very much higher in overweight unfit persons than in those of normal weight. Special care should be exercised when such persons are exposed to high temperatures. One attack of heatstroke predisposes a person to a second. An individual once affected should therefore be exposed to heat stress with caution. Predisposition is not developed in the case of heat exhaustion and heat cramps.

e. Work Schedules. Work schedules must be tailored to fit the climate, the physical condition of personnel, and the military situation. Close supervision by medical personnel and commanders is essential in achieving maximum work output with minimum hazard. Several principles must be considered:

(1) The amount of heat produced by the body increases directly with increasing work; therefore, reduction of workload markedly decreases the total heat stress.

(2) Workloads and/or duration of physical exertion should be less during the first days of exposure to heat and should be gradually increased to allow acclimatization.

(3) Decisions to modify work schedules must be governed by the local situation, heavy work should be scheduled for the cooler hours of the day such as early morning or late evening.

(4) Alternate work and rest periods may prove desirable. Under moderately hot conditions, 5-minute rest periods in the shade alternating with 25 minutes of work in the sun may be desirable. Under severe conditions the duration of rest periods should be increased.

(5) Exposure to high temperature at night as well as in the daytime will decrease the amount of work men can perform effectively.

(6) Workloads must be reduced at high temperatures when dehydration resulting from excess sweating and lack of water replacement occurs. When water is in short supply, working in the early morning and evenings will allow for the accomplishment of much more work for the expenditure of a given amount of water than working during the hottest hours of the day.

(7) Work in the direct sun should be avoided as much as possible on hot days.

(8) Unnecessary standing at attention in the heat should be avoided because continued standing places an added burden on the body's circulatory system.

(9) When the temperature is very high, physical work should be curtailed or, under extremely severe conditions, even suspended. The temperature at which work should be curtailed or suspended depends on the humidity, heat radiation, air movement, character of the work, degree of acclimatization of personnel, and other factors. Heat casualties may be expected at wet bulb globe temperature indices of 75°F and above unless preventive measures are instituted. Overexertion can cause heat injury at even lower temperatures, especially if body armor or vapor impermeable protective clothing is worn.

f. Protection from the Environment. Except when exposed to the sun's rays, an individual in a hot environment is better off wearing the least allowable amount of clothing. Clothing reduces the exposure of the body surface to solar radiation, but at the same time decreases the movement of air over the skin. To take full advantage of its benefits and minimize its disadvantages, clothing should be loose fitting especially at neck, wrists, and lower legs to allow circulation of air. Protection from the environment also includes such simple but frequently overlooked things as marching troops over grass rather than concrete and operating in the shade, if available.

g. Special Considerations in Recruit Training.

(1) Trainees are a group of unseasoned personnel who require special attention because of the unusual physical stresses involved in basic training in summer heat. Adjustment to this stress is difficult and must be taken into account in planning training schedules. Curtailment of work and scheduling strenuous training activities for the coolest parts of the days will yield greater efficiency and less disruption of training than will ignoring the weather in the interest of completing a heavy schedule. Heat casualties occur most frequently during the first 2 weeks of basic training and during the bivouac week, especially when firing on the rifle range; during squad tactical training; and retreat parades. Decreasing the heat stress accompanying these activities is important.

(2) Recruit heat casualties tend to occur in groups within particular units; therefore, each case must be promptly investigated to determine the unsafe practice or condition responsible, and corrective measures must be taken to prevent other cases.

h. Education. Prevention of heat casualties depends largely on the education of personnel exposed and especially upon supervision by informed commanders. Every individual exposed to unaccustomed high temperatures should be informed of the potentially serious results of heat injury, the general nature of these conditions, and how they can be prevented. Supervisors must be able to identify environmental conditions under which adverse effects of heat are likely to occur. They should recognize the earliest signs of heat injury and take action to prevent the development of cases. All personnel should be able to apply effective first aid. Mental confusion and overactivity usually precede collapse from heatstroke. Supervisors must be alert to detect this condition, enforce rest, and obtain medical assistance promptly. Medical personnel should assist commanders in the development of local programs for heat injury prevention.

i. The Wet Bulb Globe Temperature (WBGT) Index.

(1) *General.* The Wet Bulb Globe Temperature Index serves as a guideline for making recommendations to the commander when hot weather conditions are hazardous for the troops. With this information, decisions can be made regarding troop activity in hot weather.

(2) *Method and equipment.*

(a) The WBGT Index is computed from readings of a stationary wet bulb thermometer exposed to the sun and to the prevailing wind, a black globe thermometer similarly exposed, and a dry bulb thermometer shielded from the direct rays of the sun. All readings are taken at a location representative of the conditions to which men are exposed. The thermometers are suspended in the sun at a height of 4 feet above ground, as shown in Figure 6-1. A period of 30 minutes should elapse before readings are taken.

(b) The wet bulb thermometer is a standard laboratory glass thermometer with its bulb covered with a wick (heavy white corset string or shoestring). The wick dips into a flask of clean, preferably distilled, water. The mouth of the flask should be about three-fourths of an inch below the tip of the thermometer bulb. The water level in the flask should be high enough to ensure thorough wetting of the wick. The water should be changed daily after rinsing out the flask and washing the wick with soap and water. The water and wick must be free of salt and soap, or erroneous readings may result.

(c) The globe-thermometer apparatus consists of a 6-inch hollow copper sphere painted flat black on the outside and containing a thermometer with its bulb at the center of the sphere. The thermometer stem protrudes to the outside through a rubber stopper tightly fitting into a brass tube soldered to the sphere (Figure 6-1). The sphere has two small holes near the top used for suspending the sphere with wire. The globe must be kept dull black at all times, free of dust or rain streaks.

(d) The dry bulb thermometer is a standard laboratory glass thermometer with its bulb protected from direct sunlight.

(e) The WBGT Index is computed as follows:

$$\begin{aligned} \text{WBGT} &= 0.7 \times \text{wet bulb temperature} \\ &+ 0.2 \times \text{black globe temperature} \\ &+ 0.1 \times \text{dry bulb temperature} \end{aligned}$$

Example: The following readings are obtained:

Wet Bulb = 70°F
Dry Bulb = 100°F
Black Globe = 130°F

The WBGT Index at this particular time is computed as follows:

$$\begin{aligned}\text{WBGT Index} &= (0.7)(70) + (0.2)(130) + (0.1)(100)\\ &= 49 + 26 + 10\\ &= 85°\text{F}\end{aligned}$$

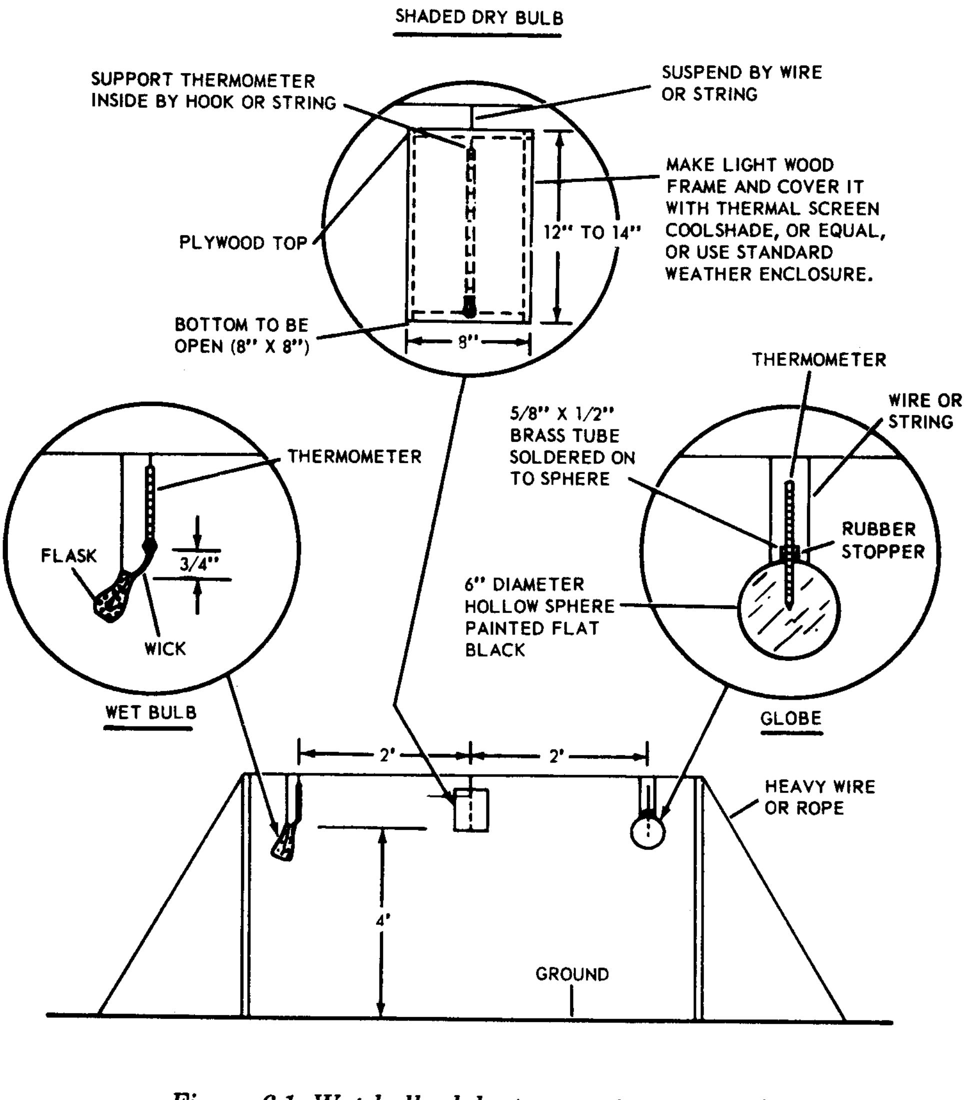


Figure 6-1. Wet bulb globe temperature apparatus.

6-5. Use of the WBGT Index in the Control of Physical Activity

It should be emphasized that the measurements must be taken in a location which is the same as, or closely approximates, the environment to which personnel are exposed.

a. When the WBGT Index reaches 82°F, discretion should be used in planning heavy exercise for unseasoned personnel.

b. When the WBGT reaches 85°F, strenuous exercises such as marching at standard cadence should be suspended for unseasoned personnel during their first 2 weeks of training. At this temperature training activities may be continued on a reduced scale after the second week of training.

c. Outdoor classes in the sun should be avoided when the WBGT exceeds 85°F.

d. When the WBGT reaches 88°F, strenuous exercise should be curtailed for all recruits and other trainees with less than 12 weeks training in hot weather. Hardened personnel, after having been acclimatized each season, can carry on limited activity at WBGT of 88°F to 90°F for periods not exceeding six hours a day.

e. When the WBGT index is 90°F and above, physical training and strenuous exercise should be suspended *for all personnel* (excluding essential operational commitments not for training purposes, where the risk of heat casualties may be warranted).

f. Wearing body armor or mission oriented protective posture (MOPP) in effect adds 10°F to the measured WBGT. Limits should be adjusted appropriately.

Section II. COLD INJURIES

6-6. General

a. Cold injury is defined as tissue injury produced by exposure to cold. The type of injury produced depends upon the degree of cold to which the body is exposed, the duration of the exposure, and the environmental factors responsible for injuring the body.

b. Cold injury can occur at nonfreezing and at freezing temperatures. Pathologically, all cold injuries are similar. Nonfreezing cold injury is associated with exposure to water and cold. Chilblain, immersion foot, and trench foot are the three common terms applied to nonfreezing cold injury, and a description of each appears below. However, these three terms apply to the same basic injury. The other injury, frostbite, is an injury caused by freezing cold. Hypothermia is a condition caused by cold and body heat loss.

(1) Chilblain results from intermittent exposure to temperatures above freezing, in high humidity.

(2) Immersion foot results from prolonged exposure, usually in excess of 12 hours, in water at temperatures usually below 50° F. It is not limited to the feet, but may involve other areas following immersion. Exposure for several days in water at 70° F in tropical latitudes has produced severe injury.

(3) Trench foot results from prolonged exposure to cold—and usually wetness—at temperatures from just above freezing to 50 °F. It is often associated with immobilization and dependency of the lower extremities. The average duration of exposure resulting in trench foot is 3 days.

(4) Frostbite is produced by exposure at temperatures of freezing or below. Depending upon the air temperatures, the time of exposure varies from a few minutes to several hours. High altitude frostbite results from exposure at high altitude to temperatures varying from -20 °F to -80°F. At these very low temperatures, severe injury may be instantaneous, especially to exposed parts such as fingers, ears, and the nose.

(5) General hypothermia is an acute problem resulting from prolonged cold exposure and body heat loss. If an individual becomes fatigued during physical activity, he will be more prone to heat loss, and as exhaustion approaches, sudden blood vessel dilation occurs with resultant rapid loss of body heat.

6-7. Predisposing Factors

Cold injury, as it involves a military population, behaves in general according to accepted epidemiologic principles. A specific agent is present and a variety of environmental and host factors influence the incidence, prevalence, type, and severity of the injury. Three main factors are involved in cold injury:

a. Agent Factors. Cold is the specific agent in cold injury and is the immediate cause of tissue damage without respect to the influence of modifying factors. If, however, the effect of cold is considered in terms of loss of body heat, the effect of moisture as a conductor of heat is readily apparent, and the ways in which various host and environmental factors modify the extent and severity of cold injury become clear. However, the effect of cold cannot be evaluated in direct relation to air temperature alone.

b. Environmental Factors.

(1) Weather is a predominant factor in cold injury. Temperature, humidity, precipitation, and wind modify the rate of body heat loss. Low temperatures and low relative humidity favor development of frostbite. Higher temperatures (just above freezing to 50°F) together with moisture are usually associated with trench foot. Wind velocity accelerates body heat loss under conditions of both coldness and wetness. The effect of low temperatures is intensified as air movement past the body increases. This can be the result of wind against the body or the effect of a body moving rapidly through the air, such as in running, skiing, or riding in an open vehicle. The effects of wind speed on chilling the body are illustrated in Table 6-2.

Table 6-2. Windchill Chart

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F) 50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill 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	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148

(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER in less than one hour with dry skin. Maximum danger of false sense of security.	INCREASING DANGER Danger from freezing of exposed flesh within one minute.	GREAT DANGER Flesh may freeze within 30 seconds.

NOTE: 1. Trench foot and immersion foot may occur at any point on this chart.
2. F = 9/5 C +32.

(2) The incidence of cold injury varies greatly according to the type of combat action. Units in reserve or in rest areas have few cases of cold injury. On holding missions or on static defense, exposure is greater, and a moderate increase in incidence is expected. On active defense or offense marked increases in cold injuries usually occur. Immobility under fire, prolonged exposure, lack of opportunity to rewarm and change clothing or carry out personal hygienic measures, fatigue, and state of nutrition may be involved.

(3) Adequate clothing properly worn is essential to survival. Clothing for cold weather combat has been designed to be worn as an assembly for protecting the head, torso, and extremities. Failure to wear the total assembly, and inadequate supplies of properly sized items of clothing are important factors leading to cold injury. The assembly depends upon the layering principle to conserve body heat. Accordingly, loose layers of clothing with air space between and under an outer wind- and water-resistant garment provide maximum protection. It is flexible; also, outer layers may be removed for comfort and efficiency to permit escape of perspiration in higher air temperatures or during strenuous physical exertion. Clothing wet by perspiration loses much of its insulating value. Care must be taken to prevent perspiration from accumulating in the clothing. In all forms of cold injury, prevention of body heat loss by proper protection of the body is as important as wearing efficient head, hand, or footgear. All articles of clothing must be loose enough to avoid constriction.

c. Host Factors.

(1) *Age.* Within the usual age range of combat personnel, age is not significant.

(2) *Rank.* Trench foot and frostbite injuries are higher in front-line riflemen, and predominantly in those of the lower ranks because they have greater exposure. The decreased incidence of cold injury among higher ranks is because of a combination of factors, such as experience, intelligence, leadership, receptivity to training, and significantly less exposure.

(3) *Previous cold injury.* A previous episode of trench foot, frostbite, or immersion foot greatly increases the individual's risk to another cold injury of the same part previously injured.

(4) *Fatigue.* Fatigue is a factor contributory to cold injury because as personnel become exhausted they fail to carry out simple preventive measures. This occurs more frequently in personnel who have been in combat for 30 days or more without rest. Mental weariness may cause apathy leading to the neglect of actions vital to survival. Frequent rotation of troops from the frontlines for even short periods lessens the effects of fatigue.

(5) *Discipline, training, and experience.* Individual and unit discipline, training, and experience are closely related as they influence the incidence of cold injury. Well-trained and well-disciplined men profit from combat experience in the cold. They are better able to care for themselves through personal hygiene, care of the feet, change of clothing, exercise of the extremities in pinned-down positions, and similar simple but effective measures. Preventive measures necessary for survival in the cold should be continuously stressed to the troops, so that they will be able to cope with these problems.

(6) *Psychosocial factors.* Cold injury tends to occur in passive, negativistic, or hypochondriacal individuals, who display little muscular activity and are prone to pay less attention to carrying extra footwear; changing socks when needed; and reducing smoking under combat conditions where cold injury is a threat.

(7) *Race.* In terms of numbers at risk, and independent of geographic origin, the Blacks appear to be considerably more vulnerable to frostbite than do the Caucasians.

(8) *Geographic origin.* The geographic origin of the individual seems to be a significant factor among Caucasians in the incidence of cold injury. Origin from warmer climates of the United States (including Puerto Rico) (in states where the mean minimum January temperature is above 20°F) predisposes cold injury.

(9) *Nutrition.* Poor nutrition contributes to susceptibility to cold injury. Adequately clothed and protected personnel living and working in cold climates do not require an increase in caloric intake above that normally provided in the military ration.

(10) *Activity.* Too much or too little activity can contribute to cold injury. Overactivity with rapid and deep breathing can cause the loss of large amounts of body heat. Perspiration trapped in clothing markedly reduces the insulating quality of the clothing. On the other hand, immobility causes decreased heat production with the danger of resultant cooling, especially of extremities.

(11) *Drugs and medications.* Personnel should be made aware of the effects of smoking in decreasing peripheral circulation and of alcohol ingestion in dilating peripheral vessels. Both tobacco and alcohol should be avoided when the danger of cold injury exists.

6-8. Prevention of Cold Injuries

a. General. Cold injuries are preventable except in unusual situations. Successful prevention requires vigorous command leadership; prior planning in such activities as cold weather training; and the provision of cold weather clothing and equipment. Specific preventive measures are directed toward conserving body heat and avoiding unnecessary exposure of personnel to cold, moisture, and activities or factors favoring cold injury.

b. Meteorological Data. All commanders must be familiar with the use of meteorological data such as humidity, temperature, wind, and ground surface condition which influence the risk of cold injury. The windchill chart helps each commander judge the severity of the environment. Some weather conditions require shortening the exposure time of individuals engaged in patrols, guards, or motor movements in unheated vehicles despite the adequacy of their clothing and equipment. These can frequently be anticipated by the use of meteorological data and existing weather conditions to predict the hazard for the ensuing 12-hour period.

c. Cold Injury Control Officer. Each platoon or comparable-sized unit should have a cold injury control officer or NCO; who is carefully selected on the basis of leadership, interest, and ability to supervise others in simple but constant preventive activities. He should frequently check clothing supplies; inspect his men daily for personal hygiene; care of their feet; and early signs and symptoms of cold injury; ensure that socks are changed at appropriate intervals and that all reasonable efforts are made to keep them clean and dry; encourage efforts to exercise even if only their extremities; ensure that constriction of extremities by clothing, equipment, and footgear is avoided.

d. The Buddy System. Members of squads and patrols should be taught to observe their companions for evidence of cold injury. If blanching of the skin is noted, immediate care will usually prevent the development of cold injury. Holding (not rubbing) a warm hand on the blanched area until it returns to normal color will rewarm a companion's ear, nose, or cheek. Fingers can be warmed against the skin of the abdomen or in the armpit. Toes can be rewarmed by holding them against a companion's bare chest or abdomen, care being taken to provide protection from the wind. A symptom of incipient frostbite of fingers and toes is the sudden and complete cessation of the sensation to cold or discomfort in the part. This is often followed by a pleasant feeling of warmth. If these danger signals are instantly heeded, cold injury can be prevented.

e. Personal Measures.

(1) Wear or carry adequate clothing for the weather to be encountered. Remove excess layers of clothing before perspiration starts so that clothing does not become wet. Avoid wetting clothing or footgear, since moisture causes loss of insulating quality.

(2) Wear clothing and footgear in loose layers to permit layers of air to provide good insulation and to permit good circulation of blood to all parts of the body. Tailored, tight-fitting uniforms are dangerous in cold climates.

(3) Keep hands well protected; mittens are more protective than gloves. Avoid lengthy exposure of bare hands and wrists that will cause stiffening and reduce circulation, since it takes a long time to recondition the hands to normal use. Do not touch metal, snow, or other objects with bare hands.

(4) Avoid immobilization in the cold. If the situation permits, walk about and exercise periodically to generate and maintain body heat. If unable to walk about, shift positions frequently, especially moving the toes, feet, legs, fingers, and arms. Sit or stand on insulating material such as wood, cardboard, or other poor conductor rather than on cold or wet ground or snow.

(5) Remove excess clothing when near a fire or in a warm inclosure; otherwise, the body adjusts to the warm temperature and excess clothing. Upon returning to the cold air, the body will adjust more slowly to the cold and excessive amounts of body heat will be lost. The result will be the loss of more heat than the body gained during warming, with an increased susceptibility to cold injury.

f. Clothing.

(1) A standard number of layers of clothing cannot be prescribed for universal wear during winter months. Flexibility must be provided for local conditions. Certain basic principles are important, including ventilating the body during physical activity, the cleanliness and repair of clothing to prevent loss of insulation, and avoidance of constriction produced by snug fitting socks, boots, underwear, sweaters, jackets, and trousers.

(2) Ground forces personnel in cold areas should be equipped with insulated rubber combat boots. Frequent change of socks is important with these boots because of increased sweating, retention of sweat, and a lowered resistance to fungal infections. Although sweating in these boots does not contribute to the loss of insulation, it does lead to softening the soles of the feet by the retained sweat. Trauma to macerated tissues, produced by walking, results in a loss of skin from the soles of the feet which may require hospitalization. Cold injuries to the feet have been reported when wearing the insulated boot. These injuries usually result from inactivity and dependency of the feet, as occurs with prolonged sitting or standing without frequent foot or leg movement. Periodic exercise, plus good foot hygiene and dry socks, will help to prevent such injuries. The insulated boot should also be inspected periodically for punctures. A hole in the boot renders it ineffective and may cause cold injuries.

(3) In all types of footgear, feet perspire more and are less ventilated than other parts of the body, so that moisture accumulates in socks, decreasing their insulating quality. Because of this and the fact that the feet are susceptible to cold injury and less frequently observed than the remainder of the body, special foot and sock care is essential. Extra socks should be carried by all personnel. Socks damp from perspiration will dry if carried unfolded inside the shirt and should be changed daily and washed whenever the opportunity permits. Socks and other clothing charged with dirt, grease, or mineral salts from perspiration will conduct heat more rapidly, thus affording less protection against the cold.

g. Unusually Susceptible Groups. Individuals with host factors listed in paragraph 6-7 require greater protection and supervision of preventive measures in order to prevent cold injury.

CHAPTER 7

PREVENTION AND CONTROL OF MISCELLANEOUS DISEASES

7-1. Schistosomiasis

a. General. Schistosomiasis (Bilharziasis) is a parasitic worm disease of man in which schistosomes (blood flukes) live and reproduce in the veins of the human host. Three types of flukes are of importance — *Schistosoma mansoni*, *Schistosoma haematobium*, and *Schistosoma japonicum*. The disease is wide spread, but tends to be more prevalent in the warmer climates.

b. Life Cycle of Schistosomes.

(1) Blood flukes are modified forms of flatworms. The life cycles of all three species of *Schistosoma* are very similar (Figure 7-1). The adult male and female worms live in the veins of the host (infected humans and in some cases domestic and wild animals). Eggs are laid and ultimately find their way into feces and/or urine. The eggs hatch upon coming in contact with fresh water, and a free swimming form is released — the miracidium. This organism is microscopic in size and lives only 6 to 8 hours. During this time it must come in contact with an appropriate species of snail. If it does, the miracidium penetrates the body of the snail. During the next few weeks asexual reproduction takes place in the body of the snail with growth and maturation into the cercarial form of the fluke. After about a month cercariae begin to emerge from the body of the snail and swim about freely in the water. A single infected snail can produce thousands of cercariae and release them for periods of 6 months and longer.

(2) Man becomes infected when he comes in contact with water contaminated with cercariae. This may occur when he works, bathes, or swims in this water. He can also become infected when he drinks this water, since the cercariae will penetrate the mucosa of the mouth. Cercariae can penetrate the intact skin within 6 to 8 minutes through a combination of secretion of a digestive enzyme from the mouth and a wiggling motion of the tail.

(3) The tail is shed after penetration is complete. After fully entering the body and migrating to the liver, the cercaria begins maturing into an adult male or female blood fluke. Over a period of about 1 month the schistosomes mate and migrate to the blood vessels of the intestines or urinary bladder, depending on the species of the schistosome.

(4) The severity of the disease produced is determined by the species of fluke. *Schistosoma japonicum* infections tend to lead to more severe illness. Also, the number of cercariae which enter the body has a direct bearing on the severity of disease; that is, the heavier the infestation, the more severe the disease. A heavy infestation can occur from a single massive exposure or from multiple small exposures.

c. Clinical Symptoms of Schistosomiasis. Early symptoms are variable, both in the time of their appearance and their intensity, and may occur in every part of the body. Itching and rash at the site of penetration may manifest immediately after exposure. Three to 10 weeks later, a variety of general symptoms that may impair the patient's ability to function effectively may be present and may last from several weeks to several months. These signs and symptoms include fever, abdominal pain, diarrhea, loss of appetite, blood in the urine, and weight loss. There may be remissions and relapses, but spontaneous cessation of early symptoms usually occurs in most cases if reinfection does not occur. After a number of years, late symptoms of various kinds may appear in the circulatory, respiratory, digestive, or nervous systems separately or in combination. Characteristically, there is cirrhosis of the liver with accompanying splenic enlargement. These late symptoms are due to scarring in the various organs due to eggs erroneously entering the circulation system rather than passing from the body. Emaciation may be extreme; without treatment, schistosomes may persist and reproduce in the body for up to 20 years. This chronic disease weakens those infected and inhibits their productivity. Eventually it causes an early death.

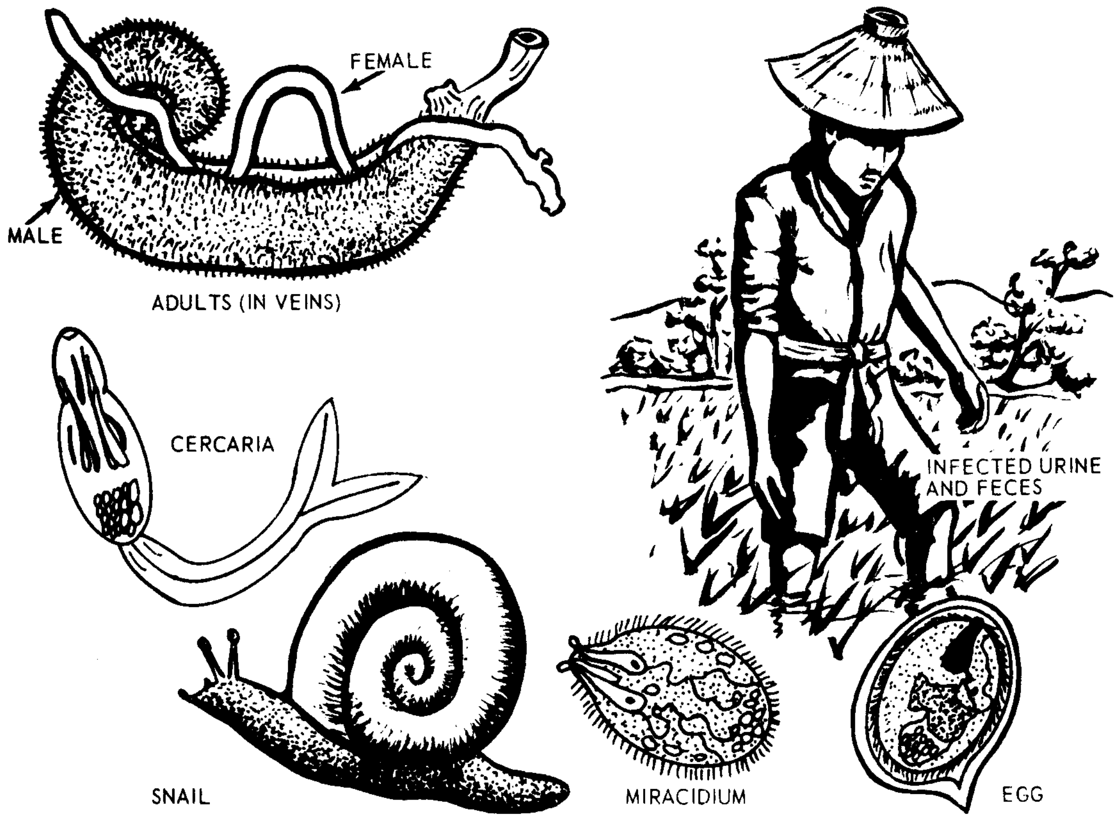


Figure 7-1. Life cycles of schistosoma species.

d. Prevention. Under combat conditions in endemic areas, the avoidance of cercariae-infested water is often difficult or impossible. Precautions that can be taken by individuals to prevent or reduce chances of infection are as follows:

(1) Clothing, especially if it has been impregnated with arthropod-repelling compounds (M-1960), serves as an effective barrier. Trousers should be tucked into the tops of boots and as much of the skin covered as possible.

(2) Applying insect repellent (DEET) to exposed portions of the skin that may come in contact with infested water will give added protection for a short time.

(3) Surveys by trained personnel should be made as early as possible to locate infested bodies of water. These should be posted with warning signs.

(4) Orders regarding avoidance of exposure should be strictly enforced. Troops should be told of the need to avoid contact with infested water. Swimming, bathing, clothes laundering, and vehicle washing in fresh water ponds, streams, and canals should be prohibited in endemic areas. Personnel required to handle or enter the water should be protected as much as possible by rubber hip boots, waders, rubber gloves, or other waterproof clothing. Since cercariae require a few minutes to penetrate the skin of an unprotected area of the body, the immediate application of any available disinfectant, soap, or even brisk rubbing the skin with a towel or article of clothing, may reduce the chance of infection. Where possible, water used for laundering or bathing by small units away from their base should be taken from subsurface sources. Surface water should be processed if a subsurface source is not available. Holding water in storage for 72 hours after its removal from surface sources (in snail-free containers) will eliminate the cercariae. If this is not feasible, Lyster bags of treated water can be used. Filtration of water through a diatomite filter removes cercariae. Routine chlorination and iodination destroy all cercariae after 30 minutes contact. Bringing water to a boil also destroys the cercariae.

(5) Improving the level of sanitation in underdeveloped areas where schistosomiasis is endemic offers another means of control of this disease. It must be kept in mind that this is a long-term approach to preventing infection.

(6) There are snail killing compounds (molluscicides) which can effectively reduce the population of the intermediate host and thereby break the cycle. The disadvantage is that much time must elapse after application of the molluscicide before the benefits are realized.

7-2. Tetanus

Tetanus occurs throughout the world.

a. This disease is the result of a toxin produced by *Clostridium tetani* bacteria. The source of the bacteria is human and animal feces. The bacteria enters the body through a wound. The bacteria can only grow and produce toxin under anaerobic conditions; therefore, deep puncture or perforating wounds are most susceptible to infection with *Clostridium tetani*.

b. Tetanus is characterized by painful muscular contractions, especially in the jaws and neck. Eventually death results from respiratory paralysis. Case fatality rates may range as high as 65 percent.

c. The best preventive measure for tetanus is active immunization using tetanus toxoid. After a tetanus prone injury, booster doses of toxoid should be given if more than 5 years have elapsed since the patient received his last booster. If the patient has not had active immunization, a combination of active and passive immunization may be indicated. Not to be underestimated is the value of careful debriding and cleaning of all wounds.

7-3. Malnutrition

a. General. Malnutrition is a very broad term which literally means "bad nutrition." Malnutrition refers to any one of the many signs or symptoms of any type of disorder in the nutritional well-being of the individual. Both starvation and obesity are forms of malnutrition. Malnutrition can take many forms, depending on the nutrient or nutrients involved. Nutritional disease can result from an inadequate intake of nutrients or from an excessive intake of nutrients.

b. Inadequate Intake of Nutrients.

(1) An inadequate intake of nutrients results in body deficiencies of needed materials and causes deficiency diseases of various types. Epidemics of deficiency diseases and symptoms of nutritional deficiencies are rarely seen in modern armies. Nutritional deficiencies occur as a result of individuals eating fad foods, poor food habits, improper selection of foods, loss of appetite, or disturbed body function. Deficiencies may occur at times among small groups isolated from sources of supply and are common among prisoners of war. When a deficiency has progressed to a point where disease can be recognized, the soldier has already declined in physical efficiency and often is incapacitated. More widespread and, therefore, of greater military importance are the mild deficiencies resulting from an intake of vitamins and other nutrients below the necessary minimum amounts. Symptoms, such as fatigue, inefficiency, weakness, irritability, insomnia, and gastrointestinal disturbances, may be seen in troops who have subsisted for long periods of time on rations of borderline adequacy. A subclinical deficiency may be confused with battle fatigue. In fact, vitamin deficiency may contribute to the development of battle fatigue.

(2) In operations involving active combat, particularly assault operations, the problem of maintaining physical fitness through adequate nutrition is difficult. It is of the utmost importance that the soldier consume sufficient calories each day to compensate for the energy he expends. If the soldier must fight under a condition of gross caloric deficiency, his physical condition will deteriorate rapidly and he will become operationally useless in a few days. It is necessary not only to furnish sufficient calories but also to furnish them in foods which are palatable and acceptable. Failure to consume sufficient food may be caused by loss of appetite due to fatigue and tension; by monotony of the ration; lack of time to consume food because of tactical circumstances; or increased physiological requirements leading to a discrepancy between the amount of food supplied and the amount required.

c. Excessive Intake of Nutrients.

(1) The excessive intake of calories eventually results in obesity; that is a body weight in excess of 20 percent above the ideal weight for a given height. Obese patients have a higher incidence of diabetes, high blood pressure, and heart attacks than do people of normal weight. In addition, excess weight can contribute significantly to the development of orthopedic problems. In the United States, obesity is the most common form of malnutrition.

(2) The basic cause of obesity is the continued intake of food in excess of that needed to meet the energy requirements of the body. The reasons individuals eat more food than they require are very complex. They appear to be deeply involved in dietary habits established early in life, to boredom, to emotional problems, and to emotional relief obtained from the sense of pleasure provided by an overly full stomach.

(3) The prevention of obesity is much easier than its treatment. Prevention requires an appreciation of the hazards of obesity, frequent accurate determinations of body weight, and dietary restraint when necessary. Prevention also involves educating personnel that overeating is as bad as undereating.

7-4. Skin Diseases

a. Definition. Skin diseases are those diseases which predominately affect the skin, resulting in signs and symptoms, such as scaling, itching, swelling, and blistering.

b. Types.

(1) *Infections.*

(a) Bacteria such as streptococci and staphylococci may invade skin, or skin glands, producing impetigo, boils, and furuncles.

(b) Fungi cause athlete's foot and other common skin diseases. The major signs of the disease are scaling or cracking of the skin, especially between the toes. Diagnosis is by examination of skin scrapings for fungus. The disease is spread by direct contact with the fungus and is potentiated by poor personal hygiene, especially continuous excess moisture such as with damp socks.

(2) *Infestations.* Scabies is a disease of the skin caused by a tiny mite. The mite causes tiny papules or small lines to form on the skin. Itching is intense and secondary infection occurs as a result of scratching. The source of infection is man, and transmission may occur from man-to-man or indirectly by way of contaminated sheets or clothing. Diagnosis is by mite identification.

c. Prevention. The main principle in prevention of skin disease is cleanliness. Education in the principles and practices of good personal hygiene is most important. Daily showers or baths and frequent changes of underclothing are essential. Thorough washing, careful drying and powdering will also prevent skin disease. Individuals with obvious skin lesions should not be permitted to use barber shops, swimming pools, or gymnasiums without medical examination and written approval.

7-5. Viral Hepatitis

a. Viral hepatitis is an acute infectious disease which is characterized by fever, loss of appetite, nausea, fatigue, and jaundice. The urine may become dark brown in color. This is one of the diseases of the liver which is often referred to as "yellow jaundice."

b. The disease is worldwide in distribution.

c. There are three main types of viral hepatitis:

(1) *Hepatitis A.*

(a) The incidence of this disease is highest in rural and underdeveloped areas. Children and young adults are the most susceptible. In temperate areas, most cases occur in autumn and winter.

(b) This infection is caused by a virus. Man is the main reservoir. The infection is spread by the feces of the infected person. Epidemics have been traced to contaminated water and ice, milk, seafood such as oysters and clams, and vegetables contaminated with raw sewage.

(c) The incubation period is 2 weeks to 2 months; the average is 1 month. It is felt that immunity is conferred by an attack of infectious hepatitis.

(d) Control is directed toward good personal hygiene, proper disposal of feces, adequate water sanitation, such as chlorination to 5 mg/l in tropical areas, and food sanitation. Food service facilities and food handlers should be inspected frequently. Intramuscular immune globulin is given to those in close contact and is thought in most cases to simply produce a light or asymptomatic case rather than to actually prevent the infection. Certain military personnel who are going to be in specified endemic areas receive immune globulin at regular intervals (every 4 to 6 months). Immune globulin is not an active immunization; rather, it provides passive protection for several months.

(2) *Hepatitis B.*

(a) This infection is caused by a virus quite different from the virus that causes Hepatitis A. The reservoir is man. The infection is spread by saliva, semen, blood, and blood products. Other body fluids such as urine and vaginal secretions are thought to perhaps be infectious as well. Feces do not appear to transmit the agent.

(b) The incidence of this disease is approximately the same as Hepatitis A. In years past most of the transmission occurred via blood transfusions and needle sticks. However, the principal mode of transmission currently is probably sexual contact.

(c) The incubation period is 1-6 months; the average is 3 months. Ninety-five percent of people getting Hepatitis B will recover completely with lifelong immunity. Five percent will never get rid of the infection, and go on to become lifelong carriers of Hepatitis B, capable of transmitting the infection to others.

(d) Control is directed towards good personal hygiene and other control measures generally aimed at the control of sexually transmitted diseases. Controlling the spread of Hepatitis B by blood and needles is aimed at testing all donated blood for the virus; and educating medical personnel on the risk of exposure to blood and saliva from infected persons, as well as the importance of preventing accidental needle sticks. Hepatitis B Immune Globulin and Hepatitis B Vaccine are of great value in certain instances of close contacts of infected persons, or in people at high risk of such contact.

(3) *Hepatitis Non-A and Non-B (Hep NANB).*

(a) This infection is caused by one or more viruses which give a clinical picture much like that seen with Hepatitis A and Hepatitis B.

(b) Mode of transmission and epidemology of the disease closely resemble that of Hepatitis B. Most cases appear to follow exposure to blood and/or blood products. Hepatitis NANB accounts for 90 percent of all cases of posttransfusion hepatitis.

(c) Control mainly consists of avoiding unnecessary exposure to blood, blood products, and unsterilized needles.

7-6. Allergic Reactions

a. There has been an enormous increase in the numbers and kinds of drugs used to treat disease. Exposure to these drugs in the home, exposure to a large variety of chemicals at work, and the administration of immunizations to nearly everyone are just a few of the possible situations which could result in serious allergic reactions. With the use of the proper precautions, the number of allergic reactions can be greatly decreased.

b. An allergic reaction is a disease state which is the result of an altered degree of reactivity in an individual. This altered reactivity is caused by a primary contact with a chemical in the form of a medication, immunization, insecticide, plant pollen, molds, dust, or other chemicals. The reactivity demonstrates itself at a later date when the individual is again exposed to the same agent.

c. In general, the principles involved in allergic reactions are the same as those discussed in Chapter 4. In both cases antigens stimulate the body to produce antibodies. At a later date, reexposure to the antigen results in an antigen-antibody combination. For example, a patient is given penicillin for the treatment of his pneumonia. For reasons that are not known, he is sensitive to penicillin, and the penicillin acts as an antigen and stimulates antibody production. If this person is again given penicillin, the penicillin antigen will react with the penicillin antibodies present, and an allergic reaction will result. Thus, in both immunizations and allergic reactions, antigens and antibodies are involved. The difference is in the result of the antigen-antibody combination. In the case of immunizations, the antigen-antibody combination protects the individual from disease. In allergic reactions the antigen meeting the antibody results in a chain reaction which produces an allergic reaction.

d. The steps recommended to minimize allergic reactions from immunizations are discussed in Chapter 4. These same steps apply to allergic reactions from any cause and can be outlined as follows:

(1) Ask individual for a history of previous allergic reactions.

(2) Check individual's medical records for any record of allergic reactions.

(3) Avoid unnecessary exposure to sources that cause an allergic reaction.

(4) Have a physician and an emergency anaphylactic tray available in situations where allergic reactions are a possibility.

(5) Attempt to educate all personnel as to the cause, nature, and prevention of allergic reactions.

7-7. Rabies

a. General. Rabies is a viral disease of warm-blooded animals. Rabies is transmitted to man by infected saliva which gains entry into the body by a bite, or by contact with saliva through an existing scratch or wound. Once signs and symptoms occur, the disease is virtually always fatal in man. The clinical findings are pain at the site of the bite, fever, and periods of rage alternating with calm intervals. Attempts at drinking cause painful spasms in the throat muscles so that the patient refuses to drink (hydrophobia). Convulsions occur and death results from respiratory paralysis. The only treatment for clinical human rabies is supportive to maintain ventilation and nutrition. Three humans have survived rabies. Each after very aggressive ventilatory support. Only one of the three recovered without permanent sequela (after effect).

b. Prevention and Control Measures.

(1) Elimination of reservoir. This includes programs to reduce certain wildlife species that are reservoirs of the disease. Removal of stray animals, particularly dogs, from the population is an important part of the program. Elimination of wildlife reservoirs of rabies is the most difficult rabies control measure.

(2) *Vaccination of pets.* Local regulations requiring vaccination and restraint of pets are vital. They afford our domestic animal population with protection from wildlife reservoirs of rabies. This vaccination does not produce permanent protection; therefore, it must be repeated periodically.

(3) *Education.* Public education is essential in the rabies control program. The public must be aware of the dangers of rabies to themselves and to their pets. When informed, they are more likely to comply with the control measures.

c. Management of Animal Bite Cases.

(1) Any person bitten by an animal or suspected of having had contact with a rabid animal must be referred at once to a medical facility for evaluation. The wound is thoroughly cleansed with surgical detergent. Antibiotics and antitetanus measures are used when deemed necessary.

(2) Treatment may end with these local measures. Rabies vaccine, antirabies serum, or both, may be given. This decision is made by the medical officer treating the case who may make his decision following the WHO guidelines on "post-exposure rabies immunization," or by consulting rabies control board members if the case is unusually difficult. These guidelines are outlined in TB MED 114.

(3) While the patient is being treated, the animal should be apprehended because clinical observation of the animal's condition is helpful in determining which treatment the patient needs. It is usually the job of the military police to apprehend the animal and submit it to veterinary facilities for confinement and examination.

(4) If the animal is killed, its intact head should be placed in a waterproof bag; packed in ice, and carried to a veterinary or medical laboratory for examination to determine if rabies infection is present.

CHAPTER 8

CLASSIFICATION OF MEDICALLY IMPORTANT ARTHROPODS

8-1. General

a. Entomology is the study of insects and other arthropods. Medical entomology is the science dealing with arthropods and their relationship to the health of man. Throughout history arthropods have transmitted diseases which have killed more people than all man's wars combined. In the Middle Ages over 25,000,000 Europeans died from plague, an arthropod-borne disease. Even today over 1,000,000 humans die every year from malaria, a mosquito-borne disease.

b. All living things are divided into the plant or animal KINGDOMS. Within each kingdom are major divisions called PHYLA (singular, PHYLUM). Man is the phylum CHORDATA, which consists of mammals, birds, fish, and reptiles—those animals with backbones. Insects and their relatives are in the phylum ARTHROPODA and are called arthropods. This phylum contains 86 percent of all the species in the animal kingdom, and most of these arthropods are true insects. For example, there are over 300,000 species of just one type of insect, the beetle.

c. To further differentiate one animal from another, PHYLA are further subdivided into CLASSES, which are in turn divided into ORDERS, then FAMILIES, then GENERA (singular, GENUS), and finally SPECIES. Each level of classification is based on characteristics common only to organisms within that particular category. Therefore, every living creature which has been described has a unique biological classification which separates it from every other living thing. All classifications are Latin or Latinized words so they will be universally recognizable. Table 8-1 shows the biological classification of a mosquito and of man.

d. When referring to a particular organism, only its GENUS and SPECIES names are given. Since some species are further divided into SUBSPECIES a third word will be given if appropriate. These two (or three) Latin words are called the scientific name of the organism, and no two species of organisms will have the same scientific name. Thus the scientific name of the bedbug is *Cimex lectularius* in the genus *Cimex,* species *lectularius*. The head louse is *Pediculus humanus capitis*, while the closely related body louse is *Pediculus humanus humanus* (the third word being the subspecies). These names are always written in italics or are underlined. Only the first (genus) name is capitalized. Frequently, publications have another word at the end of the scientific name, as in *Homo sapiens* Linnaeus. It is the last name of the scientist, called the AUTHOR, who first described the species. If the author's name is in parentheses, it indicates that the species was originally described in another genus. For example, the yellow fever mosquito, *Aedes aegypti* (Linnaeus), was originally described by Linnaeus as *Culex aegypti* before the genus *Aedes* was later separated from the genus *Culex.* When the same genus is used repeatedly within the same sentence, paragraph, or scientific article, the genus name may be abbreviated to its first letter (capitalized), followed by a period and it is italicized or underlined. For example, "Two common cockroaches are *Periplaneta americana* and *P. brunnea.*"

Table 8-1. Biological Classification of a Mosquito and Man.

Name of Category	Mosquito	Man
KINGDOM	ANIMAL—capable of motion, no chlorophyll.	ANIMAL—capable of motion, no chlorophyll.
PHYLUM	ARTHROPODA—jointed appendages, exoskeleton, dorsal heart, ventral nerve cord, cold blood.	CHORDATA—jointed appendages, endoskeleton, ventral heart, dorsal, nerve cord.
CLASS	INSECTA—three pairs of legs, one pair of antennae, wings usually present.	MAMMALIA—mammary glands for suckling young, hair, four-chambered hearts, warm blood.
ORDER	DIPTERA—two wings, second pair of wings modified into halteres or balancers, sucking mouthparts, complete metamorphosis.	PRIMATES—limbs elongate, "hands" and"feet" enlarged, often with a thumb, each of five digits with flattened or cupped nails.
FAMILY	Culicidae—the true mosquitoes. Adult with scales on wings, elongate proboscis, wings usually longer than abdomen.	Hominidae—the family of man.
GENUS	*Culex*— (note that the genus is capitalized and underlined).	*Homo*— (Latin for man).
SPECIES	*pipiens*— (note that the species name is always written in small letters and underlined. This species name refers to the piping or whining sound of the flying mosquito.	*sapiens*— (Latin for learned).
SUBSPECIES	quinquefasciatus	sapiens

8-2. Phylum Arthropoda

The phylum Arthropoda possesses these general identifying characteristics: segmented body, jointed appendages, exoskeleton, and bilateral symmetry. This phylum includes the following major classes: Arachnida (spiders, ticks, mites, scorpions); Chilopoda (centipedes); Diplopoda (millipedes); Crustacea (crayfish, crabs, lobsters, barnacles, sow bugs, water fleas); and Hexapoda or Insecta, such as fleas, lice, flies, mosquitoes, bedbugs, and kissing bugs. These arthropods occupy diverse habitats and, as a group, are the most successful animals in the world.

a. Class Arachnida. The class Arachnida is represented by arthropods such as ticks, mites, scorpions, and spiders. Arachnida usually have two body regions, the cephalothorax and abdomen. The adults have four pairs of legs, but no wings or antennae. Ticks and mites are the most important members of this class since they transmit diseases. Scorpions and spiders affect human health by injecting toxic venoms.

b. Class Chilopoda. The class Chilopoda consists of the centipedes. The centipede has a distinct head and a many-segmented, flattened, worm-like body. Each segment bears a single pair of legs. The first segment behind the head bears a pair of poison claws used to paralyze insects or other prey. A few species are capable of inflicting painful bites on man.

c. Class Diplopoda. The class Diplopoda or millipedes are elongated, worm-like arthropods with many body segments and legs, hence the name "thousand legger." The head is distinct and the remaining segments form a continuous trunk or body. Each of the body segments bears two pairs of legs, except the first three segments, which have one pair each. Millipedes have repugnatorial glands which open through pores along each side of the body. The secretions from these pores are offensive and repel other insects, and can cause skin irritation.

d. Class Crustacea. The class Crustacea is comprised of crabs, lobsters, shrimps, sow bugs, barnacles, and water fleas. These animals live in water or in moist environments and feed on decaying vegetation and animal matter. A member of this class has two pairs of antennae and five or more pairs of legs. The anterior body region is the cephalothorax (head and thorax are fused). Some crustaceans are medically important as intermediate hosts for internal parasites.

e. Class Insecta (Hexapoda). The class Insecta (Hexapoda), which comprises the true insects, is the largest and most important class of arthropods. An adult insect can be distinguished from other arthropods as follows: it has three distinct body regions—the head, thorax, and abdomen; the head has one pair of antennae and usually one pair of compound eyes; and, the thorax has three pairs of legs and usually two pairs of wings. Some insects, such as those belonging to the order Diptera, have only one pair of wings and a pair of balancing organs or halteres.

8-3. Growth and Metamorphosis

Metamorphosis is the change in form or appearance of an animal as it develops from birth through maturation. When an egg hatches, the immature form appears and begins to feed and grow in size. It will shed its exoskeleton periodically (a process known as molting) to allow more room for growth. After each molt, the young form is called an instar, for example, first instar or second instar. Medically important arthropods undergo "gradual" or "complete" metamorphosis.

a. Gradual metamorphosis includes three major stages: egg, nymph, and adult. Nymphs resemble adult forms except for their small size, lack of wings, and sexual immaturity. The nymphs molt several times before they gradually become adults.

b. Complete metamorphosis includes four stages: egg, larva, pupa, and adult. The egg hatches into a larva or caterpillar-like stage which begins to feed and grow through several instars. After the last larval instar, it changes or molts into a nonfeeding stage called a pupa. The pupal stage is completely different in appearance from the larval stage, and is a transformation stage wherein larval tissues breakdown and reorgnize. When the pupa completes its development, the adult stage emerges. Mites and ticks undergo a slightly modified complete metamorphosis during their life cycle. Here we have four stages: egg, larva, nymph, and adult. The egg hatches into a larva, which has six legs. The larva feeds and molts into an 8-legged nymphal stage which resembles the adult. After the last nymphal molt, the sexually mature adult is formed.

8-4. Effects of Arthropods on Man

Man lives daily in close association with many arthropods, some of which are destructive to his health (Figure 8-1). These arthropods affect man and animals in the following ways:

a. Disease Transmission. Arthropods do their greatest damage to man when they act as disease vectors. Many arthropod-borne diseases produce a high mortality rate in man. Others with their long convalescent period cause a manpower drain resulting in a major economic loss every year. Mosquitoes, flies, lice, fleas, mites, and ticks are among the most important vectors of arthropod-borne diseases.

b. Entomophobia. Arthropods, even though wholly innocuous, frequently cause man acute annoyance and worry, which may lead to a nervous disorder and sometimes sensory hallucinations. Such disorders may require medical treatment. Most people find the presence of arthropods in large numbers unpleasant even if they do not bite.

c. Annoyance and Blood Loss. Arthropods may also cause annoyance and blood loss, although blood loss is usually of little importance in man.

d. Accidental Injury to Sense Organs. An insect may get into the eye and cause pain, worry, and occasionally injury. Insects may fly or be blown into the nose, mouth, or ear and cause acute pain and, at times, injury.

e. Envenomization. Many arthropods inject toxins into man that cause swelling, irritation, pain, and sometimes paralysis. Those that inject a venom by their bites include centipedes and spiders. Those that inject venom by their sting include bees, wasps, and scorpions. Many people are sensitive to bee and wasp stings and may suffer anaphylactic shock resulting in death in some cases.

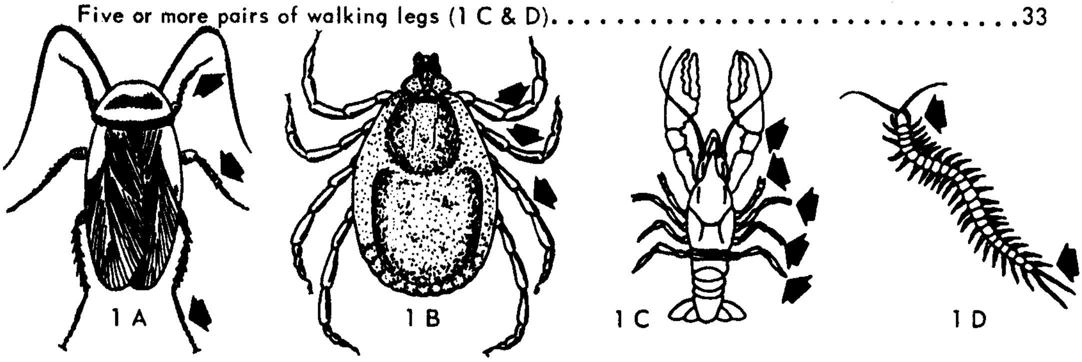
f. Dermatosis. This is a skin irritation (generally localized) caused by the bites of mosquitoes, fleas, lice, and bedbugs.

g. Myiasis. Certain flies may invade the organs and tissues of man and animals. This condition is known as myiasis. The cattle grub, the screwworm, and blow flies are examples of flies which cause myiasis. The capacity of these insects to invade any and all parts of the body is to be emphasized.

h. Allergy. This condition is a hypersensitive reaction to insect protein. This condition may occur among people with repeated prolonged exposure to the same type insect, such as beekeepers or workers in insectaries. It may also result from a single exposure to insects with highly allergenic proteins, such as mayflies or gypsy moth caterpillars.

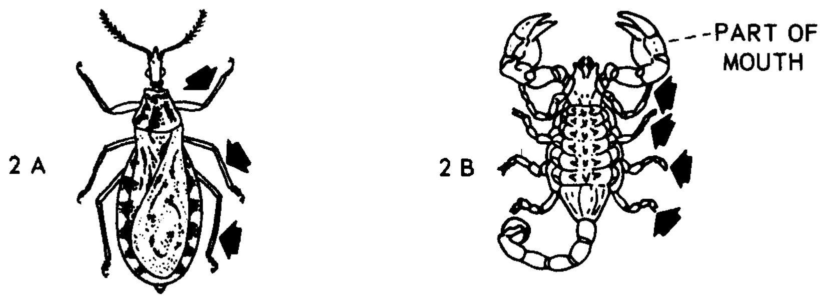
1. Three or 4 pairs of walking legs (1 A & B) 2

   Five or more pairs of walking legs (1 C & D) 33



2. Three pairs of walking legs (2 A) 3

   Four pairs of walking legs (2 B) 25



3. Wings present, well developed (3 A) 4

   Wings absent or rudimentary (3 B & C) 13

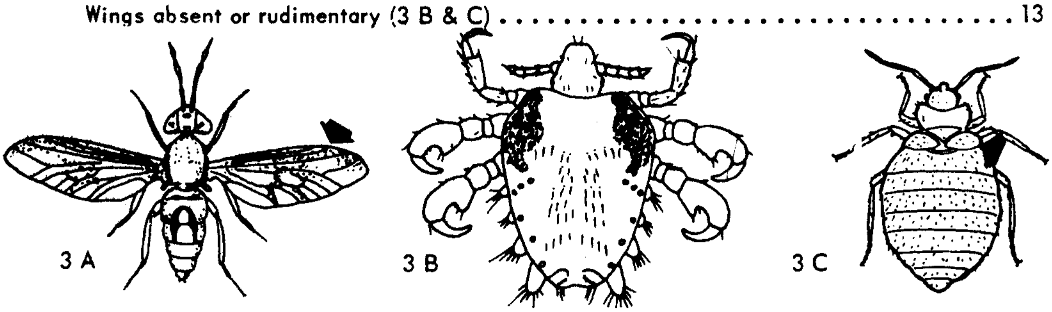
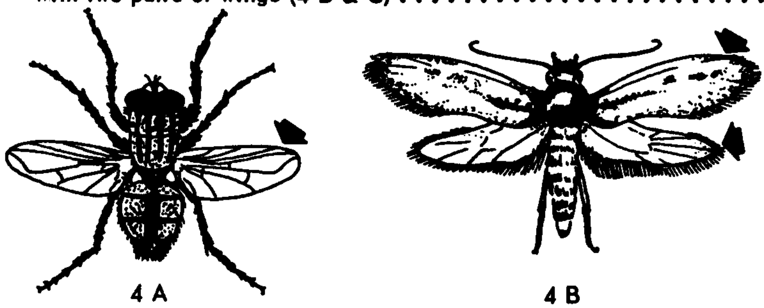


Figure 8-1. Key to common classes and orders of arthropods of public health importance.

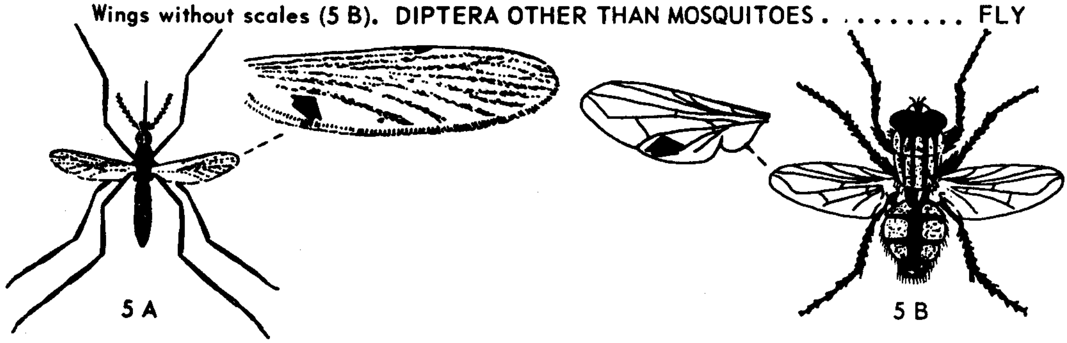
4. With one pair of membranous wings (4 A). ORDER DIPTERA 5

With two pairs of wings (4 B & C) 6



5. Wings with scales (5 A). FAMILY CULICIDAE .... MOSQUITO

Wings without scales (5 B). DIPTERA OTHER THAN MOSQUITOES .... FLY



6. Mouthparts adapted for sucking, with elongate proboscis (6 A) 7

Mouthparts adapted for chewing, without elongate proboscis (6 B) 9

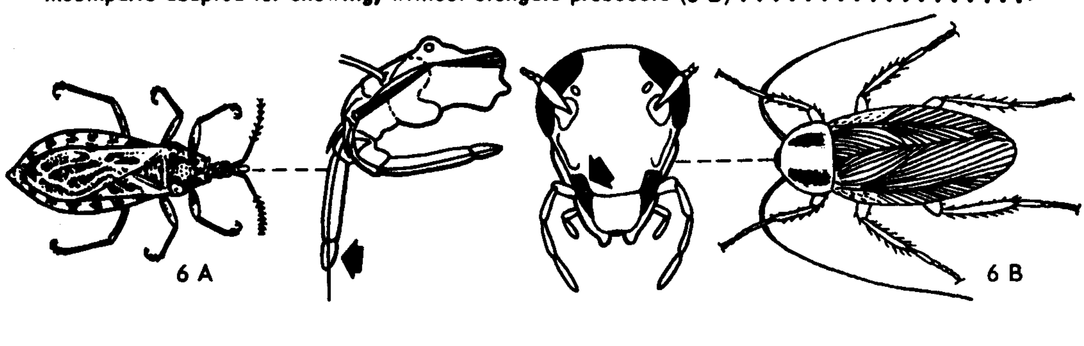
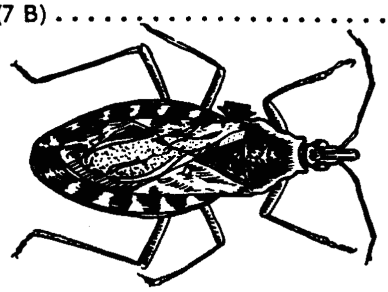


Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

7. Wings densely covered with scales; proboscis coiled (7 A). ORDER LEPIDOPTERA . . . . MOTH OR BUTTERFLY

Wings not covered with scales; proboscis not coiled (7 B) 8

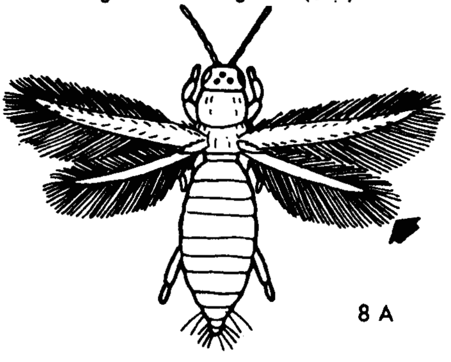
7 A



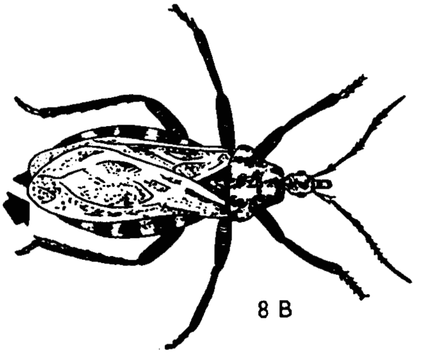
7 B

8. Wing with fringe of long hair (8 A). ORDER THYSANOPTERA . . . . THRIPS

Wing without long hair (8 B). ORDER HEMIPTERA . . . . KISSING BUG



8 A

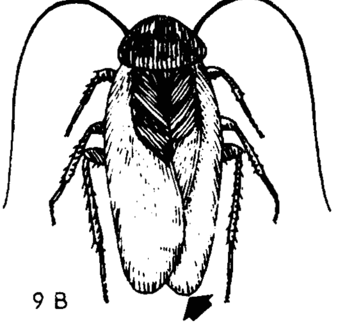


8 B

9. Both pair of wings membranous and similar in structure (9 A) 10

Front pair of wings shell-like or leathery, serving as covers for the second pair (9 B) 11

9 A

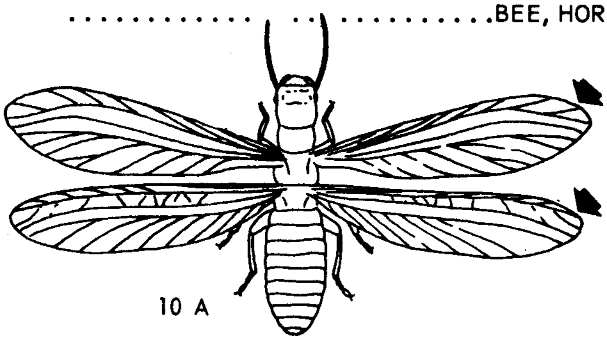


9 B

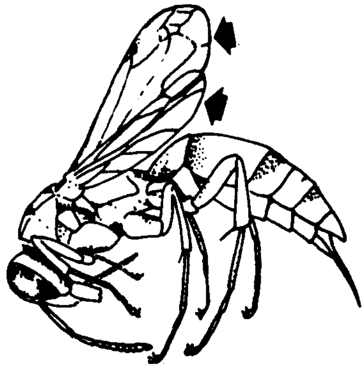
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

10. Both pairs of wings similar in size (10 A). ORDER ISOPTERA . . . . TERMITE

Hind wing much smaller than front wing (10 B). ORDER HYMENOPTERA . . . . .BEE, HORNET, WASP, YELLOW JACKET, OR ANT



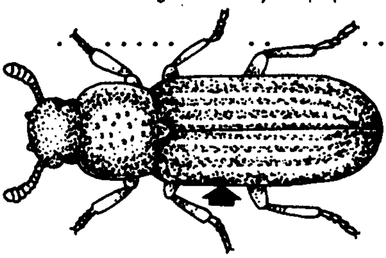
10 A



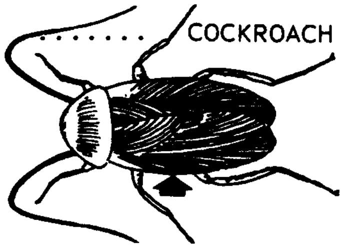
10 B

11. Front wings horny or leathery, without distinct veins (11 A) 12

Front wings leathery or paper-like, with distinct veins (11 B). ORDER ORTHOPTERA . . . . COCKROACH



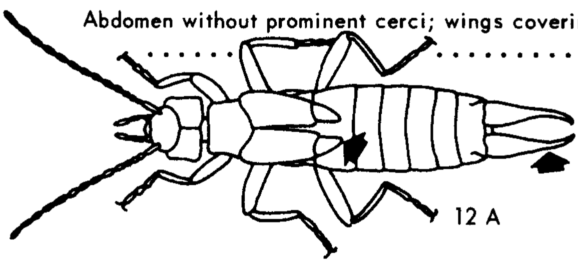
11 A



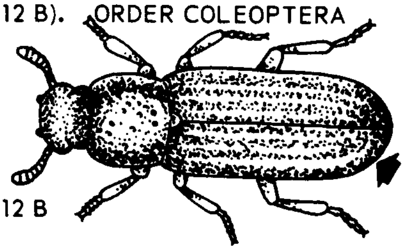
11 B

12. Abdomen with prominent cerci; wings shorter than abdomen (12 A). ORDER DERMAPTERA . . . . EARWIG

Abdomen without prominent cerci; wings covering abdomen (12 B). ORDER COLEOPTERA . . . . BEETLE



12 A

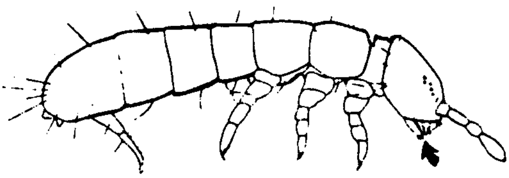


12 B

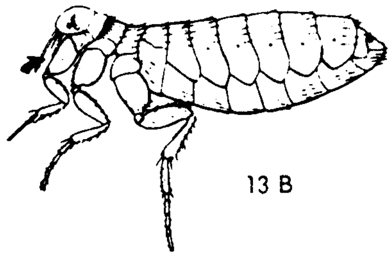
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

13. Mouthparts with jaws for chewing (13 A) 14

Mouthparts with a long beak or stylets for sucking up food (13 B) 21



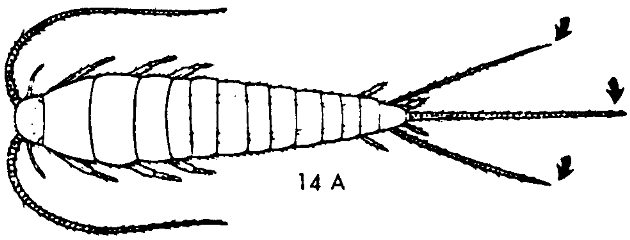
13 A



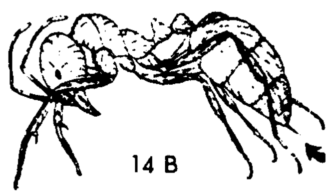
13 B

14. With three long terminal tails (14 A). ORDER THYSANURA . . SILVERFISH AND FIREBRAT

Without three long terminal tails (14 B) 15



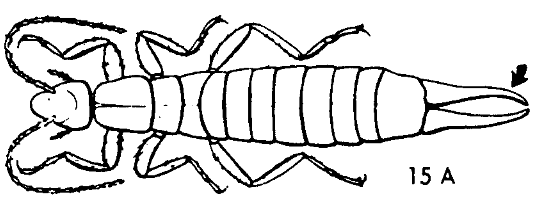
14 A



14 B

15. Abdomen with prominent pair of cerci (15 A). ORDER DERMAPTERA .... EARWIG

Abdomen without prominent pair of cerci (15 B) 16



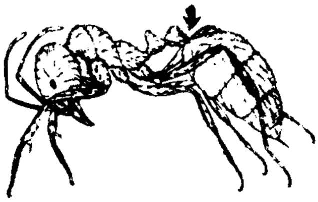
15 A

15 B

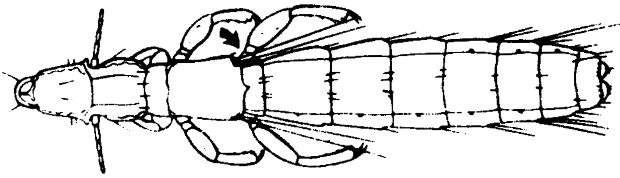
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

16. With narrow waist (16 A). ORDER HYMENOPTERA .... ANT

Without narrow waist (16 B) 17



16 A

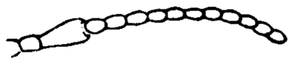


16 B

17. Antenna with fewer than 8 segments (17 A) 18

Antenna with more than 8 segments (17 B) 19

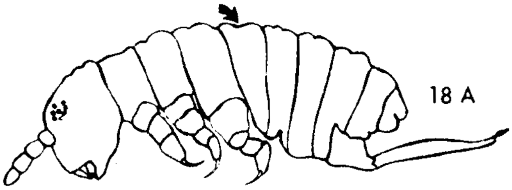
17 A



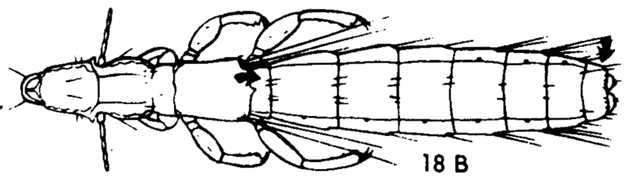
17 B

18. Abdomen with 6 or fewer segments (18 A). ORDER COLLEMBOLA......... SPRINGTAIL

Abdomen with more than 6 segments (18 B). ORDER MALLOPHAGA .... CHEWING LOUSE



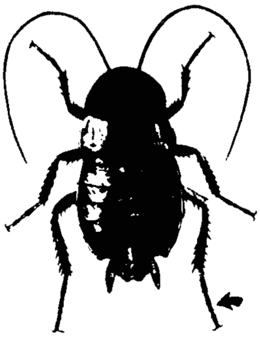
18 A



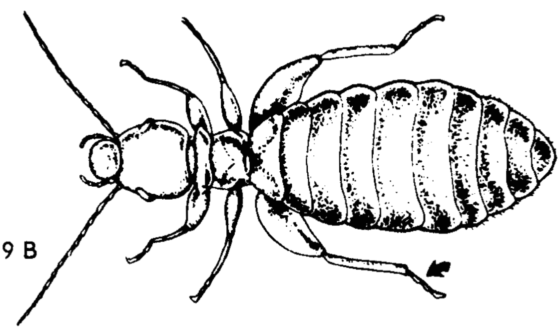
18 B

19. Tarsus with 4-5 segments (19 A) 20

Tarsus with 1-3 segments (19 B). ORDER PSOCOPTERA ...... BOOK LOUSE OR PSOCID



19 A

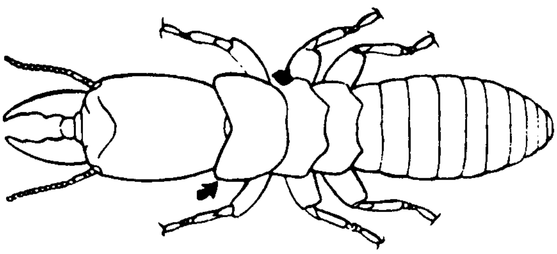


19 B

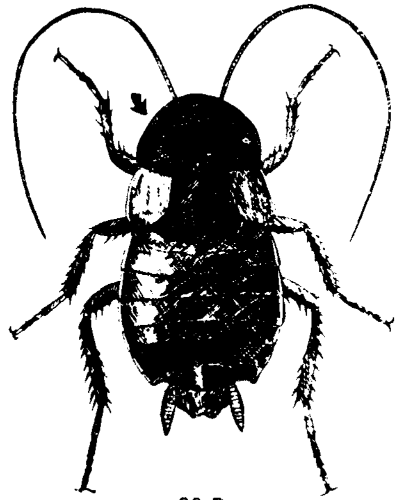
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

20. Pronotum narrower than head, never covering head (20 A). ORDER ISOPTERA . . . TERMITE

Pronotum broader than head, often covering head (20 B). ORDER ORTHOPTERA . . . . COCKROACH



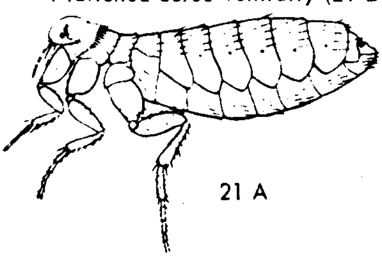
20 A



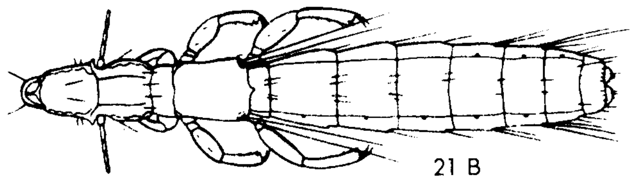
20 B

21. Flattened laterally (21 A). ORDER SIPHONATERA . . . . FLEA

Flattened dorso-ventrally (21 B) 22



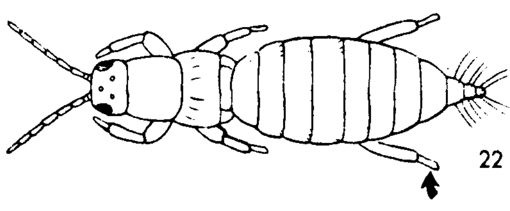
21 A



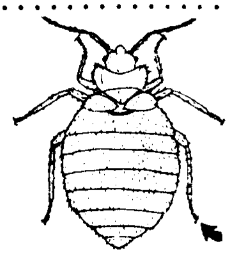
21 B

22. Foot terminating in protrusible bladder (22 A). ORDER THYSANOPTERA . . . . THRIPS

Foot not terminating in protrusible bladder (22 B) 23



22 A

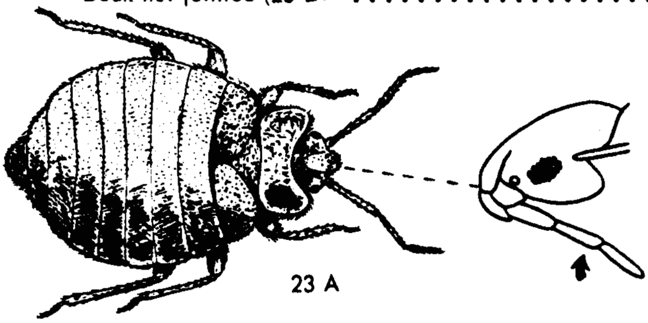


22 B

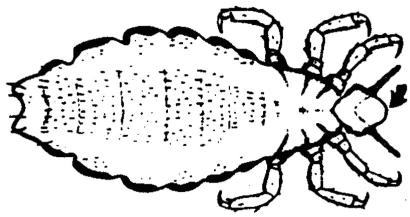
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

23. Beak jointed (23 A). ORDER HEMIPTERA . . . . BEDBUG

Beak not jointed (23 B) 24



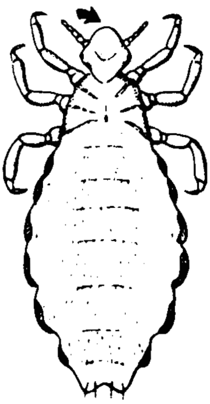
23 A



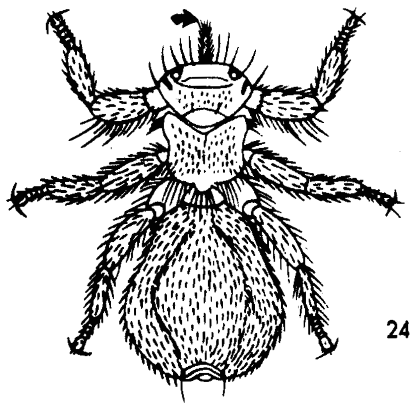
23 B

24. Mouthparts retracted into head (24 A). ORDER ANOPLURA . . . . SUCKING LOUSE

Mouthparts not retracted into head (24 B). ORDER DIPTERA . . . . KED OR LOUSE FLY



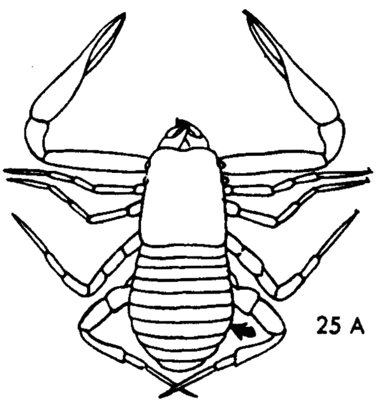
24 A



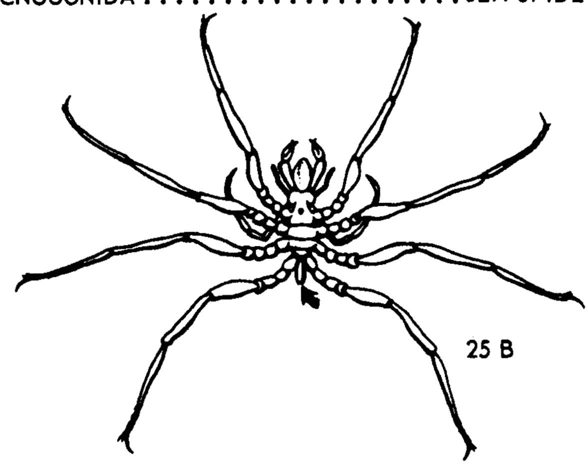
24 B

25. Abdomen well-developed (25 A). CLASS ARACHNIDA 26

Abdomen peg-like (25 B). CLASS PYCNOGONIDA . . . . SEA SPIDER



25 A



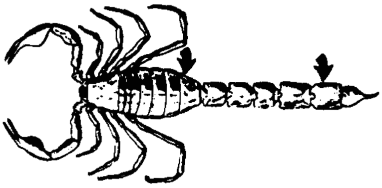
25 B

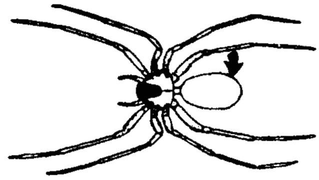
Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

26. Abdomen distinctly segmented (26 A) 27

Abdomen not distinctly segmented (26 B) 31

26 A



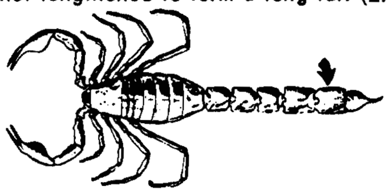


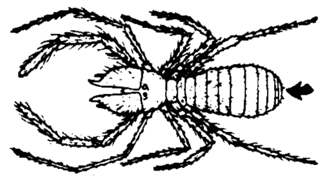
26 B

27. Abdomen lengthened to form a long tail (27 A) 28

Abdomen not lengthened to form a long tail (27 B) 29

27 A

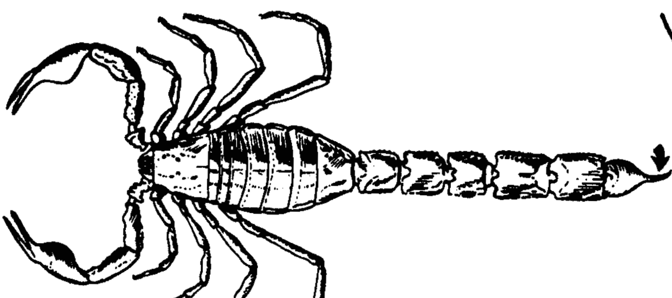




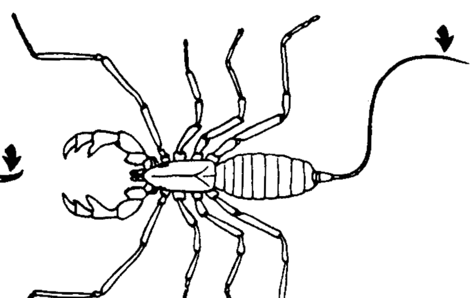
27 B

28. Tail with stinger (28 A). ORDER SCORPIONIDA . . . . SCORPION

Tail without stinger (28 B). ORDER PEDIPALPIDA . . . . WHIP SCORPION



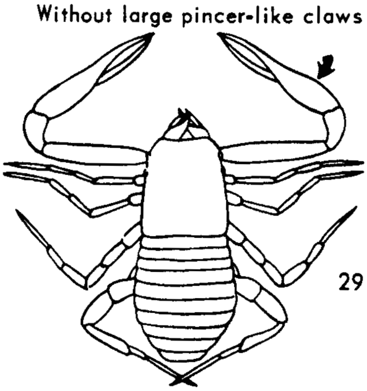
28 A



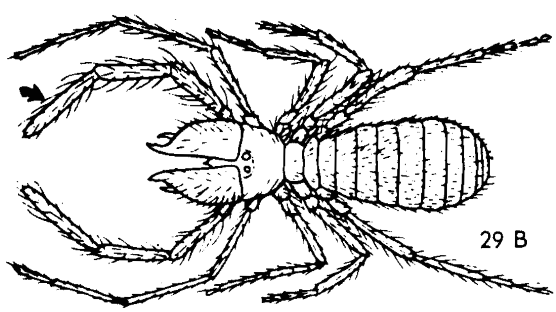
28 B

29. With large pincer-like claws (29 A). ORDER PSEUDOSCORPIONIDA . . . PSEUDOSCORPION

Without large pincer-like claws (29 B) 30



29 A

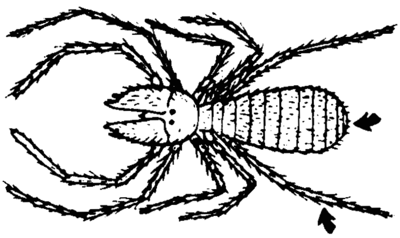


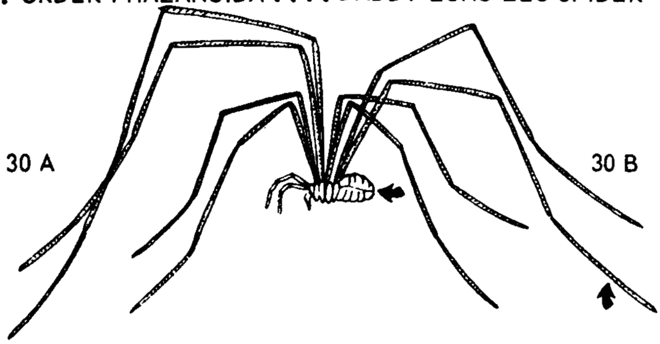
29 B

Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

30. Legs not longer than body (30 A). ORDER SOLPUGIDA . . . . SUN SPIDER

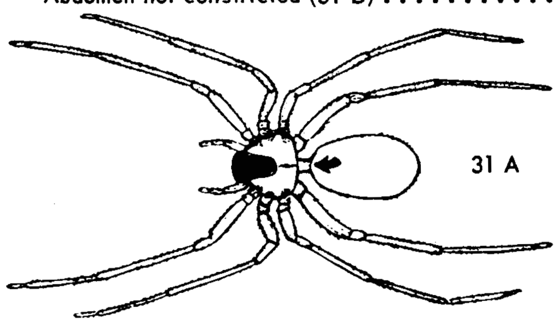
Legs much longer than body (30 B). ORDER PHALANGIDA . . . . DADDY LONG-LEG SPIDER

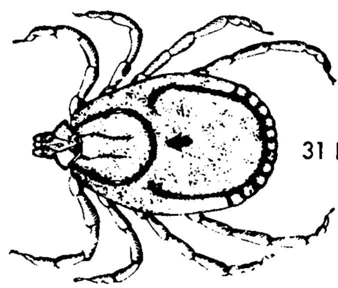

30 A


30 B

31. Abdomen constricted to form a narrow waist (31 A). ORDER ARANEIDA . . . . SPIDER

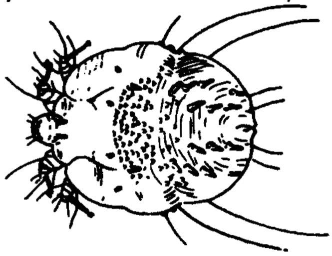
Abdomen not constricted (31 B) 32

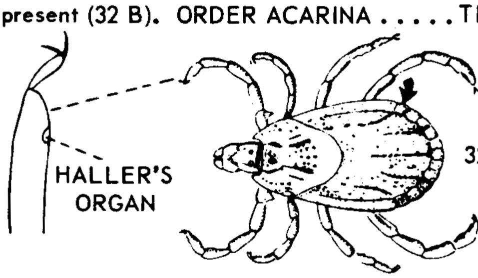

31 A


31 B

32. Body with long hair; Haller's organ absent (32 A). ORDER ACARINA . . . . MITE

Body without hair or short hair; Haller's organ present (32 B). ORDER ACARINA . . . . . TICK

32 A


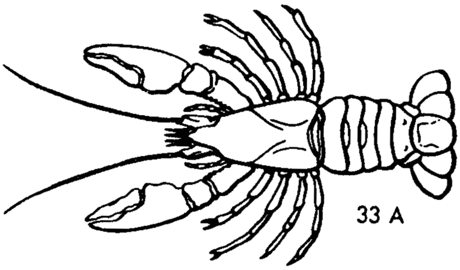


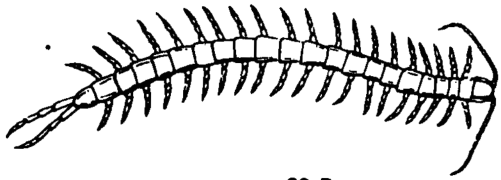
32 B

Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

33. Five to 7 pairs of walking legs (33 A). CLASS CRUSTACEA 34

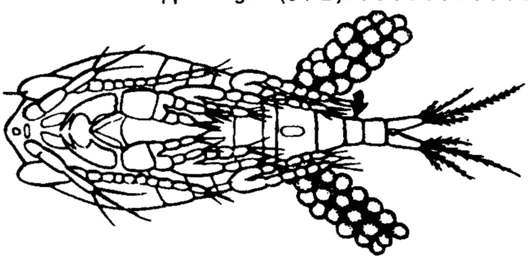
More than 14 pairs of walking legs (33 B) 36

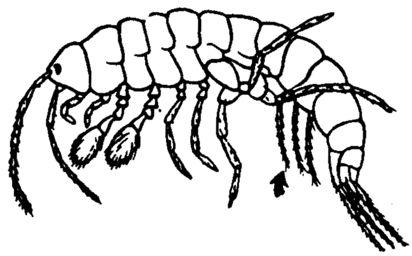

33 A


33 B

34. Abdomen without appendages (34 A). ORDER COPEPODA . . . . COPEPOD

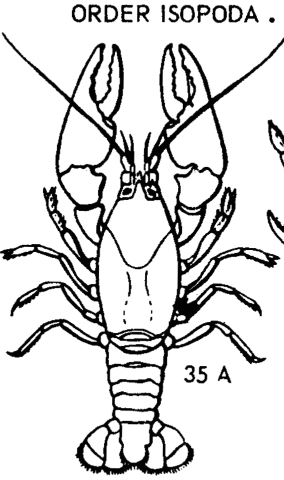
Abdomen with appendages (34 B). 35

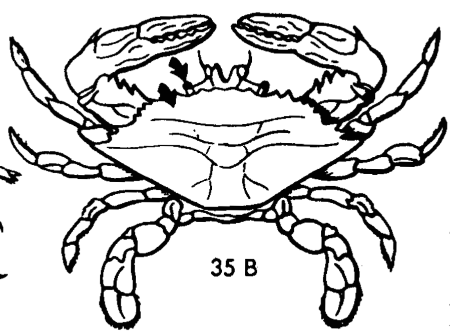
34 A


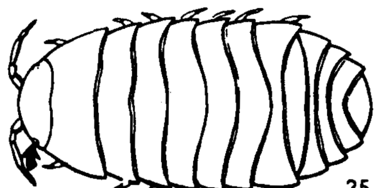

34 B

35. Thorax covered with a fused plate; eyes, when present, on movable stalks (35 A & B) . . . .
ORDER DECAPODA .LOBSTER, CRAB, CRAYFISH, SHRIMP, ETC.

Thorax not covered with a fused plate; eyes, when present, not on movable stalks (35 C & D). .
ORDER ISOPODA . . . . .SOWBUG, PILLBUG


35 A


35 B


35 C

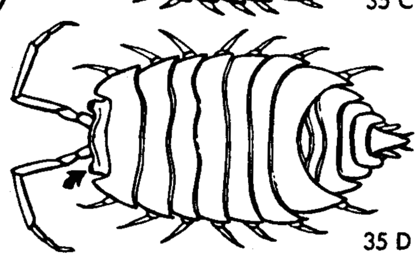
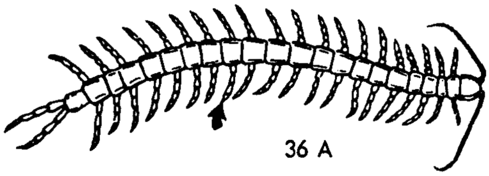

35 D

Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

36. One pair of legs per body segment (36 A). CLASS CHILOPODA .... CENTIPEDE

Two pairs of legs per body segment (36 B). CLASS DIPLOPODA .... MILLIPEDE



36 A

36 B

Figure 8-1. Key to common classes and orders of arthropods of public health importance (continued).

CHAPTER 9

ARTHROPODS AND ARTHROPOD-BORNE DISEASES

Section I. RELATIONSHIP BETWEEN ARTHROPODS AND DISEASE

9-1. General

The most important effect of arthropods on human health is the transmission of diseases. To prevent or control outbreaks of arthropod-borne disease, the Pvnt med specialist must know the identification, biology, surveillance, and control of the arthropods which transmit them. He must also know where the disease organisms are harbored when there are no outbreaks in human populations.

9-2. Chain of Infection in Arthropod-Borne Diseases

a. For man to contract a disease, he must acquire the living disease organism, or pathogen. The effects of the pathogen living within the human body causing the symptoms, sickness, and even death we call the "disease." Pathogens of arthropod-borne diseases are viruses, rickettsiae, bacteria, protozoa, and filarial worms (nematodes). Some arthropods like houseflies are mechanical carriers of pathogens. Pathogens can stick to the legs or mouthparts of the fly when it lands on contaminated matter, and then rub off when the fly lands again on a dinner plate or eating utensil. But in most arthropod-borne diseases, the pathogen must be transferred through a series of three living things—the chain of infection — in order to affect health.

(1) *Reservoir.* The first link in the chain of infection is the reservoir, an animal which is the source of the disease. The reservoir harbors the disease pathogens within its body at a level which permits their transfer to an arthropod, usually while the arthropod is biting. The reservoir may be completely asymptomatic or may be sick and dying of the disease. Examples are the domestic rats which can be reservoirs of plague, and monkeys which can be reservoirs of yellow fever. Man is the only reservoir for diseases such as malaria and epidemic typhus.

(2) *Vector.* The second link in the chain of infection is the vector — the arthropod which acquires the pathogens from a reservoir and then transmits them to another living organism. Most arthropods which transmit diseases are biological vectors. That is, the pathogen must multiply in number, complete some developmental change, or both, while inside the vector in order to infect man. In some diseases such as malaria and human filariasis, the pathogen cannot complete its life cycle without undergoing an obligatory period of development within the vector. Biological vectors transmit pathogens by a variety of mechanisms: inoculation via the mouthparts during bloodfeeding (such as mosquito transmission of malaria); regurgitation of contaminated fluids (such as flea transmission of plague); fecal contamination (such as kissing bug transmission of Chagas' disease); and, contamination of crushed tissues of the vector (such as body louse transmission of epidemic relapsing fever). The high mobility, frequent feeding, and extremely large numbers of some arthropods make them very efficient at transmitting diseases.

(3) *Host.* The last link in the chain of infection is the recipient of the pathogens — the host. After the pathogens reach the infective state within the vector, they are transmitted to the host. Once inside the host, the pathogens cause disease. In the Army, preventive medicine personnel are necessarily concerned with the diseases in which man is the host.

b. Prevention of Arthropod-Borne Diseases. Transmission of arthropod-borne disease can be prevented by breaking any link in the chain of infection, such as eliminating or treating the reservoir; eliminating the vector; or protecting the host from infection. Which link is attacked depends on the particular disease and the situation. Emphasis should always be placed on breaking the chain of infection by protecting the individual (potential host of the disease), regardless of which other links are attacked. In many deployment situations reservoir or vector elimination will be impractical. But means are available which protect soldiers against virtually all arthropod-borne diseases.

Section II. PROTECTIVE MEASURES AGAINST ARTHROPOD-BORNE DISEASES

9-3. Individual Protective Measures

a. The Army defends against arthropod-borne diseases at three levels — individual, unit, and area. The most important defense is that conducted by the individual to avoid being infected by arthropod vectors. These individual protective measures are easily taught to each soldier, but require reinforcement training and stringent supervision by leaders in order to work. Individual protective measures can prevent cases of arthropod-borne diseases. There are no substitutes for individual measures—the unit and area defenses are only supplements.

b. Properly wearing the uniform will reduce contact with biting arthropods. Between dusk and dawn, long-sleeved shirts should be worn with sleeves rolled down. Undershirts should be prohibited as outer garments. Trousers should be tucked into boot tops. Headgear should be worn whenever soldiers are outside. All these measures limit exposed skin which can attract biting arthropods.

c. Headnets and repellent parkas provide protection where mosquito and biting fly populations are abundant.

d. Repellents help prevent disease transmission by keeping biting arthropod vectors away from soldiers. The repellent, DEET, is the best general insect repellent ever developed, and is very effective when used properly. Most popular commercial repellent products contain the very same active ingredient, but in a lower concentration than the Army formulation. Any unpopularity of DEET among soldiers is due to their failure to follow the instructions and precautions which are printed on each bottle. Since the repellent action is caused by DEET's slow evaporation from the skin, it must be reapplied frequently — at least every two hours during warm weather or strenuous activity.

e. Bednets must be used to protect soldiers during sleep because the repellent will not remain effective throughout the night when most vectors, particularly mosquitoes, are biting. Even combat troops sleeping on the ground or in foxholes must use the net. The four corners can be suspended on sticks less than two feet long, or tied to low vegetation. The sides can be shortened as necessary by taping, hemming, or rolling. After entering the bednet, the soldier should tuck the sides under the air mattress or ground cloth.

f. Once inside the bednet the soldier should use the aerosol insecticide bomb to kill arthropods which may have crawled or flown in with him. The aerosol bomb cannot be used as a repellent, nor used to establish a lasting barrier on clothing or equipment, because the active ingredient inactivates once the droplets fall from the air and strike a surface.

g. Individual containers of insecticide powder are used to control lice on the body and clothing. Unit stocks are maintained by the unit supply section but not issued to soldiers until directed by medical authorities.

h. Immunizations against arthropod-borne diseases are considered individual protective measures although they are not controlled or administered by the individual soldier. Chemoprophylaxis, or use of preventive drugs, is used to prevent malaria. The drugs, in pill form, must be administered under supervision on an uninterrupted, recurring schedule. Leaders dispensing the pills must keep a roster of individual treatments and must ensure that soldiers actually swallow the medication.

9-4. Unit Protective Measures

a. Commanders are responsible for the health and welfare of soldiers in their units. It is imperative that commanders and all subordinate leaders emphasize disease prevention and control through strict enforcement of individual protective measures among all unit members. All field training must reinforce these measures even in training situations where little actual threat exists. The absence of command emphasis on individual protective measures in training will result in needless losses from disease upon deployment.

b. The unit field sanitation team assists the commander in safeguarding unit health by performing preventive medicine tasks within the unit. In the area of arthropod-borne disease prevention, team duties include—

- Monitoring the issue and requisition of individual protective items by unit supply to ensure adequate stocks are on hand.
- Instructing unit members on proper protective techniques.
- Inspecting to ensure compliance with unit policy on the use of individual protective measures.
- Supervising construction and use of field hygiene and sanitation devices to prevent diseases transmitted by filth flies.
- Supervising the impregnation of clothing with special repellent chemicals.

- Controlling, on a limited scale, disease vectors and rodent reservoirs within the unit area of responsibility. In a combat zone the unit responsibility for control includes the immediate vicinity out to 100 meters from the area occupied by the unit. Nonchemical controls include the destruction of arthropod breeding areas, rodent harborages, and rodent trapping. Limited chemical arthropod control is conducted using a 2-gallon sprayer with residual pesticides. Poison baits are used to control rodents.

9-5. Area Protective Measures

Vector and reservoir control over large areas is performed by, or under the supervision of, corps preventive medicine units. Requests for such assistance should be made through medical channels.

Section III. MOSQUITOES

9-6. General

Mosquitoes are the most important arthropods involved in the transmission of diseases to humans. Worldwide hundreds of millions of people are infected with mosquito-borne diseases, resulting in death for over a million humans every year. Mosquitoes are in the insect order Diptera, the adults having one pair of wings and a pair of halteres. Mosquitoes comprise the family Culicidae, in which there are over 2,500 species in the world. About 165 species are in the United States. Some species have very limited geographical distributions whereas others, including some of the most important disease vectors, are found worldwide. The adults differ from other flies in having three characters in combination: long, many-segmented antennae; elongate, piercing-sucking mouthparts; and, scales on the wing veins and wing margin. Only the female mosquito sucks blood, as a requirement for maturing her eggs. Males feed only on plant juices and do not bite animals. Many mosquitoes will seek a blood meal only during specific times of the day or night, a fact that can be of great importance in preventing disease transmission.

9-7. Life Cycle of Mosquitoes

Mosquitoes have four life stages: egg, larva, pupa, and adult. *Anopheles* species lay their eggs singly on the water surface where they float by means of air sacs. The eggs of mosquitoes belonging to the genera *Aedes* and *Psorophora* are also laid singly just above the water line. These eggs are without floats. *Culex* mosquitoes lay their eggs in bundles called rafts, which float on the water surface. Mosquito larvae and pupae may be found in permanent or temporary pools or other bodies of water. Mosquito larvae, called "wigglers," have four instars during development. Most larvae breathe air by suspending themselves nearly vertically just beneath the water surface, and extending a terminal air tube to the air. Species in the genus *Mansonia* obtain air by piercing submerged stems of immersed plants. *Anopheles* larvae breathe by using palmate hairs to hold them horizontally in the water just under the surface where their bodies contact the air. Larvae of many species are found in streams, ponds, lakes, swamps, and salt and fresh water marshes.

Some are found in water in artificial containers such as bottles, cans, plant pots, old tires, and rain gutters. Many others live where water gathers in tree holes or where the leaves meet the stems of some leafy plants. Others, the "flood-water mosquitoes" of the genera *Aedes* and *Psorophora*, lay their eggs on mud just above the waterline. The water gradually dries up and leaves a dry flood pool. Later the rains fill the pool, stimulating the eggs to hatch.

9-8. Mosquito-Borne Diseases

a. Viral Diseases.

(1) *The encephalitides.* Most arthropod-borne viruses (arboviruses) which affect man are transmitted by mosquitoes. Several of these viruses cause encephalitis, a condition affecting the central nervous system. Symptoms and consequences range from asymptomatic cases to those causing high fever, temporary or permanent damage to the brain and central nervous system, and death. The encephalitides are the only mosquito-borne diseases which continue to occur in the United States. There are many of the encephalitides and other arboviral diseases in the world which are seldom publicized because of their limited geographical distributions. However, upon deployment to such areas the mosquito-borne viruses could pose a major threat to soldiers. Encephalitis viruses are vectored by many species of mosquitoes in several genera. Reservoirs include a variety of small mammals and wild or domestic birds.

(2) *Yellow fever.* This disease continues to be the most dramatic of the arboviral diseases in the tropics and subtropics throughout the world except in Asia, where the disease does not occur. In jungle areas of Africa and South America the disease is maintained in nature by vector mosquitoes which frequent treetops to feed on reservoir monkeys. Man usually becomes involved when he enters the jungle and is bitten by the vector mosquitoes. The potential for urban transmission depends on the return of an infected human to an area where the urban mosquito, *Aedes aegypti*, is present to initiate and maintain person-to-person transmission. This mosquito is the classic urban vector of yellow fever and has the accepted common name, "yellow fever mosquito." Yellow fever continues to occur sporadically in endemic areas where preventive and supportive medical measures are not available. It is considered to be of little importance to the Army because a safe, effective vaccine affords complete protection.

(3) *Dengue.* This disease is transmitted from person-to-person in the tropics and subtropics throughout the world and often occurs in epidemic form. It is usually a nonfatal disease characterized by sudden onset, high fever, severe headache, backache, and joint pains, then a rash appears 3 or 4 days after symptoms begin. The joint pains are so severe that dengue is often called "breakbone fever." There are four types of dengue virus, any of which can produce the characteristic illness. Simultaneous or consecutive infection with different types may be associated with fatal forms of the disease known as dengue shock syndrome and dengue hemorrhagic fever. The principal vector in the Western Hemisphere is *Aedes aegypti*; in the Eastern Hemisphere, *Aedes albopictus*. Dengue is an important disease to the Army

because of its wide distribution, epidemic potential, incapacitating symptoms, and slow recovery of victims. Dengue vaccines are being developed, but are not currently available.

b. Malaria. Over 1,000,000 humans die of malaria every year. There are four types of human malaria, each caused by a microscopic protozoan parasite in the genus *Plasmodium (P)*. Human malaria is transmitted only from human-to-human, and only by mosquitoes in the genus *Anopheles*. The most serious malaria is caused by *P. falciparum* and is found mostly in the tropics and subtropics. Severe anemia and involvement of the liver, spleen, or brain often cause fatalities. Malaria caused by *P. vivax* is most widely distributed and is found worldwide in tropical, subtropical, and warmer temperate regions. Although seldom fatal, relapses can occur for years after the initial infection because of parasites which remain dormant in the liver and unpredictably reappear. Malaria caused by *P. malariae* and *P. ovale* are relatively rare and have limited geographical distributions. All four protozoans have very complex life cycles which require development both in man and *Anopheles* mosquitoes in order to be completed. Malaria is important to the Army because of the wide distribution, incapacitation or death of victims, and slow recovery or relapses in survivors.

c. Filariasis. Filariasis is caused by filarial worms (nematodes) which live in various parts of the lymphatic system of man. The disease is found in many parts of the world, but mostly in the tropics and subtropics. Man is the only reservoir and host, and the disease is transmitted from person-to-person by many mosquitoes in several genera. Symptoms of initial infections, which respond well to treatment, vary from asymptomatic to high fever and inflammation of lymph nodes. In some people who have had prolonged and repeated infections, there may be gross enlargement and deformity of limbs, external genitalia, or breasts. These pronounced enlargements are also called "elephantiasis." Human filariasis is not considered to be important to the Army because initial infections are treatable and because the elephantiasis manifestations occur only after years of repeated, untreated infections.

9-9. Surveillance

a. General. Surveys are essential for planning, operating, and evaluating any effective mosquito-control program, whether for the prevention of mosquito-borne diseases or for decreasing the populations of these biting insects to a level permitting normal activities without undue discomfort. Two types of surveys are widely used.

(1) *Original basic survey.* This survey determines the species, sources, locations, densities, and flight range of mosquitoes. It may also include information on life cycles; feeding preferences; larval habitats; adult resting places; recommendations for a control program; and setting up immediate aims and long-term objectives.

(2) *Operational survey.* This is a continuing evaluation, which is extremely valuable in the daily operation of a mosquito-control program, that provides information on the effectiveness of control operations and data for comparison throughout a season or from year to year.

b. Survey Maps. Each garrison should prepare two maps of the mosquito survey and control areas. The maps indicate the locations of mosquito light traps (such as T-1 and T-2), resting stations (R-1 and R-2), biting stations (B-1 and B-2), and larval stations (L-1 and L-2). A complete description of each station is prepared separately from the map to include all pertinent information, such as: L-15 is located in area 5, on Cebu Creek, near a large sycamore tree. If for any reason an old station is closed or discontinued, the number that was originally given that station will not be used for a new station. Since these data will be of great value in conducting epidemiological or ecological studies, it is important that the survey maps be reviewed annually.

c. Field Collecting Kit. Suggested list of supplies for Field Collecting Kit (Figure 9-1).

- Case, medical instrument and supply set.
- Aspirator.
- Insect repellent.
- Forceps.
- Knife.
- Medicine dropper.
- Pillboxes, assorted.
- Vials, assorted.
- Chloroform killing tube.
- Hand mirror.
- 8-ounce bottle of 70 percent alcohol.
- Camel's-hair brush, small.
- Rubber tubing (siphon).
- Turkey baster.
- Dipper.
- Notebook and pencil.
- Scissors, small.
- Compass, small.
- Area map.
- Rubber boots.

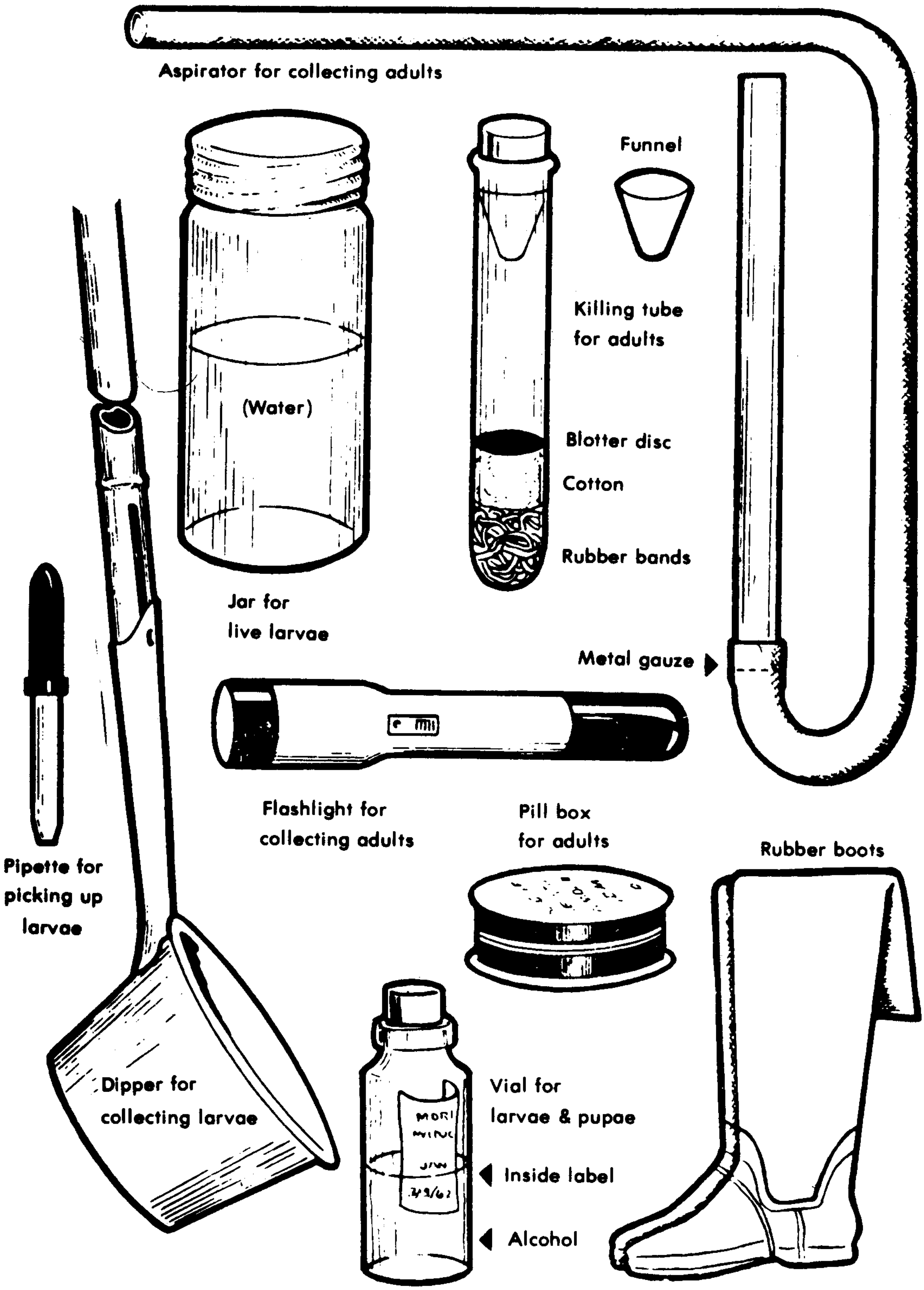


Figure 9-1. Equipment for mosquito surveys.

d. Adult Mosquito Collections and Surveys. The adult survey permits evaluation of the incidence of mosquitoes and shows the relative abundance of the various species present at any time. Using this information and reference material on the breeding sites and habitats of mosquito species, the entomologist, with the help of the preventive medicine specialist, can determine the need for a control program. Knowing the species of adult mosquitoes in an area can simplify the search for larval breeding places. The adult mosquito survey furnishes data for mosquito control (both chemical and nonchemical) at the best time and place; also for reporting to the preventive medicine officer the extent of the problem with the results of control operations. Interpreting adult mosquito survey reports and translating this information will save manpower, materials, and equipment and justify the entire operation. In conducting adult mosquito surveys, three types of collections should be made — *light traps, resting stations*, and *biting collections*. In an intensified epidemiological survey, other collection methods, such as animal-baited traps or CO_2 traps, may be used.

(1) *Light-Trap Collections.*

(a) Many mosquito species are attracted to light, making it possible to use this response in sampling adult populations between dusk and dawn. The New Jersey mosquito light trap, developed in the 1930's, has been used widely in obtaining data on the intensity and species composition of mosquito populations. The New Jersey light trap requires a 120v AC power source.

(b) The Center for Disease Control (CDC) miniature light trap and the Army miniature light trap were developed for greater portability in making live mosquito catches in remote areas which could not otherwise be sampled. This trap operates on batteries. This small plastic trap results in catches of about one half as many mosquitoes as the New Jersey trap. In one instance the miniature trap collected 25,000 *Psorophora confinnis* in a single night. It has also been used with success in collecting *Culicoides* and *Phlebotomus* flies.

(c) Light traps attract many species of adult mosquitoes from distant areas when they are placed in locations remote from competing light sources. As the mosquitoes reach the light they are blown downward through a screen funnel into a killing jar or a mesh bag suspended below the trap. The killing jar is made from a pint or quart fruit jar or plastic container. A layer of sodium or potassium cyanide is placed in the bottom, covered with a layer of sawdust or cotton and a layer of plaster of Paris or cardboard. For safety reasons rubber bands or rubber chunks saturated with chloroform may be substituted for cyanide. Some workers only use paradichlorobenzene in the killing jar. A perforated paper cup is placed in the mouth of the jar to hold the specimens, keeping them dry, clean, and easy to remove. To prevent loss of potency, keep the jars capped when not in use.

(d) The mosquito light trap is mounted on a post, or hung from a tree, with the light 5 to 6 feet above the ground. It should be located 50 or more feet from buildings in open areas near trees and shrubs. It should not be placed near other lights, in areas open to strong winds, or near industrial plants giving off smoke or gas. The number of light traps necessary for an adequate survey will vary with the size and geographical location of the area

to be surveyed. The traps are operated on a regular schedule from 3 to 7 nights each week. They are turned on just before dark and turned off after daylight. An automatic time clock may be used to start and stop the trap, or it may be turned on and off by hand. The collection should be removed each morning and placed in a labeled box until it can be sorted and identified. Special attention must be given to the killing jars to insure that they are always charged. An extra set of killing jars may be provided, thus allowing the jars to be rotated with the jars on the traps. This exchange will permit the jars to dry out if high humidity or rain has occurred, and will facilitate recharging the jars at regular intervals. The jars containing the specimens are returned to the laboratory or office where the mosquitoes are separated from other entomological specimens that were captured.

(e) Separating mosquitoes from other specimens is best accomplished by emptying the killing jar contents on a sheet of white paper. Use forceps to tease a few of the specimens to one side of the mass and carefully observe for mosquitoes. Some species of mosquitoes are very small, whereas others are extremely large; therefore, do not rely on size for identifying adult mosquitoes. There are other insects that closely resemble mosquitoes, such as midges, crane flies, and some species of *Culicoides*.

(f) Place the adult mosquitoes in pillboxes between layers of lens paper or facial tissue. The layers of lens paper are cut in pieces slightly larger than the pillbox. Since identification of many species of mosquitoes is dependent upon the color and location of scales on the body, it is very important that the adults be handled gently when preparing for shipment. Never use cotton or gauze as packing material because specimens tend to cling to the fibers, and upon removal identifying features are destroyed. The number of specimens in each layer should not exceed ten. To minimize damage to the specimens, pack them so that they do not come in contact with one another. Pack them firmly to avoid shifting in the container but not so firmly as to damage the specimens.

(g) Provide identifying data on the cover of each pillbox. Without this information, all the work of collecting the specimens is lost and the specimens are worthless. Each pillbox cover should have the trap number, dates operated, location, and collector; for example, T-5, 5-6 June 1985, Fort Sam Houston, Tex., coll: Jones. For adult mosquito light trap collections, similar data are supplied on the form that accompanies the specimens in the pillbox. Sometimes more than one pillbox is required to pack all the mosquitoes collected from one trap. If three pillboxes are used for the collection, the following should be added: 1 of 3, 2 of 3, and 3 of 3.

(h) Light trap data forms will vary from area to area; however, all the information placed on the pillbox of specimens is also entered on the form.

(i) Different species of mosquitoes react differently to light. Light trap collections must therefore be used in conjunction with other methods of sampling mosquito populations. They have proven very useful in measuring densities of some of the culicine mosquitoes, such as *Aedes*

sollicitans, Aedes vexans, Aedes nigromaculis, Culex pipiens, and *Mansonia perturbans*. Some anophelines, especially *Anopheles albimanus, Anopheles crucians, Anopheles atropos*, and *Anopheles walkeri*, are also readily taken in light traps. The common malaria mosquito, *Anopheles quadrimaculatus*, however, is seldom taken in significant numbers.

(2) *Resting Stations.*

(a) Adults of many species are inactive during the day, resting quietly in dark, cool, humid places. Careful inspection of daytime shelters give an index to the population density of these mosquitoes. This method is especially useful for anopheline mosquitoes and is commonly used for *Anopheles quadrimaculatus*. It is also of value in estimating populations of some culicines such as *Culex quinquefasciatus* and *C. tarsalis*. Mosquito resting stations may be divided into two types: natural and artificial.

(b) Natural resting stations are places normally present in an area, such as houses, stables, chicken houses, privies, culverts, bridges, caves, hollow trees, and overhanging banks along streams. With experience one is able to evaluate the suitability of shelters by casual inspection. Dwellings, especially when unscreened, often prove to be satisfactory resting stations. These resting stations are important when mosquito-borne diseases are being investigated. Under such conditions they furnish an index to the number of mosquitoes which may bite man and transmit diseases.

(c) Artificial resting stations may be used if suitable natural resting stations are not available in sufficient numbers to give a satisfactory evaluation of the mosquito population. It may be necessary to construct special shelters or to use boxes, barrels, kegs, or other similar items, as artificial resting stations. Many types of artificial shelters have been used. They should always be placed near the suspected breeding places in shaded, humid locations. Mosquitoes enter such shelters at dawn, probably in response to changes in light intensity and humidity and ordinarily do not leave until dusk. Artificial shelters built in the form of an outdoor privy 4 feet square and 6 to 7 feet high have been successfully used.

(d) One collection each week from each station is sufficient for a routine survey and control operation. Resting stations are usually visited on one of the days selected to service mosquito light traps. A route can be selected to allow visits to all resting stations and light traps without too much duplication of travel.

(e) A flashlight, chloroform killing tube, and pillboxes are the equipment required for collecting mosquitoes from resting stations. An aspirator is also used for collecting adult mosquitoes. The chloroform tube will require recharging each week when used extensively. It operates more effectively when vapor is sufficient to knock down a mosquito instantly. It should be recharged if time is required for the mosquito to drop after the tube is placed over it.

(3) *Biting Collections.*

(a) Collecting mosquitoes as they bite is a convenient method of sampling populations. In making biting collections or counts, you expose part of your body by rolling up your sleeves or trouser legs, or by removing your shirt, and sit quietly for a designated period of time (usually 10 to 15 minutes). The mosquitoes are collected with an aspirator or chloroform tube, either by the collector or a coworker. In many parts of the tropics it is customary to make biting collections about sundown from a domestic animal, such as a white horse. If collections are made at night, a flashlight is required. Whether collections are made from humans or animals, it should be recognized that some individuals are more attractive to mosquitoes than are others. It is, therefore, desirable for the same person or animal to be used throughout a given survey. Collections must be made at regular intervals and at approximately the same time of day, so that biting rates at different stations may be compared to show trends in mosquito populations.

(b) With day-biting species, the index may be based upon the number of mosquitoes alighting upon one's clothing in a given time interval (the landing rate), rather than those actually biting. This is more practical when populations are very high, and is useful for a rapid check of mosquito abundance before and after control operations. The landing rate method has been used especially with species of *Aedes* or *Psorophora* found in salt marshes, rice fields, or the arctic, and subarctic tundras.

e. Adult Mosquito Collecting Equipment.

(1) The required equipment is simple and inexpensive. It consists of a collecting tube or aspirator, pillboxes, cages (for live collections), field record forms or notebook, pencil, flashlight, and map.

(2) The collecting tube may be made from a glass or plastic tube of any convenient size (Figure 9-2). Usually large test tubes about 1 inch in diameter by 7 inches in length are preferred. The tube is filled to a depth of about 1 inch with finely cut rubber bands, art gum, or other available rubber. Saturate the rubber with chloroform. Place a disk of blotting paper over the rubber, then a half-inch of cotton, and then press the last two or three disks of blotting paper cut slightly larger than the tube over the cotton. Close the tube with a cork stopper. Collecting tubes remain effective for several weeks and can be recharged when necessary by removing the disks and cotton and adding more chloroform. Some workers wrap the base of the collecting tube with adhesive tape to lessen breakage, and others add an inverted paper cone inside the mouth of the tube to trap specimens more easily. The addition of crinkled tissue paper to the tubes helps keep specimens dry and prevents breakage, making identification easier.

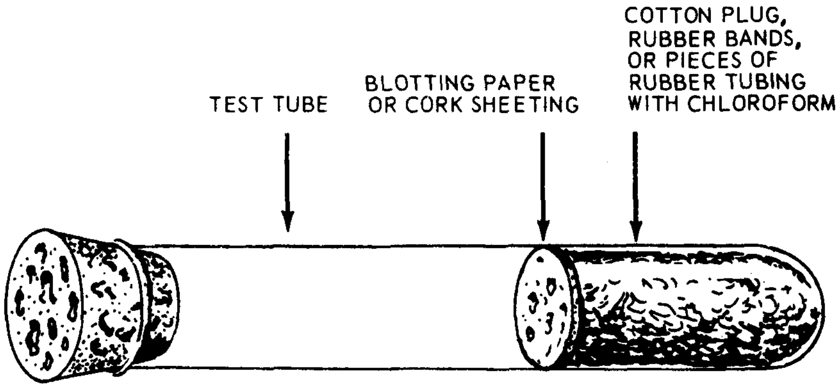


Figure 9-2. Collecting tubes.

(3) A simple aspirator is prepared from a selection of clear plastic (or glass) tubing 12 inches long with an inside diameter of about 3/8 of an inch. One end of the tube is covered with bobbinet or fine wire screening and then inserted into a piece of rubber tubing 2 to 3 feet long.

(4) Small pillboxes or salve boxes with tissue discs are used for holding dead mosquitoes until they can be identified (Figure 9-3).

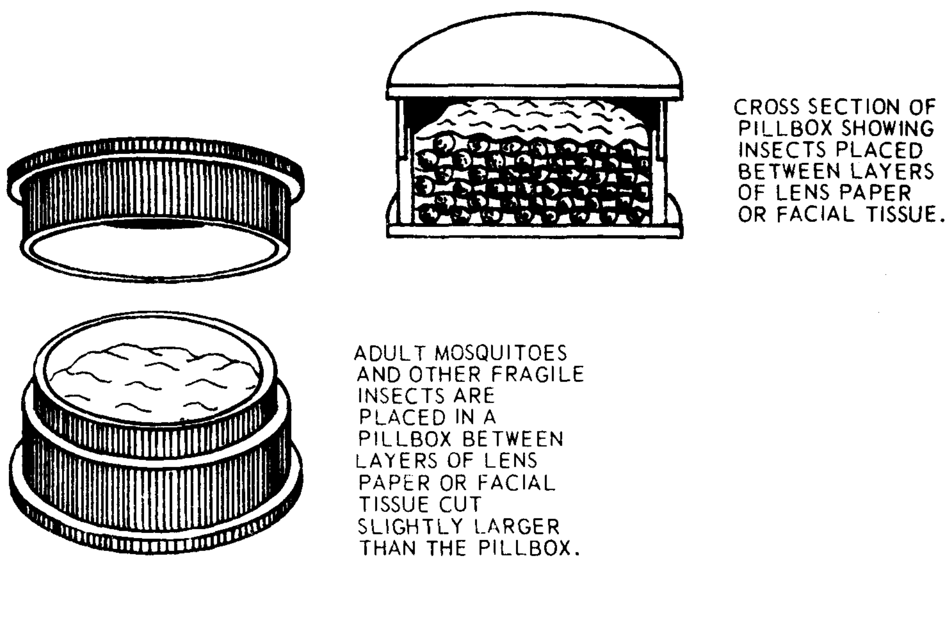


Figure 9-3. Small pillboxes or salve boxes for holding dead mosquitoes.

f. Mosquito Larval Collections.

(1) *General.*

(a) Larval surveys are used to determine the precise areas in which mosquitoes breed and to indicate their abundance. For this reason, larval surveys are of special value in control operations.

(b) Mosquito larvae are found in water, from warm, brackish, seaside marshes to the pure cold water of melted snows. They are found in such diverse locations as rivers, lakes, ponds, crab holes, pitcher plants, eave troughs, funerary urns, bottles, cans, reservoirs, tree holes, old tires, and vases.

(c) Mosquitoes have adapted themselves to almost every conceivable type of aquatic situation. It is necessary to obtain information regarding the general breeding habits of the species known or suspected to be present in the area prior to initiation of larval surveys. An experienced person may be able to spot the probable mosquito-breeding places in a specific area by means of a rapid reconnaissance survey. These places should be carefully numbered and marked on the map. More detailed inspection is then required to determine the specific breeding sites and establish permanent larval sampling stations.

(2) *Collection Procedures.*

(a) Mosquito larvae are usually found where surface vegetation or debris is present. Thus, in larger ponds and lakes, larvae are usually confined to the marginal areas. You must proceed slowly and carefully in searching for mosquito larvae, since disturbing the water or casting shadows cause the larvae to dive to the bottom. Anopheline larvae are collected by a skimming movement of the dipper with one side pressed just below the surface. The stroke is ended just before the dipper is full. Larvae will be lost if the dipper is filled to the point that it runs over. It is best to press the dipper into the clumps of erect vegetation with one edge depressed so that the water flows from the vegetation into the dipper. Culicine larvae of the genera *Aedes, Culex,* or *Psorophora* require a quicker motion of the dipper, since they are more likely to dive below the surface when disturbed.

(b) Always record the number of dips made and the number of larvae found. Transfer the larvae to small vials by using a widemouth pipette and preserve them in alcohol for later identification. It is possible to get a rough idea of the breeding rates by computing the number of larvae of each species per dip. The number of dips required will depend upon the size of the area, but for convenience they should be made in multiples of 10. Make inspections at intervals of 1 to 2 weeks during the breeding season. Areas which are entirely free of larvae at one time may be found breeding heavily at other times. Laboratory identifications of specimens are tabulated on a record form.

(c) Variations in the procedure described above are required when inspecting for some species. For example, *Mansonia* larvae remain below the water surface throughout their development. These larvae are found by pulling up aquatic plants such as cattail, sedges, and pickerelweed, and washing them in a pan of water. A search of the bottom muck and trash from the area where the host plants have been uprooted may be productive. This material should be scooped up and examined in pans of clear water.

(d) *Aedes aegypti* requires a careful search for artificial containers in which these domestic mosquitoes breed. Such inspections are usually made on a premise-by-premise basis where bottles, tin cans, vases, automobile tires, and all other containers of water are examined. The *Aedes aegypti* index is obtained by dividing the total number of premises inspected into those in which breeding is found. Collection of the larvae may require a dipper but is more frequently accomplished directly by means of a widemouth pipette.

(e) Inspection for *Aedes triseriatus* and *Aedes varipalpus* involves searching for tree holes and artificial containers in which these species breed. These are often too small to admit an ordinary dipper, but water can be siphoned into a dipper or pan where the larvae can be seen.

(f) If you are in the field and unable to return to the laboratory for a long period of time and the larvae are at the desired state of development, they may be killed and preserved in 70 percent ethanol. The preferred method for killing larvae in the laboratory is "the hot water technique." Specimens are killed in hot water (approximately 180° F) and transferred to 70 percent ethanol and 1 percent glycerin. The larvae can be shipped in a vial containing the 70 percent ethanol and 1 percent glycerin solution (Figure 9-4). Field collection data should accompany the specimens through each step in the preparation and shipment phases.

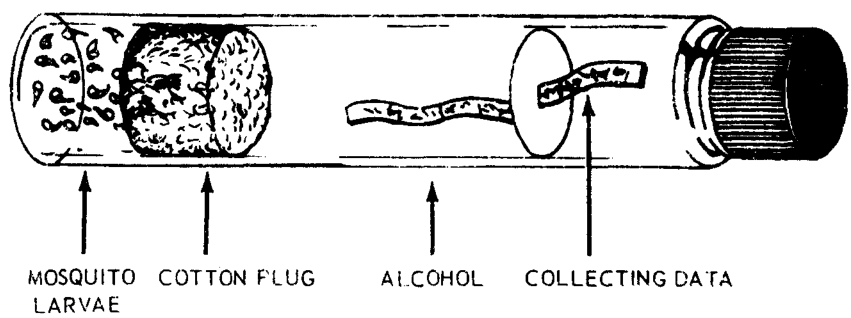


Figure 9-4. Vial for shipping.

(3) *Mosquito Larval Collecting Equipment.*

(a) A white enamel dipper about 4 inches in diameter is most often used for collecting mosquito larvae. The handle of the dipper may be extended to a convenient length by inserting a piece of cane or wood. Other specialized dippers are used for specific areas and sampling procedures where the volume capacity of the dipper can be directly correlated to the water surface area. The number of larvae per square foot or square meter may be computed with reasonable accuracy.

(b) White enamel pans are used instead of dippers by some individuals. A convenient-sized pan is about 14 inches long, 9 inches wide, and 2 inches deep. This pan is used to sweep an area of water until the pan is half full. It may then be floated on the water surface while the larvae are removed.

(c) Inspection of small artificial containers or cisterns may require the use of a flashlight or a mirror to reflect light into the breeding place. Large bulb pipettes or siphons made of rubber tubing are sometimes used to remove water from small obscure areas such as tree holes. The water is then put in a dipper or pan where the larvae are counted and collected. Widemouthed pipettes are used for removing larvae from the dipper or pan; and small vials serve to hold the larvae until they can be identified. Screened-bottom spoons may be substituted for pipettes if the larvae are to be transferred to widemouthed bottles.

9-10. Prevention of Mosquito-Borne Diseases

a. Individual Protective Measures. Most cases of mosquito-borne diseases can be prevented by using individual protective measures (paragraph 9-3). However, soldiers have historically failed to use these measures and mosquito-borne diseases have taken a needless toll in every Army deployment to areas where mosquito-borne diseases were present. Malaria chemoprophylaxis is effective, but only when soldiers strictly adhere to the treatment regimen.

b. Unit Protective Measures. Commanders must emphasize individual protective measures in training and strictly enforce their use upon deployment. AR 40-5 requires that malaria chemoprophylaxis be administered under supervision and that a roster be kept to ensure no treatments are missed. Educating unit personnel on the consequences of malaria and other mosquito-borne diseases promotes voluntary compliance with individual protective measures, including chemoprophylaxis. Expeditious isolation and evacuation of suspected disease victims is critical. An infected soldier who remains in the unit may become the source of infection for others. The field sanitation team should treat mosquito larval habitats in and around the unit using the 2-gallon sprayer and insecticide. Emptying artificial containers and filling in small areas which contain standing water is also necessary. A chemical barrier applied to vegetation immediately surrounding the unit area will deny resting places for adult mosquitoes. Spraying walls and ceilings of tents and buildings in the unit area is also effective for this purpose.

c. Area Protective Measures. Appropriately equipped preventive medicine teams provide mosquito control on an area basis. Mosquito larvae and adults are susceptible to these control efforts. The most effective means of control is long-range, permanent cultural control by destroying larval habitats through modifying the environment. This includes digging drainage ditches, filling in low areas, and other measures to permanently remove standing water. Cultural control is practical only in static military situations like fixed installations. Biological controls in larval habitats, also applicable to static situations, include the introduction of small fish (*Gambusia spp.*) or larvae of *Toxorhynchites spp*. mosquitoes, both of which are predaceous on mosquito larvae. Upon deployment the Army will be too mobile to warrant permanent controls, so temporary chemical controls must be used. Thorough surveys must be conducted to determine the target species, their habitats, and behavior (see paragraph 9-9) before any chemical control on an area basis is begun. After survey completion, ground or aerial application of larvicides to larval habitats is effective. Adult mosquitoes are best controlled with ultra-low-volume (ULV) equipment. Residual sprays can be applied to vegetation around occupied areas, as well as to walls and ceilings of buildings, to deny adult resting sites. In built-up areas where container-breeding vector mosquitoes are present, area preventive medicine teams should organize and supervise a program to empty artificial containers, remove trash piles and discarded vehicle tires, and to implement other measures which will destroy or modify larval habitats.

Section IV. BITING FLIES

9-11. General

Biting flies, like mosquitoes, are in the order Diptera. They have one pair of wings and a pair of halteres. All flies have four developmental stages: egg, larva, pupa, and adult. Biting flies get their name from the pain associated with their attacks. They actually have piercing-sucking mouthparts instead of biting mandibles. The "biting" pain occurs as they use specialized mouthparts to saw, puncture, or otherwise pierce the skin. Some species then siphon blood through a feeding tube inserted into the wound, while others lap up the pool of blood and tissue fluid that forms at the skin surface. There are many species of biting flies, and the same type of fly that transmits a fatal disease in one part of the world may only be a nuisance pest elsewhere. Control of a biting fly vector in a given situation requires extensive knowledge of the species involved, its habitats and behavior, and the relationship between the fly and the disease. A brief description of the important types of biting flies are included in this section. Specific information on biology, surveillance, and control should be obtained from the medical entomologist supporting the area of operations.

9-12. Biting Flies and Diseases

a. Sandflies (Phlebotomus spp. and Lutzomyia spp. of family Psychodidae). The sandflies are tiny, mothlike flies with hairs covering their wings and body. Regarding disease transmission, they are second only to mosquitoes in the number, importance, and wide distribution. They are found worldwide in tropical, subtropical, and warmer temperate regions. The diseases these flies transmit are bacterial (bartonella), viral (sandfly fever), and protozoan (Leishmaniasis, including forms which are fatal, chronically debilitating, or which cause gross disfigurement and scarring).

b. Blackflies (Family Simulidae). The blackflies are small (about 1/5 inch long), dark, stout-bodied flies with short broad wings. They are frequently called buffalo gnats or hump-backed flies because of their large, rounded thorax. In Africa and South America blackflies transmit Onchocerciasis or "river blindness," a disease which frequently causes permanent blindness as a result of the migration of filarial worms through the eyes.

c. Tsetse Flies (Glossina spp., Family Muscidae). The tsetse flies are a little larger than houseflies and have prominent elongated mouthparts. They fold their wings scissorlike across each other, and the wings extend well beyond the tip of the abdomen when folded. Tsetse flies are found in sub-Saharan Africa, where they transmit the protozoan disease African trypanosomiasis (African sleeping sickness).

d. Deer Flies and Horseflies (Tabanus spp., Chrysops spp., Family Tabanidae). These medium to large flies are known worldwide as ferocious biters and can seriously interfere with field operations. They prefer warm, sunny areas, and are especially active on humid days. They are known to vector bacterial (anthrax and tularemia), protozoan (trypanosomiasis), and helminth (Loa loa) diseases to man and animals.

e. Other Biting Flies. The biting midges or "no-seeums" (*Culicoides spp.*), the stable flies (*Stomoxys calcitrans*), and horn flies (*Haematobia irritans*) are other biting flies which can inflict painful bites and cause such annoyance so as to significantly interfere with military operations.

9-13. Prevention of Diseases Vectored by Biting Flies

a. Individual Protective Measures. Soldiers can help prevent bites by using repellents, bednets, aerosol sprays, and by wearing the uniform properly to limit exposed skin. Avoidance of infested areas, if possible, is important because some individual measures will not provide protection against specific flies.

b. Unit Protective Measures. The field sanitation team should use the 2-gallon sprayer and pesticide to spray tent walls, vegetation, or other areas where the flies are observed resting. Impregnation of uniforms with repellents, and issue of fly swatters to soldiers, can also provide relief. Spraying larval habitats is usually impractical because the breeding areas are too extensive or too far removed from where the highly mobile flies attack personnel.

c. Area Protective Measures. Reduction of larval habitats can be accomplished using portable backpack sprayers, vehicle-mounted hydraulic sprayers, or by aerial application of pesticides. Temporary control of adults is provided by portable, vehicle-mounted, or helicopter-mounted ULV equipment.

Section V. FILTH FLIES

9-14. General

Nonbiting flies (Diptera families) associated with garbage, human and animal waste, and other decaying organic matter are called filth flies. Examples are houseflies and blow flies. Their habitats, behavior, and physical characteristics account for the ease with which they transmit disease organisms to food and cooking or eating utensils. The adult fly's diet includes almost any kind of organic filth, as well as foods for human consumption. The mouthparts are adapted for sponging and siphoning, and consist of a food tube terminating in a fleshy pad, the labellum. Because they can ingest only liquid foods by capillary action through the labellum, flies moisten the labellum by regurgitating liquid from their last meal. This drop of vomitus is teeming with disease organisms, some of which remain after most of the dissolved food material is sponged up. Filth flies also defecate freely while feeding and crawling. The germ-laden feces are another vehicle for disease transmission. Pathogens, which adhere to the legs and mouthparts as the fly crawls over contaminated matter, are mechanically transferred to food or utensils on which the fly lands later.

9-15. Life Cycle

The life cycle of filth flies, like other Diptera, consists of the egg, larva, pupa, and adult. The following description of the housefly life cycle is a good generalization for most filth flies. Eggs are laid in moist organic filth and may hatch in less than 12 hours. The larva, or maggot, feeds on this material and may complete its development in 4 days. The last instar larva crawls to a drier area where it pupates in shallow holes in the soil or under ground litter. After 3 to 5 days the adult fly emerges. Mating occurs in 1 or 2 days and the female then lays about six batches of eggs (approximately 120 eggs each) at 3 or 4 day intervals. This tremendous reproductive potential enables explosive increases in filth fly populations, especially when larval habitats are readily available.

9-16. Diseases

Filth flies are responsible for mechanically transmitting, often in epidemic proportions, diseases such as cholera, dysentery, and typhoid. In situations where their breeding has been unhampered, fly-borne disease epidemics have made hundreds of soldiers miserably sick within a few days.

9-17. Surveillance

a. General.

(1) Routine fly surveys are used to determine the effectiveness of control operations, the increase or decrease in fly populations, and the medically important species present in an area. Measuring fly populations is difficult; also, the advantages and disadvantages of certain methods are debatable. There are several types of surveys that are in general use, with modifications in the technique used.

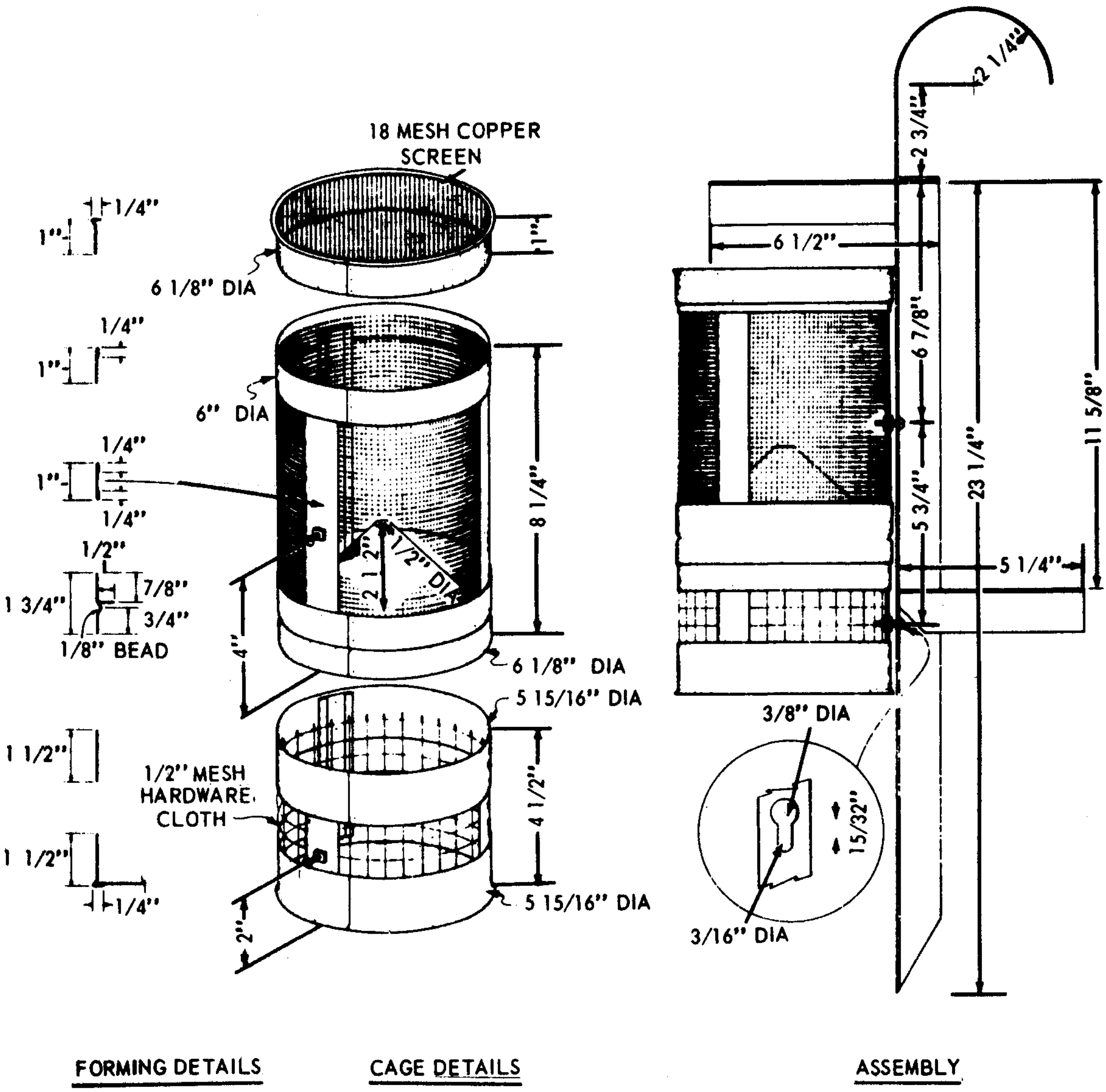
(2) In fly surveys, emphasis is usually placed on adult densities. Surveys on larval populations are infrequent because specific identification of larval forms is difficult and the detection of larvae in breeding areas is time-consuming. Therefore, when conducted, larval investigations usually are based on the observation of potential breeding areas rather than on qualitative or quantitative studies of population densities. Such surveillance should be carried on only by observers who are familiar with the breeding habits of flies. By noting the location, extent, and prevalence of the various fly-breeding media, such observers are able to approximate the fly-breeding potential of an area. Actual detection of fly larvae in any medium is usually limited to those surveys investigating the source of uncontrolled high fly densities in a community.

(3) For making an estimate of adult fly populations, count the number of flies for a standard measure of time or area; or for a number of samples; or any combination of these factors. The evaluation of a fly control program is based upon the comparison of periodic quantitative samples of the fly population. The devices used in securing these samples as well as the frequency of their use must be uniform; otherwise, an accurate comparison of the data obtained is impossible. By observing this principle, even the simple process of counting the number of flies resting on a barnyard post will yield evaluation data which are on a par with those derived by the use of such devices as flytraps and grills.

b. Flytrap.

(1) For qualitative surveys of the fly population, the flytrap is a useful tool. Traps vary in size, but the outlines of their construction are similar. This trap is durable, is easy to transport and handle, and has proven to be satisfactory for the collection of flies. The operating principle of the trap is simple. Flies are induced to enter the trap by means of an attractant and after entering the trap, fly upward toward the light. Once they pass through the small aperture at the top of the cone and into the cage, little chance is afforded for their escape.

(2) Since success of trapping flies depends upon getting the flies to enter the trap, the selection of the attractant is of prime importance. Because certain attractants may be more attractive to one species of flies than to another, the bait should contain attractants which are suitable for several different kinds of flies. A bait of fish scraps will attract vast quantities of blowflies, but the catch of houseflies may be so small as to be totally disproportionate to their actual abundance. Consequently, to obtain a qualitative picture of the domestic fly population, an all-purpose bait consisting of fish heads or chicken entrails together with waste vegetables and fruits is most satisfactory. The baits should be placed in containers about 2 inches in depth and slightly smaller in diameter than the cage cylinder (Figure 9-5).



NOTE

BANDS AND VERTICAL
MEMBERS TO BE
24 GA. SHEET METAL
STAND TO BE 1 1/4" X 1 1/4" ANGLE IRON
WITH 1" X 1/8" STRAP IRON CARRYING HANDLE
BOLTS TO BE 1/8" X 3/4" STOVE BOLTS
SPOT WELD ALL BANDS, SOLDER ALL SCREEN
AND HARDWARE CLOTH

Figure 9-5. Flytrap — attached bait pan type.

(3) A modified version of the flytrap (Figure 9-6) often is used to obtain "flesh" flies for virological or bacteriological examination. The device, a "fly cone" or "cone net," is a mobile trap in which the relative proportions of the cage and cone have been reversed and a field attractant substituted for the prepared bait. In operation, the cone is placed quickly over the desired attractant or fly concentration so as to trap the specimens below. Throw a dark cloth around the cone to drive the flies upward and into the cage, then remove and cover the cage by sliding a lid across the open end. When flies are abundant, several cages may be required at one site. The "fly cone" may also be used to sweep flies out of grass or other vegetation. The data derived from flytraps are useful, not only in indicating the prevalent species, but also in showing their seasonal abundance. In addition, trap collections may be used for quantitative evaluations.

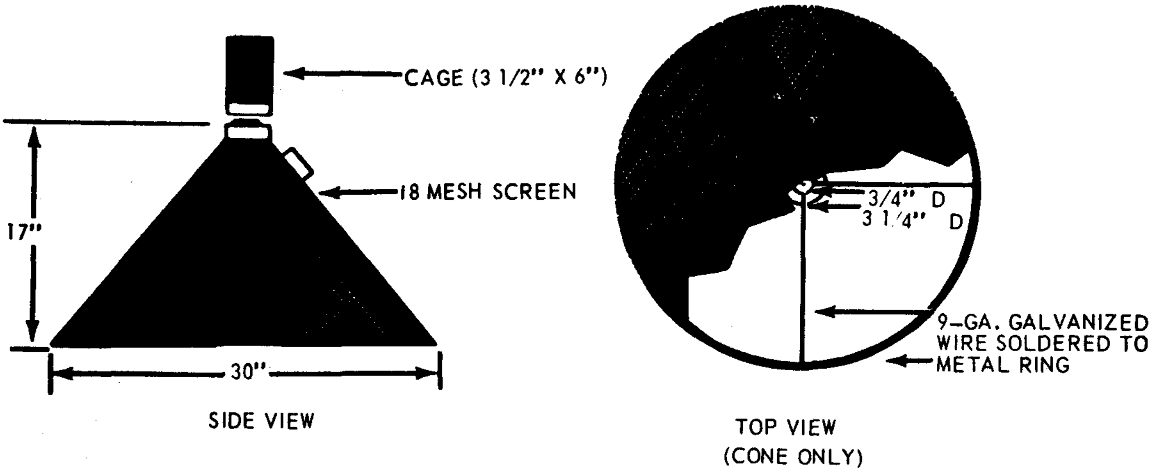


Figure 9-6. Fly cone.

(4) When placing traps in the field, you should select locations that sample all sections of the community. Trap schedules can be arranged as desired. A satisfactory plan is to set out the trap in the early afternoon of 1 day and collect it the following afternoon. Kill the trapped flies by placing the trap in a tight container and exposing them to a fumigant such as chloroform, carbon disulphide or ether, or by spraying them directly with a contact insecticide. Collections are then measured by volume, weight, or actual count.

c. Fly Grill. The grill is a slatted device (Figure 9-7) used in making outdoor fly surveys to measure the concentration of flies at a specific location. Garbage and manure are suitable attractants for houseflies. The technique is to place the grill over the attractant, momentarily disturbing the flies and then counting the number that return and alight on the slats. You should avoid casting a shadow on the grill or exciting the flies to the extent that they leave the site. In instances where the grill count is not compatible with the visual density of flies, the grill may be agitated several times in order to secure an accurate reading. One reading per attractant is sufficient.

(1) In making grill counts, flies may be counted on a purely quantitative basis, but for efficiency of operation, determining the various types of flies is essential. Since this field identification is macroscopic and must be done rapidly, you must be thoroughly trained in this technique.

(2) For community programs, grill counts are set up on a block basis with the five highest counts in a block being averaged to give the block a rating. In some instances the highest count in a block is the only reading used, but this technique frequently fails to show the effect of the control measures.

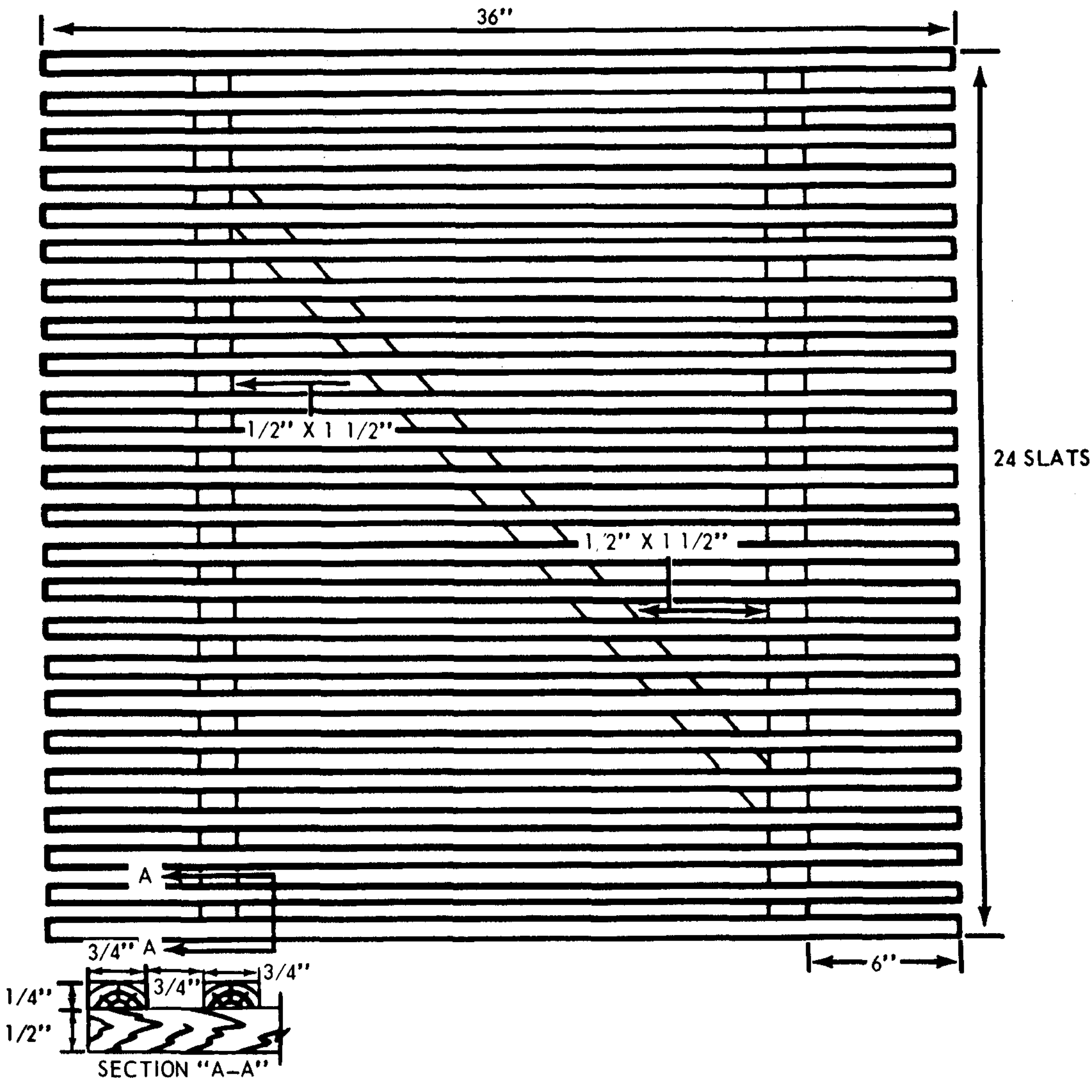


Figure 9-7. Fly grill.

d. Net. By sweeping an ordinary insect net through fly concentrations, it is possible to secure small samples of the fly population. This method is suitable for quantitative or qualitative surveys where rapid, extended coverage is desired, or where collecting species of flies usually not obtained in flytraps and grill operations (such as male specimens of *Fannia canicularis*) is desired.

e. Fly Baits. Fly baits can be prepared by painting a solution of molasses and vinegar (1:2 ratio) over a square foot of surface area on heavy cards. After a bait card is exposed for a 5-minute period at a location frequented by flies, the number of flies attracted to it is recorded. This method is useful in determining fly densities in barns or houses.

f. Fly Strips. Strips of sticky flypaper suspended in buildings and outdoors can be used as a relative indicator of fly activity. Such strips should be exposed for a definite time period, after which the number of captured flies is counted.

g. Visual Observation. This method is useful when used by experienced personnel. By counting the flies in a measured area of observation such as a room or a square yard, it is possible to obtain a relatively accurate indication of fly prevalence.

h. Shipping Flies. Flies collected for identification should be prepared for shipment in the same manner as previously described for shipping adult mosquitoes (Figure 9-3).

i. Forms and Graphs for Recording Fly Incidence. Forms for recording and maintaining weekly indexes of fly populations can be prepared and maintained at each garrison. The weekly index is the average number of flies observed from all fly survey stations. For example, the fly counting stations are observed weekly and the average number of flies observed per station is the index for that period of a week. A barograph can be prepared and maintained which portrays at a glance the status of fly population at the garrison as compared with previous surveys.

9-18. Prevention of Diseases Transmitted by Filth Flies

a. Individual Protective Measures. Except where tremendous fly populations cause severe personal annoyance, the individual concern is not as much with preventing fly contact with the body, as with preventing filth flies from contaminating food and utensils. Therefore, the most effective individual protective measures are disciplined personal hygiene and field sanitation, especially the proper disposal of waste, cleansing of hands and utensils before eating, and proper disposal of garbage. Sanitation is of paramount importance — the exposed excrement of one soldier too lazy to walk to an approved latrine, can cause an epidemic of dysentery. The aerosol spray kills flies in an enclosed area, but is ineffective outdoors.

b. Unit Protective Measures. Actions of the commander, other unit leaders, the field sanitation team, and individuals are critical in preventing diseases transmitted by filth flies. There are two key elements to prevention: denying filth flies a place to develop and denying their contact with food and eating utensils. Commanders must insist on disciplined personal hygiene and field sanitation techniques. Subordinate leaders must supervise stringently to ensure compliance. No mission of the field sanitation team is more important than that of preventing these diseases. The team must ensure that latrines are properly constructed and maintained, and ensure that the unit food service facility properly disposes of kitchen wastes and protects food from contamination by flies. Wherever possible, food preparation and serving areas are screened and aerosol spray be used to kill occasional invading flies. Fly swatters are also very effective for this purpose. Field expedient screens can be made by sewing or taping extra bednets around enclosures. The 2-gallon sprayer and pesticide should be used to spray tent walls, screens, waste disposal facilities, and other areas where adult flies congregate. Do *not* spray inside latrine pits, garbage sumps, or grease pits to kill larval flies. Spraying these larval habitats not only hastens resistance to pesticides, but also kills larvae of beneficial insects which are predatory on filth fly larvae. Properly constructed and maintained waste disposal sites will, in themselves, prevent development of filth flies.

c. Area Protective Measures. Preventive medicine teams control filth flies in large areas by destroying larval habitats and by killing adult flies. Cultural control in large breeding areas is accomplished by modifying the environment to stop fly development. An example is identifying an improperly maintained sanitary landfill, providing recommendations to correct the problem by burying the garbage, and finally, supervising units which accomplish the task. Chemical control of larval habitats is used as a last resort. Portable or vehicle-mounted ULV equipment is used by the preventive medicine team to control adult flies in occupied areas. Residual sprays can be applied to walls, ceilings, and other common resting sites.

Section VI. FLEAS

9-19. General

There are about 1900 species of fleas worldwide, and they are found wherever jild or domestic animals live. About 100 species feed on birds. Fleas are small (2-4 mm long), wingless insects with piercing-sucking mouthparts for sucking blood. They are compressed laterally, which facilitates their movement through the hair of host animals. Their strong hind legs enable them to jump several inches horizontally or vertically.

9-20. Life Cycle

a. The average life cycle of most fleas is 1-3 months, but may range from 3 weeks to over a year depending on species and environmental conditions. Fleas undergo complete metamorphosis, that is four separate stages of development. Only the adult stage is found on animals.

b. The eggs are laid in locations where the emerging larvae can readily feed on organic debris. The larvae do not bite animals. In the field environment common larval habitats are animal nests and burrows, where the larvae use their chewing mouthparts to feed on organic nesting material, bits of shed skin and hair from the nesting animals, and even the feces of adult fleas. In urban areas common habitats are rodent nests, pet bedding, carpets, cracks in wooden floors, and even couches and stuffed chairs. The larval stage may last from a week to 8 months.

c. The pupa, found in the same habitat as the eggs and larvae, is encased in a white, loosely spun cocoon commonly covered with debris. The pupal stage lasts from 1 week to over a year. The fully developed adult may remain in the pupal cocoon until stimulated to emerge by vibrations of approaching animals. That is why, upon entering a building which has been deserted for months, one's legs may suddenly become covered by hundreds of biting fleas.

d. The adult flea is an efficient disease vector. Both males and females suck blood and will feed daily for several weeks, often changing hosts after each blood meal. Infected adults may resist starvation for over a year and then transmit disease pathogens during the next feeding. Female fleas lay eggs daily in batches of 3 to 18 until a total of about 500 have been laid. This great reproductive potential further justifies the flea's reputation as a serious pest and efficient disease vector.

9-21. Flea-Borne Diseases

a. Plague. Plague has affected the course of history by decimating human populations in armies, cities, and even continents. In fourteenth-century Europe, plague killed over 25,000,000 people. Plague continues to occur worldwide on an endemic basis. The plague bacteria, *Yersinia pestis* (pasteurella pests), are acquired by vector fleas from wild or domestic rodent reservoirs. The infected fleas will readily move to other mammals to seek blood, thus transmitting the fatal disease to human hosts. Once established in a human population the plague can be communicated from human-to-human, without the flea vector, via contaminated sputum and exhaled air from lung lesions of diseased individuals. This form of the disease is responsible for the epidemics through history. The most notorious plague vector on a worldwide basis is the Oriental rat flea, *Xenopsylla cheopis*.

b. Murine Typhus (Endemic or Flea-Borne Typhus). This rickettsial disease, found worldwide, is transmitted from rodent reservoirs to man through the feces of infective fleas, primarily *Xenopsylla cheopis*. Rats are in the biological family Muridae, from which the word Murine is derived. Although seldom fatal, the fever, aches, and pains of Murine typhus can incapacitate a soldier, and recovery is slow.

9-22. Surveillance

a. General.

(1) The ectoparasites collected from animals or from their nests are of value only if precise and accurate data are recorded at the time of collection. Astute field observations and care in recording data are of great importance and can be accomplished only if adequate preparations for a field trip

have been made. Complex instruments are not a prerequisite for accurate data recording. On the contrary, the procedures used are elementary but are of great importance in arriving at an understanding of host-parasite relationships.

(2) Placing traps where they will produce the greatest number of animals requires a knowledge of animal habits. Often, animal runways, droppings, or nests will furnish clues for trapping areas. Chance plays a role in a "good catch," but the number of traps set and the time spent in selecting sites for setting traps will influence the size of the catch. Some animals, such as species of the genera *Microtus* and *Sorex*, are active during daylight hours. If traps are set early in the day, they should be visited again just before dark, Those traps containing animals should be emptied, rebaited, and reset. Then, if practical, traps should be visited at least once during the night and as soon after daylight as possible to collect captured nocturnal animals.

(3) A maximum number of ectoparasites can be removed from a host animal only if extreme care is exercised in handling the animal.

(4) Some techniques used in flea surveys also apply in collecting other ectoparasites, such as mites, ticks, lice, and bat bugs.

b. Field Procedure. The following procedure is effective for collecting rodents and ectoparasites:

(1) Use plastic bags for transporting small rodent hosts, bats, and their ectoparasites from the field to the laboratory.

(2) Upon arrival at a positive trap site, take a plastic bag large enough to accommodate the livetrap and place the trap inside it. Loosely close the bag (so that the animal does not suffocate) and tag the bag with the essential survey data (locality, habitat, date, and time of capture). Proceed to the next trap. Only place one animal in each bag. Parasites from each animal must be kept separated from others to provide a true location of infestations.

c. Laboratory Procedure.

(1) Upon returning to the field station or laboratory, open each bag and add a chloroform-saturated gauze pad. While waiting for the rodent to die, transfer the survey data from the tag to permanent records. When the animal is dead, remove the rodent from the bag and place him in a white enamel pan. Comb the rodent to dislodge the ectoparasites. Place the ectoparasites in a labeled vial containing alcohol. Carefully examine the pan, plastic bag, and gauze for ectoparasites.

(2) Ectoparasites must be handled carefully to avoid loss of bristles and broken legs. A camel's-hair brush moistened in alcohol is excellent for picking up ectoparasites; however, there is a possibility of specimens clinging to the brush and subsequent contamination of the next vial. A dissecting needle moistened with alcohol is useful in picking up mites and fleas (Figure 9-8). Jewelers' forceps may also be used if care is exercised in handling the ectoparasites.

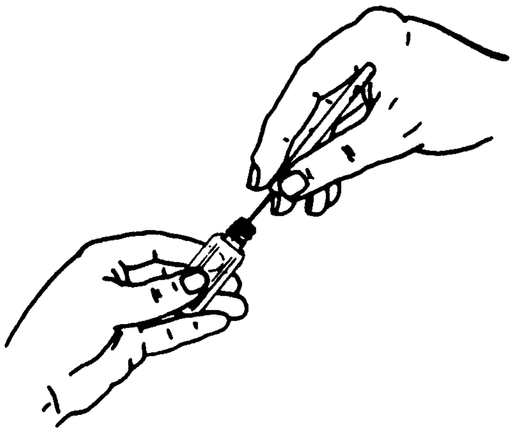


Figure 9-8. Dissecting needle moistened with alcohol for picking up mites and fleas.

(3) The enamel pan should be thoroughly cleaned after each animal has been examined.

(4) After all ectoparasites have been removed from the animal, a small tag is attached to a hind leg. The tag must be the same number that is on the bag and in the vial. The animal is ready for measuring, weighing (Figure 9-9), and processing. Disposal of rodent carcass should be by burial or burning.

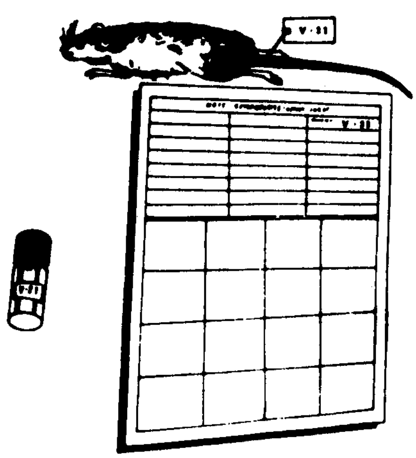


Figure 9-9. Animal ready for measuring and weighing.

d. Collection of Nests.

(1) There are many ectoparasites which live in the nests of rodents and birds. For an ectoparasite survey to be representative of the ectoparasites in an area the nest must be collected. When possible the animal and its nest should be collected together to identify the host and its ectoparasites. When the occupant is not in the nest, examine the nest carefully for feathers, pellets, and other signs which will help identify the host.

(2) These nests may be placed in large paper or plastic bags. As with the smaller paper bags containing trapped animals, these bags should be labeled with date, sequential number, and collection data. All information should be written on the bag prior to placing the nest material in the bag.

(3) Nests are usually found in hollow trees, under fallen logs, and in caves and crevices. It is usually profitable to hire indigenous people for the specific purpose of hunting nests; however, they must be instructed to use care in recording accurate information and in collecting the nest.

(4) Nests should be removed from the site with extreme care. Not only the nesting material but the top layer of soil under the nest should also be removed. Place all the material in the paper bag and twist the top of the bag tightly, then fasten it with a rubber band.

(5) In the laboratory the contents of the nest may be placed in a white enamel pan and examined bit by bit for ectoparasites. When all adults have been collected the nesting material may be returned to the paper bag and allowed to set for 30 days or more. Place wet paper towels in the paper bag every other day. At the end of the waiting period, examine the nesting material again for any remaining adults.

(6) The above method is time consuming and tedious. The processing time can be reduced by using a Berlese funnel if a power source is available (Figure 9-10). This device consists of a funnel with a light inside of it. This funnel is inverted atop another funnel. The apex of the second funnel is attached to a collecting container with alcohol inside it. The nest material is placed inside the lower funnel. A screen in the lower funnel helps prevent the nest material from dropping into the alcohol. When the light is on and the funnel is closed and taped, the heat drives any ectoparasites from the nest material down into the alcohol. Normally, this is occurs in 18 to 24 hours.

f. Recording Results. A survey record must be maintained. This record includes data on the terrain; climatic conditions at time of collection; the host — its measurements, identity, site of capture; the ectoparasite; the collecting device; and type of bait used.

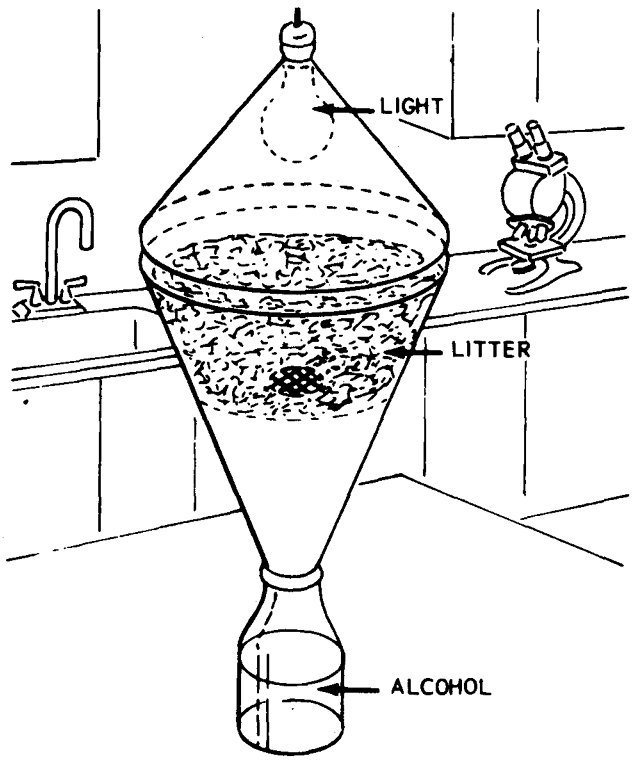


Figure 9-10. Berlese funnel.

9-23. Prevention of Flea-Borne Diseases

a. *Individual Protective Measures.* Fleas normally attack humans by jumping onto the legs and then crawling to find exposed skin. Therefore, tucking trousers into the top of boots, and applying DEET on the trouser legs, around the waist, and at the wrists will prevent many flea attacks. Since bednets will not exclude fleas, soldiers should avoid sleeping near rodent nests or burrows; near areas frequented by wild or domestic mammals; or other likely infested locations. Flea control with the aerosol insecticide bomb is only temporary because more fleas will enter the area soon after the insecticide droplets settle to the ground. Soldiers operating in areas where plague is endemic should be immunized.

b. *Unit Protective Measures.* If possible, a unit should not bivouac in a known flea-infested area, or where rodents are numerous. The field sanitation team should use the 2-gallon sprayer and insecticide to spray rodent runways, nests, and burrows, and the ground around living and sleeping areas where flea infestations are present. Where plague or Murine typhus is endemic, rodents should not be trapped unless recommended by the medical authority. Fleas will leave the cooling body of a rat killed in a trap and seek a new host (including a nearby soldier).

c. *Area Protective Measures.* Preventive medicine teams are equipped and trained to control both vector fleas and reservoir rodents.

Section VII. LICE

9-24. General

a. There are two insect orders of lice (singular, louse): the Mallophaga (chewing lice), which have chewing mouthparts and are found mostly on birds; and, the Anoplura (sucking lice), which have piercing-sucking mouthparts and are found only on mammals. Most species occur on only one or a few species of host animals. Normally, man is not the host of the chewing lice and is the host to only three of the 250 species of sucking lice: the body louse, head louse, and crab louse. These three species spend their entire life on the body or clothing of man and are almost never found on any other animal. They do not exist in nature as free-living insects, but rather must be in almost constant contact with man in order to survive.

b. The sucking lice of man are small (less than 4 mm long), wingless, grayish-white external parasites with piercing-sucking mouthparts for sucking human blood. The legs terminate in hooked claws for grasping human hairs. They are found throughout the world and are worst in cooler climatic areas where thick clothing and infrequent bathing provide an ideal living environment.

9-25. Life Cycles

a. General. Lice have incomplete metamorphosis consisting of an egg stage, a nymph stage with three nymphal instars, and the adult stage. The crablike appearance of the crab louse easily distinguishes it from the head or body louse. Head and body lice are nearly identical in appearance, but can easily be differentiated by their respective habitats and behavior.

b. Body Lice. The body lice spend most of their lives in the clothing of man, moving to the skin to engorge with blood and then returning to the clothing. The eggs are attached to the clothing, usually along seams or folds, where the female will lay about 10 eggs each day for a total of 300 eggs in her lifetime. The total life cycle will be completed in about 3 weeks. Body lice are transferred in the clothing or bedding of people living in crowded conditions. Also, body lice will migrate to others from the feverish body of a louse-borne disease victim, or from the cooling body of one who has succumbed to the disease. In wartime epidemics, the lice are spread when the clothing of a disease fatality is worn by a survivor who then contracts the same disease.

c. Head Lice. Head lice spend their entire life on the head and neck of the host. They tend to be most numerous on the back of the neck and behind the ears. The barrel-shaped eggs, called "nits," are glued individually to hair strands near the scalp. The slang term "nit-picking," which refers to picking at very small things, arose during an earlier era when mothers picked the nits from the hair of their children. The three nymphal instars remain in the hair and on the scalp where they feed on blood daily. Likewise the adult male and female lice live, feed, and reproduce on the head. Head lice infestations are not only common in wartime or disaster situations, but occur in schools, nursing homes, and other institutions where people are in close contact. Head lice are spread through physical contact, infested bedding, and through sharing combs, hair brushes, or caps.

d. Crab Lice (Pubic Lice). The preventive medicine specialist will deal with many more rumors than actual cases of crab lice. Since neither crab lice nor head lice transmit diseases, both are considered nuisances rather than serious medical threats. The crab lice spend their entire lives on the human body, and almost exclusively in the pubic hairs of adults. However, heavy infestations will spread to the hairs of the chest, armpits, and even the eyebrows. Crab lice are occasionally found on prepubescent children, but only in the eyebrows. Eggs are attached singly to individual strands of hair. The eggs hatch in about a week and the emerging nymphs immediately begin feeding on blood. The three nymphal instars are completed in 2 or 3 weeks, and the adult lice live a maximum of 1 month. Crab lice are the most sedentary of the three human lice species and are extremely poor crawlers when away from their natural habitat. They remain in place for days, rarely detach, and must feed on blood for several hours daily. They cannot survive when separated from a human host for more than 24 hours. The spread of crab lice is almost exclusively through sexual contact or bed-sharing, and only rarely via toilet seats or other locations where a dislodged louse may be able to infest another person. Crab lice multiply slowly; usually the female will only lay one egg a day for a total of 15 to 30 eggs in her lifetime. The total life cycle is over 3 weeks long. Therefore, one should discount reports that severe infestations of crab lice literally appeared overnight.

9-26. Louse-Borne Diseases

a. General. Only the body louse, *Pediculus humanus humanus*, is a disease vector. Since they are found only on man, then man is the only reservoir for louse-borne diseases. The head louse, *Pediculus humanus capitis*, and the crab louse, *Phthirus pubis*, do not transmit diseases but cause an itching inflammation of the skin, called pediculosis.

b. Epidemic Typhus. Outbreaks of this rickettsial disease are most frequent during wars and natural disasters. Its epidemic spread is dependent on poor hygiene and sanitation, crowded living conditions, and abundant lice populations. Mortality has ranged between 10 and 40 percent during epidemics. Epidemic typhus is transmitted through contaminated feces of the louse, not through the mouthparts. After a body louse feeds on an infected person, the rickettsiae from the blood multiply rapidly in the louse's midgut (stomach) and in about a week are found in the feces in tremendous numbers. The contaminated feces are excreted onto the human skin as the louse engorges with the blood of the host. The rickettsiae then penetrate the skin through abrasions, scratches, or the bite wound.

c. Epidemic Relapsing Fever. This disease, caused by a spirochete, is endemic when transmitted by ticks but characteristically epidemic when transmitted by body lice. Mortality has exceeded 50 percent in untreated cases during epidemics. It is transmitted to man through the infected tissues of the lice, not through the mouthparts or feces. Within a day after the louse feeds on the blood of an infected person, the spirochetes in the louse disappear from the gut and reappear in great numbers a few days later in the louse's blood, where they circulate throughout the body cavity. They do not reenter the mouthparts or digestive system and are transmitted to man only when the louse is crushed or damaged and its blood contaminates the skin or mucous membranes of the human host.

d. Trench Fever. A nonfatal rickettsial disease, trench fever, became epidemic in Europe during both world wars. Like other louse-borne diseases, it spreads quickly among troops living in crowded, unhygienic conditions. Its symptoms vary greatly, but can incapacitate soldiers when it causes high fever, severe headache, and joint pains.

9-27. Surveillance

An infestation of head or crab lice is easily detected. Head lice adults and nymphs can be observed by separating the hair with a comb. The eggs can be seen on single hairs. A body louse infestation is more difficult to detect. It is necessary to remove the clothing of persons and examine the inner seams and folds of the clothing for eggs, nymphs, and adults.

9-28. Prevention of Louse-Borne Diseases

a. General. The body louse is the only species which transmits diseases. Control measures discussed here will be directed primarily toward that species. Additional information on the control of head and crab lice is available through preventive medicine services and from entomologists.

b. Individual Protective Measures. Individual containers of insecticide powder for louse control must be stocked by each unit supply section, but are issued only when directed by medical personnel. Directions for individual application are printed on each container. It is important to note that body louse control must include treatment of the clothing, where the lice live. Laundering clothing at 140°F for 20 minutes, or standard dry cleaning procedures, will also kill all stages of body lice. Frequent bathing and changing of clothing (including undergarments) can help prevent infestations or ensure their early detection.

c. Unit Protective Measures. The field sanitation team must insure that individual containers of insecticide powder for louse control are available for issue. Once the powder is issued to each soldier, commanders must ensure that unit leaders are supervising individual delousing procedures. The field sanitation team is authorized to stock hand-operated dusters for situations in which an entire unit must be deloused. However, the bulk quantity of insecticide powder needed is not authorized for routine stockage but must be furnished by medical authorities.

d. Area Protective Measures. Preventive medicine teams can conduct mass delousing operations using 10-gun power delousers. Each dusting apparatus can delouse 600 people each hour. A potential epidemic of louse-borne disease can be stopped quickly with this operation.

Section VIII. CONE-NOSE BUGS

9-29. General

Cone-nose bugs, also called assassin bugs or kissing bugs (order Hemiptera, family Ruduviidae), are blood-sucking insects. They measure 1/2 to 1 inch in length. The anterior half of each wing is leathery and the posterior half is membranous. The elongated head is cone-shaped with a three-segmented feeding proboscis folded under between the legs. The marginal edge of the upper abdomen in many species is flared upward to form a depression for the wings.

9-30. Life Cycle

Stages of development are the egg, nymph, and adult. Habitats vary, with some species living completely in the jungle environment, and others (including the most important vectors) living in close association with man. These latter species are found hiding during the day in thatched roofs or walls, or in corners or cracks where they are almost invisible under a covering of dust and dirt. At night the bugs greatly engorge with blood after inflicting a painless bite, usually in the facial area. After feeding the bugs return to their hiding places. All five nymphal instars and the adult bugs feed on blood. The entire life cycle is completed in 1 or 2 years, and infected bugs remain so for life. Bugs living in thatched roofs have also transmitted the disease through feces which fall into the eyes, nose, or mouth of a sleeping human.

9-31. Disease Transmitted by Cone-Nose Bugs (Chagas' Disease).

A protozoan disease that occurs in Central and South America, Mexico, and occasionally in the Southwestern United States, Chagas' disease is transmitted to man in the feces of the cone-nose bug. The feces are passed while the bug is biting the individual. The disease has both acute and chronic manifestations, either of which can be fatal. The acute form can inflame the heart, brain, or other organs, causing death within 3 months, but often much sooner. The chronic form may not be noticed for 10 or 15 years, but causes slowly evolving heart damage ending in early death. Even when detected within the first few days after the initial symptoms of moderate fever and a subdermal swelling (usually around the eyes), treatment is not always effective. There is no cure for the chronic form or for the acute form after the initial symptoms, and tissue damage is irreversible. The reservoirs for Chagas' disease include man, dogs, rodents, armadillos, bats, and sloths.

9-32. Surveillance

When surveying for cone-nose bugs, inspect both sylvatic (wild) and domestic habitats. Within the sylvatic environment, palm trees and bromeliads are the most important habitats. These can be examined manually. Domestic habitats include thatched huts, rubbish piles, and the nests of rodents coinhabiting human dwellings. The survey tools used for both types of habitats are aerosol insecticide spray (bombs) and forceps.

9-33. Prevention of Chagas' Disease

Cone-nose bugs are difficult to control, therefore, the most effective method of disease prevention is to avoid sleeping in thatched huts or other rural buildings, and, likewise, to avoid sleeping under palm trees or near woodpiles, both of which can harbor several vector species. Residual spraying of thatched roofs and walls, and into cracks and crevices of buildings and woodpiles, is effective. Bednets will prevent entry by cone-nose bugs, but if you roll near the net, the bugs can still bite by extending their mouthparts through the cloth mesh.

Section IX. TICKS AND MITES

9-34. General

a. Ticks and mites are in the class Arachnida, order Acarina, which are not insects. They are wingless, have no antennae, and have four pairs of legs. The two body regions — a combined head and thorax (cephalothorax) and an abdomen — are fused into a single segment. Mouthparts are adapted for piercing and sucking. There are two families of ticks: the hard ticks (family Ixodidae), and the soft ticks (family Argasidae). All ticks are ectoparasites of animals, but only a few of the more than 200 families of mites include species which are parasites of man or animals. In general, mites are much smaller than ticks, and usually require magnification to be seen clearly. Ticks and parasitic mites are found worldwide wherever wild or domestic animals are present. Some species are found only on a few types of host animals, whereas others have little host specificity.

b. Adult ticks can usually be separated from mites by their larger size. The presence of a sensory Haller's organ near the end of the front pair of legs of ticks positively differentiate them from mites, which lack this feature. Hard ticks can be separated from soft ticks based on appearance and behavior. Hard ticks have a dorsal shield (scutum) which covers the dorsal surface of the abdomen either wholly (in males) or partially (in females). Soft ticks have no shield. Hard ticks are also tapered anteriorly (toward the head) while soft ticks are usually blunt.

9-35. Life Cycles

a. Ixodidae Ticks.

(1) Hard ticks undergo four stages of development: egg, six-legged larva, eight-legged nymph, and eight-legged adult. The mated, blood-fed female lays eggs on the ground, usually in a single mass which may number in the thousands. Eggs hatch in 2 weeks to several months and the emerging larva (seed tick) immediately seeks a blood meal by crawling to a vertebrate host or by climbing a few inches up low vegetation and waiting for a suitable host to pass within reach. After feeding, the engorged larva usually drops to the ground and molts to the eight-legged nymph stage. Some species of ticks will remain on the same host through the nymphal stage and drop off after mating and feeding in the adult stage. The eight-legged nymph resembles the adult, but is sexually immatqre. Nymphs seek a host as do larvae and must consume a blood meal prior to molting. After feeding, some nymphs drop to

the ground for a final molt to the sexually mature adult stage. Again the tick finds a vertebrate host, mates, engorges on blood, and drops to the ground. Males die soon after mating and females die shortly after laying their eggs. Only the female becomes greatly distended when engorged.

(2) During feeding, hard ticks usually remain attached to the host for several days. This accounts for the wide distribution of many species. Off a host their mobility is restricted by their small size and slow movements. They can, therefore, be abundant along animal trails, in thickets, in low vegetation, and other locations frequented by potential hosts. In the absence of a host, or during unfavorable environmental conditions, infective ticks can survive for long periods. The life cycle of most species takes about 1 year, but varies from 3 months to over 3 years.

b. Argasidae Ticks. Soft ticks have the same developmental stages as hard ticks, but their behavior and habitats are different. Most soft ticks spend their lives in the immediate vicinity of a host's habitat, and attach to the host only briefly for feeding. The larvae, nymphs, and adults remain in the vicinity, feeding several times in each developmental stage. Engorgement with blood typically requires 15-20 minutes, after which the tick leaves the host until the next feeding. The female soft tick will lay several batches of eggs, 20 to 50 in each, but requires another blood meal before each batch. Eggs are laid in animal nests, burrows, or nearby cracks and crevices. The total life cycle varies among species from about 2 months to several years. Some specimens have lived for 25 years.

c. Mites. The developmental stages of the typical mite are the egg, larva, nymph (two or three instars), and adult. Scabies mites spend their entire life cycle on the human body, whereas only one stage of some parasitic mites will attack man. In the life cycle of the chigger mites, only the six-legged larva, the true "chigger," requires animal hosts. They do not burrow beneath the skin; rather they attach their mouthparts and engorge on tissue fluids. After a single feeding they drop from the host. The nymphs and adults then feed only on plant juices. The soft-bodied mites are very fragile and are usually killed the first time the host scratches the intensely itching bite sites or bathes with soap. The lingering itching and dermatitis associated with chiggers is caused by the host's reaction to the salivary secretions of the mite.

9-36. Tick-Borne and Mite-Borne Diseases

a. Ixodidae Ticks. Hard ticks are among the most efficient arthropod vectors and are capable of transmitting pathogenic viruses, rickettsiae, bacteria, and protozoa. They also cause tick paralysis, a potentially fatal result of their neurotoxic salivary secretions. They can withstand severe environmental stresses, and may live for years. They have few natural enemies and have a wide range of hosts. Some can transmit pathogens to the next generation through their eggs (transovarial transmission). All these factors contribute to their potential as disease vectors. In the United States hard ticks transmit Rocky Mountain spotted fever, tularemia, Q fever, Lyme disease, and human babesiosis. Elsewhere they are vectors of other serious diseases seldom publicized because of their respective limited range of occurrence.

b. Argasidae Ticks. Soft ticks transmit endemic relapsing fever, caused by strains of the same species of spirochete (type of bacteria) transmitted by the body louse as epidemic relapsing fever. Transmission by ticks is through the bite or through contaminated body secretions of both sexes of adult and immature stages. Rodents and man are reservoirs for tick-borne relapsing fever.

c. Mites. Chigger mites transmit scrub typhus, a rickettsial disease, from rodent reservoirs to man in Eastern Asia. The pathogens are transferred from adult female mites to their offspring through the egg. The immature mites then transmit the disease to man as they feed on human tissue fluids. Scabies, a mangelike condition caused by the mite *Sarcoptes scabiei*, occurs throughout the world. Symptoms range from a mild rash to serious skin irritations which can lead to secondary infection. The mites burrow under the skin, leaving open sores or linear burrows which are usually first noticeable in the webbing between the fingers or around the wrists. Allergic reactions cause severe itching, restlessness, and loss of sleep. Some parasitic mites usually found on other host animals will attack man, causing an itching dermatitis which can subsequently lead to secondary infection.

9-37. Surveillance

a. Ticks. Tick surveys are conducted to determine the following: species of ticks present in an area; infested area boundaries; necessity for use of repellents and control measures; and the presence of known disease vectors. Ticks are more commonly found in wooded areas where wild or domestic animals are availablefor food. Also, ticks are more often found in shaded areas. You should survey to the perimeter of the shade. However, do not overlook such areas as fields, pastures, and open grazing areas. Such areas usually include flora and topographic features that preclude control through the use of insecticides; therefore, personnel must use repellents to prevent attachment by the ticks. Surveys should be conducted at garrisons and bases where ticks are known or suspected to be present. The survey findings can be used to recommend action for prevention and control of tick-borne disease.

(1) There is no easy or simple method of conducting tick surveys, and like most other entomological surveys, it requires experience to perfect a technique. "Tick drags" have been used with success in the past. A flannel cloth 1 yard square is used to collect the ticks. There are two methods by which the tick drag is used:

(a) Pull the drag for 100 yards, stop, and collect the ticks that have attached to the drag. The index is recorded as number of ticks/100 square yards.

(b) Place the flannel cloth on the surface litter of the ground, stand on the drag for 5 to 10 minutes, and then collect the ticks that are present on the flannel cloth.

(2) A preliminary survey should be made in the area selected for tick surveillance to determine "hot spots" within the area. Tick infestations usually are not distributed equally over an area. After the infested areas have

been located, routine surveys should be conducted weekly, or at least monthly, depending upon the use of the area for training or bivouac purposes.

b. Equipment Required for Tick Surveys.

The following equipment and supplies are required for tick surveys: 1 square yard cotton flannel cloth, forceps, and vials containing 70 percent ethyl alcohol and 1 percent glycerin. As the ticks are collected they are placed directly into the vials of solution.

c. Records for Tick Surveys. A record is maintained to compare the status of tick incidence at each sampling location. A routine surveillance should include an incidence index. For example, the number of ticks collected at each spot sampled is divided by the number of "tick sampling stations," and the result is the index. The index may be determined on a weekly or monthly basis and recorded by graph for comparative purposes. The major stage of biological development should be recorded, that is, the number of larvae, nymphs, and adults.

d. Chiggers. Chigger infestations are located by placing a 12-inch square white or black plate on a selected location. A number of 4-inch square black plates will serve the same purpose. After a period of 1 to 5 minutes the plates are picked up and observed for the presence of chiggers. The chigger is reddish orange and varies in length from 150 microns when unengorged to 600 microns when fully engorged. The chiggers are collected with a camel's-hair brush and placed in 85 percent ethyl alcohol. Chiggers are more commonly found in areas consisting of shade, grass, brush, rotten logs, and tree stumps. Shaded and moist habitats are best for mite habitation and should be surveyed first. An index of chigger incidence is obtained by dividing the number of chiggers collected by the number of times the area is sampled.

e. Equipment Required for Chigger or Mite Survey.

(1) The following equipment is required for collecting mites or chiggers: 12-inch square plate, painted black or white; a camel's-hair brush trimmed to a fine point; vials containing 85 percent ethyl alcohol; and a notebook and pencil. You should wear high top boots with trousers tucked inside the boots. Insect repellent should be applied to exposed skin areas and points of entry through the clothing.

(2) Mites are preserved in vials of 85 percent alcohol and packed in regular mailing containers for shipment to an Army area laboratory.

9-38. Prevention of Tick-Borne and Mite-Borne Diseases

a. Individual Protective Measures. Avoidance of known or likely infested areas will help prevent attacks. Tucking trousers into the boots followed by a liberal application of repellent to the trouser legs, around the waist, and around other openings in the uniform, will repel mites and most ticks. Hard ticks usually do not complete their attachment and begin feeding until they have been on a host for 3 to 5 hours. Therefore, finding and removing ticks at least every 2 hours can prevent disease infections. To remove an attached tick use forceps to grasp the mouthparts as close to the skin as possible. Pull the tick away very slowly, allowing the tick to withdraw its mouthparts. Do not crush the tick or break off the embedded mouthparts which could be a source of infection. Repellent or other chemicals can be applied to the tick prior to its removal, but may have no noticeable effect. Do not burn or kill the tick prior to removal, this may cause regurgitation of infective fluids into the bite wound. After removing the tick, apply an antiseptic to the site.

b. Unit Protective Measures. Brush and low vegetation should be cleared from the bivouac or training site, including several meters around the outside of the perimeter, if possible. The field sanitation team should supervise the impregnation of field uniforms with clothing repellent. Use the 2-gallon sprayer to apply pesticide to the ground around sleeping and resting areas, to low vegetation in and around the unit area, and along animal trails, nests, and burrows. A continuous insecticide barrier should also be applied to the vegetation and ground immediately outside the cleared unit perimeter.

c. Area Protective Measures. Preventive medicine teams are equipped and trained to control both ticks and mites. These teams can also control small rodents which serve as hosts for mites and ticks. A single case of a tick-borne or mite-borne disease is justification for seeking their assistance.

CHAPTER 10

THE BIOLOGY AND CONTROL OF RODENTS

10-1. General

Throughout man's history the rodent has played an important and often decisive role in man's development. Plague, a disease transmitted from rodents to man by fleas, caused the death of approximately one-fourth of the European population in the Middle Ages. In more recent times it has been estimated that, in the United States alone, damage to crops caused by rodents amounts to millions of dollars each year.

a. Rodents consist of a large group of mammals classified in the order *Rodentia.* This order encompasses a wide variety of animals including squirrels, chipmunks, and prairie dogs as well as rats and mice. The rodents are commonly identified by the presence of two sets of chisel-like incisor teeth and the absence of canine teeth. This arrangement of teeth facilitates the rodent's eating habits. Rodents are almost exclusively herbivorous or seed eaters. The exceptions to this are domestic rats and house mice, which are omnivore.

b. During recent times three rodent species have associated themselves with man for their primary requirements of food and shelter. These are the Norway rat, the roof rat, and the house mouse. A pictorial key for field identification of these three domestic rodents are provided in Figure 10-1.

10-2. Norway Rat

a. The Norway rat, *Rattus norvegicus* has been incriminated in the transmission of a number of diseases to man. Among these are plague, typhus, leptospirosis, rat bite fever, Rocky Mountain spotted fever, tick-borne relapsing fever, and scrub typhus. They may also be involved in the transmission of various kinds of food poisoning through contamination with urine or feces.

b. In nature, the life span of the Norway rat is approximately 1 year; however, it may live up to 4 years in a laboratory situation. At approximately 3 to 5 months of age the rat becomes sexually mature. The gestation period is about 22 days. As a result, approximately seven litters can be produced yearly. Normally, a litter will consist of from eight to 12 young, thus giving a single female a potential of 84 young per year. Fortunately, only about 20 young are actually weaned each year. Due to its close contact with man, the Norway rat has developed an affinity for man's food; therefore, it prefers meat, fish, and garbage. This species normally consumes from three-fourths to 1 ounce of food a day and requires approximately one-half to 1 ounce of water. In his search for food, the Norway rat will travel 100 to 150 feet from his harborage. Because he is heavier and less agile than other domestic rodents, the Norway rat is usually found on ground levels. Normally they burrow into the ground for harborage.

c. The physical characteristics of the Norway Rat include the—

- Tail is shorter than the head and body;
- Body is thick with a blunt nose;
- Adult rat weighs approximately 16 ounces; and
- Eyes and ears are small.

10-3. Roof Rat

a. The roof rat, *Rattus rattus*, is involved in the transmission of the same diseases as is the Norway rat. The Norway rat is generally found in temperate regions, whereas the roof rat is normally restricted to tropical and subtropical locations. In nature, the life span of the roof rat is approximately 1 year. At approximately 3-5 months of age the female becomes sexually mature. It is capable of producing six litters of six to eight young annually; however, only about 20 of these are actually weaned. Although the roof rat will eat various types of human food, it does prefer vegetables, fruits, or grain. The food and water requirements of this rodent are similar to those of the Norway rat. As opposed to the Norway rat, the roof rat does not burrow in the ground but is found in attics, between walls of buildings, and may also nest in trees.

b. The physical characteristics of roof rats include the—

- Tail is longer than the head and body;
- Body is slender;
- Adult weighs 8 to 12 ounces; and
- Eyes and ears are large.

10-4. House Mouse

a. The house mouse, *Mus musculus*, adapts itself to a variety of living conditions and is found throughout the world in close association with man. Although it prefers houses and out buildings, it has been known to nest in holes gnawed in frozen beef carcasses in storage lockers. The house mouse has a longevity of approximately 1 year and is sexually mature at about 6 weeks. The gestation of this species is only 19 days. Up to eight litters may be produced each year, with six to eight young per litter. Only about 35 are actually weaned. The house mouse is omnivorous; however, it tends to prefer grain or grain products. It requires approximately one-tenth of an ounce of food and approximately one-twentieth of an ounce of water each day.

b. The physical characteristics of the house mouse include the—

- Body is small;
- Tail is as long as the body and head; and
- Adult weighs 1/2 to 3/4 ounce.

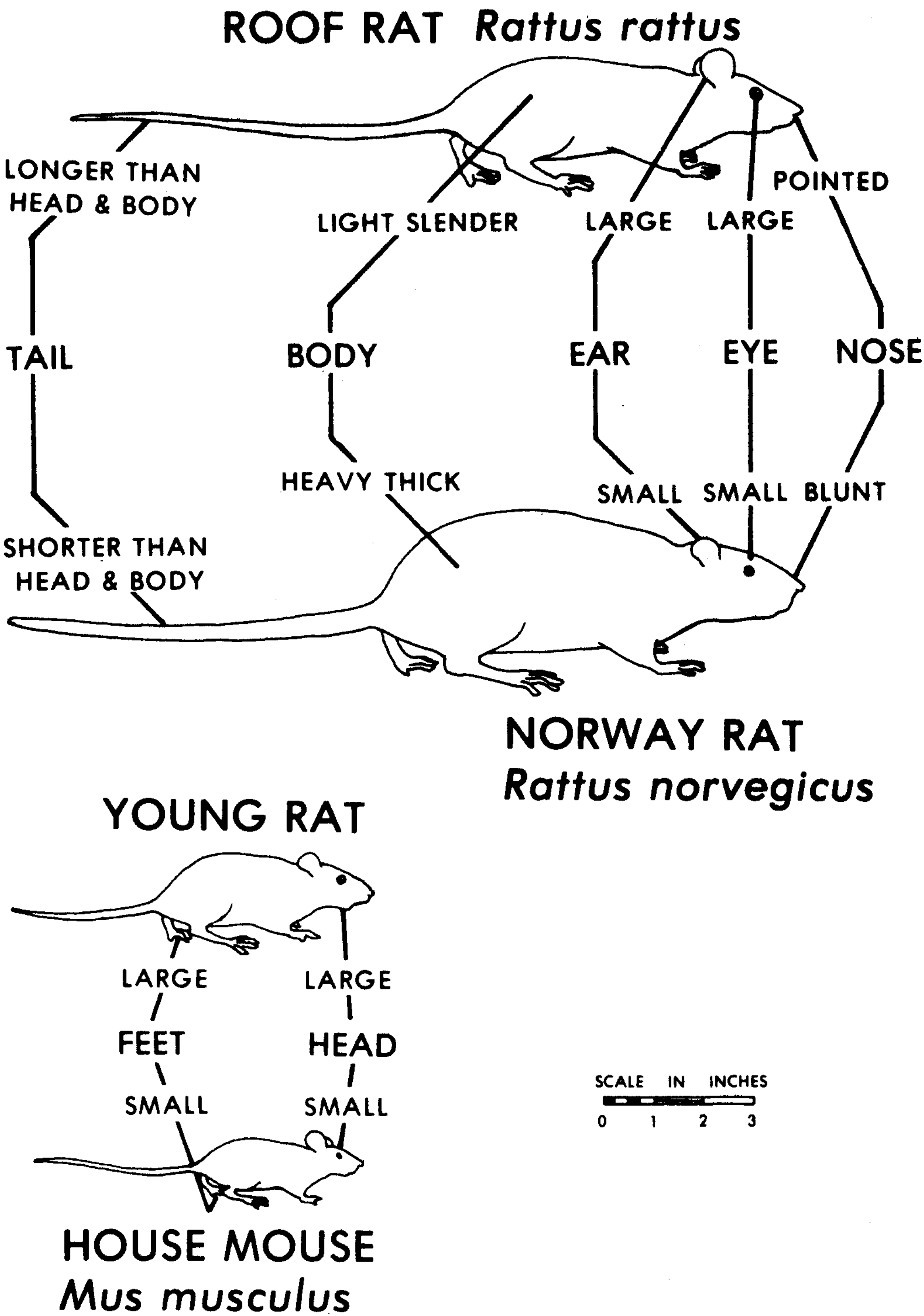


Figure 10-1. Pictorial key of domestic rodents.

10-5. Domestic Rodent Control

Six steps are generally recognized as part of a domestic rodent control program.

a. Survey. To determine if an infestation exists it is necessary to conduct a rodent survey. This may be accomplished by two methods. The first is the inspection for signs, such as droppings, rub marks, dust trails, and burrows or damage to stored materials. The second method of survey is the use of traps. A trapping program will employ both live and snap-type traps. If a trapping program is planned, data must be gathered with respect to population density, location of the infestation, and bait preference. This data will provide the basis for determining the: types of traps to use; maintenance of traps required; and the placement of traps for successful catches. When trapping rats, trap placement is far more important than bait selection. Unbaited snap traps can be used if the trigger is enlarged to provide a platform on which rats may step.

b. Environmental Sanitation. Environmental sanitation is the most important means of domestic rodent control. It is necessary to eliminate all possible food sources. Garbage and other food sources should be stored in rodent-proof containers. Garbage collection should be conducted so that excess amounts of material does not build up. Dry food stores and other possible food sources should be stacked on pallets 12 to 18 inches above the floor. Food storage areas should be swept daily and all refuse disposed of. Grass around the building should be kept closely cut to eliminate harborage areas around the building.

c. Rodent Proofing. Rodent proofing involves structural modification to existing buildings to prevent either the entry or movement of rodents. Openings as small as one-fourth of an inch may admit small mice. All external openings such as windows on the ground level should be screened with one-fourth inch galvanized hardware cloth. Each door and door jam should have a collar and cuff fabricated from galvanized metal. The holes around electrical lines or pipes as they enter the building should be sealed with caulking or cement. If roof rats are a problem, the second and sometimes the third stories of the building will have to be treated in this manner. Double-wall construction with hollow spaces in the walls should be eliminated as much as possible.

d. Rodent Ectoparasite Control. The rat flea index is the average number of fleas found per rat. Normally, an index of three or more will require ectoparasite control measures. If disease transmission involving the rodent or its ectoparasites is an important consideration, it will be necessary to provide ectoparasite control before killing the rodents. It will be necessary to determine what ectoparasites are on the rodents during the initial rodent survey operation. The survey is conducted as described in Chapter 9. Ectoparasites may be controlled by applying insecticidal dusts to rodent burrows and nests. The rodents will carry the dust into the nests killing the ectoparasites on the rodent and in the nest.

e. Rodent Killing. To prevent the rodent from moving from one area to another after the control measures in *b* and *c* above have been carried out, it is necessary to eliminate the population so that it does not slowly rebuild. The use of anticoagulant rodenticides is recommended. These poisons act on the coagulating mechanism in the blood and after 5 to 14 days the rodent dies of internal bleeding. Anticoagulant poisons are used routinely in control operations because of their safety around humans. When dealing with large infestations it may be necessary to use "one shot" rodenticides, such as zinc phosphide. As rodents develop shyness to "single dose" poisons relatively fast, they should not be used in an area for more than 1 week at a time. No matter what type of rodenticide is used, if used indoors it must be placed in a tamper-proof bait station for safety purposes and to provide the rodent with a relatively secure area in which to feed. It may be necessary to provide anticoagulant rodenticide in bait boxes in food service and food storage facilities as a preventive measure to intercept any rodent that might enter at a later time. Rodenticides must always be used in accordance with the pesticide container label instructions.

f. Maintenance. Once rodents have been eliminated within a building a preventive control program is established. The program includes the use of anticoagulants and maintenance of rodent proofing measures. High standards of housekeeping must also be strictly enforced to eliminate potential food sources. Periodic inspections are essential to insure that control measures are being carried out. It may be necessary to maintain a preventive control program using glue boards, traps, or anticoagulant rodenticides.

CHAPTER 11

VENOMOUS ANIMALS AND THEIR CONTROL

11-1. General

Envenomization is the injection of poison by the bites and stings of certain animals. Tens of thousands of poisonings from envenomizing animals occur every year. Sixty-five percent are attributable to arthropods and about 50 percent of all fatalities are caused by stings of hymenoptera (bees, wasps and ants). There are approximately 6,700 cases of snake venom poisoning each year.

11-2. Snakes

a. Nineteen of the 115 species of snakes found in the United States are venomous.

(1) Rattlesnakes (family Crotalidae) are the only snakes with a rattle. Rattlesnakes, of which there are several species, are variable in color and pattern. They possess heat sensitive loreal pits (on each side of the head) to help detect their prey. Found in all states of the United States (except Maine, Delaware, Alaska and Hawaii), rattlesnakes are nocturnal reptiles that feed on small rodents.

(2) Water moccasin or cottonmouth (family Crotalidae) are colored olive green to black, although the young can be lighter with dark bands. They are found in the Southeastern United States with their range extending west to Central Texas. Cottonmouths are found in swamps, rivers and ponds. Generally an aggressive snake, the cottonmouth is curious and will investigate any commotion in the water. It is capable of biting under water and feeds on small rodents, birds, fish and turtles. They also possess loreal pits.

(3) Copperheads (family Crotalidae) are tan to reddish-brown snakes with hourglass shaped reddish-brown bands on their backs. They are found in the Southeastern United States and the Midwest. Although their specific habitat is variable, they are generally found where their food (small birds, rodents, frogs and insects) is available. Brush and rubbish piles are good sites. Copperheads are nocturnal and like the other members of this family have loreal pits and eliptical pupils.

(4) Coral snakes (family Elapidae) are American relatives of the Asian Cobra. They are most readily identified by their distinctive color pattern of red, yellow and black bands with the red and yellow bands touching. Coral snakes range from the Southeastern United States, as far north as North Carolina, west to Texas with a desert species with red, white and black bands found in Arizona. These snakes are found in sandy or loose soil areas and are semi-burrowing. They are shy, do not often bite people, and feed on snakes, lizards and insects.

b. Snake venoms are classified into three main groups on the basis of the clinical picture that results from envenomization.

(1) *Hemotoxins.* The venom of pit vipers, such as rattle snakes, moccasins, and copperheads, is representative of this class. The site of the bite rapidly becomes swollen, discolored, and painful. Usually the swelling, discoloration, and pain progresses toward the heart.

(2) *Neurotoxins.* The venom of the coral snake is representative of this class. This type of poison affects the nervous system and symptoms vary from foggy vision, dizziness, and other comparatively mild symptoms to rigid or flaccid paralysis.

(3) *Mycotoxins.* The venom of the Asian sea snakes is representative of this class. Mycotoxins cause muscle necrosis.

11-3. Scorpions

a. Scorpions undergo gradual arachnid metamorphosis. Most species have a sting equivalent in intensity to a bee sting, but some species found in southern Arizona and Mexico can cause death. Scorpions are found under logs, boards, rocks, and debris often clinging to the underside of the object rather than resting on the ground. Scorpions feed at night and look for cracks and crevices to hide in during the daytime. They may crawl into bedding, clothing, and boots if these articles are left lying on the ground overnight.

b. Although there are pesticides labeled for the control of scorpions, the most effective control is nonchemical. Good sanitation effectively eliminates both harborage and food sources (in the form of small insects).

11-4. Spiders

a. General. Spiders are a large group of predaceous arthropods. They are cosmopolitan in distribution, but the majority are found in the temperate and tropical zones. Most spiders use venom to paralyze insects and small animals. Generally, the venom of most spiders does not bother man. Very few spiders have mouth parts which can penetrate the skin of man. Of those that can bite, local symptoms or allergic reactions can occur. In many parts of the world, however, dangerous spiders do exist; in some areas they are abundant. Two dangerous types of spiders in the United States are the black widow and the brown recluse.

(1) *Black widow spiders.* The black widow spiders are solid black with a red hourglass marking on the underside of the abdomen. They have dangerous bites and are known to kill people. Black widows build irregular webs in dark places, in which they may be seen hanging upside down. Sometimes the white egg sacs are seen in the webs. Places in which black widows are commonly found include piles of lumber, the underside of rocks and logs, dark corners of abandoned buildings, and outdoor latrines, especially under the seat.

(2) *Brown recluse spiders.* The brown recluse spiders are tan-colored with a dark brown, fiddle-shaped marking on the cephalothorax. Unlike most spiders, they have only six eyes instead of eight. They do not weave a web, but may be seen running around under old logs or in wood rat

nests. The bite of a brown recluse spider results in considerable necrosis at the bite, requiring several months to heal.

(3) *Tarantulas* are very large, dark brown or black, hairy spiders. They may be seen walking across roads, trails, and empty lots during certain times of the year. The venom of the tarantulas found in the United States is harmless to man.

b. Control of Spiders. Whenever discovered, the spider and its web should be destroyed with a broom or a stick. The egg sac which may be present in the web should not be overlooked, but special care must be taken when an egg sac is being removed, because the female, when guarding her eggs, is quite aggressive and inclined to attack. Control may be achieved using a residual spray.

Note

Consult AMEDD entomologist in support of the area for specific recommended pesticides for spider control.

11-5. Medically Important Hymenoptera

a. General. For centuries bees, wasps, yellow jackets, hornets, ants, and other stinging insects in the order Hymenoptera have been feared by man, and treated with due respect. Entomophobia is experienced by many people at the mere sight of hymenopterous insects. Many of these insects live in close proximity to man. Honey bees are raised commercially in hives, but frequently leave to nest in walls and spaces in buildings or in hollow trees. Carpenter bees bore holes in timbers of houses or in dead trees. Mud daubers often build their mud cells on or in buildings. Paper wasps, yellow jackets, and hornets construct paper nests under eaves, in attics, or in vegetation. Other Hymenoptera, such as bumble bees, cicada killers, ants, some species of yellow jackets, and solitary bees and wasps, make their nests in the ground. Frequently these insects sting if they are stepped on or picked up. They also sting in defense of their nests.

b. Public Health Importance. The public health importance of these insects is at least threefold. The *stings* of these insects are often exceedingly painful. People differ widely in their reaction to hymenoptera venom. Some show little effect following a bee, wasp, or ant sting, while others experience a violent reaction with anaphylactic shock and die in a very short time. Such a wide variation in reaction is due to an individual susceptibility-resistance phenomenon or to a hypersensitivity that has developed following one or more previous stings. Parrish (1963) has studied 460 deaths in the United States which were officially reported as due to venomous animals during the period 1950 to 1959. He reported that 229 of these deaths (50 percent) were due to the stings of Hymenoptera. This was more than the number caused by snakebites (138 deaths or 30 percent) or spiders (65 deaths or 14 percent). In 167 (or 73 percent) of the 229 deaths due to stinging Hymenoptera, death occurred in less than an hour after the person was stung, usually as a result of *anaphylactic* shock. People who are allergic to stings of hymenopterous insects should be taken to a physician immediately if they are stung. Upon the advice of their physicians, many of these people carry adrenalin or antihistamines with them for prompt administration after being stung. They can be desensitized to insect venom by competent medical specialists. Parrish reported that eight deaths resulted from hundreds of stings in each of these individuals, pointing out the much greater hazard from the colonial species, such as honey and bumble bees, yellow jackets, and hornets, than from solitary bees and wasps.

c. Control of Hymenoptera. When necessary, control of these stinging insects should be attempted with caution, preferably at night. Beekeepers may be contacted to remove migrating swarms of honey bees. Insects nesting in holes may be killed by painting the entrances with liquid formulations of pesticides labeled for this type of control. The nests of the paper wasps (Polistes) should be sprayed first with an insecticide aerosol bomb to kill the insects, then knocked down and buried.

CHAPTER 12

PEST CONTROL OPERATIONS

12-1. Introduction

The control of insects, rodents, and other pests is an essential service that should have high priority for combating disease; maintaining morale and efficiency, and preventing property losses. The possibility of loss of life and reduction in effective man-hours as a result of diseases such as malaria, typhus, dengue, and encephalitis makes an effective pest control program imperative.

12-2. Responsibilities

a. Directives. Responsibilities within the Army for various aspects of pest control are defined in AR 40-5, AR 40-12, AR 40-574, AR 40-657, AR 420-10, AR 420-76, AR 700-93, and DOD Dir 4150.7

b. Commander. The commander at each level of command is responsible for the enforcement of regulations, including those that provide guidance on protecting personnel of his command from insects and animals which may be reservoirs or vectors of disease. Also, those for the control of insects, rodents, fungi, and other pests that damage property, equipment, and supplies.

c. Installation Medical Authority. The installation medical authority has the primary responsibilities in all activities pertaining to the health of personnel and will provide technical guidance for the control of pests affecting the health, morale, and efficiency of Army personnel and their dependents. He will investigate the prevalence, distribution, and significant habits of disease vectors; will determine the adequacy and safety of control measures applied; and will assist the troop training programs in preventive medicine.

d. Engineer. The installation engineer is responsible for conducting operations at fixed installations for the control of pests, including animal vectors and reservoirs of diseases.

e. Unit. All units of company, battery, or similar size deployed to the field must have a unit field sanitation team (AR 40-5). The unit field sanitation team, in a field situation, has the responsibility for the control of pests within the unit area. The team is responsible to the commander for the health and sanitation within the unit area.

f. Preventive Medicine Units. The preventive medicine detachment, Team LA has been given the responsibility for pest control on an area-wide basis. This unit is operational in areas where the Corps of Engineers has not assumed pest control responsibility.

12-3. Integrated Pest Management

The overall objective of any pest control program is to manage pests which could adversely affect operations or health or destroy property. This must be accomplished through the use of integrated pest management techniques. Integrated pest management is the management of pest populations by using all suitable types of control in a compatible manner so as to avoid damage and minimize adverse side effects.

12-4. Types of Control

a. Biological control — reduction of pest populations by using living organisms encouraged by man (includes reproductive and genetic control).

b. Mechanical control — removing pests by hand or using mechanical devices to trap, kill, or keep them out (includes construction and maintenance).

c. Physical control — using energy factors in the environment such as heat, cold, light, sound, x-rays, and infrared rays to kill pests or attract them to a killing mechanism.

d. Regulatory control — using regulations and laws in areas to eradicate, prevent, or control infestations or reduce damage by pests, includes quarantine programs.

e. Cultural control — careful nonchemical changing of the environment to make it less favorable for a particular pest, thereby managing its population, including habitat modification and sanitation.

f. Chemical control — reduction of pest populations or prevention of insect injury by using materials to poison them, attract them to other devices, or repel them from specific areas, including the use of pheromones, insect growth regulators, and repellents.

12-5. Control Operations

In the organization of a pest control program, regardless of size, supervisory and operational personnel should consider the following factors:

a. Biological data. The first consideration in program planning is the collection of biological data which includes:

(1) A listing of the principal pests and their location in an area and their characteristics that affect control efforts.

(2) Climatic effects on seasonal distribution and on workload requirements.

(3) Establishment of hazard/economic threshold levels for each pest.

(4) Requirements for protection of the environment.

(5) Precautions required for protection of nontarget organisms such as fish and wildlife.

b. Selection of control techniques. After considering the biological data, select the most effective combination of control techniques listed in paragraph 12-4, for each individual pest problem. Minimize the use of chemical control through maximum use of nonchemical pest control techniques.

12-6. Aerial Dispersal of Insecticides

a. Policy. The aerial dispersal of pesticides permits the rapid treatment of large areas and the treatment of areas and situations inaccessible to ground equipment. It is particularly useful in controlling unexpected outbreaks of vector-borne diseases such as malaria, yellow fever, and encephalitis. All aerial spray operations will be conducted in strict compliance to requirements of AR 40-574.

b. Authorization. Aerial dispersal of pesticides may be authorized:

(1) For the control of mosquitoes and other insects of medical significance when —

- Reduction of breeding sites through draining, clearing, or filling cannot be accomplished.
- Areas requiring treatment are either too extensive or inaccessible to ground operated equipment.
- Screening, repellents, space sprays and residual treatment are not in themselves adequate to control vector-borne diseases.
- Tactically necessary in a combat zone.
- Sudden, excessively high insect population levels occur on military or other property which require the immediate suppression of potential vectors of disease such as disaster reliefs, and civil defense.
- Aerial spraying is more economical than use of ground control methods.

(2) For control of vegetation and economic pests that damage or destroy property when —

- The infested areas are too large to be treated effectively from the ground.
- Aerial spray is more economical than use of ground control methods.
- Time does not permit ground control procedures and immediate control is necessary to prevent large scale outbreaks of pest populations, and to provide economic disaster assistance. Control of vegetation may be necessary to comply with laws regulating growth of noxious weeds and for other reasons where weed or brush presence is not desirable.

c. Limitations. There are certain limitations to consider when using aircraft for the dispersal of pesticides, including—

- Degree of vegetative cover (dense vegetation limits penetration of the pesticide).

- Meteorological conditions such as unfavorable temperature, rainfall, turbulence, and excessive wind velocity.

- Availability of compatible aircraft and equipment.

- Terrain characteristics that might cause hazardous flying conditions.

- Availability of experienced pilots.

- Availability of pesticide applicators DOD certified in the aerial spraying category. The survey, evaluation, planning, and conduct of an aerial spray mission require knowledge and expertise of a specialized nature. The training and supervision of the equipment assembly and loading crew, calibration of equipment, and the delineation of the spray target require equipment and technical knowledge generally beyond the capability of most activities.

- Adequate lead time. In order to legally apply pesticides aerially, a process of mission validation and environmental assessments must be performed.

CHAPTER 13

PRESERVATION OF MEDICALLY IMPORTANT ARTHROPODS

13-1. General

The purpose of proper arthropod preservation is to facilitate arthropod handling, to aid in identification, and to ensure proper storage. A variety of methods have been used for these purposes. Universal storing procedures include pinning, slide mounting, alcohol preservation, and labeling.

13-2. Pinning

Two types of pinning methods are used depending on the size, stage, and species. As a general rule specimens smaller than a housefly are mounted on minuten pins or paper points. Larger specimens can be mounted on regular insect pins (sizes 1 to 3).

a. Minuten pin or paper point mounting. The mosquito is an insect which should be mounted on a minuten pin or paper point. Adult specimens must be either freshly killed or relaxed so that the appendages will not break when handled. The safest orientation of the specimen is in a horizontal position with the legs directed toward the pin. If a paper point is used, the left side of the thorax should be attached with adhesive to the upper side of the paper point so that the right side of the specimen can be examined from above. Only a very small amount of adhesive is necessary (Figure 13-1). If a minuten pin is used, it is first placed in a minuten cork that is pinned by a No. 3 insect pin. Then pierce the adult mosquito between the legs with the minuten pin extending it close to but not through the thoracic dorsum. The adult mosquito is placed on the left side of the No. 3 pin with the right lateral side viewed from above.

b. Mounting on regular insect pins (sizes 1 to 3). Large species that can be pinned directly by insect pins are houseflies, blister beetles, and cone-nosed bugs. A relaxed specimen is held with thumb and forefinger, and an insect pin is stuck through the appropriate area on the specimen to a desired height, usually about 1/4 inch from the top of the pin. A pinning block is useful to ensure that specimens and associated labels are on the same level on each pin. The pin with the specimen is then stuck through a piece of balsam wood or cardboard. The legs and antennae are arranged in a natural, well-positioned manner to diminish breakage and to aid in accurate identification (Figure 13-1). After the specimen is dried at room temperature for several days, labels are added and the specimen is stored indefinitely in a dark, dry, container with moth crystals or paradichlorobenzene flakes in one corner to control dermestid beetles.

Figure 13-1. Pinned insects.

13-3. Slide Mounting

A number of arthropods such as fleas, mites, and lice are mounted on glass slides. Before mounting a specimen, the slide should be cleaned. Mounts of these specimens require additional preparation in order to obtain the best results.

a. Body fluids, nonchitinous tissues, and digestive tract contents are often removed. This can be accomplished by mechanical or chemical means. A puncture in the membranous areas of specimens can be made with a needle, and then the body fluids and contents can be pumped out. Or, specimens can be placed in caustic solutions, such as 5 to 10 percent potassium hydroxide (KOH), which is used as a chemical "clearing" agent. The specimens are left in this liquid from 1 to 48 hours depending on the darkness of the specimens. If left in KOH too long, overclearing results in identifying structures becoming invisible. If the specimens are removed too early, identifying structures cannot be seen. After clearing, the specimens are washed in distilled water for about 15 minutes. When using a water soluble mounting medium (Berlese or Methocellulose) the specimens can be mounted after the water rinse. If a nonwater soluble medium (Balsom or Euparol) is used, the specimens are put in 70 percent ethyl alcohol for 3 hours. Then they are placed in absolute alcohol for another 3 hours. Specimens should always be handled with care, using a camel's-hair brush or fine forceps. The alcohol removes water from the arthropods. Next, specimens should be put in a final clearing agent such as carbol-xylol, xylene, cellosolve, or clove oil for 30 minutes.

b. Proper orientation of the specimen is necessary for easy examination of desired morphological structures. For example, a partial incision between the 7th and 8th abdominal segments of a culicine larva aids in the vision of the anal segment characteristics. The dorsal side of the mosquito larva should be viewed from above. Fleas are mounted with the head pointed to the left and legs pointed to the upper edge of the slide.

c. The specimen is placed in the desired position on a slide in a small drop of Canada balsam and allowed to dry overnight at room temperature or in an incubator at 37° C.

d. After this initial drying which stabilizes the specimen, additional Canada balsam is added and a coverslip is placed over the specimen. It is often desirable to add bits of coverslip glass in the corners of the balsam to support the specimen. Then appropriate data are written on slide labels.

e. The slide should finally be dried in a horizontal position for several weeks at room temperature or in an incubator at 37°C.

13-4. Alcohol Preservation

Many specimens can be killed, preserved, and stored in ethyl alcohol. Specimens frequently stored in alcohol are fleas, lice, bedbugs, mites, ticks, and mosquito larvae. The concentration of the alcohol usually used is 70 to 75 percent, but often a higher concentration is needed for specimens with large amounts of body fluid, such as spiders. They are simply placed in glass vials or jars filled with alcohol. A few drops of glycerin may be added to prevent damage to the specimens if the alcohol evaporates. For permanent storage, vials or jars with specimens are filled with alcohol, plugged with a bit of cotton at the open end, and inverted into a large jar. Place a layer of cotton on the bottom of the large jar, then fill the jar with alcohol (Figure 13-2). The top is then secured on the jar.

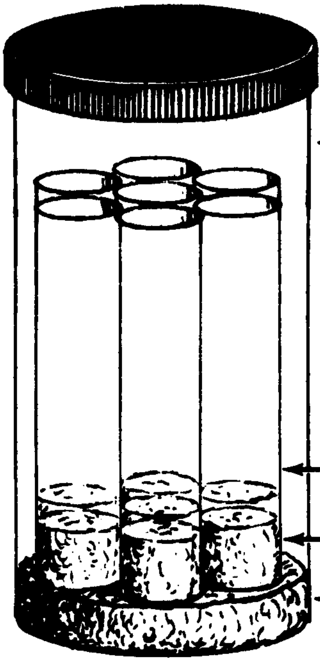


Figure 13-2. Small specimen vials in large jar for permanent storage.

13-5. Labeling

Without adequate data a specimen is practically worthless. The basic information needed includes the general locality, specific host or habitat, date, and name of collector. Other information, such as time of collection, elevation, and weather conditions, may also be added. For specimens on points or pins, the hard paper labels should not exceed 3/8 by 3/4 inch in size. For slides, labels are available which will fit neatly on a standard microscope slide. Waterproof black ink is commonly used in printing labels; however, a hard pencil is satisfactory for temporary labels. For specimens in alcohol the label should be placed inside the vial. For information on pinned specimens, the locality label should be stuck on the pin underneath the arthropod. After identification, another label with the determination, date of determination, and name of individual who identified the specimen is placed under the first label. If the specimen is mounted on a slide, the name of the medium is also included on the label.

CHAPTER 14

PESTICIDES

14-1. General

The recent expansion in the field of pesticides and dispersal methods has resulted in a high degree of specialization. Mosquito control by chemical methods once involved only the application of light oils to breeding areas by simple hand sprayers and the release of pyrethrum sprays from "flit guns." Today there is a great variety of more effective materials and dispersal methods to choose from when developing control programs. The problem is further complicated by differences in effectiveness against specific pests, development of resistance, and the high toxicity of some of the new materials to humans. A tendency to regard the new chemicals as cure-alls has been a very serious obstacle to their proper use. The neglect of routine measures such as adequate sanitation results in failure to attain permanent control. Attention to nonchemical insect control measures should receive particular emphasis now that resistance is present in so many of our pest species. The use of pesticides should augment, not replace, the use of basic preventive measures (see Chapter 12).

14-2. Definitions

a. Pesticide. Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests; also any substance or mixture of substances used as a plant regulator, defoliant, or desiccant.

b. Direct supervision. Supervision that includes being at the specific location where the work is conducted and maintaining a line-of-sight view of the work performed. Direct supervision is required only during the application of restricted use pesticides.

c. Onsite supervision. Supervision that includes being physically located on the installation, but not necessarily at the specific worksite during the work performance, and being able to be contacted and at the worksite within 30 minutes.

d. Certified applicator. Military or civilian personnel certified in accordance with the "DOD Plan for the Certification of Pesticide Applicators" or with some other Environmental Protection Agency (EPA) certification plan, and certified in the category in which a pesticide is applied.

14-3. Laws and Regulations

Without pesticides we would not have the food, fiber, and landscape plants we need. But because pesticides can be dangerous, numerous laws have been passed which affect pesticide use. These laws try to balance the need for pesticides against the need to protect people and the environment from their misuse. Federal law specifies that all pesticides must be classified as "general use" or as "restricted use." *General Use Pesticides* are those which when applied in accordance with their directions for use generally will not cause unreasonable adverse effects on the environment or man. *Restricted Use Pesticides* are those which when applied in accordance with their directions for use may generally cause, without additional regulatory restrictions, unreasonable adverse effects on the environment including injury to the applicator. Restricted use pesticides must be applied by, or under the direct supervision of a certified applicator. In addition, the DOD further categorizes pesticides into "controlled" and "uncontrolled" pesticides. *Controlled Pesticides* are those which are limited for use by only trained pesticide applicators and under the onsite supervision of a DOD certified applicator. *Uncontrolled Pesticides* are those available without control through the military supply system or through local purchase. Uncontrolled pesticides may be applied by uncertified personnel without direct supervision.

14-4. Standard Pesticides

Many types of chemicals and formulations are used in pest control operations. The insecticides, rodenticides, and other supplies standardized for military issue have been carefully selected to provide a minimum number of items with maximum military application and safety. With few exceptions, these items, if used as recommended, will provide satisfactory control of pests of military importance. When approved by the pest management consultant concerned, pest management material may be procured locally if:

- Needed for an emergency.
- Required due to a unique local situation.
- Used in quantities so small that assignment of a National Stock Number (NSN) is not feasible.

Installations must make every effort to use pest management material in the Federal Supply Catalog before requesting local purchase authority.

14-5. Types and Uses of Pesticides

a. The most common types and uses of pesticides include—

- *Insecticide*—Controls insects and other related pests such as ticks and spiders.
- *Fungicide*—Controls fungi.
- *Herbicide*—Controls weeds.
- *Rodenticide*—Controls rodents.
- *Avicide*—Controls birds.
- *Repellent*—Keeps pests away.
- *Attractant*—Lures pests.
- *Defoliant*—Removes unwanted plant growth without killing the whole plant immediately.

- *Desiccant (Sorptive Dust)*—Dries up plant leaves and stems; and insects.

b. Pesticides can also be grouped according to what they do. The major groups are—

- *Contacts*—Kills pests simply by contacting them.
- *Stomach poisons*—Kills when swallowed.
- *Sterilants*—Renders pests unable to reproduce.
- *Systemics*—Taken into the blood of an animal or sap of a plant, they kill the pest without harming the host.
- *Fumigants*—Gases which kill when they are inhaled or otherwise absorbed by the pest.
- *Anticoagulants*—Prevent normal clotting of blood.

c. Finally, common pesticides used in the military may be grouped by the chemical class to which they belong, such as, organophosphate, carbamate, and chlorinated hydrocarbon. The discussion on toxicity of pesticides, paragraph 14-13, presents a brief overview of pesticides by the six chemical groups (including chemical classes).

14-6. Insecticides

a. Because insecticides are the type of pesticide most frequently used by the military, they will be covered in greater detail here than will the other pesticides.

b. Insecticides are often classed according to the insect stage of development on which the insecticide acts: *Ovicides*, which kill insect eggs; *Larvicides*, directed against the immature stages of insects; and *Adulticides*, for the control of adult insects.

c. Another system of classifying insecticides is based on their method of entry into the insect's body, as stomach poisons, contact poisons, and fumigants. Stomach poisons must be swallowed to cause death. Contact poisons penetrate the body wall, frequently through the tarsi, as the insect rests on a surface covered with a residual insecticide. Fumigants are volatile chemicals whose vapors enter the insect through the breathing pores (spiracles). In addition, there is a group of chemicals called dessicants. These agents are dusts or crystals which scratch, abrade, or absorb the fatty, water-resistant outer layer on the exoskeleton, causing the insect to lose body fluids and die from dehydration. A few insecticides can kill in several ways. EXAMPLE: Lindane can kill by acting as a stomach poison, a contact poison and, to some degree as a fumigant.

(1) *Stomach Poisons.* These are generally used against insects with chewing mouthparts, but may also be used under certain conditions against insects with sponging, siphoning, or lapping mouthparts. The four principal ways of using stomach poisons are—

- The natural food of the insect, such as the foliage of plants, is thoroughly covered with poison so that the insect cannot feed without also feeding the poison.

- The poison is mixed with a substance that is very attractive to the insect, possibly more so than its natural food. The poisoned bait mixture is then placed where the insects can easily find it.

- Certain poisons, such as sodium fluoride, may be sprinkled over the runways of insects so that they get it on their feet or antennae. In cleaning these appendages with their mouthparts, the poison is swallowed.

- Systemic insecticides, which are readily absorbed and distributed throughout living organisms, are used to impregnate the tissues of plants and animals, so that insects feeding upon these tissues are killed. By this means, sucking insects can be controlled with stomach poisons. A stomach poison must be quick acting, inexpensive, and must be available in large quantities. It must not be distasteful to the target insect and cannot be phytotoxic (toxic to plants) if used on plants.

(2) *Contact Poisons.* These poisons are relatively new insecticides whose most common use are as contact poisons but are also effective as stomach poisons when eaten by insects. These materials include the plant-derived poisons rotenone and nicotine, and most of the synthetic organic insecticides. This group of insecticides kill insects by contacting and entering the insect's body directly through the integument and into the blood; through the mouth and into the digestive system; or by penetrating the respiratory system through the spiracles into the trachae. The materials may be applied directly to the insect body in a spray or dust or as a residual application to surfaces on which insects come in contact. Some of the more common contact insecticides are described in the following section and are grouped according to chemical structure.

(3) *Fumigants.* Gaseous poisons used to kill insects are called fumigants. The use of fumigants is generally limited to treatment in tightly sealed containers or enclosures. Fumigants are dispersed as true gases so that they reach the pest in molecular form. Molecules of gas can penetrate cracks, crevices, and tightly packed material. Fumigant materials are available in three forms, solids, liquids, and gases. All modern fumigants that give effective control of insect pests are also toxic to man. Therefore, fumigants must be applied ONLY by trained personnel who have demonstrated satisfactory knowledge of the properties of fumigants and the methods for safe handling and application.

(4) *Desiccants.* Finely powdered silica gels and silica aerogels are sometimes used for the control of cockroaches, fleas, and other household insect pests. These compounds cause death from dehydration by removing the

outer layer of the arthropod exoskeleton, either by absorbing the fatty material or by abrasion. The silica gels are reported to be nontoxic to man and other warm-blooded animals. Sorptive dusts are amorphous rather than crystalline compounds, so they do not cause silicosis. The main problem with these compounds is keeping the applied material in areas where insects can come in contact with it.

14-7. Supplementary Materials

These are chemicals that are not primarily toxic in themselves, but add to the effectiveness of pesticides. The major types of supplementary materials now used are solvents, emulsifiers, spreading and wetting agents, adhesives or stickers, and synergists.

a. Solvents. A solvent dissolves the basic chemical converting it from a solid to a liquid with the molecules of the insecticide evenly dispersed throughout the resultant solution. The solvent acts as both a carrier for a chemical and as a diluent. Some solvents, such as petroleum oils, also add to the insecticidal properties of the solution. Two general types of solvents are commonly used with insecticides:

- Volatile solvents, such as xylene, which evaporate after spraying and leave a residual deposit of the insecticides.

- Nonvolatile solvents such as petroleum oils which leave the surface coated with a thin film of the toxicant and diluent.

b. Emulsifiers. An emulsifier is a surface active agent that stabilizes a mixture of a liquid within a liquid. An emulsifier forms a tough film around each droplet of oil which resists the tendency of the droplets to coalesce and separate into continuous layers of oil and water. Early emulsifiers used in pest control were soaps, but modern usage requires detergents. Through use of these compounds it is possible to obtain an emulsifiable concentrate formulation of an insecticide. An emulsifiable concentrate (57 percent malathion) consists of a technical grade insecticide, a solvent, and an emulsifier.

c. Spreading and Wetting Agents. Many of the synthetic materials developed as emulsifiers and detergents are used as wetting and spreading agents. Spreading agents, such as Hercules Triton B-1956, may be added to oil larvicides to decrease the surface tension and cause the oil to spread as a thinner film on the water surface. Wetting agents aid in the formation of a continuous film of insecticide on water repellent surfaces, or increase the rate with which water soaks into or wets solid material. Some of these materials, called dispersants may be added to insecticidal dusts to produce water-wettable insecticide powders (also called water-dispersible powders).

d. Adhesives or Stickers. Adhesives are materials that are added to sprays to improve retention of the deposit, such as delaying the dilution of the pesticide by rain. The most widely used stickers today are petroleum white oils and fish oil which are used in conjunction with various sprays on orchard and truck crops. Gelatin, glue, resin, and other gums are also valuable adhesives.

e. Synergists. Synergists are compounds which when added to insecticidal mixtures will increase the insecticidal toxicity so that the amount of insecticide needed can be decreased. EXAMPLE: The addition of the relatively inexpensive synergist, piperonyl butoxide, to pyrethrum-based fly sprays makes it possible to reduce the amount of pyrethrum needed, and still obtain effective control, resulting in substantial monetary savings. Many synergists, such as piperonyl butoxide, MGK 264, sulfoxide, and sesamin are used in fly and mosquito control, particularly in aerosol bombs and space spraying forumlations.

14-8. Types of Formulations

Insecticides must be mixed properly before they can be used. To use most insecticides in technical grade form is impossible because of their physical properties, which make them unsuitable for direct application. Diluents, solvents, wetting agents, emulsifiers and/or other agents must be added before application can be made. When mixing insecticides you must remember several factors—

- Will the preparation be applied to plants, animals or humans?

- Will it come in contact with foodstuffs? What is the pest to be controlled?

- What will the treatment cost. EXAMPLE: An oil solution may be chosen to protect a wooden building against termites because oil helps the insecticide penetrate wood and give more than surface protection. Oil solutions, however, are not used on plants as they are phytotoxic. The seven main types of insecticide formulations used in the control of pests are technical grade materials, dusts, granules, wettable powders, emulsions, solutions, and aerosols. Fumigants are poisonous gases which require no further formulation, but are used in the form provided by the manufacturer.

a. Technical Grade Materials. A technical grade insecticide is the basic toxic ingredient in its purest commercially available form. This material is rarely chemically pure. Technical grade diazinon, for example, contains only about 94 to 97 percent of the active chemical. Technical grade materials are, in most cases, diluted with a carrier or diluent before use.

b. Dusts. Insecticidal dusts usually are formulated from talcs, clays, and other inert carriers. Sulphur dust is merely finely pulverized sulphur. Dusts are usually low in cost, easy to apply, nonstaining, and nontoxic to plant life. Insecticides in dust form usually are not considered dangerous by absorption through the skin, but may be dangerous if inhaled. The two main disadvantages of dusts are they do not adhere well to vertical surfaces and they are easily removed by wind and rain.

c. Granules. Granules are formulations in which the chemical is impregnated on or in vermiculite, attaclay or other suitable carrier, and then formed into granules or pellets varying in size from 20 to 60 mesh. Granular formulations of insecticides are especially useful in treating areas covered by thick vegetation not easily penetrated by liquid sprays. Granular formulations are also widely used in the control of various soil infesting agricultural and ornamental plant pests. Particle size for granules is commonly expressed in terms of the mesh of a sieve through which all but the coarsest particle will pass. A 20-mesh sieve will have 20 meshes per linear inch or 400 openings per square inch.

d. Wettable Powders. Wettable powders, which can be suspended in water for use as sprays or dips, are formulated by adding wetting agents to dusts. With some of the kaolin types of clay, the addition of a wetting agent is not necessary. This type of formulation is called a suspension and requires frequent agitation to prevent the solid particles from settling out. Suspensions are usually sprayed in more dilute form than solutions in order to prevent clogging of the spray nozzles. Wettable powder formulations are especially useful in treating outbuildings, adobe, concrete and thatch structures because the insecticide remains as a deposit on the surface while the carrier, water, is absorbed into the porous structure. Suspensions are also widely used in vegetable pest control, as they are not normally phytotoxic and adhere well to plant surfaces.

e. Oil Solutions. Most of the new synthetic insecticides are soluble in a majority of the organic solvents. The insect cuticle is easily wetted and penetrated by oils, making oil solutions effective as contact insecticides. In residual spraying, the solvent evaporates from the treated surfaces, leaving the insecticide in relatively pure form. Several types of oils are used as solvents for insecticides. Deodorized kerosene is used as the solvent in fly sprays. Diesel oil or number 2 fuel oil are the solvents commonly used for dilution of insecticide concentrates for mosquito larviciding and aerosoling. Chlorinated hydrocarbons, such as chlordane, diazinon, and lindane, and the organic phosphates, such as malathion, are often diluted with aromatic hydrocarbon oils which themselves are somewhat insecticidal.

f. Emulsions. Emulsions are similar to solutions in their effect upon insects. Most insecticidal emulsions are first prepared as emulsifiable concentrates with a high percentage of active ingredient. The technical grade insecticide is dissolved in a highly efficient solvent such as commercial grade xylene. An emulsifying agent is added to the concentrated solution, forming the emulsifiable concentrate. This concentrated material is then diluted with water before use to form an emulsion with the desired percentage of active ingredient. Emulsions are most commonly used as residual sprays, both indoors and outdoors. Emulsions should not be applied to humans or domestic animals as the toxic ingredients may be absorbed through the skin.

g. Aerosols. Aerosols are fine sprays with a droplet size between 0.1 and 50 microns (1 micron equals 0.0001 millimeter) and having 80 percent of the material, by weight, in particles less than 30 microns in diameter. Droplets 10 to 30 microns in diameter appear to give the best control for outdoor application against mosquitoes. Aerosols that kill insects by contact are not suitable for residual applications. Their chief value is in space spraying.

h. Baits. Bait formulations have the technical active ingredients mixed with edible or attractive substances. The bait attracts the target pests and the insecticide kills them when they ingest the formulation. The amount of active ingredient in most bait formulations is quite low, usually less than 5 percent.

14-9. Dispersal Methods

Although several methods exist for the dispersal of pesticides, one method is usually more suitable for a specific situation than any other. The ability to choose the best method requires understanding the control methods most commonly used in the military.

a. Fumigation. Fumigation is the use of gaseous poisons to kill insects, rodents, and other pests. These gases must be used with care since they are toxic to humans. Because of their gaseous states, they are able to penetrate packaged commodities, clothing, and structures which are inaccessible to other materials. Since the gases diffuse readily, in most instances, they leave no harmful residues when properly aerated. Fumigants lack residual properties and are used only when other materials (sprays and dusts) are ineffective or unsuited to the problem because of contamination, or because of penetration requirements. Fumigants enter the insect via its respiratory and integument system. Because of their extremely small particle size, fumigants can be used effectively only in airtight or nearly airtight spaces.

b. Fogging. Fogs are very fine sprays having a droplet size ranging between 0.1 and 50 microns, with at least 80 percent of the particles measuring less than 30 microns in diameter. There are two principal types of fogs — thermal and cold. Thermal fogs are produced by atomizing an insecticide formulation with either hot gases or superheated steam, and they have the appearance of dense white clouds. Cold fogs are generated by air blast forcing the insecticide through a small orifice, or by the mechanical shearing action of a rapidly rotating disc or fan. Ultra Low Volume (ULV) cold fogs are replacing most other fogging applications at military installations. The chief value of fogs is in space spraying for flying insects. Fogs leave very little or no residual, so frequent applications are required to achieve satisfactory control. Because of their small particle sizes, fogging outdoors should be conducted only when air movements are minimal, and when the air at ground level is cooler than the air six feet above the ground. Fog applications are usually most effective in the evening and early morning.

c. Spraying. Spraying is the application of liquids atomized into droplets of 100 microns in diameter or larger. Fine sprays are in the 100 to 400 micron range, and coarse sprays are 400 microns or larger. Because of their larger size, spray particles "fall out" much more rapidly. As a consequence, sprays are used principally for the application of insecticides to surfaces that pests will contact or ingest at some later time.

d. Dusting. Dusting is the dispersal of insecticides in the form of solid particles. Particle sizes of dusts extend over the same range as liquid particles. Dusts with particle sizes in the range of 15 to 60 mesh diameters are referred to as "granules" or "pelleted insecticides." Dusts are very effective against crawling insects, particularly those confined to limited areas, such as fleas and lice. Because they are less readily absorbed, properly applied dusts are less hazardous to domestic plants and animals than gaseous or liquid insecticides. If undisturbed, dusts retain their effectiveness over a longer period of time than do liquids.

e. Miscellaneous Control Methods. Other control measures include the application of insecticides with a paint brush, swab, or roller, and the use of liquid baits.

14-10. Insect Resistance

a. General. Many insects, including mosquitoes, flies, lice, and roaches, have developed resistance to insecticides. This means that an insect can survive in the presence of a chemical which was formerly lethal. It does not mean that every insect of this kind will survive the application of the insecticide, or does it mean that the resistant insects will live indefinitely in the presence of a heavy application. Insects are said to be resistant if a sizable number can survive after contact with an insecticide which has been applied at a practical dosage.

b. Development of Resistance. Like other animals, insects vary in the effects that diseases, chemicals, or other injurious things have upon them. Thus, when insecticides are applied at normal rates, not all of the exposed insect population will receive a death-dealing dose. Some will survive due to genetic characteristics inherent in their makeup. Those surviving will mate and pass on to their descendants the ability to withstand the insecticide. Careless spraying may result in the deposit of an insufficient or excess amount of material, so that the most susceptible insects are killed while naturally resistant individuals are left to multiply. Some insects are known to have developed resistance to almost every insecticide that is used by the Army. An important point to remember is that insects can develop resistance to different kinds of insecticides at the same time. This means that if several chemicals are used together, the chance of rapidly exhausting the supply of effective insecticides is thereby increased.

c. Precautions.

(1) Use insecticides properly. Improper use will build up resistant insect populations that will be difficult to control.

(2) Do not use mixtures of insecticides, since insect populations can develop resistance to many kinds of insecticides at the same time.

(3) Monitor the effectiveness of the insecticides that have been applied. If control becomes unsatisfactory even though the insecticides have been applied properly, report this situation to the commander who is responsible for forwarding the information through technical medical channels.

14-11. Repellents

Repellents are chemical compounds used as liquids, creams, aerosols, or solids to prevent biting or other annoyances by insects or other animal life. Some repellents are more effective for some uses than are others. Personal protection from the bites of mosquitoes, biting flies, fleas, ticks, chiggers, leeches, and other pests may be obtained by the application of repellents to the skin and/or to the clothing. As one of several ways the individual may protect himself in the absence of other pest control operations, the timely use of insect repellents is extremely important. Frequently, when the threat of disease transmission is the greatest, only individual protection measures are available.

a. Personal Use or Skin Application. Repellents for personal use are applied directly to the skin. Usually, a few drops rubbed between the hands, and spread evenly over the face, neck, hands, and other exposed skin areas offer protection for several hours, depending upon the pest species concerned. A few additional drops may be spread on the clothing at the shoulders and other areas where the cloth fits tightly against the body. Be careful to keep the chemicals out of the eyes. The chemical is lost from the skin by washing, abrasion, absorption, and evaporation and must be reapplied as required. The effectiveness of the material is lost more rapidly in hot, humid climates where profuse sweating occurs. Repellents which are recommended for application on the skin may also be applied by hand or by sprayer to the outside of the clothing if desired; however, several special items have been developed for impregnation of clothing to either repel or kill mites, insects, or other pests. The repellent for personal uses is DEET, which provides protection against all types of mosquitoes and other biting Diptera and fleas. It is relatively effective against ticks and chiggers.

b. Clothing Application. Formulations are designed so that clothing or blankets can be dipped into a solution of the repellent. These formulations are able to withstand one or two launderings or wettings without losing their repellent properties. The principal requirement for a clothing treatment chemical for military use is the protection of troops against chiggers, ticks, and leeches in many areas of the world. Detailed directions for use of these materials vary with the specific item and with the type of clothing being treated. Instructions issued by the local surgeon should be followed.

14-12. Hazards of Pesticides

With very few exceptions, all pesticides must be regarded as potentially hazardous. To prevent the accidental poisoning of man, his domestic animals, or valuable wildlife, it is essential that personnel handling these materials be trained in the hazards involved with using pesticides.

a. The most important factors to be considered in estimating the hazard of a given pesticide are—

- Its acute oral and inhalation toxicity.
- The degree of skin (dermal) absorption.
- The cumulative effect in the body.
- The concentration of toxicant handled in mixing or applying the chemical.

- The amount of the toxicant that must be applied to achieve control or the frequency of application.

- The conditions under which the chemical is applied and the degree of exposure to the residues.

- The physical and chemical properties of the toxicant.

An awareness of these factors, combined with earnest attention to all recommended safe handling procedures, will make the safe use of pesticides possible.

b. It is important to distinguish between toxicity and hazard. Toxicity is defined as the potential of any chemical to produce damage. Hazard is defined as the probability that a given chemical will cause damage when used in a particular way or place; therefore, will vary greatly with local conditions and application methods. In some instances a highly toxic chemical is less hazardous for a certain use than one of a lower toxicity.

14-13. Toxicity of Pesticides

a. General. There are two types of toxicity associated with pesticides that are of concern to man and the environment. These two types are referred to as acute and chronic toxicity. Acute toxicity is the effects of pesticides resulting from a one-time or high level exposure to the pesticide. Chronic toxicity is the effects of pesticides resulting from repeated exposure to low levels of pesticides over prolonged periods of time. Acute toxicity values of pesticides can be determined in the laboratory as—

- Oral toxicity — The reaction following ingestion of the pesticide by mouth.

- Dermal toxicity — The reaction caused by absorption of the chemical through the skin or other tissues.

- Inhalation toxicity — The reaction following absorption of pesticides through the lungs.

Acute toxicity is ordinarily measured in milligrams of the pesticide, per kilogram of body weight of the test animal (normally rats) that produces a 50 percent mortality (LD_{50}) in laboratory tests. Since a milligram is 1/1000 of a gram and a kilogram is 1000 grams, the toxicity is actually expressed in milligrams per kilogram or liter (mg/kg or mg/l). The data on acute toxicity have been used to group pesticides in four toxicity categories as indicated in Table 14-1. These groupings have considerable practical value because manufacturers must label each package of pesticide with key signal words such as "Danger," "Warning," and "Caution" and list antidotes where required or other necessary precautions.

Table 14-1. Acute Toxicity and Precaution Categories of Pesticides

Toxicity Category Number	Description	Oral LD_{50} (mg/kg)	Inhalation LD_{50} (mg/1)	Dermal LD_{50} (mg/kg)	Label Signal Word
I	Highly toxic	Less than 50	Less than 0.2	Less than 200	DANGER
II	Moderately toxic	50-500	0.2-2	200-2000	WARNING
III	Slightly toxic	500-5000	2-20	2000-20,000	CAUTION
IV	Practically nontoxic	More than 5000	More than 20	More than 20,000	CAUTION

Chronic toxicity effects are much more subtle and difficult to observe. They cannot be measured in the laboratory and present the greatest potential hazard to man and the environment since repeated exposure can have an accumulative effect.

b. Toxic Actions of Pesticides.

(1) *Organophosphate pesticides.* This group of pesticides includes some of the most toxic including the pesticide parathion. On the other hand, many organophosphates including those most often used in the military are only moderately toxic, and some, notably malathion, when formulated and used correctly are among the safest pesticides. This group of pesticides act on the body by inhibiting cholinesterase, an enzyme essential to the proper functioning of the nervous system. Signs and symptoms of organophosphate poisoning are observed in stages. They normally occur in this order —

(a) Mild Poisoning

- fatigue
- headache
- dizziness
- blurred vision
- too much sweating and salivation
- nausea and vomiting
- stomach cramps or diarrhea

(b) Moderate Poisoning

- unable to walk

- weakness
- chest discomfort
- muscle twitches
- constriction of pupils of the eyes

earlier symptoms become more severe

(c) Severe Poisoning

- unconscious
- severe constriction of pupils of the eyes
- muscle twitches
- secretions from mouth and nose
- breathing difficulty
- death due to respiratory failure,if not treated

(2) *Carbamate pesticides.* The carbamate pesticides are similar to the organophosphate pesticides with regard to toxicity as used in military operations. They also act on the body by inhibiting the cholinesterase and producing the same signs and symptoms of organophosphate pesticide poisoning.

(3) *Chlorinated hydrocarbon pesticides.* In the past, pesticides in this group were probably used in larger quantities than any other group of synthetic pesticides. In recent years, however, their use has become quite limited due to their potential for long-range adverse effects on man and the environment. Their action in the body is primarily associated with the central nervous system. Signs and symptoms of chlorinated hydrocarbon poisoning are—

- headache
- nausea
- vomiting
- general discomfort
- dizziness

In severe poisoning, convulsions, coma and death due to respiratory failure may occur.

(4) *Fumigants.* These are generally the most hazardous of all pesticides because they are both inhaled and absorbed through the skin. They are capable of causing death in a matter of minutes rather than hours. Signs and symptoms of poisoning include —

- poor coordination
- slurring words
- confusion
- sleepiness

(5) *Plant derived or man-made botanical pesticides.* Plant derived or man-made botanical pesticides used by the military are among the safest to use in pest control operations. Signs and symptoms of pesticide exposure may include —

- contact dermatitis
- asthmatic reactions

(6) *Anticoagulant rodenticides.* These pesticides, which are widely used as rodenticides, are derivatives of coumarin or indanedione. One of the early members of this group is warfarin. These pesticides, in addition to causing capillary damage, interfere with the formation of prothrombin, which results in extensive internal hemorrhages. These pesticides have the advantage of being formulated in very low concentrations of active ingredient; consequently, repeated ingestion over a period of several days is required to produce lethal poisonings in mammals, including man. The principal sign or symptom of poisoning is bleeding.

14-14. Pesticide Storage and Mixing

a. Storage Site. All pesticides must be stored in a secure space which can be locked. This space must be designated for the sole purpose of pesticide storage. The site should not be located in a multipurpose structure. The construction of the storage site must render it fire proof. Fire fighting features of the area should include a fire extinguisher but not sprinkler systems. Walls and floors must be coated with a nonabsorptive finish. Also floors must be skid-proof and must include a 4-inch continuous curb to contain spills. An exhaust air ventilation system that furnishes at least six fresh air changes per hour must be provided. The storage area should be windowless for security reasons. Spark-proof lighting and fixtures are necessary if pesticide stocks chosen have flash points below 100 degrees fahrenheit; however, local fire codes must be met.

b. Containers. Most containers designed for insecticides are adequate for prolonged storage; however, stocks should be inspected frequently for detection of any leaks or unsafe storage conditions. If necessary repackage using only containers and materials approved for that use. Herbicides must be physically separated from other pesticides. Keep differing formulations separated to preclude cross contamination. All pesticide containers must be labeled with the original label or the manufacturers facsimile. *Never store unlabeled containers.* Metal shelving and pallets must be used for pesticide storage.

c. Mixing Site. Criteria for the pesticide storage site also apply to the pesticide mixing area. The pesticide mixing room should be of fireproof construction, and a fire extinguisher, emergency eye lavage and deluge shower must be located in the immediate vicinity. Walls and floors should be coated with a nonabsorptive finish; the floors must be skid-proof and provided with a 4-inch high continuous curb. Shelving should be metal. The mixing area should contain a chemically resistant sink and countertop, both enclosed by an exhaust hood with a face air velocity of at least 150 feet per minute. Adequate room ventilation of at least six fresh air changes per hour must also be provided. The sink should be equipped with a back-flow prevention device.

d. The pesticide storage and mixing sites are frequently located within a single structure. This is usually within the pest control facility.

14-15. Handling Pesticides

a. Contamination. Handling concentrates when preparing dilute solutions is one of the most hazardous operations associated with pest control. Contamination of the skin with high concentrate material can result in rapid poisoning and death. Therefore, maximum precautions must be observed in handling concentrate materials.

b. Safety Precautions. Operators exposed to fumes, vapors, dusts, and mists of pesticides may suffer illness as a result of prolonged contact. It is as important to protect the operator continually exposed to dilute pesticides as it is to protect the operator occasionally exposed to concentrated pesticides. The following are some of the primary precautions which must be observed in handling pesticides:

(1) Smoking, eating, or drinking is not permitted while pesticides are being handled.

(2) All pesticides must be handled in well ventilated areas, even outdoors when appropriate, to minimize inhalation.

(3) Emergency showers and eye lavages must be near pesticide mixing areas.

(4) Personal protective equipment to include coveralls, rubber gloves and boots, and goggles should be worn. Remember to READ the label. Hearing protection is required around gasoline powered equipment.

(5) Coveralls and other clothing worn during application are worn only during duty performance. Garments are cleaned daily to limit contamination. Laundering should be provided for by the installation. Protective clothing should never be taken home.

(6) Clothing contaminated by spillage must be immediately removed and thoroughly laundered. Any contamination of the skin, particularly with liquid concentrates or solutions, must be washed off with detergent and water.

(7) Respirators, approved for use with pesticides, must be worn while pesticides are being handled, mixed or dispersed. Care should be exercised when selecting the respirator type to ensure that it is designed for the substance and formulation in use. EXAMPLE: A respirator approved for use with sprays may not be adequate for fumigants. The mask should also be fitted to the individual using it by someone trained in respirator fitting. Respirators should be stored in a clean, convenient, sanitary location, free from contaminants when not in use. The Army's Respiratory Protection Program and additional information concerning respirators can be found in TB MED 502.

14-16. Pesticide Disposal

The safe and legal disposal of unwanted pesticides, containers and residues presents a chronic problem to the pest controller. This problem can be kept under control by applying a few basic principles.

a. Pesticides. The best way to dispose of unwanted pesticide concentrates is to use them. This can only be done when the pesticide is used for the purpose for which it was originally labeled; if the intended usage is still legal. If disposal through use of the chemical is not possible, efforts should be made to dispose of the pesticide by returning it to the manufacturer through the Defense Property Disposal Officer (DPDO). The generating agency or property disposal office is responsible for storage of the pesticide during the disposal process. Most disposal problems involving concentrated pesticides can be avoided by maintaining a complete pesticide inventory and by reviewing the amounts of pesticides used on the Pest Management Report, DD Form 1532. Pesticide procurement can then be adjusted to match past usage and anticipated usage based upon monthly and quarterly work plans. Problems resulting from the disposal of unwanted dilute pesticides can be completely eliminated by performing thorough pretreatment surveys and carefully calculating amounts of dilute pesticide needed. All pesticides which the Armed Forces have determined to be obsolete must be disposed of in accordance with the directive declaring it obsolete.

b. Containers. Pesticides are packaged in a variety of containers. In most cases disposal may be accomplished by rinsing the container three times with a quantity equal to one tenth the capacity of the container each time (for example, rinse a 5 gallon drum three times with 0.5 gallons of water each time). Retain the rinse water and use it in the diluent when mixing the next batch of the same pesticide. After rinsing the container, render it unusable by crushing or puncturing. It can then be buried in a sanitary landfill. Not all containers can be rinsed, such as combustible containers which formerly contained organic or metallo-organic pesticides. These must be disposed of in a pesticide incinerator, or buried in a specially designated landfill. Paper containers, aerosol cans and other ready to use pesticides can generally be buried in small quantities. Dispose of these in the sanitary landfill after emptying.

c. Residues. Pesticide residues and rinse liquids should be added to spray mixtures in the field whenever possible. If not, they must be disposed of in the same manner prescribed for the specific pesticides involved.

d. Repackaged Pesticides. All unusable pesticides in deteriorated or leaking containers must be recontainerized or overpacked in Department of Transportation (DOT) approved containers. This must be accomplished prior to storage or turn-in to DPDO. The new container should have the original label or manufacturer's facsimile, attached to it, or should be labeled with specific information as detailed in Change No. 9, DPDS-M 6050.1.

e. Labeling. The following are requirements for labeling pesticides to be turned in to DPDO:

(1) *Excess serviceable pesticides.* An excess serviceable pesticide may be reused or sold only if it has a complete EPA approved label on its container, and only if the product has not deteriorated or had any substance added to it.

(2) *Unserviceable pesticides.* An unserviceable pesticide lacks proper labeling or its composition has been altered. It must be marked "For Disposal Only."

(3) *Unlabeled pesticides.* An unlabeled pesticide must be marked "For Disposal Only."

(4) *Suspended and Cancelled Use Pesticides.* Unless an amended label can be obtained from the manufacturer, the product must be declared unserviceable and marked "For Disposal Only."

(5) *Repackaged pesticides.* A repackaged pesticide may not be transferred, sold, redistributed, or turned in to DPDO unless it is designated for return to the manufacturer or "For Disposal Only."

14-17. Clean Up of Pesticide Spills

a. General. These guidelines provide simple instructions on cleaning up small spills of pesticides (1 quart or less).

b. Personnel Protection.

(1) If the pesticide gets into the eyes or on the skin, immediately flush with water under low pressure. Further, wash the skin with soap and water. Remove contaminated clothing and blot up any pesticides on the clothing.

(2) Once the pesticide is washed off and clothes changed, the persons should go to the nearest MTF. Exposed persons should know what pesticide they were exposed to and its strength (concentration).

c. Cleanup and Disposal. Spilled pesticides should be cleaned up immediately. The steps below should be followed.

(1) Block off or isolate the immediate area where the spill occurred.

(2) Pour cat litter, sawdust, or other absorbent material on the spill to soak it up. Ventilate the room by opening doors and windows and turning on exhaust fans.

(3) Scoop up the contaminated absorbent and put it into a plastic bag.

(4) Mop up the spill area with warm water and detergent.

(5) After mopping, place the mophead into the bag with the contaminated absorbent. Close and seal the bag and place it in a refuse container for pickup by an approved sanitation disposal service.

(6) Cleanup personnel should wear coveralls and waterproof footwear (rubbers or galoshes). They should not eat, drink, or smoke during the cleanup and should thoroughly wash afterwards with soap and clean water.

(7) Discard broken or damaged pesticide containers in the same manner as the absorbent material.

14-18. First Aid

a. Immediate Action. The first consideration when an accident occurs, such as gross contamination of the body with concentrates or the inhalation of poisonous gases, is remove the victim from the toxic atmosphere or from other types of continued exposure. The second consideration is artificial respiration if the victim is unconscious and not breathing. Medical aid must then be obtained. Simultaneous measures while awaiting medical aid or en route to it are—

(1) Removal of contaminated clothing.

(2) Dousing with water or washing contaminated skin areas.

(3) Artificial respiration, if victim is unconscious.

b. Required First Aid Information. A person with knowledge of the incident should accompany the victim to the medical facility to provide medical personnel with the nature of the accident, the material being used, the first aid given, and the victim's activities following exposure up to the time of his arrival at the medical facility. The poison container or a label from it should be delivered with the patient to the medical facility.

c. Antidote Information. The responsible supervisor at each military installation where pesticides are used must provide the nearest medical facility with information on all chemicals being used; so that antidotes can be made available and medical officers are aware of toxic symptoms. Information regarding treatment may be obtained from the nearest poison control center. No matter what the nature of the poison, it is important to reduce the exposure. Anyone who has collapsed in an atmosphere of toxic gas must be moved to fresh air at the earliest possible moment by rescuers with adequate protection. As in the case of other exposures, decontamination should be carried out as soon as the condition of the patient permits. Emesis and/or gastric lavage is indicated if poison has been taken internally. A saline laxative may be used to speed evacuation of the gut; oil laxatives should be avoided where it is possible that an organic solvent or a halogenated hydrocarbon insecticide is involved. If the skin has been contaminated it should be washed thoroughly with soap and water. If the eyes have been splashed, the face should be washed and the eyes irrigated with water.

CHAPTER 15

SELECTION AND USE OF PESTICIDE DISPERSAL EQUIPMENT

Section I. INTRODUCTION

15-1. General

One of the most important considerations in any pest control program is the selection, use, and care of pesticide dispersal equipment. The requirement to apply pesticides as liquids and dusts has given rise to the production of numerous models of similar items.

15-2. Types of Equipment

The relatively small number of items approved for use at military installations represents the results of thorough research and development programs. The approved items best meet the needs for pesticide application in the military services.

a. The following items are approved for dispersing liquid formulations:

- Hand sprayers.
- Compressed air sprayers.
- Hydraulic piston-pump sprayers.
- Nonthermal fogger.
- Helicopter mounted sprayer.
- Back pack sprayer-duster.

b. The following items are approved for dispensing dust formulations:

- Rotary duster.
- Plunger duster.
- Backpack sprayer-duster.
- Power duster for delousing (delousing outfit).

Section II. HAND SPRAYERS

15-3. General

Hand sprayers have a tank capacity of 1 to 3 quarts (Figure 15-1) and use oil base insecticide solutions or water-emulsions.

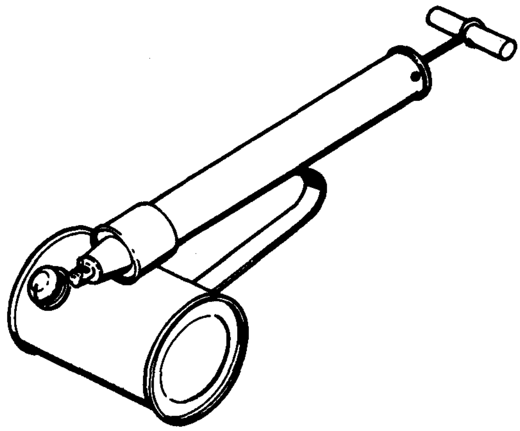


Figure 15-1. Hand sprayer.

15-4. Uses

They are used to dispense a fine mist in buildings for control of flies and mosquitoes. These sprayers also may be used to apply a coarse mist as a residual spot treatment on walls, floors, and in cracks for cockroach and ant control. They can be used to apply repellents to the clothing of troops in the field.

Section III. SPRAYER INSECTICIDE HAND 2-GALLON

15-5. General

The 2-gallon compressed air sprayer is provided with four nozzles which permit changing spray patterns as required by different jobs. The sprayer is shown in Figure 15-2.

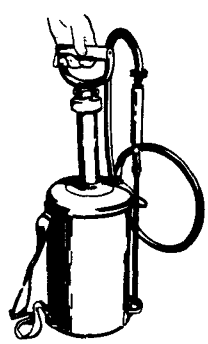


Figure 15-2. 2-gallon sprayer.

15-6. Uses

The 2-gallon sprayer is used to apply residual sprays in and around buildings and low spot treatment of outdoor areas, such as water filled containers, garbage pits, and latrines. It may also be used to apply repellents to the clothing of troops in the field.

15-7. Nozzle Selection

Nozzle selection is extremely important; selection is based upon the job to be performed and the desired spray pattern (Figure 15-3).

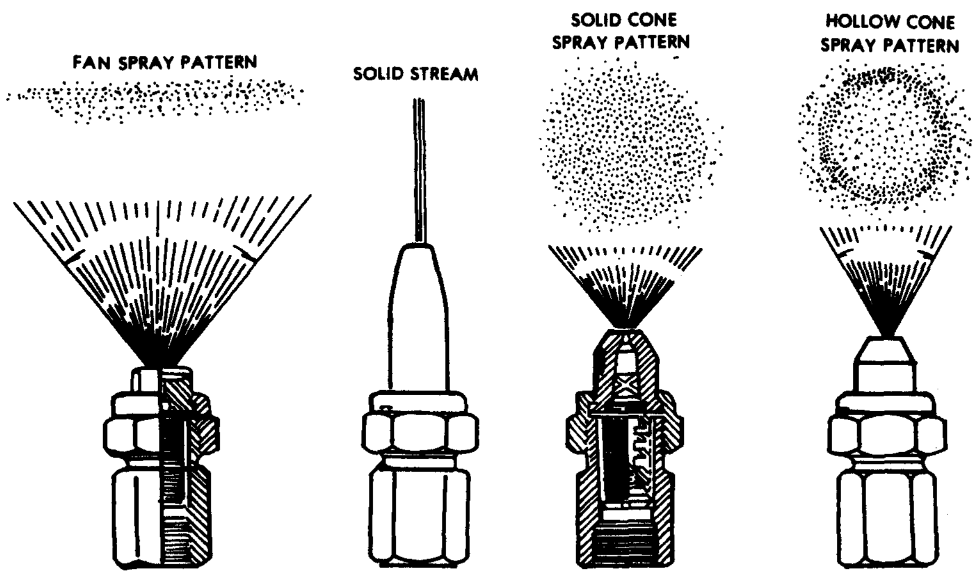


Figure 15-3. Spray patterns.

a. The solid-stream nozzle is designed to apply a fine stream of insecticide to cracks and crevices to control roaches and ants.

b. The flat-fan nozzle produces a fan shaped pattern and is used in residual spraying, both inside and outside buildings. It can be used for most applications of pesticides on flat surfaces.

c. The hollow-cone nozzle forms a hollowed cone shaped spray pattern and is most frequently used in mosquito larvaciding operations and for other outdoor requirements. However, the hollow-cone nozzle can be used for residual spraying indoors.

d. The full-cone nozzle forms a solid cone shaped spray pattern. It is most useful in situations where a large volume of dispersed pesticide is preferred. (EXAMPLE: heavy vegetation or adobe walls.)

15-8. Calibration

A task that is performed when preparing to use the 2-gallon sprayer is calibration. Without determining the flow rate in advance of spraying pesticides, the operator cannot know whether he is applying the proper quantity of pesticides as specified by the label. If he applies too much, he is violating the law; too little, he may not achieve adequate control.

a. The first step in calibration is to put some water in the sprayer (1/2 gallon is sufficient). Pressurize the sprayer 40 to 60 psi. This requires about 30 to 35 strokes of the pump. An equally, if not more reliable method is to pump the sprayer up until it becomes too hard to pump.

b. While being timed, discharge the sprayer through the spray wand into a small graduated cylinder. After 30 seconds, shut off the sprayer and determine the rate in ounces per minute. (EXAMPLE: 2 oz/30 sec = 4 oz/60 sec.)

c. The person operating the sprayer must then determine the amount of time he requires to spray 100 square feet. (EXAMPLE: 1 min/100 ft^2.)

d. After completing *b* and *c* above, many calculations can be made. EXAMPLE: If the decision has been made to spray an acre with this 2-gallon sprayer, we could calculate the amount required to spray that acre. (EXAMPLE: 43,560 ft^2 = 1 acre, therefore there are 435.6 areas of 100 square feet each in an acre. So we will use 1742.4 oz or 435.6 x 4 oz to spray that 1 acre.)

15-9. Operations

Operation of the 2-gallon sprayer involves two steps, mixing and application.

a. Mixing. When mixing pesticides, care must be exercised to read and follow the label directions explicitly.

(1) If the label directs the individual to mix a given amount of pesticide, such as 4 oz, in a gallon of water (128 oz) the result will yield more than 1 gallon of mixed material (132 oz).

(2) If the label states that to mix 1 gallon of finished spray, the individual mixing should use a given amount of concentrate (EXAMPLE: 4 oz), then the resulting mixture cannot measure more than 128 ounces. During the mixing process, an adjustment in the amount of diluent mixed with the concentrate must be made. (EXAMPLE: 128 oz finished spray — 4 oz pesticide = 124 oz water.)

(3) During mixing always use personal protective equipment to protect yourself against accidental poisoning. Use measuring cups and graduated cylinders to ensure accuracy. Triple rinse the funnels and measuring devices using the rinse as part of the diluent (as discussed in (2)) and immediately attend to spills and splashes. Lastly, never transport pressurized equipment, but wait to pressurize the tank until you arrive on site.

b. Application.

(1) Exercise care when applying pesticides from the 2-gallon sprayer, do not permit the pressure to drop too low. Frequently repressurize to 60 psi to ensure an even, consistent application of the pesticide. However, when applying pesticides in cracks and crevices, a lower pressure (15-20 psi) is best to avoid splatter.

(2) Crack and crevice application is made by holding the nozzle down next to the crack and spraying into the crack only. DO NOT preform a band application by spraying above the crack and allowing the pesticide to flow down into it.

(3) Do not store leftover pesticides in the sprayer. (Leftovers can be limited by surveying the area in advance.)

(4) After emptying the sprayer, rinse it with an appropriate diluent three times using 0.5 gallons for each rinse. The rinse material should be either sprayed back over the original application site or used as diluent to mix the next batch of the same pesticide.

(5) Store the sprayer upside down with the pump mechanism removed. Periodically, the leather cup (Figure 15-2) and plunger tube should be lubricated with SAE 30 oil. Do not use graphite.

Section IV. HYDRAULIC PISTON-TYPE SPRAYERS

15-10. General

Hydraulic sprayers are used for spraying large volumes of pesticides to large outdoor areas. All three liquid formulations, solutions, emulsions, and suspensions can be used in a hydraulic sprayer. The unit comes equipped with a bypass valve that furnishes agitation which is necessary when applying suspension formulations. Hydraulic sprayers are engine driven water pumps; therefore, care of the engine is very important.

15-11. Uses

The unit comes equipped with a spray gun and a subsoil injector or ground feeder.

a. Spray gun. The spray gun can be adjusted to apply pesticides from a mist to a solid stream. This range of application technique is part of the reasons that hydraulic sprayers are such a valuable piece of equipment. In discussing the different pest arthropods we can see the value of different application techniques. In addition to insect control the hydraulic sprayer is used for plant and weed control.

b. Subsoil injector or ground feeder. This piece of equipment is used for control of soil-borne insects and diseases. Termites and ants are examples of insects controlled by use of this device.

15-12. Calibration

The spray gun and the subsoil injector must be calibrated to ensure that the pesticide is applied as the container label directs. To calibrate hydraulic sprayers you must consider the pump pressure, the application speed or time, and the nozzle or orifice size.

a. Pressure. Hydraulic sprayers are equipped with a pressure relief valve and a pressure gauge. This can be set to apply pesticides from zero (0) to 300 psi (pounds per square inch). An increase in pressure increases the application rate and a decrease in pressure decreases the application rate. A pressure increase changes the volume output and the droplet size. When applying volatile pesticides, pressure becomes very important. There are three major considerations when applying volatile pesticides:

- Low pressure,
- Low wind, generally under 5 mph, and
- Large droplets.

These three items usually appear on the label of volatile pesticides. Smaller droplets created by higher pressures are likely to drift and kill or contaminate nontarget areas.

b. Speed or time. Speed or time are the same because how fast you spray a given area is the same as how long you stay on the area. A good rule of thumb to use when applying pesticides is; when you half the speed you double the application rate and vice versa. This knowledge becomes important when following label directions. EXAMPLE: the label says apply 3 gallons per 1000 square feet (sq ft). You measure an area 10 ft x 100 ft = 1000 sq ft and start spraying the area after selecting your application technique. It takes you 3 minutes to cover the 1000 sq ft. You then time the flow into a container for 3 minutes and measure the amount of liquid that flowed. Suppose that this amount of liquid was 2 gallons, then you can set up a proportion equation:

$$\frac{2\text{ gal}}{3\text{ min}} = \frac{3\text{ gal}}{X} \quad \text{cross multiply } 2X = 9 \quad X = 4.5\text{ min}$$

Therefore, to apply 3 gallons per 1000 sq ft, you must slow your speed down.

c. Nozzle or orifice size. The hydraulic sprayer comes equipped with nozzles of various sizes. The third item that can be changed to alter the calibration is the nozzle. If you use a nozzle with a larger opening you will have an increase in the application rate. If you need to change the dosage calculation a small amount then either the pressure or nozzle selection will give the desired results; however, for large changes speed or time adjustments must be made.

15-13. Operation

Operation of the hydraulic sprayer consists of mixing and applying pesticides. The unit has a portable suction hose for use in barrels, drums, or any other liquid holding implement. Since the calibration is always accomplished using water there is no pesticide contamination during this operation. Exercise extreme caution during the actual spray operation and wear all protective clothing and equipment as specified on the container label. Should a broken hose or leaking valve occur during spraying, stopping the gasoline driven engine will stop the spray operation and protect the applicators, other people, and the environment. Always mix pesticides for use in the hydraulic sprayer as specified on the container label.

Section V. ULTRA-LOW-VOLUME AEROSOL GENERATORS

15-14. General

The nonthermal insecticide fogger is used to treat extensive outdoor areas for flying insect control. All adulticiding chemicals depend on direct contact with target insects to achieve effective control. Chemical dispersal units have been designed to produce a droplet spectrum which meets label requirements and results in the most economical use of chemicals, equipment and labor. Factors such as chemical characteristics, meteorology, vehicle speed, foliage and building density have a direct effect on the overall results of the program and should be considered at all times. There are three types of ULV equipment in the supply system.

15-15. MICRO-GEN Model G-9HD Chemical Dispersal Unit

This unit produces a chemical droplet spectrum with over 85 percent of the droplets being less than 20 microns in diameter. Designed for outdoor applications, the powerful discharge and high production capabilities of this unit enable the operator to cover large areas quickly and effectively (Figure 15-4). The wind velocity should be relatively constant and not below 3 mph or above 10 mph. For operating instructions and maintenance requirements, see the Operator's Manual which is provided with the machine.

15-16. Fog Generator LECO Model-HD

This unit is designed for dispensing concentrated pesticides at an Ultra-Low-Volume (ULV) rate with droplets of optimum size. The concentrated pesticide is forced from the tank through the system by air pressure obtained from the blower. The pesticide flows from a tank to the remote control unit. When fogging, the pesticide flows to the specially designed LECO dispersing head where it is sheared into optimum size droplets by an air blast from the blower and dispersed into the atmosphere. After dispersal, the droplets stay suspended in the air and drift with prevailing winds to the insect infested areas. For information on the operation and maintenance of the LECO, see the operators manual and parts list that comes with the unit.

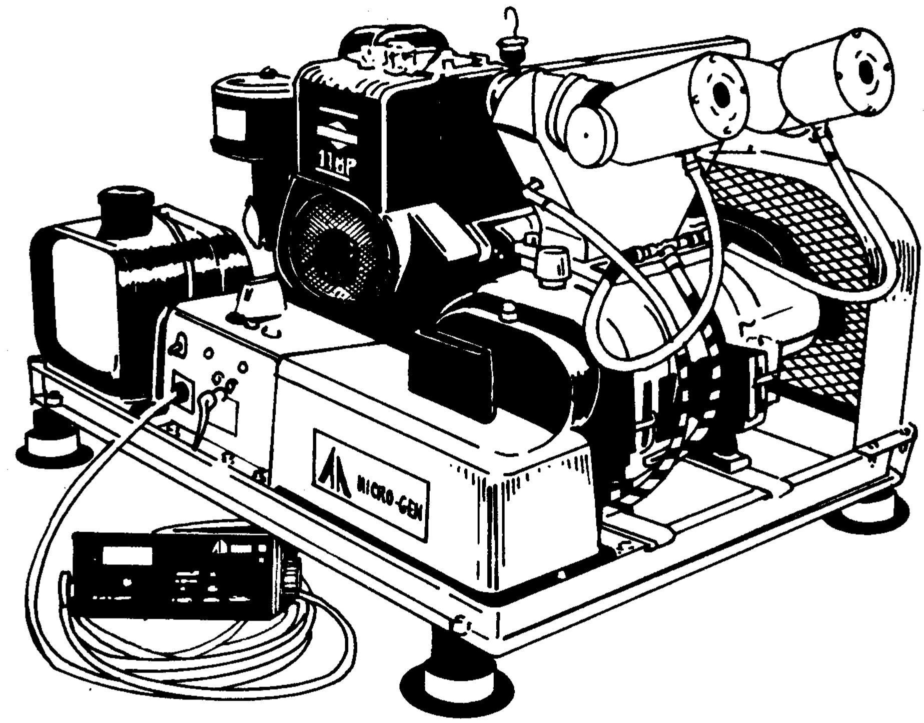


Figure 15-4. MICRO-GEN Model G9HD.

15-17. London Aire ULV Aerosol Generator Model-XKA

This equipment is used for the same purpose as the two above ULV generators. Specific operational and maintenance instructions are contained in TM 5-3740-214-14 which is provided with the equipment.

Section VI. DUST DISPENSERS

15-18. General

The types of equipment used for dispensing dust are the rotary duster, plunger duster, backpack sprayer-duster, and power delouser.

15-19. Rotary Duster

This hand-cranked duster holds 5 to 10 pounds of dust or granules (Figure 15-5). It is carried in front of the operator and held by shoulder straps. It is used in the application of residual dusts or granules for control of ants and ectoparasites in grass and mosquito larvae in swampy areas.

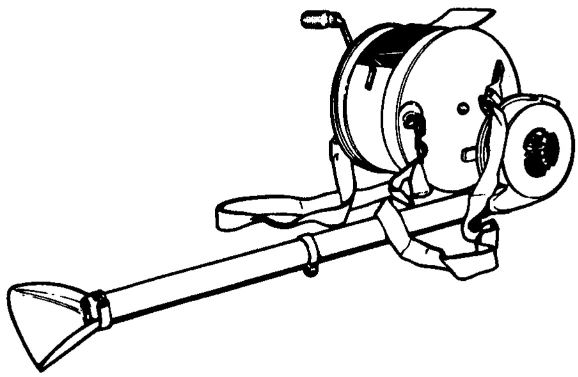


Figure 15-5. Rotary duster.

15-20. Operation of Rotary Duster

a. Crank.

(1) Attach crank to drive shaft on right hand side of duster. Cranking must be done by the right hand. Do not attempt to operate with left hand as this reverses the action of the fan and will not give the required results.

(2) It is unnecessary to crank rapidly. Thirty to thirty-five revolutions per minute will produce efficient performance. In the event the dust is not completely dry and tends to accumulate in the fan case, two or three rapid turns of the crank will correct the trouble.

b. Discharge Tubes. Couple the two straight tubes and large nozzle together, and attach to the fan case outlet.

c. Fan Case. By loosening the screw located on the rim of the fan case, the discharge assembly can be rotated to any angle desired, front or rear or vertical. This feature permits the operator to maintain a natural position, without stooping or bending. When the desired angle is obtained, tighten the screw.

d. Loading Duster. Fill the hopper about half full, but a greater quantity may be added if inconvenient to load often.

e. Feed Adjustment. The left side of the hopper is marked: OFF—5—10—15—20. These figures indicate the approximate dosage per acre; however, as dusting materials vary greatly in the physical condition, the dust delivery should be carefully checked for maximum economy. Calibration is accomplished by loading the duster with a known quantity of dust and determining the time needed for dispensing at the rate of 30-35 rpm.

f. Shoulder Straps. Hook the straps on the upper loops on each side of the duster and throw the straps over the shoulders. Cross them on your back, bringing them forward under the arms, and hook them in the lower rings on the duster. The straps are adjustable. Another method of assembling the straps is to hook the two ends of one strap to the upper rings on the duster, carry the strap around the back of the neck, assemble the other strap around the waist, and hook the ends to the two lower rings.

15-21. Plunger Duster

This hand-held duster (Figure 15-6) holds about 1 pound of dust. It is suitable for spot treatment for fleas, ants, stored product insects in warehouses, and ornamental insects in shrubbery. Its primary use is for delousing troops or civilian populations.

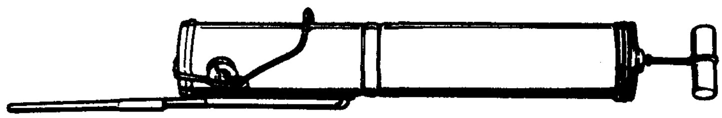


Figure 15-6. Plunger duster.

15-22. Backpack Sprayer-Duster

The backpack sprayer-duster is capable of accomplishing a wide variety of control operations. It is particularly useful for ectoparasite control and for application of pesticides over areas where vehicular traffic is unable to transverse or is prohibited. The unit is mounted on the back of the operator by means of a form fitted plastic frame. Operational and control information is provided in the equipment manual.

Section VII. POWER DUSTER FOR DELOUSING PERSONNEL

15-23. General

This powder-dusting equipment (Figures 15-7) consists of a small portable gasoline engine, an air compressor, 10 lengths of hose, and 20 dust guns (Figure 15-8). It is operated under the technical supervision of a medical entomologist and is especially suited for dusting troops in rear areas, prisoners of war, civilians in occupied areas, and troops boarding transport aircraft or ships.

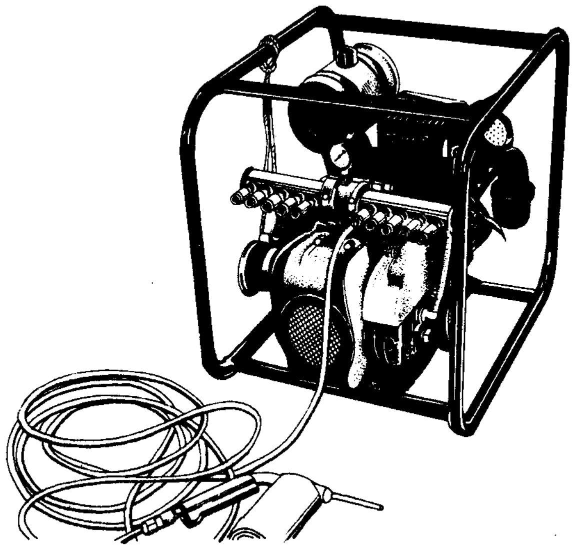


Figure 15-7. Power duster for delousing personnel.

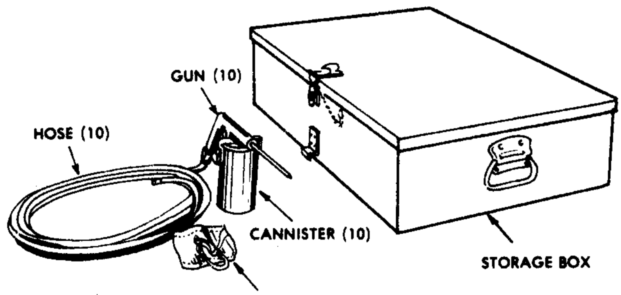


Figure 15-8. Delousing guns for delousing outfit.

15-24. Delousing Procedures

a. First dust the subject's head, having him rub the powder into his hair until it is whitened; then dust his hat (Figure 15-9).

b. Have the subject stretch his right arm out to the side at shoulder height, insert the nozzle of the duster into the sleeve next to the skin, and direct the flow of powder toward the armpit. Hold the trigger on the duster down until powder is seen coming from the loosened neck of the shirt. The subject's face should be turned away from the side being dusted.

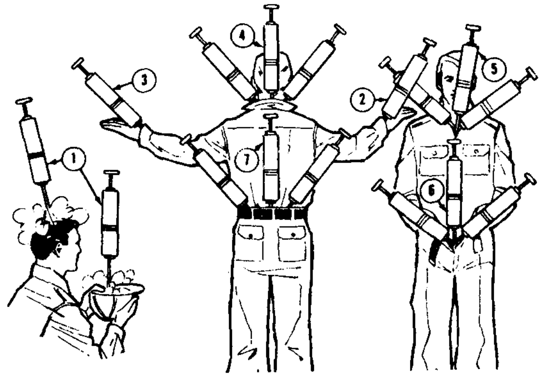


Figure 15-9. Delousing procedures.

c. Repeat the same operation (*b* above) in the left sleeve at this time, or after the operation in *d* or *e* below.

d. Insert the nozzle inside the shirt collar at the back of the neck next to the skin; blow powder toward right side, waistline, and left side. Be sure that some powder is dusted on the collar where lice are likely to hide. This can be done most effectively with the operator standing in front of the subject and the subject resting his chin on his chest.

e. Insert the nozzle inside the shirt collar at the front next to the skin; blow powder toward right armpit, waistline, and left armpit. The subject should lean forward with his head tipped backward.

f. With the subject standing, insert the nozzle inside the top of his loosened drawers at the front next to the skin; blow powder toward right side and leg, toward crotch, and toward left side and leg.

g. Insert the nozzle inside the top of the loosened drawers at the back next to the skin; blow powder toward right side and leg, toward buttocks, and toward left side and leg.

Section VIII. AERIAL SPRAYER

15-25. Helicopter Mounted Sprayer

The helicopter mounted sprayer is a pesticide dispersal unit mounted on the interior of a UH-1 helicopter. It is mounted in the helicopter before filling it with pesticide. The sprayer uses technical grade pesticide, therefore it dispenses ULV applications. The pesticide is dispersed at relatively low altitudes and is targeted for the control of small flying insects such as mosquitoes. The pressure required to disperse the pesticide is generated by a propellor. The nozzles are fitted with pressure activated diaphragms that will only open when an overall system pressure of 40 psi is achieved. Consequently this unit can only be operated during forward movement of the aircraft. The helicopter mounted sprayer is invaluable for the control of small flying insects over large areas where ground traffic is prohibited. Operational and maintenance procedures are discussed in TM 5-3740-211-14.

CHAPTER 16

WATER SUPPLY

Section I. GENERAL

16-1. Waterborne Diseases

Preventive medicine personnel are involved with water supply because water is a vehicle for transmitting many diseases, such as cholera, typhoid fever, amebiasis, shigellosis, schistosomiasis, poliomyelitis, and infectious hepatitis. Many of these diseases are described in Chapter 5. Furthermore, water supply has been known to be the vehicle for diseases not normally transmitted by water.

16-2. Responsibilities for Providing an Adequate Potable Water Supply

a. The Corps of Engineers, Quartermaster Corps, and the Army Medical Department share responsibilities for the water supply. The Corps of Engineers is responsible for making a treated water supply available to all Army units in garrison. It is also responsible for the design, procurement, installation, operation, and maintenance of fixed water supply systems and for the quality and quantity of the water. The Corps of Engineers coordinates its responsibility with the Army Medical Department to ensure that the water is safe to drink. The Quartermaster Corps is responsible for procurement, treatment, and distribution of water in the field.

b. The Army Medical Department inspects fixed water supplies from source to consumer and recommends changes necessary for the protection of the troops' health. In the field, the Army Medical Department is responsible not only for making recommendations to protect the troops' health but also for approving sanitary aspects of field water supplies.

Section II. QUALITY REQUIREMENTS FOR WATER

16-3. General

a. To be satisfactory for human consumption, water must be free of all pathogens or substances in concentrations that can cause harmful effects. Water meeting these requirements is said to be *potable*. Drinking water should also be *palatable*; that is, clear, cool, and relatively free from taste and odor.

b. Economics is sometimes considered in setting quality requirements. For example, limits may be set on calcium and magnesium, the principal hardness-forming constituents in water. Water hardness precipitates soap; thereby requiring more soap to be used for cleaning. Similar standards have been set on iron and manganese contents in water, since these chemicals discolor clothes.

16-4. Bacteriological Standards

a. Since the concentration of pathogenic organisms in natural water and in drinking water is generally very low, it is not practical to determine the number of these organisms to decide whether or not the source and the finished water are safe. Instead of measuring these organisms directly, preventive medicine personnel accept indirect evidence from the presence of so-called indicator organisms.

b. The organisms selected as the indicator are ones that are always present in great numbers when pathogens are present and that respond to the environment in the same manner as pathogens. Furthermore, they are easily identified and counted by simple procedures. Coliforms, the bacteria present in the intestinal tract of warm-blooded animals, have been selected as the indicator because they meet these requirements. They can be found in fecal wastes from man in large numbers, 10^{11} to 10^{13} per capita per day, and can be easily identified both numerically and qualitatively in laboratories. The absence of coliform bacteria is evidence of bacteriologically safe water. These bacteria are more resistant to the aquatic environment and to disinfection than many pathogens of intestinal origin.

c. The coliform group is not a species but consists of several genera of bacteria, some of which are not found in the intestinal tract. The *Aerobacter aerogenes*, for example, originate from soil or vegetation. The coliform group includes gram-negative, nonspore-forming, rod-shaped bacteria which may be aerobic, faculative, or anaerobic. These bacteria will ferment lactose at 35°C (95°F) with gas formation within 48 hours.

d. In the examination of water, either the membrane-filter technique (paragraph 16-19*c*(1) and Appendix B) or the multiple-tube fermentation technique (paragraph 16-19*c*(2)) may be used to identify the presence of coliform bacteria.

(1) For the membrane-filter technique, the standard sample volume is 100 milliliters. The maximum contaminant level (MCL) for coliform contamination in fixed installation potable water supplies is:

(a) One coliform colony/100 ml for the average of all monthly samples; AND

(b) Four coliform colonies/100 ml in not more than one sample, if fewer than 20 samples are collected per month; OR

(c) Four coliform colonies/100 ml in not more than 5 percent of the samples, if more than 20 samples are collected per month. When a standard sample for the membrane-filter technique shows a larger number of colonies than permissible, daily samples from the same sampling point must be collected and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality. Coliform analysis in the field is generally conducted by the membrane-filter technique.

(2) In the examination of water by the multiple tube technique, each standard sample must consist of five standard portions of 10 ml each. Fixed water supplies examined by this technique must meet the requirements listed below (TB MED 576). If these requirements are not met, additional samples must be collected from the same outlet in accordance with the remedial action outlined in TB MED 576 (Appendix K).

(a) Coliforms shall not be present in more than 10 percent of the portions per month; and

(b) Not more than one sample may have three or more portions positive when less than 20 samples are examined per month; or,

(c) Not more than 5 percent of the samples may have three or more portions positive when 20 or more samples are examined per month.

(3) The MCL for coliform contamination in field water supplies is one coliform colony/100 ml. When a standard sample for the membrane-filter technique from a field water supply shows a larger number of colonies than permissible, corrective actions by the water purification operators must be taken and a new set of samples from the same sampling point must be collected and examined daily until the results obtained from one set of samples show the water to be of satisfactory quality.

16-5. Physical and Chemical Standards

a. Physical and chemical standards for water provided to fixed Army installations are contained in TB MED 576. These standards are based on the National Interim Primary Drinking Water Regulations (NIPDWR) and the National Secondary Drinking Water Regulations (NSDWR). Physical and chemical standards are provided in Table 16-1.

b. The major health, aesthetic, and economic reasons for performing physical and chemical analysis on water supplies are discussed for the following contaminants:

- *Arsenic (A).* Arsenic is found in many foods in varying amounts. Its widespread use in pesticides is a cause for concern because of the entry of these pesticides into food and water supplies. Arsenic is highly toxic and ingestion of as little as 100 mg results in severe poisoning and normally 130 mg is fatal. Regular ingestion of arsenic will show cumulative effects. A single dose may require 10 days for complete elimination from the body. Arsenic is easily absorbed through the gastrointestinal tract and lungs, and it is distributed throughout the body tissues and fluids. There is some evidence that arsenic causes cancer of the lungs and skin. Physiological effects of severe arsenic toxicity include kidney degeneration, edema, liver cirrhosis, dermatitis, and bone marrow injury.

- *Barium (B).* Barium is a general muscle stimulant, especially for the heart muscles. Fatalities have occurred as a result of consuming barium salts used in rat poison. The fatal dose for humans is approximately 550-600 mg. Barium is capable of causing a nerve block. In small doses, it produces transient increases in blood pressure. Little is known about the effect of regular ingestion of low levels of barium salts in the water supply. However, barium is easily removed from water by sedimentation.

- *Cadmium (Cd).* Cadmium is a highly toxic element. It is found in ground waters as a result of seepage from various sources such as electroplating plants. The zinc used to galvanize iron is often contaminated with cadmium which may be released into the water. The emetic threshold for cadmium is 13-15 mg/l. Cadmium accumulates in the kidneys and liver. Physiologic changes caused by cadmium include loss of bone minerals and chronic kidney disease.

- *Chloride (Cl^-).* Limitations on the concentration of chlorides in drinking water are set primarily because of palatability. Chlorides in high concentrations give water a salty taste. The taste threshold generally is between 150 and 500 mg/1. Corrosion of hot water supplies may also occur when high chloride concentrations are present.

- *Chromium (Cr).* Sources of chromium in water include electroplating wastes and spent battery acid. Chromium, when inhaled, is a known carcinogen. It is not known whether chromium ingested with drinking water will cause cancer. The chromium of primary concern is that in the hexavalent form (Cr^{6+}).

- *Copper (Cu).* Copper is a beneficial and essential element in human metabolism. A deficiency in copper results in nutritional anemia in infants. The daily adult copper requirement has been estimated as 2 mg. Usually, a normal diet will satisfy this requirement, but a supplement from water is not harmful. Copper does affect the palatability of water, and the taste becomes perceptible with a concentration of 1-5 mg/1. At 4 mg/1 copper has been responsible for imparting a green tint to silver-blonde haired persons. Also, a very large dose of copper can result in liver damage.

- *Cyanide (CN^-).* Cyanide is toxic to man. However, the body is able to detoxify cyanide by converting cyanide to thiocyanate if it is consumed in doses of less than 10 mg. Usually, chlorination of water at a pH of less than 7 will reduce cyanide to a safe level.

- *Oxygen (0^2).* The primary effect of dissolved oxygen is its corrosiveness. Iron corrodes in natural waters at a rate roughly proportional to the concentration of dissolved oxygen. The solubility of oxygen in water decreases with increasing temperature and decreasing pressure. Water in closed loops, such as closed heating and cooling systems, becomes noncorrosive after a short time as the oxygen in the water is consumed as the iron is oxidized. This condition will exist as long as no air or replenishing water enters the system. A relatively large amount of dissolved oxygen in natural water helps maintain the ecological balance. The addition of organic wastes, such as sewage, quickly increases the oxygen demand and adversely effects the aerobic biological systems in the water way, causing putrefaction.

- *Carbon Dioxide (CO^2).* The presence of dissolved carbon dioxide in water also has an effect on corrosion. In hard water, the amount of carbon dioxide present will determine whether or not a protective layer of calcium or magnesium carbonate will be deposited on the metal surface. The carbon dioxide, which forms carbonic acid in water, can dissolve this protective layer or prevent deposits from forming. In soft water, the carbon dioxide reacts with iron, releasing hydrogen into the water.

- *Hydrogen Sulfide (H_2S).* Hydrogen sulfide enters the water as the decomposition of organic matter occurs, or by the action of sulfate reducing bacteria under anaerobic (oxygen depleted) conditions. Hydrogen sulfide is readily recognized by its "rotten egg" odor and is quite poisonous. Concentrations of hydrogen sulfide may be found upon opening water tanks for cleaning; if this occurs, thoroughly ventilate the tank and use a hydrogen sulfide detection device before entering.

- *Dissolved Solids (TDS).* All natural water contains some dissolved solids. In fact, people become so accustomed to drinking water which contains dissolved solids that pure distilled water tastes flat and unpleasant. Generally, concentrations of dissolved solids are quite high before the water becomes unpleasant. Highly mineralized water also deteriorates distribution and domestic plumbing and appliances.

- *Fluoride (F^-).* A low level of fluoride in drinking water is effective in reducing the incidence of dental caries. However, an excessive concentration (over 3 mg/1) will result in increased mottling of tooth enamel (dental fluorosis) in children. Long term consumption of water containing fluoride concentrations greater than 8 mg/1 can result in bone changes or crippling fluorosis. The optimum fluoride content for a water supply is dependent on the average atmospheric temperature of the area, but it is generally between 0.6 and 1.2 mg/1. Fluoride doses in excess of 2.25 grams may be lethal.

- *Hardness.* Hardness in water is categorized as carbonate (temporary) hardness and noncarbonate (permanent) hardness. Carbonate hardness is caused by the carbonates of calcium and magnesium. The term "temporary" means that the calcium and magnesium carbonates are precipitated from the water when the water is boiled. The precipitate usually forms a soft light-colored scale which can be removed from accessible surfaces. A small amount of carbonate hardness is desirable in domestic fresh water systems to control corrosion. This is particularly true in hot water distribution systems where the service life otherwise would be greatly reduced. With the proper amount of carbonate hardness a fine scale of calcium carbonate is deposited on the pipe surface. This deposit prevents oxygen from reaching the metal surface, thus retarding corrosion. Noncarbonate hardness includes chlorides, sulfates, and possibly nitrates of calcium and magnesium. The evaporation of water containing these salts leaves a highly corrosive residual (calcium chloride, magnesium sulfate, and magnesium chloride) and creates a hard brittle scale (calcium sulfate). The effect most often observed from hardness is the great amount of soap required to form lather in hard water.

- *Iron (Fe).* Iron is objectionable in water supplies because it imparts both taste and color to water. A concentration of 0.3 mg/1 will cause staining of laundry and fixtures. A somewhat higher concentration will cause a bitter taste. The flavor of coffee and tea are affected if brewed with water containing substantial amounts of iron. Iron may enter from the ground as a result of corroding water tanks and pipes, or from hill deposits of iron ore in the water table.

- *Lead (Pb).* Lead is a cumulative poison. It is absorbed from food, water, and the atmosphere. A total weekly intake of more than 3.0 mg is considered unsafe. Lead sometimes enters water supplies as a result of the corrosion of lead components in the system. Paints containing lead can be a source of lead in a water supply. Incorrect disposal of industrial waste is also a source of contamination of water. Physiologic effects of chronic exposure to lead include anemia, cramps, and motor nerve paralysis. Severe encephaolopathy can occur with ingestion of large doses.

- *Manganese (Mn).* The effects of manganese in water are similar to those of iron. However, the taste and stain effects occur at lower concentrations. Manganese may build up in distribution systems; if these coatings slough off, they can cause brown blotches on laundry and black precipitates in the water. The taste of manganese in water is similar to the taste of iron.

- *Mercury (Hg).* Mercury is widely distributed in the environment and is often found in mining, agricultural, and industrial discharges. Mercury is a cumulative poison. Fish is the primary source for mercury in our diet. Symptoms of mercury poisoning include pharyngitis, gastroenteritis, vomiting, bloody diarrhea, and circulatory collapse. Central nervous system toxicity is indicated by severe headaches.

- *Nitrates (NO^{3-}).* The presence of excessive concentrations of nitrates in water is believed to cause methemoglobinemia (nitrate cyanosis). When consumed, nitrate is converted to nitrite in the intestine. The nitrite attacks the hemoglobin in the blood, converting it to methemoglobin, which reduces the oxygen carrying ability of the blood. Wastes from chemical fertillizer plants and chemical fertilizers applied to crops are possible sources of nitrates in drinking water.

- *Phenols.* Phenols are introduced into water mainly from industrial effluents. Phenols are known to be harmful to humans, and are very toxic to fish. Low concentrations of phenols impart an unpleasant taste to water, and may react with chlorine to impart a medicinal taste in chlorinated water.

- *Selenium (Se).* Selenium is highly toxic. It is also believed to cause tumors and may increase the incidence of dental caries. Some soils have a high selenium content. Ground water from these areas may have a selenium content which is dangerously high.

- *Silver (Ag).* Silver occurs naturally in the environment. The major problem associated with silver in drinking water is that skin, eyes and mucous membranes turn a blue-gray color. Once absorbed, silver is held indefinitely in the tissues, particularly the skin. Toxic effects may include kidney, liver, and spleen pathologic changes, especially at high levels (400, 700, and 1000 mcg/1).

- *Sulfates (SO_4^{-2}).* Limitations on the concentration of sulfates in water are set primarily in consideration of their laxative properties. Both sodium sulfate (glauber salt) and magnesium sulfate (epsom salt) are well known laxatives. Calcium sulfate is also a laxative. Generally, the threshold concentration for the laxative effect of sulfates is 500-700 mg/1. The laxative effect of sulfates is commonly noted by tourists or other casual users of water which is high in sulfates; however, regular users evidently become acclimated to the presence of the sulfates.

- *Trihalomethanes (THMs).* Trihalomethanes are very persistent in the environment. THMs may be mutagenic/carcinogenic to man. THMs are formed when free available chlorine combines with decaying organic materials. THMs can only be measured in a laboratory using a gas chromatograph. The MCL is 0.1 mg/l total THMs.

- *Zinc (Zn).* Zinc is essential to the human body and the average adult requires 10-15 mg daily. Zinc concentrations in excess of 30 mg/1 may cause nausea and fainting. Indicators of high concentrations are a metallic taste and a milky appearance in water.

Table 16-1. Drinking Water Quality Standards for Fixed Installations

	NIPDWR	NSDWR
	Bacteriological Standards	
Coliform Based on Analytical Method		
	Physical Standards	
Turbidity	1 unit	
Color	15 units	
Taste and odor		3 units
	Chemical Standards (inorganic)	
Arsenic	0.05 mg/1	
Barium	1.0 mg/1	
Cadmium	0.0 10 mg/1	
Chloride	250 mg/1	
Copper		1.0 mg/1
Corrosiveness		Noncorrosive
Fluoride	1.4-2.4 mg*	
Foaming Agents		0.5 mg/1
Iron		0.3 mg/1
Lead	0.05 mg/1	
Manganese		0.05 mg/1
Mercury	0.002 mg/1	
Nitrate (as N)	10.0 mg/1	
Selenium	0.01 mg/1	
Silver	0.05 mg/1	
Sulfate		250 mg/1
Total Dissolved Solids (TDS)		500 mg/1
Zinc		5 mg/1
	Chemical Standards (organic)	
Endrin	0.0002 mg/1	
Lindane	0.004 mg/1	
Methoxychlor	0.1 mg/1	
Toxaphene	0.005 mg/1	
2,4D	0.1 mg/1	
2,4,5TP Silvex	0.01 mg/1	
Trihalomethanes	0.1 mg/1	

*The maximum concentration level for fluoride is based upon annual average of maximum daily air temperature for the location of the installation. See Table 1, page 67, NIPDWR.

c. Standards for military field water supplies are established on a short-term and long-term basis. The short-term standards apply to emergency water supply for periods not exceeding 7 days. The long-term standards are limits preferable for water to be used continuously in excess of 7 days. Local conditions or short requirements may necessitate use of water containing higher chemical concentrations but only with specific approval of the surgeon. QSTAG 245 and STANAG 2136 set forth minimum standards for potability of drinking water in combat zones as agreed to by the United States, United Kingdom, Canada, and Australia in addition to other NATO nations. Standards for field water supplies are listed in Table 16-2.

Table 16-2. Minimum Potability Standards for Field Water Supply

	Combat Element	
	Short Term[1]	Long Term[1]
	Bacteriological	
Coliform—MPN	1.0 per 100 ml	1.0 per 100 ml
	Physical	
Turbidity	Reasonably clear	5.0
Taste and Odor	Reasonably free	Free
Color		50
	Chemical	
Arsenic (AS)	2.0 mg/1	0.2 mg/1
Cyanides (incl Cyanogen chloride)	20.0 mg/1	2.0 mg/1
Mustard (S&N)[2]	2.0 mg/1	2.0 mg/1
Nerve Agents	0.2 mg/1	not aval
Chloride (Cl)		600.0 mg/1
Magnesium (Mg)		150.0 mg/1
Sulfates (SO_4)		400.0 mg/1
Total Solids		1500.0 mg/1

[1] Under environmental conditions where water consumption substantially exceeds 5 liters per day, the tolerance level should be proportionately reduced.

16-6. Chlorine Residual and pH Requirements

For disease control, disinfection is the most important step in treatment of water because other operations do not assure removal of all the disease-producing organisms. Disinfection is therefore included in all Army water treatment. The disinfectant normally used for water supplies except individual supplies is chlorine, which is available in steel cylinders as liquid chlorine and in solid form as calcium hypochlorite.

a. The effectiveness of chlorine as a bactericidal agent depends upon the amount of chlorine present, the contact period, the temperature, and pH. Obviously, effectiveness is enhanced with an increase in the amount of chlorine present and with an increase in the contact period. Since chlorine, like other chemicals, reacts more rapidly at higher temperatures, its disinfecting ability increases with elevations in temperature; however, chlorine should not be used in hot water because the chlorine is lost too rapidly to be effective as a disinfectant.

b. The effectiveness of chlorine increases as the pH decreases. When chlorine is introduced into water, it forms hypochlorous acid (HOCl) and hypochlorite ion (OCl^-). The proportion of each of these depends upon the pH. As the pH decreases, the hypochlorous acid increases. Since hypochlorous acid is uncharged, it can diffuse more readily through the membranes of microorganisms than can the charged hypochlorite ion. For this reason, chlorine is more effective at a low pH.

c. An understanding of chlorine dosage and demand is essential in defining the meaning of chlorine residual.

- *Chlorine dosage.* Chlorine dosage is the amount of chlorine added to water. Dosage is expressed as a concentration, normally in terms of parts per million (ppm) or milligrams per liter (mg/l).

- *Chlorine demand.* Chlorine in water rapidly oxidizes organic matter including the portions of microorganisms that must be oxidized to inactivate them. In these reactions, chlorine is reduced to chloride and is no longer available as a disinfectant. Inorganic matter such as iron and manganese also consumes chlorine. Chlorine demand is the amount of chlorine participating in these oxidation reactions during a specified contact period.

- *Residual chlorine.* Residual chlorine is the concentration of chlorine remaining after the chlorine demand has been satisfied. Maintenance of a chlorine residual in a water system is important to provide continuing protection against pathogens introduced into the system through such occurrences as cross-connections and line breaks. Residual chlorine can be divided into several types:

- *Free available chlorine.* Free available chlorine refers to hypochlorous acid and hypochlorite ion present in water. These are the most effective forms of chlorine for disinfection.

- *Combined available chlorine.* Chlorine added to water that contains ammonia or organic nitrogen reacts and forms compounds called chloramines. Chlorine combined in this manner is still available for disinfection but is much less effective. This form of chlorine is called combined available chlorine.

- *Total available chlorine.* The total available chlorine is the sum of the free available chlorine and the combined available chlorine.

d. When water is supplied by the Army to the distribution system of a fixed installation, a measurable chlorine residual must be maintained at all times in the parts of the system where water circulation is continuous. A measurable chlorine residual may not be required when the water is stored for long periods in properly protected distribution reservoirs, or when iron, manganese, or other chlorine consuming compounds would make the maintenance of such a residual impractical. If sanitary deficiencies are known or suspected, the concentration of chlorine in the water produced must be the same as required in the field.

e. Field treatment units employing coagulation and filtration are capable of removing a high degree of suspended solids. When these units are employed, sufficient chlorine must be added to provide a free available chlorine residual after 30 minutes of contact time.

f. The minimum residual of 5 mg/l after treatment must be maintained with 1 mg/l free available chlorine at the point of consumption as prescribed by TB MED 576 to prevent transmission of infectious hepatitis. Higher concentrations may be prescribed by the command surgeon on the basis of his knowledge of endemic diseases and local environmental conditions.

Section III. WATER CHEMISTRY

16-7. General

Chemistry is that branch of science which deals with the composition of matter, the changes which matter undergoes, and how the changes take place. Chemistry is used in various functions of preventive medicine, such as in drinking water and wastewater analysis.

16-8. Matter

This is anything that has weight and occupies space. It is found in three states: *solid* such as ice, rock, glass; *liquid* such as water, alcohol, coffee; and *gas* such as air, hydrogen, oxygen. Matter has physical properties such as color, odor, taste, solubility and chemical properties which change and form different substances under given conditions. EXAMPLE, iron rusts under moist conditions.

a. Types of Matter. The three types of matter are elements, compounds, and mixtures.

(1) *Elements.* Elements are the basic constituents of all matter. They cannot be reduced to simpler forms of matter. Common elements and their symbols are listed in Table 16-3.

Table 16-3. Common elements and their symbols

Element	*Symbol*
Aluminum	Al
Calcium	Ca
Carbon	C
Chlorine	C1
Copper	Cu
Fluorine	F
Hydrogen	H
Iodine	I
Iron	Fe
Nitrogen	N
Oxygen	O
Potassium	K
Sodium	Na
Sulfur	S

(2) *Compounds.*

(a) Compounds are composed of two or more elements in chemical combination, meaning they are held together by certain strong electrical forces. They cannot, therefore, be separated from each other by physical means such as sedimentation or filtration. A particular compound is formed by combining specific elements in definite proportions such as a ratio of 2:1.

(b) Formulas for compounds frequently used in preventive medicine are provided in Table 16-4. In these formulas the letter symbols indicate the elements to be combined, and the small numeral(s) indicate(s) the ratio of one element to another. If no numeral is indicated, the numeral "1" is understood.

(1) *Atom.* An atom is the smallest particle of an element that has all of the properties of the element. It consists of the nucleus (core) and orbital paths around the core. The nucleus contains protons (positive-charged particles) and usually neutrons (neutral-charged particles). Electrons (negative-charged particles) revolve around the nucleus in the orbital paths.

(2) *Molecule.* A molecule is the smallest unit of a compound that has all of the properties of the compound. It is, therefore, composed of elements in chemical combination.

(3) *Mixtures.* Mixtures are composed of two or more elements and/or compounds in physical, not chemical, combination. They can be separated into their physical components by physical means such as sedimentation. EXAMPLE, a mixture of sand and water, each a compound, can be separated by sedimentation. Since no chemical combination occurs, regardless of the proportions, no formula can be written. EXAMPLE, a mixture of sand and water combined by any ratio is still sand and water.

b. Structure of Matter. The structure of matter is either atoms or molecules.

Table 16-4. Formulas for compounds frequently used in preventive medicine

Compound	Formula
Alum (Aluminum Sulfate)	$Al_2(SO_4)_3$
Ammonium Chloride	NH_4Cl
Calcium Chloride	$CaCl_2\ (H_2O)$
Calcium Chloride (Anhydrous)	$CaCl_2$
Calcium Hypochlorite	$Ca(OCl)_2$
Carbon Dioxide	CO_2
Carbon Monoxide	CO
Carbon Tetrachloride	CCl_4
Disodium Phosphate	Na_2HPO_4
Ethyl Alcohol (Ethanol)	C_2H_6O
Ferric Chloride	$FeCl_3$
Ferrous Ammonium Sulfate	$Fe(NH_4)_2(SO_4)_2$
Hydrochloric Acid	HCl
Lime (Calcium Oxide)	CaO
Limestone (Calcium Carbonate)	$CaCO_3$
Magnesium Sulfate	$MgSO_4$
Manganous Sulfate	$MnSO_4$
Methyl Alcohol	CH_3OH
Potassium Hydroxide	KOH
Potassium Iodide	KI
Potassium Phosphate	K_2HPO_4
Soda Ash (Sodium Carbonate)	Na_2CO_3
Sodium Azide	NaN_3
Sodium Hydroxide	$NaOH$
Sodium Hypochlorite	$NaOCl$
Sodium Iodide	NaI
Sodium Thiosulfate	$Na_2S_2O_3$
Sulfuric Acid	H_2SO_4
Water	H_2O

c. *Numbers and Weights of Matter.*

(1) *Atomic number.* An atomic number indicates the number of protons in the nucleus of an atom. In any neutral atom, the atomic number is also equal to the number of electrons.

(2) *Atomic weight.* The atomic weight is the sum of the numbers of protons and neutrons in one atom of an element. Since the mass of both the proton and the neutron is approximately one atomic mass unit, the mass of the nucleus is approximately equal to the mass of the protons and neutrons. The mass of the electrons is disregarded because it is relatively so small. A list of elements with their atomic numbers and weights is shown in Table 16-5.

Table 16-5. Elements with their atomic numbers and weights

Name	Symbol	Atomic number	Atomic weight	Name	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	227	Molybdenum	Mo	42	95.95
Aluminum	Al	13	26.98	Neodymium	Nd	60	144.27
Americium	Am	95	243	Neon	Ne	10	20.183
Antimony	Sb	51	121.76	Neptunium	Np	93	237
Argon	A	18	39.944	Nickel	Ni	28	58.71
Arsenic	As	33	74.91	Niobium	Nb	41	92.91
Astatine	At	85	210	Nitrogen	N	7	14.008
Barium	Ba	56	137.36	Nobelium	No	102	253
Berkelium	Bk	97	249	Osmium	Os	76	190.2
Beryllium	Be	4	9.013	Oxygen	O	8	16.000
Bismuth	Bi	83	109.00	Palladium	Pd	46	106.4
Boron	B	5	10.82	Phosphorus	P	15	30.975
Bromine	Br	35	79.916	Platinum	Pt	78	195.09
Cadmium	Cd	48	112.41	Plutonium	Pu	94	242
Calcium	Ca	20	40.08	Polonium	Po	84	210
Californium	Cf	98	251	Potassium	K	19	39.100
Carbon	C	6	12.011	Praseodymium	Pr	59	140.92
Cerium	Ce	58	140.13	Promethium	Pm	61	147
Cesium	Cs	55	132.91	Protactinium	Pa	91	231
Chlorine	Cl	17	35.457	Radium	Ra	88	226.05
Chromium	Cr	24	52.0l	Radon	Rn	86	222
Cobalt	Co	27	58.94	Rhenium	Re	75	186.22
Copper	Cu	29	63.54	Rhodium	Rh	45	102.91
Curium	Cm	96	247	Rubidium	Rb	37	85.48
Dysprosium	Dy	66	162.51	Ruthenium	Ru	44	101.1
Einsteinium	E	99	254	Samarium	Sm	62	150.35
Erbium	Er	68	167.27	Scandium	Sc	21	44.96
Europium	Eu	63	152.0	Selenium	Se	34	78.96
Fermium	Fe	100	253	Silicon	Si	14	28.09
Flourine	F	9	19.00	Silver	Ag	47	107.880
Francium	Fr	87	223	Sodium	Na	11	22.991
Gadolinium	Gd	64	157.26	Strontium	Sr	38	87.63
Gallium	Ga	31	69.72	Sulfur	S	16	32.066
Germanium	Ge	32	72.60	Tantalum	Ta	73	180.95
Gold	Au	79	197.0	Technetium	Tc	43	99
Hafnium	Hf	72	178.50	Tellurium	Te	52	127.61
Helium	He	2	4.00	Terbium	Tb	65	158.93
Holmium	Ho	67	164.94	Thallium	Ti	81	204.39
Hydrogen	H	1	1.008	Thorium	Th	90	232.05
Indium	In	49	114.82	Thulium	Tm	69	168.94
Iodine	I	53	126.91	Tin	Sn	50	118.70
Iridium	Ir	77	192.2	Titanium	Ti	22	47.90
Iron	Fe	26	55.85	Tungsten	W	74	183.86
Krypton	Kr	36	83.80	Uranium	U	92	238.07
Lanthanum	La	57	138.92	Vanadium	V	23	50.95
Lead	Pb	82	207.21	Xenon	Xe	54	131.30
Lithium	Li	3	6.940	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.99	Yttrium	Y	39	88.92
Magnesium	Mg	12	24.32	Zinc	Zn	30	65.38
Manganese	Mn	25	54.94	Zirconium	Zr	40	91.22
Mendelevium	Mv	101	256				
Mercury	Hg	80	200.61				

(3) *Molecular weight.* The molecular weight is the sum of atomic weights of the elements in a molecule. Molecular weight of compounds is computed as illustrated in the following examples:

Molecular weight of the compound hydrochloric acid (HCl):

1 (atomic weight of H) + 35.5 (atomic weight of Cl) = 36.5 (molecular weight of HCl)

Molecular weight of the compound sodium thiosulfate ($Na_2S_2O_3$):

23 (atomic weight of Na) x 2 (number of atoms)	=	46
32 (atomic weight of S) x 2 (number of atoms)	=	64
16 (atomic weight of 0) x 3 (number of atoms)	=	48
Molecular weight of $Na_2S_2O_3$	=	158

16-9. Ionization

This is a process in which some compounds, when put into solution, dissociate into charged particles called ions.

a. Ions. Positive-charged ions are called cations (Table 16-6). The negative-charged ions are called anions (Table 16-6).

EXAMPLES:

Hydrochloric acid (HCl) put into solution dissociates into cations (H^+) and anions (Cl^-).

Sodium hydroxide (NaOH) put into solution dissociates into cations (Na^+) and anions (OH^-).

Table 16-6. Common ions used in preventive medicine

Anions		Cations		Radicals	
Name	Symbol	Name	Symbol	Name	Symbol
Chloride	$C1^{-1}$	Calcium	Ca^{+2}	Bicarbonate	HCO_3^{-1}
Fluoride	F^{-1}	Copper	Cu^{+2}	Carbonate	CO_3^{-2}
Iodide	I^{-1}	Hydrogen	H^{+1}	Hypochlorite	$OC1^{-1}$
Oxide	O^{-2}	Magnesium	Mg^{+2}	Hydroxyl	OH^{-1}
Sulfide	S^{-2}	Zinc	Zn^{+2}	Sulfate	SO_4^{-2}

b. Acids and Bases. Any compound which has free hydrogen cations (H^+) is an acid, such as hydrochloric acid (HCl). Any compound which has free hydroxyl anions (OH^-) is a base, such as sodium hydroxide (NaOH). An acid compound and a base compound form a salt. Although salt ionizes when put into solution, it produces neither hydrogen nor hydroxide ions; but some salts produces radicals (*c* below).

c. *Radicals.* A radical is two or more ions acting as one unit or one ion (Table 16-6). Generally, a radical is two or more anions. For example, hydroxyl anions (OH^-) and carbonate anions ($CO_3=$) are radicals. Water for human consumption is ordinarily tested for an anion (chloride ion—Cl^-), a cation (iron ion—Fe^{+3}), and a radical (sulfate group—$SO_4=$).

16-10. pH

This is a symbol for the logarithm of the reciprocal of the molar concentration of the hydrogen ion ($pH = \frac{\log 1}{H+}$). It is a measure of the acidity or alkalinity of a solution. Table 16-7 shows common items on the pH scale.

Table 16-7. pH ranges of common items

	pH	solution
	*0	1 molar HCl
	1	acid stomach
	2	gastric juice lemon juice
increasingly acid	3	vinegar, wine, soft drinks
	4	tomatoes, grapes rainwater from SO_2 polluted air
	5	black coffee
	6	normal rainwater urine (5 to 7) saliva (6.2 to 7.4)
neutral solution	7	pure water blood
	8	seawater
	9	baking soda phosphate detergents
increasingly basic	10	soap solutions milk of magnesia
	11	nonphosphate detergents
	12	
	13	
	*14	1 molar NaOH

*pH values of 0 and 14 are theoretical. They can only be approached asymptotically.

a. A neutral solution has a pH of 7.

b. An acid solution has a pH of less than 7.

c. An alkali solution has a pH of more than 7. Hydroxyl anions (OH^-) of a base compound (paragraph 16-9) are only a part of alkalinity, as alkalinity may be due to many things, such as carbonates ($CO_3^{=}$) in an aqueous solution.

16-11. Solutions.

a. Solute and Solvent. A true solution is composed of a solute and a solvent. The solute is what is dissolved, and the solvent is what dissolves the solute. For instance, sugar (the solute) is dissolved in coffee (the solvent).

b. Emulsion. A liquid mixture of two or more liquids not normally dissolved in one another, but held in suspension one in the other by forceful agitation or by emulsifiers.

c. Suspension. A solution in which the solid solute does not dissolve in the solvent but becomes suspended. The solute, therefore, will settle to the bottom after a period of time.

d. Colloidal Solution. A solution in which the solute neither dissolves nor settles to the bottom.

e. Terms Used to Describe Solutions.

(1) *Diluted*—A small amount of solute in a great amount of solvent.

(2) *Concentrated*—A great amount of solute in a small amount of solvent.

(3) *Saturated*—As much solute dissolved in the solvent as possible without precipitation.

(4) *Supersaturated*—More solute than solvent can normally hold. This is accomplished by varying the temperature, agitating, and/or increasing the surface area, such as using powder rather than chunks or blocks of chemicals.

(5) *Percent by weight (Solid in a Liquid).*

$$\text{Percent} = \frac{\text{weight of solute x 100}}{\text{weight of solute and solvent.}}$$

(6) *Percent by volume (Liquid in a Liquid).*

$$\text{Percent} = \frac{\text{volume of solute x 100}}{\text{volume of solute and solvent.}}$$

(7) *Molar*—Designates a solution with its amount of solute expressed in moles (molecular weight stated in grams) per liter of solution.

EXAMPLE: Eighteen grams of HCl (hydrochloric acid) combined with enough water to make one liter is an approximate 0.5 molar solution. Eighteen grams is about 0.5 of one mole (36.5 grams).

(8) *Normal*—Designates a solution with its amount of solute expressed in gram equivalent weights per liter. A gram equivalent weight is equal to the gram molecular weight divided by the number of effective hydrogens or hydroxyl ions. Generally, only acid and base normalities are used in preventive medicine.

EXAMPLES:

(a) A one normal solution of HCl is equal to 36.5 grams (gram molecular weight) divided by the number of effective hydrogens (1) and combined with enough water to make 1 liter of solution.

(b) A one normal solution of sulfuric acid (H_2SO_4) is equal to 1 gram molecular weight (98 grams) divided by the number of effective hydrogens (2) or 49 grams of sulfuric acid in enough water to make 1 liter of solution.

Section IV. FIXED INSTALLATION WATER SUPPLY

16-12. Sources of Water for Fixed Installations

Water supplies for fixed installations are usually obtained from underground sources such as wells and springs, or surface sources such as rivers, lakes, and streams.

a. Wells that are properly located, constructed, and operated are expected to produce safe water with less treatment than is required for surface sources, because natural filtration increases the quality of the water as it percolates through the soil. Wells should be located at a sufficient distance from sewers, septic tanks, latrines, and polluted bodies of water to prevent cross-contamination. This distance depends upon local conditions such as direction of movement of underground water, tightness of soil, and rate of pumping. Provision should be made to seal the wells to protect them from surface drainage and flooding.

b. The same principles that apply to the location, construction, and operation of wells apply to springs, which occur when ground water rises to the surface of the earth. In general, the spring should be protected at the surface by a concrete or other watertight box, extending into the ground sufficiently to prevent surface contamination. Cutoff walls should extend deep enough to make surface water flow 10 feet to mix with spring water. The outlet pipe should be sealed into the wall of the box to prevent leakage. The earth surfaces in the vicinity should be graded to divert surface water from the spring. Some spring water must receive treatment in addition to simple chlorination.

c. Most surface sources (rivers, lakes, and streams) are contaminated and must be treated. Laboratory facilities must be available for control of the treatment processes. Surface water supplies should be drawn from the cleanest possible source that will provide an adequate quantity.

16-13. Treatment Methods

The development of surface or ground water of questionable bacteriological quality into safe, palatable water for garrison purposes requires the application of one or more of four basic processes: coagulation, sedimentation, filtration, and disinfection.

a. Coagulation and Sedimentation.

(1) Through coagulation and sedimentation, particles that could rapidly clog filters are removed. Chemical coagulation involves the formation of a heavy gelatinous mass (floc) which settles rapidly. As the floc settles, it forms larger and larger masses and collects the suspended particles. The most common coagulants in use today are aluminum sulfate (alum), ferric chloride, and ferrous sulfate. After the coagulant is added to the water, mixing is necessary to distribute the chemical throughout the water and to aid in floc formation. Mixing can be accomplished in baffled basins or by mechanical agitation. Flocculation can be accomplished by slow-moving paddle wheels, operating in a tank having a detention period of 20 to 40 minutes. After these processes are completed, the water is received in sedimentation basins, where the floc rapidly settles out.

(2) The basic processes of chemical mixing, coagulation, and sedimentation can be accomplished in a single tank—the upflow clarifier (Figure 16-1). Decreased chemical consumption results when the entering raw water makes intimate contact with previously formed sludge. This process provides treatment in a smaller space and in a shorter time.

b. Filtration. The production of clear, potable water usually requires filtration. A *rapid sand filter*, the type commonly used, consists of a bed of sand or other media about 30 to 36 inches thick. The sand removes some bacteria, finely divided clay, and suspended matter not removed by coagulation and sedimentation. The bed is supported on either a layer of gravel about 12 inches thick or some type of porous plate. During filtration, the water flows through the sand bed into a clear well for storage. Filtration continues until the resistance to flow by material removed by the filter becomes excessive. Flow through the filter is then reversed to clean the sand particles. This process is called *backwashing*.

c. Disinfection. Disinfection of water may be accomplished in a number of ways, but the cheapest, most effective, and most widely used method is chlorination. Water that has been treated efficiently by the process of coagulation, sedimentation, and filtration will facilitate effective chlorination. Destruction of pathogens remaining after other treatment processes, as well as those from possible later contamination, is essential. For this reason, chlorine is applied to the filter effluent (post-chlorination). Sometimes chlorine is applied to raw water (prechlorination) before filtration to improve coagulation and control undesirable growths of algae and related organisms that increase the filter loading.

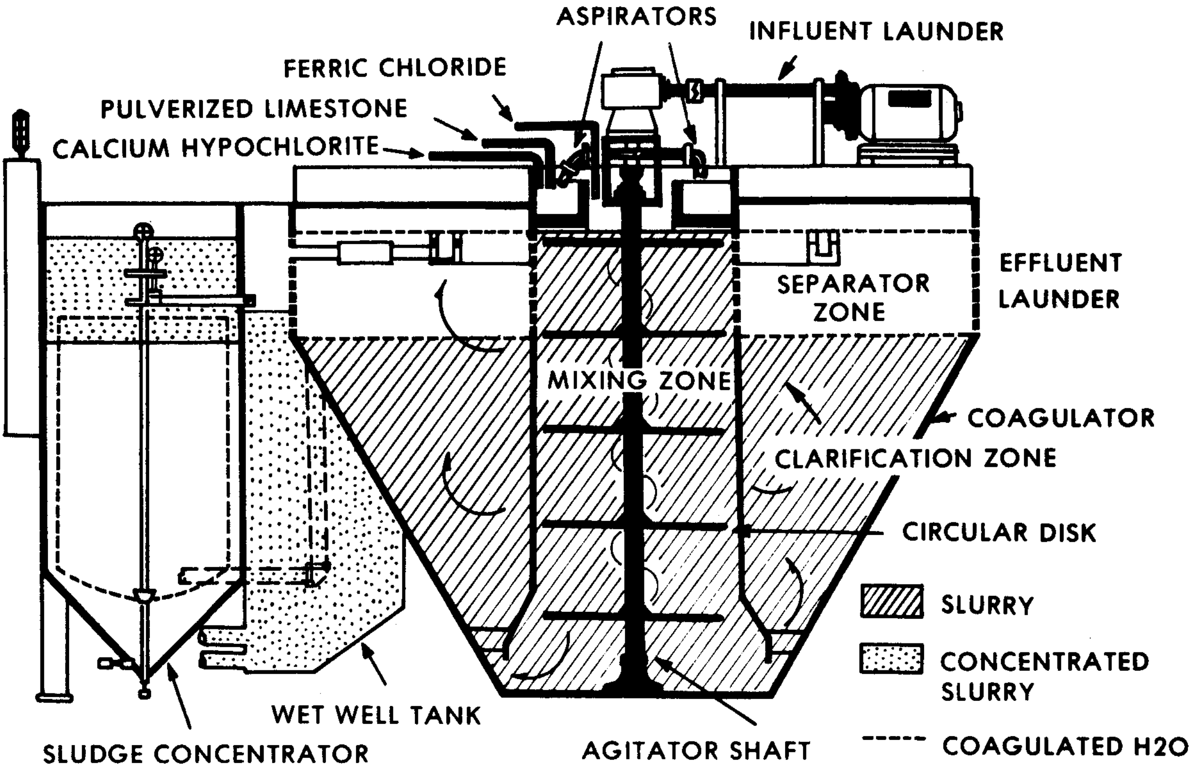


Figure 16-1. Cross section of the upflow clarifier.

16-14. Distribution Methods

Water is distributed to consumers at fixed installations in several ways, depending upon local conditions. The distribution methods are by gravity, by use of pumps with some storage, or by use of pumps without storage.

a. Gravity Distribution. Gravity distribution is possible when the source of supply is at a sufficient elevation above the installation to maintain an adequate pressure in the mains for garrison purposes, including fire service. If the conduit from the source to the installation is adequate in size and is safeguarded against accidental breaks, this method is the most reliable and economical.

b. Pumps with Some Storage. Pumps are operated at their rated capacity. During low water use, the excess water is stored. During high water use, this stored water is used to supplement that which is pumped. This method is reliable and economical, since it ensures an adequate supply of water at all times and uses the pumps at their rated capacity.

c. Pumps Without Storage. In the use of pumps without storage, pumping operations are varied to meet demand. This is the least desirable system, as a power failure would completely interrupt the water supply.

Furthermore, several standby pumps are usually required to minimize pressure fluctuations in the water mains during periods of high consumption.

16-15. Cross-Connections in Water Systems

a. Health officials, both civilian and military, have been concerned for a long time about cross-connections between safe water systems and raw or unsafe water systems. Such connections have been the greatest single cause of waterborne epidemics in the United States. On a worldwide basis, the single most important source of waterborne disease is open shallow wells, but cross-connections in established systems undoubtedly account for the second most important source of waterborne intestinal disease.

b. Cross-connections may be defined as a connection or arrangement of piping or outlets through which a backflow can occur, resulting in contamination of potable water. It may be a connection between a supervised potable water supply and an unsupervised supply of unknown quality.

(1) A *direct* cross-connection is a continuous enclosed interconnection of potable and nonpotable water systems. Whenever the water pressure in the potable system is less than the pressure in the nonpotable system, backflow of nonpotable water into the potable supply occurs. Backflow as a result of pressure loss in the potable system is called backsiphonage. Backpressure, which is an increase of the water pressure in the nonpotable system, can also result in backflow. Examples are completely submerged outlets from potable water supply lines to closed plumbing fixtures, tanks, vats, and interconnections of dual water-distribution systems.

(2) An *indirect* cross-connection, frequently referred to as a potential cross-connection, is one in which the interconnection is not continuously enclosed. Backflow is always due to backsiphonage with an indirect cross-connection. The interconnection is usually a gap or space across which nonpotable water may fall or be sucked, blown, dropped, forced, or otherwise made to enter a potable supply. Examples include faucet openings terminating below the spill level of bathtubs and sinks.

(3) To prevent cross-connections, the following procedures or devices should be used—

- Provide an air gap. The air gap must be at least two times the inside diameter of the potable water piping, but must not be less than one inch and need not be more than 12 inches. This procedure provides protection against both backsiphonage and backpressure conditions.

- Vacuum breakers. Pressure and atmospheric vacuum breakers are primarily end-of-service line solutions to a cross-connection. They should not be used in water service connections. They are placed at the end of a potable water line, and at fixtures or equipment that discharge to atmospheric pressure. These do not protect against backpressure, only against backsiphonage. There must be no valve downline from an atmospheric-type vacuum breaker.

- Reduced pressure principle (RPP) devices. These devices protect against both backpressure and backsiphonage.

- Double check valve assemblies. These devices work in a backpressure or backsiphonage mode. These devices neither discharge water, nor do they provide a visual sign of backflow or unit malfunction. Therefore, they do not offer the degree of protection provided by the RPP devices.

- Devices or air gaps must be installed in accessible locations with ample clearance to aid inspection and maintenance. Devices should be protected from freezing.

Section V. FIELD WATER SUPPLY

16-16. General

The primary objective in supplying water in the field is to provide potable water for drinking and culinary purposes regardless of the area or tactical situation and, when possible, to provide the same quality of water for bathing purposes. When conditions permit, it is desirable to remove color, turbidity, odor, and taste. The field situation is very different from fixed installations where water is usually treated at a central source and distributed under pressure throughout the installation. In the field, water is treated by means of Quartermaster-operated portable equipment. Tank trucks, water trailers, collapsible fabric drums, and 5-gallon water cans are used to transport the treated water to the using units. In semifixed installations, such as hospitals or depots, distribution pipes may be used. The water purification bag (Lyster bag) is widely used as a storage container; calcium hypochlorite is used as the disinfectant. In an emergency, the individual may treat his drinking water with iodine tablets. When other treatment methods are not available, water should be brought to a vigorous boil. In areas where infectious hepatitis is prevalent, water should be boiled for at least 1 minute to destroy pathogenic organisms.

16-17. Estimated Daily Water Requirements

Before final selection of a field water source, water requirements must be estimated. The quantity of water required by soldiers varies, depending upon climatic conditions, type of activity, acclimatization of personnel, and tactical situation. The daily water requirements per soldier are listed in Table 16-8.

Table 16-8. Daily Water Requirements Per Soldier

Conditions of Use	Gal per unit Consumer per day: Temperate/cold climate	Desert/jungle	Remarks
In combat:			
Minimum	1/2-1	[a]2-3	For eating and drinking only, periods not to exceed 3 days.
Normal	3	[b]6	When field rations are used. Drinking plus small amount for cooking or personal hygiene.
March or bivouac	2	[b]5	Minimum for all purposes.
Temporary camp	5	....	Desirable for all purposes (does not include bathing).
Temporary camp with bathing facilities	15	....	Includes allowance for water-borne sewage system.
Semipermanent camp	20-30	....	
Permanent camp	20-30	....	

[a]For unacclimatized personnel or for all personnel when dry bulb readings exceed 105°F in the jungle.
[b]Maximum consumption factor is dependent upon work performed, solar radiation, and other environmental stresses.

16-18. Selection of a Field Water Point

a. General Guidelines.

(1) From the standpoint of quality, the best water available should always be used.

(2) If local water systems are adequate to supply both civilian and military needs, they may be used. However, additional chlorination may be required..

(3) When ground water is available in sufficient quantity, it is generally preferred; however, the amount available is usually impossible to determine quickly. This will frequently preclude the use of ground water as a source of supply at Quartermaster water points.

(4) Ordinarily, surface water is used as the source of water in the field. It can usually be treated easily by a field unit with equipment listed in the applicable TOE.

b. Water Reconnaissance or Survey. Regardless of whether surface sources are still bodies of water such as lakes and ponds, or moving water such as rivers, streams and springs, they should be investigated for pollution. Surface sources receive the runoff from the drainage areas in which they lie. Major sources of pollution, such as municipal or private sewage and other waste, can be identified by such means as area reconnaissance, map references, and information from local inhabitants. Field water points must be located as far from sources of pollution as practicable. Other information must be obtained and considered before establishing a field water point.

(1) *Quantity of water.* The quantity must be sufficient to meet the water requirements.

(2) *Quality of water.* Water should be of such quality that it can be readily treated with normal field equipment. If test kits are available, pH, chlorine demand, and presence or absence of chemical warfare agents should be determined.

(3) *Accessibility.* A satisfactory water point must be accessible to vehicles and personnel. Especially desirable features are a good road net with turnarounds, cover and concealment of the water point, and a suitable parking area. The road should be adequate to withstand vehicle traffic under all weather conditions. Drainage, security of the area, and a suitable area for bivouac of personnel should also be considered.

16-19. Treatment of Field Water Supply

a. Water Purification Equipment. The water purification equipment currently available for use by Army troops is of two types: Erdlator and reverse osmosis water purification unit (ROWPU).

(1) *Conventional water treatment.* Conventional water treatment in the field is accomplished by the Erdlator, which was named for its developer, the Engineering Research and Development Laboratory at Fort Belvoir, Virginia. Individual units include the 1500 gph and 3000 gph van-type body-mounted units and the 3000 gph base-mounted unit. These units use coagulation, sedimentation, diatomaceous earth filtration, and disinfection to treat water. An Erdlator may only be used to treat fresh water. Erdlators are discussed in greater detail in FM 10-52.

(2) *Reverse osmosis.* Another item of equipment used to purify water in the field is the ROWPU. Individual units include the 600 gph trailer-mounted unit, the 3,000 gph container-mounted unit, the 150,000 gpd (gallons per day) skid-mounted unit, and the 300,000 gph barge-mounted unit. These units use coagulation, multi-media filtration, cartridge filtration, reverse osmosis, and disinfection to treat water. The ROWPU can treat fresh, brackish, or salt water. The ROWPU is discussed in greater detail in FM 10-52.

b. Disinfecting Agent. Calcium hypochlorite [$Ca(OCl)_2$], which contains 70 percent available chlorine, is the chemical agent used in disinfecting water. It is supplied in glass ampules (one-half gram of chemical sealed in a glass tube) and in bulk containers up to 50 pounds. The quantity of calcium hypochlorite required to disinfect a given quantity of water may be calculated by applying the following formula:

$$\text{Lb of } Cl_2 = \frac{\text{Gal of } H_2O \times 8.34 \times \text{dosage (mg/l)}}{1{,}000{,}000 \times .70}$$

$$= \frac{\text{Gal of } H_2O \times \text{dosage (mg/l)}}{84{,}000}$$

(1) Lb of Cl_2 = pounds of chlorine.

(2) 8.34 = the weight in pounds of 1 gallon of water.

(3) 1,000,000 = a constant.

(4) .70 = ratio of available chlorine in calcium hypochlorite.

16-20. Water Distribution

Normally water is distributed from the water point or other approved sources to the using units by means of tank trucks, water trailers, collapsible fabric drums, or water cans.

a. Water Tank Trucks. The M50 series water tank trucks are equipped with a 1000 gallon water tank body. A manifold and piping system connects the 600 and 400 gallon tank sections to the delivery pump and two delivery lines. Water can be delivered under pressure by the pump or by gravity. The pump can also be used to fill the tanks from a water source, although the tanks are normally filled through manholes.

b. Water Trailers. There are several types of water trailers in the Army, all of which have a capacity of 400 gallons. The M107 series has an aluminum tank while the M149 and M625 water trailers have fiberglass tanks. The M149A1 can have a fiberglass or insulated stainless steel tank while the M149A2 designates an old trailer with a new stainless steel tank. All of these water trailers are pulled to the field behind a 2 1/2 ton or larger truck, and will usually meet the daily water demands of a company-size unit.

c. Collapsible Fabric Drums. These drums are made of rubber-impregnated nylon fabric with dispensing valves on one or both sides. There are three sizes of fabric drums: 55, 250, and 500 gallons. The 55 gallon drum is issued on the basis of three per company-size unit or one per 20 patients in an Army Medical Department treatment unit. The 250 gallon drum is issued on the basis of two per company or one per 100 patients in a treatment facility. The 500 gallon drum is part of the Forward Area Water Point Supply System (FAWPSS) which has six drums, a water pump assembly, and several hoses.

d. Emergency Water Containers. Under certain circumstances a sufficient number of potable water containers may not be available and a commander may be forced to use containers which are not approved for use with potable water. Such containers include military nonpotable water containers in engineer units, civilian liquid food product containers, and lastly, fuel containers, which can be used only in combat-related emergencies. Approval to use any of these types of containers for potable water must be requested from the operations commander who will consult with the command surgeon. Procedures for cleaning these containers are presented in TB MED 577.

16-21. Water Treatment for Individuals and Small Groups

Procedures for use of the following items in the treatment of water for individuals and small groups are outlined in FM 21-10.

a. Canteen and water purification tablet (iodine).

b. Canteens and calcium hypochlorite ampule.

c. Water purification bag (Lyster bag) and calcium hypochlorite ampule. (Calcium hypochlorite ampules are components of a kit which also contains three plastic tubes and three vials of chlorine test tablets for use in determining the chlorine residual.)

16-22. Water Point Inspection

Routine inspections of water points are necessary to ensure the sanitary condition of the equipment and the potability of the water. A guide is provided in Appendix D for use by the preventive medicine specialist in making the inspections.

Section VI. SANITARY CONTROLS FOR WATER SUPPLY

16-23. General

a. There are many factors that affect the quality and safety of water for human use. The first and usually the most important of these factors from a medical standpoint is the presence of living organisms in the forms of bacteria, protozoa, helminths, plankton, viruses, algae, and by-products of these organisms. The pathogenic organisms are of primary concern to the Army Medical Department. The nonpathogenic ones have some medical significance because their presence indicates both inadequate disinfection and additional chlorine demand. Even dead organic matter in water is of some medical significance for the same reason. Chemical contaminants of either an organic or inorganic nature, such as dissolved minerals, toxins, and industrial wastes, greatly affect the sanitary quality of water for human use and may be of far greater health significance than pathogenic organisms. Permissible amounts of various biological and chemical contaminants in water are listed in Tables 16-1 and 16-2.

b. The preventive medicine specialist is directly involved in collecting and testing water samples for bacteriological and chemical analysis and interpreting the findings.

16-24. Bacteriological Analysis of Water

a. Collection of Water Samples.

(1) Samples of water for bacteriological analyses must be collected in sterile bottles. Screwcap bottles of about 120-milliliter capacity are preferred, but glass-stoppered bottles or commercially-provided closable plastic containers are acceptable. These bottles must have been cleaned; capped with a protective hood of kraft paper or foil; and sterilized in an autoclave. Before the bottles are sterilized, 0.1 ml of 10 percent *sodium thiosulfate* solution must be placed in each bottle to neutralize any chlorine residual which may be in the water at the time of collection. Such neutralization prevents the chlorine from killing any living organisms in the water

samples after collection. If necessary, the laboratory provides standard cardboard and metal mailing tubes in which the bottled samples can be sent through the mail.

(2) The minimum number of water samples to be collected and tested are listed in Table 16-9. For populations larger than 50,000 increase the sample size in proportion to increased population.

Table 16-9. Minimum water samples for selected populations.

Population served	Minimum number of samples per month	Population served	Minimum number of samples per month
25 to 1,000	8	16,301 to 17,200	19
1,000 to 2,500	8	17,201 to 18,100	20
2,501 to 3,300	8	18,101 to 18,900	21
3,301 to 4,100	8	18,901 to 19,800	22
4,101 to 4,900	8	19,801 to 20,700	23
4,901 to 5,800	8	20,701 to 21,500	24
5,801 to 6,700	8	21,501 to 22,300	25
6,701 to 7,600	8	22,301 to 23,200	26
7,601 to 8,500	9	23,201 to 24,000	27
8,501 to 9,400	10	24,001 to 24,900	28
9,401 to 10,300	11	24,901 to 25,000	29
10,301 to 11,100	12	25,001 to 28,000	30
11,101 to 12,000	13	28,001 to 33,000	35
12,001 to 12,900	14	33,001 to 37,000	40
12,901 to 13,700	15	37,001 to 41,000	45
13,701 to 14,600	16	41,000 to 46,000	50
14,601 to 15,500	17	46,001 to 50,000	55
15,501 to 16,300	18		

(3) Samples from the potable water system are taken at points that are representative of the water flowing in the system. These locations on most posts are kitchens, dining halls, barracks, administrative areas, hospitals, clubs, snackbars, family quarters, and other locations where water is consumed. Occasionally, special samples for reasons determined to be important by the surgeon may be collected from raw water sources and from water in various stages of the treatment process, at dead ends, or at infrequently used points of the distribution system.

(4) Normally, samples are taken from frequently used cold water faucets. There is nothing to be gained from sampling hot water faucets. It is awkward to obtain water samples from fire hydrants and drinking fountains.

(5) One-fourth of the total number of samples required per month are collected each week during the month. If the weekly samples are collected from one of four quadrants of the post, the entire post distribution system will be sampled by the end of the month. The day of the week scheduled for collecting samples should be based upon the day of the week that the laboratory prefers to receive the samples for analyses.

b. Procedure for Collecting a Water Sample.

(1) Open the tap and let the water flow long enough to pull in water from the water main. A flow for 2 to 5 minutes should be sufficient.

NOTE

Samples shall not be collected from faucets with aerators, swivels, or add on devices unless these devices are removed prior to running water in this step.

(2) While waiting for the water to run before collecting the sample, determine the chlorine residual and pH and record this number on the DD Form 686 (Bacteriological Examination of Water). Number the sample bottle with a grease pencil and enter this number on the DD Form 686. The number of copies required of this form varies from one installation to another. The original and at least one copy must be submitted with the water sample. The original is returned to report the laboratory findings. The laboratory will advise as to the exact number of copies needed. Other copies may be routinely required by the surgeon, the facility (post) engineer, and other interested activities.

(3) Adjust the tap to produce a gentle, easy, smooth flow of water, thus preventing splashes and contaminated water from getting into the sample bottle.

(4) Remove the hood and screwcap from the sample bottle and hold them together to prevent the cap from becoming contaminated; then place the sample bottle under the flowing tap, filling it to the base of the neck. Do not overfill the bottle. DO NOT rinse the sample bottle before collecting the sample.

(5) With the cap and hood still together, replace them on the sample bottle.

(6) Close the water tap and record information pertaining to the sample on DD Form 686.

(7) Complete DD Form 686 carefully, leaving blank those blocks to be completed in the laboratory. Each block on the form serves an essential purpose. For example, it is important to identify the collection point and the specific tap from which the sample was obtained, as the water from this tap must be checked further if it is found to contain coliform group organisms (TB MED 576). Special requirements are entered in the "Remarks" Block.

(8) Samples should be analyzed within 1 hour of collection. When samples are sent to the laboratory by courier, the elapsed time between collection and examination should not exceed 6 hours. (The exception to this 6-hour rule is for samples mailed from distant installations; these samples may be held for up to 30 hours.) Samples should be refrigerated at 40°F during shipment. The time and temperature of storage for all samples should be recorded and should be considered in interpreting the analysis data.

c. Tests for Determining the Presence of Coliform Group. Since identifying or measuring specific pathogenic organisms in water is relatively difficult, a procedure for identifying indicator organisms is used. The indicator currently in use is the coliform group of organisms (paragraph 16-4*b*).

(1) *Membrane filter technique.* Generally, the membrane filter technique for bacteriological analysis of water is used in preference to the multiple-tube fermentation technique, since it has a higher degree of accuracy. It permits the examination of a larger volume of samples with increased sensitivity in coliform detection. Furthermore, the results are obtained in a shorter period of time. The procedure and the kit required in the laboratory for analyzing water by this technique are discussed and illustrated in Appendix B.

(2) *Multiple-tube fermentation technique.* This technique is used in making a complete conventional bacteriological analysis of water. It requires three successive tests: the presumptive test, the confirmed test, and the completed test. These three tests are designed to determine the presence or absence of the coliform group by successively confirming or ruling out their presence.

d. Interpretation of Test Results. Interpreting the results of bacteriological analysis is the responsibility of the preventive medicine specialist who submitted the water sample, not that of the person who performed the laboratory analysis. Carefully applying the appropriate requirements (paragraph 16-4*d*(1)), the preventive medicine specialist determines whether or not a water supply is bacteriologically safe.

16-25. Chemical Analysis of Water

a. Collection of Water Samples for Chemical Analysis.

(1) Frequently, the preventive medicine specialist is directed to collect water samples for chemical analysis. Since care must be taken to obtain a sample which is representative of the water to be analyzed, the preventive medicine specialist must request guidance regarding the exact procedure to be used from the person who directs him to collect the sample. He must also meet special requirements specified by the laboratory which is to make the analysis. These requirements include the amount of water to be collected, type of collection bottles to be used, and cleanliness standard for the collection bottles. Generally, a 16-liter to 1-gallon glass bottle which is chemically clean is satisfactory. It should be rinsed out two or three times with the water to be tested before collecting the sample.

(2) Each sample of water submitted for chemical analysis must be properly identified. It must be accompanied by DD Form 710 prepared in an original and at least one copy.

b. Interpretation of Laboratory Findings. The laboratory that performs the analysis enters the findings on DD Form 710 and returns the original to the person who made the request. The surgeon, preventive medicine officer, sanitary engineer, or environmental science officer who requested the chemical analysis is responsible for interpreting the findings. For information regarding fluoride analysis, refer to TB MED 271.

16-26. Chlorine Residual and pH Determinations

a. The chlorine residual test is used to determine if a water supply has been properly disinfected. The DPD procedure is used in determining free available chlorine residuals. The test procedure is provided in Appendix E.

b. The pH determination is made in conjunction with the chlorine residual determination. The pH test procedure is provided in Appendix F.

Section VII. SPECIAL PROBLEMS PERTAINING TO WATER SUPPLY

16-27. Ice Sanitation

a. Ice made from contaminated water or which is contaminated because of improper handling can transmit waterborne disease-producing organisms. Ingestion of these organisms by personnel can occur either from direct consumption of the ice or food or beverages in direct contact with the contaminated ice. Since disease producing organisms can penetrate the ice surface, simple washing of the ice exterior is insufficient to remove them. Waterborne diseases that are transmitted via ice can best be avoided by procuring ice only from facilities which are approved by the Army Medical Department and by sanitary handling and storage procedures.

b. There are several minimum requirements recommended for the manufacture, storage, and transport of ice which is intended for use or consumption by personnel under Army jurisdiction.

(1) Potable water must be used during ice production. This includes both the water which is to be made into ice and the water which is used for washing equipment.

(2) The floors, walls, ceilings, equipment, and utensils must be smooth, clean, and in good repair. This will prevent debris from accumulating and ultimately contaminating the ice.

(3) Containers must be made from nontoxic materials, disinfected prior to use, and handled so as to avoid contamination of the ice.

(4) Other sources of contamination that must be avoided are cross connections, unsanitary personnel, and inadequate ventilation systems.

c. Army Regulation 40-5 and MIL STD 906 list specific areas of concern in ice sanitation.

16-28. Bacteriological Analysis

a. Collection of Ice Samples.

(1) Samples of ice for bacteriological analysis must be collected in sterile containers. Screwcap wide mouth jars or specimen containers of

sufficient size to hold 100 ml samples may be used. The containers' screwcaps must be covered with kraft paper or foil.

(2) The ice collected for analysis must be representative of the source. Chip away the outer layer or portion of the ice block. Collect a portion of the internal part of the ice block, but not the core. Any portion of cubed or crushed ice is considered representative of the source.

(3) Use a sterile ice pick to chip the ice block and let the ice chips fall into the collection container without touching the lip of the container or the ice. Replace the cap and hood. Ice cubes or crushed ice may be collected from the production unit's storage bin or from bagged ice in storage using sterile tongs, an ice scoop, or other suitable collecting devices.

(4) Prepare the bottle and DD Form 686 for each sample collected and provide information as done for water samples.

b. Preparing the Sample for Analysis. Allow the sample to melt at room temperature or in a refrigerator. DO NOT heat the sample to speed up the melting process. Heat may destroy any bacteria present or cause the bacteria to grow rapidly, in either case causing false results.

c. Tests for Determining the Presence of Coliform Group. The tests are performed in the same way as for water samples (see paragraph 16-24*c* above).

d. Interpretation of Test Results. Interpretation of test results are the same as for water samples (see paragraph 16-24*d* above).

Section VIII. WATER SUPPLY IN NUCLEAR, BIOLOGICAL, OR CHEMICAL CONDITIONS

16-29. Nuclear, Biological, or Chemical (NBC) Contamination

a. General. If chemical or biological agents or nuclear weapons are used, the area's water supply will probably be contaminated. Such contamination can injure or kill. Effective detection of NBC contaminants, followed by proper decontamination, can reduce or eliminate the hazards caused by these agents. FM 3-4 has details on protection from NBC contaminants.

b. Chemical Agents. Chemical agents include nerve agents in the G- and V-series, blister agents, blood agents, and choking agents. The nerve agents, blister agents, and agents containing cyanide are the most dangerous. They are highly poisonous. Some are soluble in water. They either decompose slowly or remain poisonous after decomposition. Though water supplies may be sabotaged with chemical agents, they will more likely become contaminated as an incidental result of widespread chemical attack. Chemical agents may be spread as aerosols by generators, explosives, missiles, and aircraft spray. The method used will affect the following:

- The size of the area covered.

- The length of time contamination lasts.
- The number of soldiers affected.
- The effectiveness of protective measures.

c. Biological Agents. In many ways, biological agents resemble natural biological organisms which are removed by the usual water treatment processes. However, biological agents may involve unusual microorganisms not normally found in field water. Or there may be abnormally high numbers of organisms. Also included with biological agents are toxins. These are poisons formed as waste products by microorganisms. Biological agents may be spread by the same means as those listed above for chemical agents. They may also be spread by insects. TM 3-216 covers biological agents and means of dissemination.

d. Radiological Contamination. Although nuclear weapons have been used in war, there are no reliable data on their effect on field water supplies. However, available fallout data show such contamination must be considered. A nuclear attack over or near a water source will probably contaminate it. The ways water can be contaminated, in decreasing order of importance to the water point operator, are as follows:

- Fallout of fission products.
- Induced activity in the water and surrounding soil.
- Blow in or wash in of radioactive dust.
- Fallout of unfissioned uranium or plutonium.

The level of contamination depends on the yield of the weapon, the location of the detonation with respect to the water source, and the type of burst (air, surface, or subsurface).

16-30. Detection

a. Responsibilities. Medical, chemical, and water supply personnel are responsible for detection of NBC contaminants in water. Medical personnel must be alert for signs of NBC contaminants. Water may have an unusual taste. There may be dead animals in abnormal numbers or situations. For details of signs and symptoms of NBC contaminants, see FM 8-230. If you suspect NBC contamination, you should immediately consult local medical authorities and the nearest chemical unit. Trained personnel should test for the presence of contaminants in the water.

b. Testing Considerations. The following guidelines apply to testing for NBC contaminants:

- Test samples must be taken directly from the source in question. They should also be taken as nearly as possible at the point and depth from which the water will be drawn.

- When testing potable water using the M272 Chemical Agent Water Testing Kit, you should be aware that high concentrations of chlorine may cause misleading results. Recent tests have shown that the M272 is accurate using potable water with up to 10 mg/l chlorine in it.

- Nitrazine paper should not be used to determine pH and chlorine levels if a color comparator is available.

- A pH below 5.0 or above 9.0 is cause for further testing.

c. Chemical Agents. Chemical agents almost always leave signs. These include drastic lowering of the water pH and dead fish. If chemical contamination is suspected, tests should be performed at once. Water supply personnel may use the M272, Chemical Agent Water Testing Kit (Figure 16-2). Personnel should use the job aid card in the kit to perform the tests. They should always wear protective clothing and equipment to test water suspected of chemical contamination. Frequency of tests for chemical agents is related to mission oriented protective posture (MOPP) conditions as shown in Table 16-10.

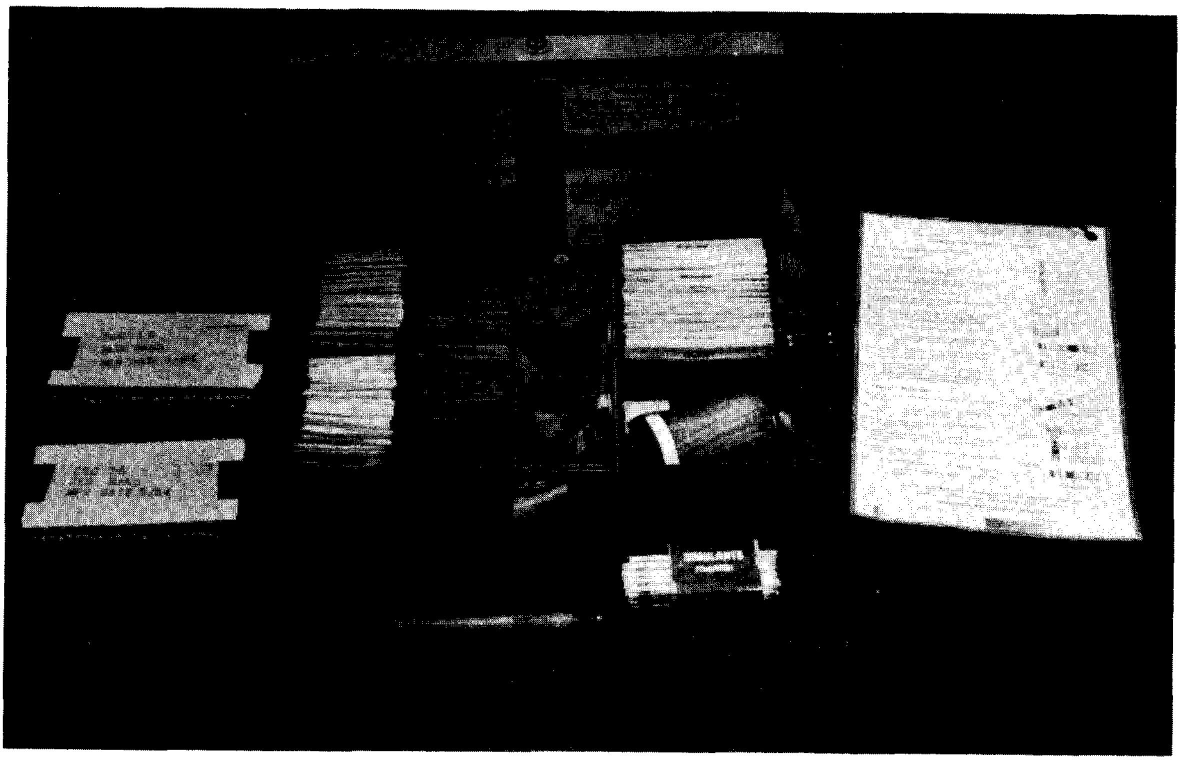


Figure 16-2. M272 Chemical Agent Water Testing Kit.

Table 16-10. Frequency of tests for chemical agents

CONDITION	FREQUENCY
No known threat	Weekly
MOPP 1	Daily
MOPP 2	Twice daily
MOPP 3	Four times daily
MOPP 4	Hourly
Known contamination	Hourly and before issue of each batch of water

d. *Biological Agents.* Biological agents are too small to be seen by the naked eye and cannot be readily detected in water. Their presence will probably be noted only after symptoms appear in victims. A Water Testing Kit — Bacteriological (Figure 16-3) may be used to test for biological contamination. If a noticeable increase in noncoliform bacteria appear, consult the local medical authority. He may require an increase in the chlorine level of potable water.

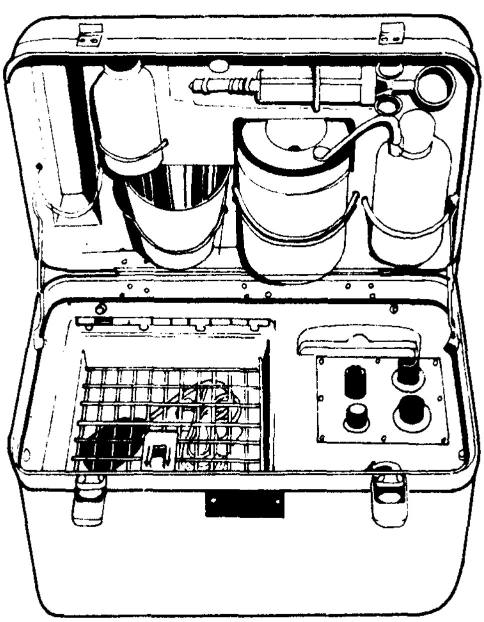


Figure 16-3. Water Testing Kit—Bacteriological.

e. *Radiological Contamination.* Both preventive medicine and water point personnel test water supplies. Their responsibilities are described below.

● *Preventive medicine personnel at all levels are responsible for quantitative analysis of radioactivity in water.* They perform the following tasks:

o Provide information on the quality of raw and treated water as it relates to radioactivity.

o Check radioactivity of streams, lakes, and underground water throughout the field army area. These data are used to decide if a source is acceptable. Medical guidance and surveillance data should always be available.

o Perform periodic tests for radioactivity of water from water points.

o Make frequent checks of purification equipment in the field army area. They check to see if the equipment is effectively removing radioactive particles.

● *Water supply personnel make initial qualitative tests for general radioactivity at proposed water point sites.* Water treatment specialists can test the area around the water point with the Radiac Set, AN/PDR-27. This set will detect surface contamination but not all radioactive particles suspended or dissolved in the water. The radiac set is available for use by survey teams. Water supply personnel should avoid use of a source where radiological contamination makes the site unsafe to occupy.

16-31. Treatment

a. Guidelines. If NBC contamination is detected, water supply personnel must make every effort to find an uncontaminated source. If they find none, they must get permission from the command surgeon to use a contaminated source. They must also take the proper protective measures. Details on protective clothing and accessories are in TM 10-277.

b. Chemical Agents. Sometimes water contaminated by chemical agents must be used. The means for removal of contamination depends on whether Erdlators or ROWPUs are being used.

(1) *Erdlator units.* Chemical agents are removed by one of two pretreatment methods. The one used depends on the agent and situation.

● *Activated carbon.* This treatment is used to remove blister agents. Activated carbon is a relatively pure, specially treated, finely powdered form of carbon. It readily absorbs many substances. First, water from the source is pumped to a separate pretreatment tank. Then equipment operators add 600 milligrams of activated carbon per liter of water and mix by recirculating with raw water pumps; contact time is at least 30 minutes. The water is then pumped to the purification unit for the standard treatment.

● *Superchlorination and dechlorination.* The operator should use two pretreatment tanks when water is cold (below 70°F) and contains hydrogen cyanide or a nerve agent. Superchlorination involves the addition of 100 mg/l of free available chlorine. This is accomplished by adding calcium hypochlorite to the tanks; then filling them with raw water and mixing for 30 minutes. The water is dechlorinated by adding 600 milligrams of activated carbon per liter of water. Two tanks are used to ensure a continuous supply of pretreated water. The residual of activated carbon must be kept in suspension; operators should use pumps if necessary. The carbon is removed by coagulation and filtration. More chlorine will have to be added later to get the required residual.

CAUTION

Calcium hypochlorite and activated carbon react violently with each other. They may cause a fire or explosion. The following safety precautions must observed:

- *Do not store activated carbon near calcium hypochlorite.*
- *Do not use the same pail to prepare slurries of these two substances.*
- *Keep both chemicals dry until ready to use them.*

(2) *ROWPUs.* No pretreatment is needed with a ROWPU. Chemical agents are removed by the reverse osmosis process and by using the accompanying chemical NBC filter. This cartridge is installed between the two product water tanks.

c. Biological Agents. Sometimes water with biological agents must be used. When operators treat such water with an Erdlator, they should use increased chlorination (with concentrations up to 20 mg/l) and dechlorination. A low pH (5.0 to 7.0) is desirable. With a ROWPU, no special treatment is needed.

d. Radiological Contamination. Both Erdlators and ROWPUs can remove a large number of radioactive particles. However, the number removed depends on how much of the contaminant is suspended and how much is dissolved. Suspended matter is easy to remove. Army purification equipment normally removed such matter effectively.

(1) *Erdlator units.* Coagulation and filtration in these units remove suspended matter very well. Removal of dissolved radioactive particles depends on the type of contaminant. The normal operation of an Erdlator unit removes very little strontium 90, iodine 131, and cesium 137 (these are the three most dangerous radiological contaminants). Erdlators may remove over 90 percent of other materials, such as yttrium.

(2) *ROWPUs.* No pretreatment is needed. ROWPU operators use the radiological NBC filter for treatment of radiological contamination. This cartridge is installed between the two product water tanks.

CHAPTER 17

FOOD SERVICE SANITATION

Section I. INTRODUCTION

17-1. General

The health of troops depends as much upon the food they eat as it does upon the water they drink, the air they breathe, and the surroundings in which they live and work. Entire armies have been defeated by such disease outbreaks as dysentery, typhoid, yellow fever, plague and malaria. Mishandling of food and food related waste has been responsible for many incidences of these diseases. Troops stationed in CONUS are not immune. At one military post in the southwest, more than 800 troops fell victim to a food-borne illness that was traced to a sick food handler who was allowed to continue to work. The attainment of quality food service is essential at all levels of command. The trend toward larger facilities increases the potential for large scale food-borne illness outbreaks and the need for highly trained personnel to manage these facilities and to inspect them as well.

17-2. Types of Food Service Facilities

a. A food service facility is defined as any fixed or mobile field or garrison dining facility; restaurant; snack bar; food plant; medical treatment dining facility; canteen; concession stand; bar; Officers, NCO, or EM club; contractor operated cafeteria; soda fountain; sandwich shop; delicatessen; exchange; commissary; troop issue subsistance activity; meat market; catering kitchen or any other type of facility or operation where food or drink is prepared, processed, stored, issued, vended or served on the premises or elsewhere, with or without charge.

b. The Pvnt med specialist will find differences in the equipment and operations of these facilities, but the principles and procedures outlined in TB Med 530 apply to all of them.

17-3. Food-Disease Correlation

a. The very nature of a food service operation inherently magnifies the possibilities for food-borne illness, the need for safe food sources, and the importance of food service sanitation measures. Since all troops in a particular area eat the same food at approximately the same time, all of them could become victims of a single unsanitary practice. The highest standards of sanitation must, therefore, be maintained at all times.

b. Any item of food may become contaminated with disease causing organisms. Some microorganisms occur naturally in foods; some are introduced during the slaughter process; and others are introduced during preparation of the food in a food service facility. This does not mean, however, that food contaminated with disease causing organisms will always make someone sick. Sickness can occur only with a combination of the following related events:

(1) Certain organisms, some of which will be discussed later in this chapter, must be introduced into the food. This may occur in a variety of ways, since bacteria are present everywhere. They can be found in the air, on or in our bodies, in the soil, and in the seas and oceans.

(2) The food must be capable of supporting the growth of organisms. Bacteria reproduce rapidly when warmth, moisture, and the right food are available to them.

(3) The food must be at the right temperature for the growth of organisms. Sufficiently high temperatures kill bacteria. Low temperatures retard the growth of bacteria. Most bacteria that affect man grow best at body temperature which is 98.6°F (37°C). Inside the body is, therefore, ideal for their growth.

(4) The food must remain at a temperature conducive to the growth of organisms long enough for extensive multiplication or for production of toxins. When conditions are right, bacteria reproduce every 20 to 30 minutes. Within a 24-hour period, a single organism, under ideal conditions, can multiply into millions of organisms. This is the reason that food should be prepared as near to serving time as possible. Certain foods should never be prepared more than 3 hours before serving. Moist foods should never be left at room temperature, since they make ideal breeding places for bacteria.

(5) The food must be consumed by a susceptible individual.

c. Fortunately, most microorganisms do not harm people. Some are helpful and serve a necessary and useful purpose. Useful microorganisms are those necessary in making cheese, wine, beer, sauerkraut, and vinegar. Other useful microorganisms are essential in our digestion of food, and still others are needed for the decay of dead matter. They assist in breaking down dead material and returning it to be part of the soil. Without them, dead trees, leaves, animals, and other matter would not rot, but would remain in their present form.

d. Harmful microorganisms are those that cause disease. All microorganisms that cause illness in man are said to be pathogenic microorganisms. Many organisms cause illness. This manual is specifically concerned with those that can cause illness when taken into the body through food. For example, typhoid fever, dysentery, and botulism are diseases that may be transmitted by the consumption of food.

17-4. Growth of Microorganisms in Food

The growth of microorganisms is dependent on several factors.

a. Food. Living things must have food. Many microorganisms grow freely in and eat the same food that humans eat.

b. pH scale. Most microorganisms grow best in material that is neither strongly acid nor strongly alkaline. Pathogenic microorganisms will not grow at a pH below 4.5.

(1) The amount of acid or alkali contained in something is measured on the pH scale. Figure 17-1 shows the pH scale. Microorganisms grow best in the middle of the pH scale, between pH 6 and pH 8.

STRONG ACID						NEUTRAL						STRONG ALKALINE
1	2	3	4	5	6	7	8	9	10	11	12	13

Figure 17-1. pH scale.

(2) Meat falls in the middle of the pH scale — the area where microorganisms grow freely. Figure 17-2 shows that most fruits contain a great deal of acid and that most vegetables are alkaline.

ACID	NEUTRAL	ALKALINE
pH		
FRUITS	MEATS	VEGETABLES

Figure 17-2. pH scale (acid, neutral, alkaline).

c. *Temperature.* For microorganisms to grow, they must have a suitable temperature. By regulating the temperature, the growth of microorganisms can be controlled.

(1) Bacteria can be divided into three groups with respect to temperature. They are heat-loving (108 °F to 180 °F), moderate-temperature-loving (41 °F to 113 °F), and cold-loving (31 °F to 90 °F). These temperature ranges are shown in Figure 17-3.

(2) Most microorganisms causing food-borne disease will not grow at temperatures of 45° F or below and 140° F or above.

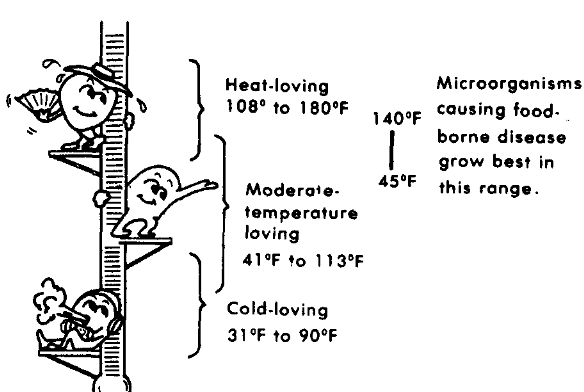


Figure 17-3. Thermometer showing temperatures at which bacteria grow best.

d. Moisture. Microorganisms absorb their food through their cell walls. They cannot absorb solid food. They need moisture to break down the food to the point where they can absorb it.

e. Time. Given enough time and the right conditions, most microorganisms can adjust to different foods. The time can be an accumulative period, not necessarily one continuous exposure period. Figure 17-4 shows how the time required for the growth and death of microorganisms may be divided into four phases.

(1) The slow-growth phase occurs when microorganisms adjust to a new environment. Most microorganisms can adjust to a new environment in about 4 hours although some require considerably less time.

(2) After they have adjusted, the rapid growth phase occurs. The growth rate increases ten times for every unit of time.

(3) The equal phase occurs when the production of new microorganisms equals the death rate of old microorganisms.

(4) The death phase occurs when microorganisms compete for food and are poisoned by the accumulation of their own waste.

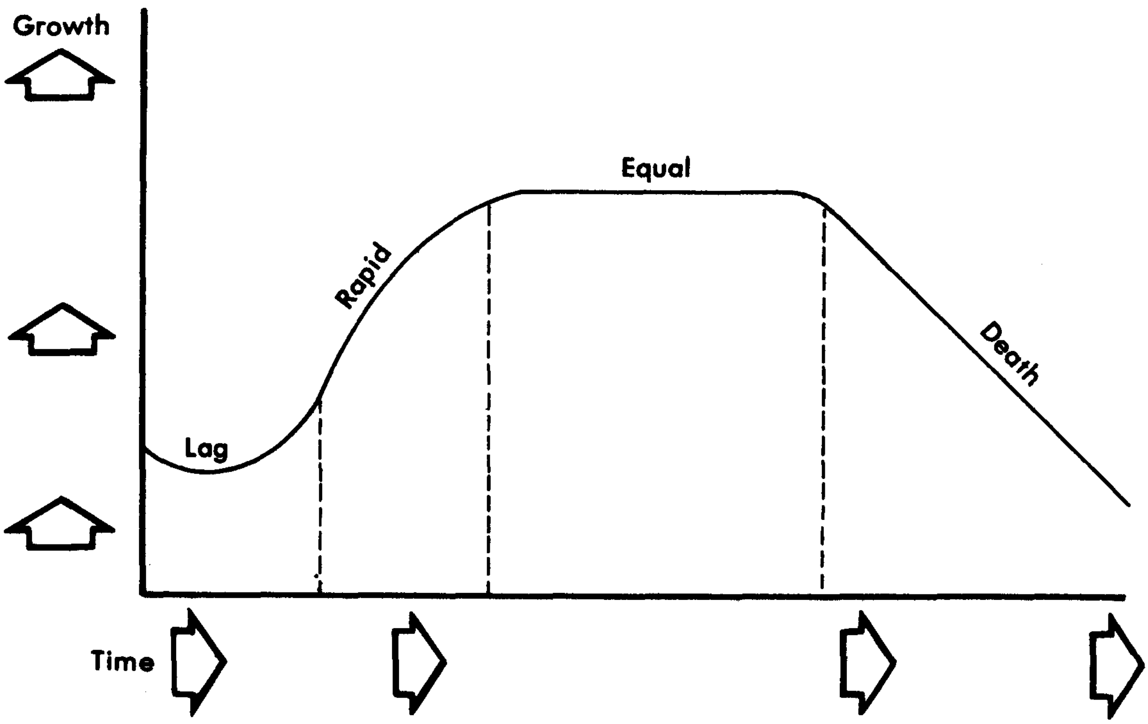


Figure 17-4. Four phases in the growth and death of bacteria.

17-5. Types of Microorganisms Causing Food-borne Disease.

a. Bacteria. Although different types of microorganisms causes food-borne illness, most outbreaks are caused by bacteria. Bacteria are single-celled plants. They are very small, but vary in size. Generally, they are 1/25,000 of an inch (.00101 mm) in size. It takes about 25,000 individual bacteria placed side by side to equal 1 inch (25.4 mm).

b. Viruses. Viruses are microorganisms even smaller than bacteria. Viruses can be seen only with the aid of the most powerful microscopes. At one time, it was thought that viruses did not cause food-borne diseases, however, it is now known that viruses can cause food-borne disease. One example of a virus-caused food-borne disease is hepatitis.

c. Parasites. Parasites are organisms that live on or in another organism. Some parasites are small like other microorganisms and can be seen only through a microscope, while others can be seen with the naked eye. Parasites are a problem for soldiers stationed in underdeveloped countries, especially in areas where night soil (human feces) is used as a fertilizer.

17-6. Potentially Hazardous Foods

Any food that consists in whole, or in part, of milk, milk products, egg(s), meat, poultry, fish, shellfish, edible crustacea or other ingredients, including synthetic ingredients, in a form capable of supporting rapid and progressive bacterial growth is considered to be a potentially hazardous food (PHF). The term does not include clean, whole, uncracked, odor-free shell eggs or foods that have a pH level of 4.5 or below or a water activity value of 0.85 or less.

Section II. FOOD-BORNE DISEASES IN THE MILITARY

17-7. Types of Food-borne Diseases

This section provides information on the common types of food-borne diseases and the specific microorganisms that cause the disease. In addition, information will be provided concerning poisonous plants and chemicals that can contribute to food-borne disease outbreaks. The common types of food-borne diseases are —

a. Food-borne Infections. Food-borne infections occur when pathogenic microorganisms contaminate food. Unlike the illness caused by the presence of a toxin, it is the live organism itself that causes the illness. The three general types of food-borne infections are caused by bacteria, parasites, or viruses.

(1) *Bacterial infections.* A number of specific bacterial organisms cause infection through food. This manual will discuss only those that are most frequently involved in outbreaks of food-borne illness.

(a) Salmonella. There are more than 1,600 different varieties of salmonella. The illness is called salmonellosis. Eggs, poultry, fish, and

meat products are frequently involved in outbreaks of salmonellosis. Contamination of these foods can occur at any time from the handling or processing stage until the food is served to the consumer. It takes 6 to 48 hours for symptoms of food borne-infection illness to occur. There are a wide variety of salmonellosis symptoms; the more common ones are fever, abdominal pain, diarrhea, frequent vomiting, and chills. Although the illness is not often fatal, it is a special hazard to those who are in a poor physical condition, or to the very young and to the aged. Typhoid fever is a type of salmonellosis. The symptoms of typhoid fever may take as long as 3 weeks to appear. Salmonellosis can be prevented by thoroughly cooking food and by educating food handlers in correct food handling procedures.

(b) Bacillary dysentery (shigellosis). Bacillary dysentery is caused by an organism of the genus *Shigella*. Outbreaks of bacillary dysentery in a food service establishment indicates a breakdown in personal hygiene and food protection. Strict food handler handwashing, especially after use of the bathroom, and personal cleanliness are the best preventive measures for shigellosis. Symptoms vary considerably in severity and may consist of bloody diarrhea, cramps, fever, and vomiting. Symptoms usually develop in 2 to 3 days after eating food containing the organisms.

(2) *Parasitic infections.* Outbreaks of food-borne illness due to parasites are not common in the United States. Outbreaks may occur at any time in overseas areas. There is an increased risk of an outbreak in areas where human waste is used as a fertilizer. Persons returning to the United States from foreign countries may bring parasites with them. You should know some of the characteristics of parasites:

(a) Amebic dysentery (amebiasis). Amebic dysentery occurs when food or water is contaminated with human feces from infected persons. The major symptom of amebic dysentery is diarrhea of varying severity. The symptom will usually develop within a few days but may take several weeks or months.

(b) Trichinosis. Trichinosis is caused by a tiny worm that infects hogs and other animals. These tiny worms burrow into the muscles of the animal. Humans become infected when they eat raw or insufficiently cooked meat that contains the live larvae. Although it is not often fatal, there is no known cure and full recovery is slow. Prevention of trichinosis is accomplished by fully cooking pork or pork products (internal temperature above 150°F).

(c) Tapeworms. Infection of humans by tapeworms found in fish, beef, pork, and poultry occurs infrequently and is not as serious a problem as that associated with trichinosis. These infections result from eating raw or insufficiently cooked foods. Most foods should be cooked to an internal temperature of 140°F; except beef to an internal temperature of 145°F; pork to an internal temperature of 150°F; and poultry to an internal temperature of 165°F.

(3) *Viral infections.* The most common viral infection seen in food-borne illness is infectious hepatitis (A). Infectious hepatitis may occur after eating shellfish, especially raw oysters and clams that were harvested from

sewage-contaminated water. When foods, such as milk or potato salad, are involved, the source of the virus is usually contaminated water or someone who has the disease that handled the food. Viruses can be easily controlled by cooking the food, pasteurizing the milk, purchasing shellfish from approved sources, using safe water supplies, and practicing proper foodhandling procedures.

b. Food-borne Intoxication. Food-borne intoxication occurs when certain microorganisms grow on food and produce chemical waste products (toxins) that are poisonous (toxic) to the person eating the food. Toxins produced do not always change the appearance or flavor of the food. Some of these toxins are difficult to destroy or render inactive; others can be easily destroyed. The toxins produced by certain strains of microorganism can withstand boiling temperatures for long periods of time and are virtually impossible to destroy by normal cooking methods.

(1) *Food intoxication due to staphylococcal enterotoxin.* Outbreaks of food-borne illness are often caused by the toxin of staphylococcal organisms. Most people are carriers of staphylococci, which are natural inhabitants of our bodies. The organisms are most frequently found in the nose and on the skin. Outbreaks of staphylococcal food-borne illness can be traced to food service workers with nasal discharge and skin infections such as infected cuts or boils. The toxins produced by staphylococcal bacteria are difficult to destroy by heat. Normal cooking times or temperatures will not destroy the toxins. Persons eating food containing staphylococcal toxins will usually become ill 1 to 6 hours later. They will experience a sudden onset of nausea, vomiting, abdominal cramps, and usually diarrhea. Frequently, they will be so ill that confinement to bed or even hospitalization is required. Although people usually recover from this illness, death does sometimes occur. Persons in poor physical condition, the very young, and the older age groups are more susceptible to this illness. The most effective preventive measure is to keep food at a safe temperature so that the bacteria does not grow and produce the toxins.

(2) *Food intoxication due to Clostridium botulinum.* Botulism is caused by a toxin which is produced by the organism *Clostridium botulinum.* It is most frequently found in underprocessed food that has a low acid content, such as home canned green beans or mushrooms. Persons suffering from botulism usually become ill within 12-36 hours. They experience blurred or double vision, and muscular weakness, with difficulty in swallowing, speaking and breathing. The toxin is extremely poisonous; a very small taste of infected food can be fatal. Heating food to the boiling point and maintaining this temperature for 3 minutes will destroy the toxin.

(3) *Food intoxication due to Clostridium perfringens.* The organism *Clostridium perfringens* is frequently associated with outbreaks of food-borne illness. This organism is not as severe as botulism and results in few deaths. The *Clostridium perfringens* organism is a normal inhabitant of the intestinal tract of man, as well as a constant contaminant of soil, nonpotable water and underprocessed foods. Most of the outbreaks caused by this type of organism have been associated with cold, precooked, or reheated meat, stew, or meat pies. These dishes are frequently prepared from foods that have been held at unsafe temperatures for extended lengths of time. Persons suffering from *Clostridium perfringens* will usually become ill within 6 to 24 hours.

They will suffer acute abdominal pain, diarrhea, and nausea, but vomiting is rare. The toxin spores will survive normal cooking temperatures and will even germinate and multiply during cooling and rewarming. Since they are difficult to kill by heating or cooking, it is important to rapidly reheat foods to prevent the growth of toxins.

c. Chemical Poisoning. There is always the possibility of consuming poisonous chemicals with food. Without adequate control and proper use, there would be many more outbreaks of food-borne illness caused by chemicals. Toxic chemicals such as cadmium, zinc (galvanized), antimony, copper, and lead have been involved. All of these metals will dissolve in certain types of acid foods, such as fruit punch and drinks, and produce a toxic or poisonous substance. Individuals can become ill within minutes of consuming foods or drinks contaminated with chemicals. Many chemicals used in cleaning and sanitizing solutions are toxic. Chemicals used to control insects and rodents are, by their nature, intended to kill. If used improperly or accidently mixed with food or drink, they can cause severe illness or death. The care and handling of cleaning products, sanitizing compounds, and pesticides is an important part of any food facility. Great quantities and varieties of pesticides are also used on crops during production of food supplies. The use of these pesticides is rigidly controlled. Food service personnel must ensure that any residue that remains on food is removed by washing, trimming, and peeling during preparation. Toxic materials used in the dining facility to maintain sanitary conditions should be plainly marked and stored in cabinets used for no other purpose, and not in rooms used for food preparation or for storage of food, clean equipment and utensils.

d. Poisonous Plants and Animals. Some plants and animals are poisonous and should not be used as food. Examples include certain mushrooms, toadstools, water hemlock, jimson weed, and the seeds from the castor bean plant. Shellfish, such as mussels and clams, taken from certain waters at particular times of the year and certain species of fish have also been involved in outbreaks of food-borne illness. Illness caused by consuming these toxic foods may occur within a few minutes after eating and is often fatal. Usually cooking the food does not destroy the material in the food that causes the illness. The best way to avoid eating a poisonous plant or animal is to obtain food products only from approved sources.

Section III. SANITARY FOOD SERVICE OPERATIONS AT FIXED ARMY INSTALLATIONS

17-8. General

Sanitary standards have been developed to reduce the entrance and multiplication of microorganisms in food. Food contaminated with pathogenic organisms can, when eaten by susceptible individuals, result in illness and possibly death. Anyone who has been involved in an outbreak of food-borne illness has witnessed the rapid reduction of military effectiveness and morale.

17-9. Control of Food Services at Fixed Installation

The commander controls all food service operations at a fixed installation. Foods or beverages cannot be sold except through commissaries, exchanges, clubs, dispensers, or other outlets authorized by the commander.

17-10. Responsibilities for Food Sanitation

a. The AMEDD is responsible for establishing sanitation standards for all food (including drinks served or dispensed). These standards pertain to the origin, manufacture, preparation, storage, and handling of foods and drinks. The AMEDD also recommends standards for the design, construction, and operation of food service facilities as well as the equipment used therein.

(1) Personnel of the AMEDD make inspections as necessary to ensure that sanitary practices are observed and that established standards are met.

(2) Sanitary inspections of food establishments which may serve as sources of food for the Armed Forces will be conducted by personnel of the military veterinary services or other governmental agencies in accordance with the provisions of AR 40-657.

(3) Preventive medicine personnel make inspections of all food dispensing establishments on an Army post.

(4) Unit surgeons advise personnel on proper sanitary practices and maintain sanitary supervision over the facilities and methods used in distributing, storing, preparing, serving, and dispensing food for their units. They are responsible for places where food is stored, cooked, served, and dispensed to ensure that the food is protected from the time it is received by the unit until it is consumed by the troops.

b. Unit commanders are responsible for the cleanliness, sanitation, and sanitary maintenance of all food service equipment, utensils, and facilities and for the sanitary storage, preparation, conveying, and serving of food. They are also responsible for the supervision of personal hygiene practices of their personnel.

17-11. Facilities

Facilities used for the preparation of food at a fixed installation must be designed, constructed, and maintained for that purpose only.

a. Water Supply and Plumbing. Food service facilities must have hot and cold potable water under pressure and a sanitary sewer system into which liquid waste can be discharged. The potable water system must be installed and maintained in such a manner that it precludes the possibility of health hazards such as cross-connections, back-siphonage, and overhead leakage. Waste or sewer lines should not pass over areas used for the preparation, storage, or serving of food; dishwashing; or storage of utensils or equipment. Condensation sometimes forms on these lines and may drip on anything below them, thus causing possible contamination. A leak in these pipes may also cause dripping on food, utensils, or equipment resulting in contamination.

b. Toilet and Handwashing Facilities.

(1) Adequate, sanitary toilet facilities are required to assure proper disposal of human excrement which carry pathogenic organisms. Toilet facilities which are properly designed, cleaned, repaired, and used help reduce the spread of contamination by flies, insects, clothing, and hands. The location of toilet facilities must be convenient to food service personnel. The toilet room must not open directly into a room where food is stored, prepared, or served or where dishes and utensils are washed and stored. It must be constructed of light colored materials which are easily cleaned. The room must be adequately ventilated and kept *scrupulously* clean at all times. The door must be self-closing.

(2) Handwashing facilities must be provided not only in the toilet room but also throughout the food preparation area to permit convenient use by all personnel. Even though hands are the most common means of transferring contamination to food, kitchen personnel are not likely to walk any great distance to wash their hands. Handwashing devices in the toilet room and in the kitchen must consist of hot and cold running potable water, soap, and individual towels. A sign should be posted in the toilet room directing personnel to wash their hands after using the toilet. If personnel do not read English, a sign in their native language must also be posted.

c. Floors, Walls, and Ceilings. Floors must be constructed of smooth, nonporous material and in good repair so that they can be cleaned properly. Floors should be constructed of material impervious to grease and other organic material to facilitate cleaning and prevent absorption. Floors that are to be washed by flooding or are subjected to liquid waste, must have drains installed to carry away the liquid; cove molding should be installed around the edge of the floor. Walls and ceilings should be light in color and smooth to a level reached by splash and spray. A light color not only aids in the even distribution of light but also facilitates thorough cleaning. Clean floors, walls, and ceilings minimize attractants for insects and rodents and contribute to efficient, sanitary food service operations.

d. Openings. Openings to the outside shall be effectively protected against the entrance and harborage of vermin. Outside openings shall be protected against the entrance of insects by tight-fitting, self-closing doors; closed windows; screening; approved, controlled air currents; or other means. Screening material must not be less than 16 mesh to the inch. When used, mechanical air curtains shall be installed in accordance with NSF Standard 37.

e. Lighting.

(1) Ample light is necessary for the sanitary preparation and serving of food. When dirt, grease, crawling insects, and evidence of rodents are exposed by adequate light, corrective action is more likely to be taken. The light in kitchens and dishwashing rooms must be evenly diffused and distributed. Permanently fixed, artificial light sources shall be installed to provide at least:

- 50 footcandles of light on all food preparation surfaces and at equipment or utensil washing work levels.

- 30 footcandles of light at a distance of 30 inches from the floor throughout the food preparation, serving and warewashing areas; and

- 20 footcandles of light in utensil, equipment and food storage areas, lavatory and toilet areas, and in dining areas during cleaning operations; and

- 10 footcandles of light in walk-in refrigeration units.

(2) Shatterproof bulbs or shielding to prevent broken glass from falling onto food shall be provided for all artificial lighting fixtures located over, by, or within food preparation, service and display facilities; storage areas for unpackaged foods; and facilities where utensils and equipment are cleaned and stored.

(3) Infrared or other heat lamps must be protected against breakage by a shield surrounding and extending beyond the bulb, leaving only the face of the bulb exposed.

f. Ventilation. Ventilation reduces condensation, which promotes mold and bacterial growth and which may drop onto food, utensils, or food preparation surfaces. Ventilation also minimizes the soiling of walls and ceilings, excessive heat, objectionable odors, and concentration of harmful gases. All food preparation, processing, and serving areas, equipment washing areas, dressing or locker rooms, toilets, and garbage or refuse storage areas must be well ventilated. If a kitchen is air-conditioned or served by a building ventilation system, its air must be exhausted to the outside and not recirculated. Unless otherwise provided for, stoves, ovens, griddles, steam kettles, deep-fat fryers, and dishwashing machines must be equipped with ventilation systems that exhaust to the outdoors. Ventilation hoods must be designed to prevent grease or condensation from dripping into food or onto food contact surfaces. Filters in ventilation hoods must be easily removable for cleaning. Installation of exhaust systems and attendant fire protection systems must be in accordance with NFPA Standard 96.

17-12. Equipment

a. Design and Construction of Equipment and Utensils. Items of equipment and utensils used in kitchens must be well designed and constructed of durable materials, and kept in good repair. If not, they are difficult to thoroughly clean and are likely to harbor accumulations of food and other soil which support bacterial growth. Utensil and equipment surfaces which come in contact with food must be constructed of or plated with materials which contain no cadmium, lead, zinc, or other toxic metal and must be free of breaks, open seams, cracks, chips and pits. Solder which is of safe materials, corrosion resistant, and does not leach out toxic substances may be used for jointing. Galvanized metal may be used for storage of dry foods only. Plastic utensils must be unaffected by high water temperatures, detergents, disinfectants, and soaps.

b. Refrigerators and Storage Rooms.

(1) Although all food supplies are perishable, they are usually classified as either perishable or semiperishable, since some deteriorate more rapidly than others. As soon as food supplies are received at the kitchen, they are checked to ensure that they are in good condition. They are then immediately stored, using the rotation (first-in first-out) principle.

(2) Kitchens are usually equipped with refrigerators of the "reach-in" and "walk-in" types for holding chilled items, frozen food cabinets for storing frozen items, and a ventilated storeroom for storage of semi-perishable items. All storage facilities must be kept clean and free of objectionable odors. Odor-absorbing foods must be stored separately from odoriferous foods. Refrigeration equipment must be designed and operated to maintain air temperatures of 40°F (4°C) or below to ensure that stored product temperatures are maintained below 45°F (7°C). Frozen food will be kept frozen and stored at a product temperature of O°F (-18°C) or below except that storage of food at 10°F (-12°C) is acceptable for a period not to exceed 7 days immediately prior to preparation or tempering. Each mechanically refrigerated unit storing PHF shall be provided with a numerically scaled indicating thermometer, accurate to +3°F (1.7°C) located to measure the air temperature in the warmest part of the refrigeration unit, and be easily readable. Zone-type thermometers without temperature graduations are not acceptable. When containers of food are placed in refrigerators, they must be covered to prevent excessive drying and contamination from items stored above them. If the refrigerators are equipped with drains, these drains should not be connected directly to sewer or waste lines. Frozen food boxes require defrosting periodically. Defrosting is required when 1/4 inch thick ice accumulates on the inside of a frozen food box.

(3) Although semiperishable foods are more durable than perishable ones, care must be taken in storing them. Improper storage can result in loss from rodent or vermin infestation and deterioration from heat, dryness, or excessive moisture. Semiperishable foods will be stored in a cool, dry, clean, well-ventilated room which is insect and rodent proof. The storeroom must be equipped with sufficient shelving for storage of bottles, cans, or packaged semi-perishables; metal containers for certain types of dry stores; and dunnage for items supplied in bags and cases. Food will not be stored directly on the floor. Storage racks and containers must be 6 inches (15cm) above the floor surface or be easily movable to facilitate inspection and cleaning. Dry stores such as sugar, flour, dried peas, and beans should be stored in the original package within metal containers to prevent insect infestation and musty odors caused by moisture absorption. Canned items stored on shelves must be inspected for leaks, swells, and excessive rust.

c. Garbage and Waste Disposal Equipment. Frequent collection and disposal of garbage are necessary to minimize odors, to prevent waste from becoming an attractant and harborage or breeding place for insects and rodents, and to avoid other nuisance conditions. An area outside the kitchen must be set aside for garbage collection.

(1) Garbage will be put in containers which are made durable metal or other material which does not leak or absorb liquids. Generally,

32-gallon galvanized cans are used. They must have tight fitting lids to discourage insects. A sufficient number of garbage cans will be provided, and kept on a stand except for emptying and cleaning. They will be cleaned thoroughly after each emptying and before they are returned to the stand. They must never be painted or whitewashed, since this makes them harder to clean. Spillage is controlled by only filling the cans to a level not more than 4 inches from the top.

(2) The garbage stand must be secured on a platform constructed near the kitchen. Most platforms range in height from 12 inches to the level of a truck floor. They may have an apron at the base. The garbage stand requires daily cleaning and must be built of durable material such as concrete or metal. When circumstances make it necessary to use wood, the slats or boards are spaced about 3 inches apart to aid in cleaning.

(3) A can washing facility must be constructed with curbing so that debris from the garbage can and wastewater will not splash or run onto the soil. It must be of concrete construction sloped to a center drain. The wastewater must drain into a grease trap that is connected to the wastewater system. It must NEVER drain into a storm wastewater system. Hot and cold running water under pressure must be provided. Personnel who handle food will not be used to clean garbage cans nor will they be used to clean grease traps.

d. Grease Trap. Grease traps must be located so as to be accessible for servicing. In new construction or renovation, grease traps must be located externally to the building.

e. Vehicles for Transporting Food. Vehicles used for transporting food should be covered and kept clean. Vehicles used to haul garbage, petroleum, or other materials which may contaminate food must be thoroughly cleaned before transporting food. Food must be protected from the sun, heat, dust, insects, and other contamination. Therefore, food being transported will be wrapped and/or boxed. Completely enclosed, refrigerated vehicles must be used for transporting perishable food and milk when excessive thawing of frozen products, dust, or a temperature rise above 45 °F (7.22°C) could occur.

17-13. Personnel

a. General.

(1) Only qualified personnel are authorized to prepare food.

(2) Food service attendants such as contract civilians and local nationals who are not fully qualified may, when authorized by the IMA, serve food or perform limited food preparation.

(3) Military personnel detailed by daily duty roster may serve food and perform limited food preparation duties such as preliminary vegetable preparation.

(4) Unauthorized personnel will be prohibited in the food preparation and storage, and equipment and utensil washing areas of a food service facility. Signs will be posted to this effect.

b. Employee Health.

(1) No person shall work in a food service facility in any capacity unless cleared for the specific duty by the IMA while:

(a) Infected with a disease in a communicable form that can be transmitted by food or who is a carrier of organisms that cause such a disease; or

(b) Having a boil, an infected wound, or an acute respiratory infection.

(2) Supervisors will inspect all personnel daily at the start of the work period. Persons who exhibit signs of illness to include skin diseases, diarrheal illness (admitted or suspected), burns, boils, or cuts are referred to the IMA for evaluation.

(3) Personnel referred for medical evaluation must provide their supervisors with a written statement signed by a physician stating duty limitations, if any, or stating that the individual is fit for duty as a food service employee.

c. Medical Examinations.

(1) The IMA determines the need for and/or extent of preemployment and periodic medical examinations. Also, based on local circumstances, the IMA may require medical examinations to detect and control the spread of diseases through food. A written policy shall be established and disseminated by the IMA. A copy of this policy will be forwarded to the MACOM Surgeon and to the Commander, USA Troop Support Agency, ATTN: DALO-TAZ-V, Ft Lee, VA 23801-5260.

(2) Normally, preemployment and periodic medical examination of food service personnel within CONUS are not required. Such examinations can give a false sense of security to employees and supervisory personnel. Therefore, emphasis and resources should be placed on training food service personnel in personal hygiene, food sanitation, and disease control.

(3) Persons who have been absent from work because of a communicable disease (including diarrheal disease) will be referred to the IMA for a determination as to fitness for duty before resuming work. Persons so referred are evaluated and if found fit, are provided a written clearance signed by a physician authorizing them to return to their food service duties.

d. Personal Cleanliness.

(1) Employees must maintain a high degree of personal cleanliness and conform to good hygiene practices during all working periods in the food service facility.

(2) Personnel working in a food service facility will wear a clean uniform daily. Except during field operations, white, pastel, or other light

colored uniforms that readily show accumulations of soil or dirt will be worn by employees, including ware washers and permanent food service attendants. This does not apply to personnel stocking canned, packaged, or otherwise fully protected foods or to checkout clerks in retail food stores. Military personnel detailed as food service attendants and who are authorized on the serving line or in food preparation areas will wear clean, light-colored uniforms or wear clean, light-colored aprons over clean duty uniforms. Wearing of round-necked "T" shirts as an outer garment is acceptable while performing custodial duties.

(3) With the exception of plain wedding bands, food service personnel will not wear jewelry such as bracelets, watches, or other similar items while preparing or handling food.

(4) Effective hair restraints will be used by personnel working in food service facilities. Hair restraints must effectively prevent hair from entering food or falling onto food-contact surfaces. Hair restraints will be kept clean. Determining the adequacy of such restraints is a command responsibility. Personnel with hair, including facial hair, that cannot be adequately restrained will be prohibited from food service operations.

(5) Personnel who handle or serve food will not be used to clean latrines, garbage cans, sewers, drains, grease traps, or perform similar custodial duties during food preparation times. This is not intended to diminish cooks' responsibilities to maintain "clean-as-you-go" procedures, or to prohibit personnel from performing custodial duties at the end of their shifts.

e. Employee Practices.

(1) Employees must consume food only in designated dining areas. The employee dining area must be located where contamination of other food, equipment, utensils, or other items needing protection will not occur. This requirement is not intended to prohibit recipe testing or consuming drinking water. Recipe testing will be accomplished by using clean sanitized utensils. Portions withdrawn for testing will be discarded as food waste. Utensils used will be cleaned and sanitized before reuse.

(2) Personnel will not use tobacco in any form while engaged in food preparation or service, or while in equipment and utensil washing or food preparation areas. An area will be designated where personnel are permitted to use tobacco. Personnel will not resume work after using tobacco without first washing their hands. Signs will be posted to this effect.

(3) Personnel will thoroughly wash their hands and all exposed portions of their arms at the beginning of duty; after using toilet facilities; using tobacco; between handling soiled and clean utensils and equipment; between handling raw and cooked foods; after performing custodial duties; after handling garbage or trash; and also as often as necessary to maintain a high level of personal cleanliness.

(4) Personnel will keep their fingernails cleaned and trimmed.

f. Training.

(1) Food service personnel will be instructed in the principles and practices of food-borne illness prevention and in first aid for choking.

(2) Educational programs, signs, and other instructional or directive material must be developed and presented in the native language of the food service personnel.

(3) Initial and ongoing training in food service sanitation will be provided to each food service employee. The scope of the training will be directed to the role of the individual in preventing food-borne illness. Training is conducted by supervisory food service personnel. Supervisors must maintain records of this training.

(4) Food service supervisors must complete an approved formal training program in food sanitation. This training should be taught by the IMA using installation veterinary and preventive medicine personnel and hospital dieticians.

17-14. Food

a. Quality of Food.

(1) *Fresh food.* Only food of unquestionable sanitary quality is used in the kitchen. Any food suspected of spoilage, contamination, or damage in any way should be brought to the attention of the veterinarian, or in his absence, the IMA. Fresh fruits and vegetables grown in areas where human excreta is used as a fertilizer or where prevalence of gastrointestinal or parasitic disease is expected must not be consumed raw, except with the approval of the IMA. If the use of fruits and vegetables in these areas is authorized, they will be cleaned and disinfected by immersion in water at 160°F (71.11°C) for 1 minute; by use of the food service disinfectant according to the directions printed on the package; or by thorough washing, then soaking for 30 minutes in a 250 mg/l chlorine solution.

(2) *Canned food.* When canned food has an abnormal odor, taste, or appearance, or the can shows an abnormality such as bulging at the ends, swelling, leaking, or excessive rusting, the food will not be served without approval of the veterinarian or the IMA. Swelling or bulging canned products are most often caused by gas producing bacteria which may be pathogenic. Canned foods declared unfit for human consumption by the veterinarian or IMA must be surveyed and destroyed or disposed of in accordance with AR 40-657 and DOD 4140.26M (Defense Disposal Manual).

(3) *Milk.* Only pasteurized milk and milk products from plants approved by the veterinarian or IMA are served in a dining facility. Milk and milk products for drinking purposes must be served either in the original individual containers in which they are packaged at the milk plant or from an approved bulk milk dispenser. When fresh milk is unavailable to a garrison dining facility in the individual size (pint or less) or in an approved dispenser, it may be supplied in containers as large as one-half gallon. Milk should be

received in the dining facility within 48 hours after the pasteurization date indicated on the milk containers. Milk must be maintained at a temperature of 50 °F (7.22 °C) or less.

(a) Bulk milk must be provided by the milk plant in a 3-gallon or 5-gallon dispenser which fits into a refrigerated cabinet designed for dispensing it (MIL STD 175). All rubber or synthetic parts required in dispensing the bulk milk must be provided in a sterile condition by the plant. Mild dispensing tubes will be cut diagonally, approximately 1/2 inch (1.5 cm) from the cutoff valve. When a reusable bulk milk dispenser becomes empty, it will be washed with warm, soapy water and rinsed with clear, hot water prior to its being returned to the distributor.

(b) When milk is served from individual containers or a container up to one half gallon, the containers are disposed of as trash. Milk left in these containers will be disposed of as food waste.

b. Protection of Food from Contamination. Every effort must be made to keep food from becoming contaminated with pathogenic organisms. Most foods furnish sufficient nutrient matter for these organisms to multiply and, in some instances, to produce large amounts of toxin.

(1) *Preparation.* Food must be prepared as near to serving time as possible. Food with a high carbohydrate content furnish a good media for the growth of bacteria. Examples of these foods are locally prepared sauces, salad dressings, ham salads, chicken salads, cream fillings, cream sauces, custards, and hash (corn beef hash excepted). Such food must never be prepared more than 3 hours before serving; never held over for another meal; or never used as sandwich fillings for box lunches. Processed meats, such as bologna, liver sausage, and spiced hams are acceptable. Meat may contain *Trichinella spiralis* or other disease-producing agents that cannot be detected upon inspection except by special techniques. Proper methods of preparation may reduce certain types of food contamination without impairing the nutritive value of the food. EXAMPLE: when meat is cooked, heat should penetrate to the center; and the temperature in all parts should be at least 150 °F (65.55 °C). This provides a safe margin, since the thermal death point for trichinae is 121 °F (55 °C). Cooking meat well done will kill tapeworms.

(2) *Storage.* Since leftover food presents a serious problem, meals should be carefully planned to reduce the amount of leftovers to the minimum. Leftover food that can be served at a later meal must be refrigerated promptly and used within 24 hours. Cooked leftovers must be quickly reheated before serving. Leftover foods, such as macaroni or casserole, will not be saved under any conditions, since a sufficiently high temperature does not penetrate to the center of them even though they are heated several hours in an oven set at a high temperature. Food in which staphylococcus enterotoxin has already formed is known to have remained toxic after boiling for more than 30 minutes. When only a portion of a large can of perishable food, such as peaches, is required, the unused portion should be left in its original container for refrigeration, since another container may not be as free of contamination as the can. Pats of butter, as well as all other foods if possible, should be handled only with utensils.

(3) *Insect and rodent control.* Flies, rats, and cockroaches are major offenders in the spread of contamination in the dining facility. Infectious disease can be transmitted by flies, rats, and cockroaches crawling over unprotected food. Such contamination is usually not apparent when the food is eaten. Strict sanitation is the best method for controlling insects and rodents. Fly control measures include eliminating the breeding places, fly-proofing by screening, making screen doors fit tightly, and eliminating cracks around door facings. Rodent control measures include eliminating harborages and food, ratproofing by sealing off all entrances that rats might use, and trapping or poisoning. Warfarin or Pival, when properly used is safe to use in the facility for rodent control. The cockroach, like the fly, feeds on a variety of foods, some of which may be contaminated. Contamination may be spread mechanically by the particles clinging to the cockroach's body. Food service facilities should be sprayed frequently with an approved, effective insecticide for cockroach control. In garrison facilities, this spraying should be done by an insect and rodent control team. Kitchen personnel may also use fly swatters, traps, and aerosols for control of these vermin; care must be exercised to prevent food contamination.

17-15. Cleaning Food Service Utensils

a. General. Whenever the mouth comes in contact with eating utensils, some saliva and germs remain on the utensils. Diseases, such as tuberculosis, mumps, and influenza, have been transmitted through supposedly clean utensils which were, in fact, inadequately disinfected in the dishwashing process. When food particles are left on eating and preparation utensils, a breeding place is present for organisms that cause food-borne illness. Food that is completely free of disease-producing organisms may be contaminated when prepared or served in utensils which have not been cleaned and disinfected. Cleaning and disinfecting utensils includes removing food particles by scraping, prerinsing in warm water, washing with a detergent solution, rinsing free of detergent, and destroying pathogens by heat or chemical treatment. Utensils may be cleaned mechanically or manually. For mechanical dishwashing, sufficient racks should be provided to ensure that no rack is filled beyond the recommended capacity. Trays must be racked and evenly spaced at least 3 inches apart with the food contact surfaces forward. The tops of the trays will be sloped toward the operator at an angle of approximately 60°. No more than five trays should be placed in a 20- by 20-inch rack.

b. Mechanical Cleaning and Sanitizing.

(1) Cleaning and sanitizing may be accomplished by using a spray-type or immersion dishwashing machine, or by any other type of machine or device that meets the NSF standards for mechanical dish or pot and pan washing equipment. Local modification of such equipment is prohibited because it may invalidate the manufacturer's warranty and NSF listing. Machines and devices will be operated in accordance with the manufacturer's instructions. Utensils and equipment placed in the machine will be exposed to all dishwashing cycles. Automatic detergent dispensers, wetting agent dispensers, and liquid sanitizer injectors, where provided, must meet the requirements of NSF Standard 29 and be properly installed and maintained.

(2) The pressure of the final rinse water supplied to spray-type dishwashing machines must be at least 15, but no more than 25, pounds per square inch measured in the water line immediately adjacent to the final rinse control valve. A 1/4 inch internal pressure system (IPS) valve must be provided immediately upstream from the final rinse control valve to permit checking the flow pressure of the final rinse water.

(3) Machine or water line-mounted numerically scaled indicating thermometers, accurate to +3°F (1.7°C), will be provided to indicate the temperature of the water in each tank of the machine and the temperature of the final rinse water as it enters the manifold.

(4) The rinse water tanks must be protected by baffles, curtains, or other effective means to minimize the entry of wash water into the rinse water. Conveyors in dishwashing machines shall be accurately timed to assure proper exposure time in wash and rinse cycles in accordance with the manufacturers' specifications attached to the machine.

(5) Drainboards will be provided and be of adequate size for handling soiled utensils prior to washing and for drying clean utensils following sanitization.

(6) Equipment and utensils will be flushed or scraped and, when necessary, soaked to remove gross food particles and soil prior to being washed in a dishwashing machine unless a prewash cycle is a part of the dishwashing machine operation. Equipment and utensils will be placed in racks, trays, or baskets, or on conveyors in a way that food-contact surfaces are exposed to the unobstructed application of detergent wash and clean rinse waters and that permits free draining.

(7) Machines using chemical for sanitization may be used provided that they meet the requirements of NSF Standard 3 for chemical sanitization, and:

(a) The temperature of the wash water is not less than 120°F (49°C).

(b) The wash water is kept clean.

(c) Chemicals added for sanitizing purposes are automatically dispensed and an alarm system is provided to indicate that the feed has been interrupted.

(d) Utensils and equipment are exposed to the final chemical sanitizing rinse in accordance with the manufacturers' specifications for time and concentration.

(e) The chemical sanitizing rinse water temperature is maintained within the temperature range specified by the machine's manufacturer.

(f) Chemical sanitizers used must meet the requirements of Title 21 CFR Section 178.1010, and be approved by the manufacturer for use with the machine.

(g) A test kit or other device that accurately measures the mg/l or ppm concentration of the sanitizing solution must be available and used.

(8) Machines using hot water for sanitizing may be used provided they meet applicable NSF standards, and the wash water and pumped rinse water are kept clean and maintained at the temperatures listed in Table 17-1.

Table 17-1. Dishwashing machines and water temperature requirements

	Temperature					
Type	Wash		Final rinse		Pumped rinse	
	°F	°C	°F	°C	°F	°C
Single tank, stationary rack, dual temperature machines.	150	66	180-195	83-91	--	--
Single tank, stationary rack, single temperature machines.	165	74	165	74	--	--
Single tank, conveyor dishwashing, and pot and pan machines.	160	72	180-195	83-91	--	--
Multitank, conveyor dishwashing, and pot and pan machines	150	66	180-195	83-91	160	72
Single tank, pot, pan, and utensil washing machines (either stationary or moving rack).	140	60	180-195	83-91	--	--

(9) Dishwashing machines will be thoroughly cleaned at least daily, and will be operated and serviced as specified by the manufacturer.

c. *Manual Cleaning and Sanitizing.*

(1) For manual washing, rinsing, and sanitizing utensils and equipment, a three compartment sink must be provided and used. Sink compartments must be large enough to accommodate the equipment and utensils. In new construction or renovation, each compartment of the sink must be individually supplied with adequate hot and cold potable running water.

(2) Fixed equipment and utensils, and equipment too large to be cleaned in sink compartments, must be preflushed or prescraped, washed with hot detergent solution, rinsed, and sanitized in accordance with *e* below.

(3) Drainboards or easily movable dish tables of adequate size must be:

(a) Provided for handling soiled utensils to be washed and for cleaned utensils following sanitizing.

(b) Located so as not to interfere with the use of the dishwashing facilities.

(4) Except for fixed equipment and utensils too large to be cleaned in sink compartments, manual washing, rinsing, and sanitizing will be conducted in the following sequence:

(a) Sinks will be cleaned before use.

(b) Equipment and utensils must be preflushed or prescraped, and when necessary, presoaked to remove gross food particles and soil. The preflush water temperature should not exceed 80°F (27°C).

(c) Equipment and utensils must be thoroughly washed in the first compartment with a hot (120-125°F) (49-52°C) detergent solution that is kept clean.

(d) Equipment and utensils must be rinsed free of detergent and abrasives with hot (120-140°F) (49-60°C) clean water in the second compartment.

(e) Equipment and utensils will be sanitized in the third compartment by use of one of the methods below.

- Immersion for at least 1/2 minute in clean, hot water at a temperature of at least 170°F (77°C); OR

- Immersion for at least 1 minute in a clean solution containing at least 50 mg/l free available chlorine as a hypochlorite at a temperature of at least 75 °F (24°C), but not more than 110°F (43°C); OR

- Immersion for at least 1 minute in a clean solution containing at least 12.5 mg/l of available iodine and having a pH of 5.0 or below at a temperature of at least 75°F (24°C), but not more than 110°F (43°C); OR

- Immersion in a clean solution containing any other chemical sanitizing agent allowed under Title 21 CFR 178.1010 that provides the equivalent bactericidal effect of a solution containing at least 50 mg/l of available chlorine as a hypochlorite at a temperature of at least 75 °F (24°C) for 1 minute (some chemical disinfectants have maximum safe use temperatures noted on label instructions that must be followed); OR

- Treatment with steam that is free from materials or additives other than those specified in Title 21 CFR 173.310 in the case of equipment too large to sanitize by immersion, but in which steam can be confined; OR

- Rinsing, spraying, or swabbing the equipment or utensil with a chemical sanitizing solution of at least twice the strength required for that solution when used as an immersion sanitizer.

(5) When hot water is used for sanitizing, the following facilities must be provided and used:

(a) An integral heating device or fixture installed in, on, or under the sanitizing compartment of the sink, capable of maintaining the water at a temperature of at least 170°F (77°C).

(b) A numerically scaled indicating thermometer accurate to +3°F, convenient to the sink for frequent checks of water temperature.

(c) Dish baskets of such size and design to permit complete immersion of the tableware, kitchenware, and equipment in the hot water.

(6) When chemicals are used for sanitization, they will be used in accordance with labeled instructions and will not have concentrations higher than the maximum permitted under Title 21 CFR 178.1010. A test kit or other device that accurately measures the mg/l concentration of the solution must be provided and used for measuring sanitizer concentration.

d. Drying. After sanitization, equipment and utensils must be completely air dried. A drying area will be provided for racks coming out of the dishwashing machine to permit air drying. Use of dish towels is prohibited.

e. Emergency Procedures. When requirements for washing and sanitizing utensils as specified cannot be met, single-service utensils will be used. An adequate supply of liquid concentrate chemical sanitizers meeting the provisions of Title 21 CFR 178.1010 will be maintained at all food service facilities to meet chemical sanitizing requirements and serve as a backup sanitizing system where hot water is used as the primary system. Commercially available products that are EPA-registered and labeled for use on food-contact surfaces will be procured to meet this requirement in garrison-type operations. Because of increased costs and limited shelf life, when compared with liquid commercial concentrate products, Disinfectant, Food Service will be used only for field operations. Sanitizers and disinfectants must be used IAW labeled instructions.

f. Handling. Cleaned and sanitized equipment and utensils will be handled in such a manner that protects them from contamination. Spoons, knives, and forks will be touched only by their handles. Cups, glasses, bowls, plates, and similar items must be handled without contact with the inside surfaces or surfaces that contact the user's mouth.

g. Storage.

(1) Cleaned and sanitized utensils and equipment will be stored at least 6 inches (15 cm) above the floor in a clean, dry location in a way that protects them from splash, dust, and other possible sources of contamination. The food-contact surfaces of fixed equipment must also be protected from contamination. Equipment and utensils will not be placed under exposed

sewer lines or water lines, except for automatic fire protection sprinkler lines. Sprinkler lines must be wrapped to prevent condensate from developing.

(2) Utensils will be air dried before storage or stored in a self-draining position.

(3) Glasses and cups will be stored inverted. Other stored utensils must be covered or inverted, wherever practical. Facilities for storing knives, forks, and spoons must be designed and used to present the handle to the employee or consumer, unless the items are prewrapped.

h. Single-service Articles.

(1) Single-service articles must be stored at least 6 inches (15 cm) above the floor in closed cartons or containers that protect them from contamination.

(2) Single-service articles will be handled and dispensed in a manner that prevents contamination of surfaces that may come in contact with food.

(3) Single-service knives, forks, and spoons packaged in bulk will be inserted into holders or be wrapped by an employee who has washed his hands immediately prior to sorting or wrapping the utensils.

(4) Straws must be individually packaged or otherwise dispensed in a sanitary manner.

(5) Single-service articles will not be reused.

i. Prohibited Storage Area. The storage of food service equipment, utensils, or single-service articles in toilet rooms or vestibules is prohibited.

17-16. Sanitary Inspection of Food Service Operations

For a guide for sanitary inspection of food service operations at a fixed installation see TB MED 530.

Section IV. SANITATION IN FIELD FOOD SERVICE

17-17. General

The main differences between field kitchens and garrison kitchens is the type and amount of equipment available for use, the conditions under which the equipment must be operated, and the manner in which the troops must be fed. In the field, no well-equipped kitchens or food service areas are provided. Frequently, meals must be prepared and served in the open in all kinds of weather. The storage and sanitary facilities provided for a fixed kitchen is lacking. Nevertheless, the field kitchen must meet sanitary requirements. Kitchen personnel must ensure that food does not become contaminated with pathogenic organisms. Their main objectives must be to —

- Use food that comes from an approved source only.
- Prevent contamination during storage, preparation, and serving.
- Prevent the growth of organisms which cause food-borne illness or spoilage.
- Prepare meals which are safe to eat and palatable.

17-18. Protection of Food During Transportation

During the field operation, the unit kitchen may be supplied with subsistence from a nearby installation, railhead, truckhead, air drop, or local procurement. Usually, the unit will pick up its food at a ration breakdown point where it is first inspected by a veterinarian or his representative. Regardless of the source, some transportation is required to get the food from the supply point to the kitchen. The vehicles used for transporting food must be clean and completely enclosed. Vehicles used to transport garbage, trash, petroleum products or other materials by which food might become contaminated must be thoroughly cleaned before transporting the food. Each unit must secure clean tarpaulins, boxes, or bags for protecting food from exposure, handling, or contact with contaminating objects. The officer who issues food supplies will report sanitary violations to the commander of the unit concerned. Vehicles used for transporting bulk quantities of meat and dairy products over considerable distances must be refrigerated.

17-19. Inspection of Food

When food is received at the dining facility, it must be inspected by the NCOIC or other permanent food service personnel for visual defects such as abnormal shape, color, and odor to determine whether it is fit for consumption. If the food appears to be unfit for human consumption, a notation is made on the field ration issue slip, or any other receipt which accompanies the food; contact the veterinary personnel and request inspection of the questionable food. If veterinary personnel find the food unfit for consumption, they direct the dining facility personnel to return the food to the delivering source or supplier with a request for immediate replacement. Food service personnel will not throw out or otherwise destroy food suspected of being unfit for consumption until authorized by the veterinarian. If the amount of food rejected by the kitchen upon delivery is of such quantity to cause an appreciable reduction in the amount of food for the soldiers, the consolidating headquarters or other issuing agency will be notified immediately so that replacements can be made in time to allow for meal preparation. Forced issue items may not be rejected. Inspection of semiperishable and perishable food items to ensure that they are in good condition will be accomplished as follows:

a. Semiperishables.

(1) *Dry stores.* Dry stores such as cereals or sugar are inspected for signs of having been exposed to greasy substances or excessive moisture. If the container is discolored, it will be opened for verification of the condition.

If the condition is unsatisfactory, it may be necessary to reject the entire issue. If the condition is satisfactory, the container will be closed and stored immediately. Containers which are open upon receipt will be returned to the source of supply for replacement unless it is obvious that they were opened for the purpose of ration breakdown.

(2) *Inspection of canned foods.* Canned foods are examined carefully for faulty containers. Spoilage of food within a can is usually indicated by some deformity or abnormality in the can itself. Normal cans have sunken ends. Defective cans, which are easy to detect, may be classified into the three types below. All three of these types must not be used unless they pass inspection by a qualified person of the Medical Department.

(a) *Leaker.* This can has a defect which allows air to enter it or the contents to leak out.

(b) *Sweller.* This can bulges at the sides and the ends.

(c) *Bulger.* This can has one end bulged.

b. *Perishables.*

(1) *Frozen food items.* When frozen food items are received at the kitchen, they are inspected for firmness and for signs of having been thawed and refrozen. When a frozen food package is hard on one side and yields easily to pressure on the opposite side, the food has most likely been thawed and partially refrozen. It should, therefore, be inspected by veterinary personnel before it is used. If the package is firm on both sides, good condition is indicated. After inspection, frozen food items must be stored immediately in a frozen food cabinet, refrigerator, ice chest, or underground food box, depending upon the kitchen facilities.

(2) *Fresh fruits and vegetables.* Fresh fruits and vegetables are inspected for mold, rot, or other defects. The good items are separated from the bad ones and refrigerated immediately, if necessary.

(3) *Meat, fish, and poultry.* Frozen meats are checked to see that the markings on the wrappers and general shapes of the packages indicate that the meats are of the cut and type listed on the field ration issue slip and required for preparing menu items. Meat as well as fish and poultry must be inspected for odor, color, and presence of slime. Odors should be mild, color should be normal, and no slime should be present.

(4) *Milk.* The temperature of milk must be 50°F (7.22°C) or below when delivered to the kitchen. Containers must be free of grease or dirt. Leaky containers will be rejected. Bulk milk containers must be delivered with both the seals intact and with valves and all rubber or synthetic parts such as milk delivery tubes protected from contamination. After the containers have been inspected, the milk must be refrigerated immediately. Milk cartons are code-dated and food service personnel must ensure that the "first-in, first-out" principle is employed.

17-20. Storage of Food

Adequate provisions must be made for storing both perishable and semi-perishable food items. Garrison food service storage procedures should be followed as closely as possible.

a. Perishables. Some units are fortunate in having a refrigerator and a generator as part of their equipment. When mechanical refrigeration is not available, improvised facilities for storage of perishables must be provided:

(1) *Iceboxes or ice chests.* Iceboxes or ice chests are used when mechanical refrigerators are not available. If the unit is operating in a building, the drains from these boxes or chests must not be connected directly to the sewers, as sewage could back up into them. It is difficult to maintain a temperature below 45°F in an icebox; however, every effort should be made to keep the temperature below 50°F. For sanitation requirements of ice used in the operation of iceboxes or ice chests; refer to *c* below.

(2) *Underground food box.*

(a) The underground food box (Figure 17-5) is satisfactory for storing perishables for a short period of time. The simplest type of underground box is the single wall type. It consists of a packing box or crate placed in a hole in the ground. Earth is packed tightly between the outer walls of the box and the walls of the hole. The top of the box can be made into a door. The underside of the top should be lined with canvas or similar material to make the box airtight. A double-walled box may be constructed by placing a small box inside a larger one. Holes are cut in the bottom of the larger box, and its outer walls covered with waterproof material. The top can be converted into a door and equipped with hinges. The hole in which the larger box is to be placed is dug a little larger than the box. The bottom of the hole is covered with a level layer of loose rock and gravel. After the larger box is lowered into the hole, the smaller box is placed inside it. The space between the walls of the two boxes is filled with straw, sawdust, or leaves, which must then be kept damp. The space between the walls of the boxes should be 3 to 4 inches.

(b) The natural refrigeration provided by subsurface storage can be supplemented by thawing frozen meats within the storage space. Frozen meats will help refrigerate other perishables during the 24-hour period required for the frozen meats to thaw. If ice is available an ice compartment should be constructed in one end of the box in such a way that water from the melting ice will not come in contact with the food. If an ice compartment cannot be constructed, food items within the storage space must be protected from contact with the ice and water from the melting ice. The temperature in ice boxes or improvised cool boxes cannot be controlled. The ice or frozen food items within a box will cool its contents only so much. Therefore, the box should only be opened for very short periods of time to remove items to be prepared. It serves no useful purpose, therefore, to require a thermometer in the box or that kitchen personnel maintain temperature charts.

(c) Normally, units in the field will not have to store large quantities of food in the food service facility. For units close to the front lines,

rations will be delivered daily and prepared and distributed shortly after they are received. In semipermanent installations where a limited reserve must be kept on hand, the dining facility probably will have to store issues of rations for 24 hours and in some instances for several days. Regardless of whether mechanical refrigeration or a cool box is used, perishable rations must be controlled so that no item remains in storage long enough to deteriorate or spoil. This requires a definite plan for rotating rations so that older rations are used first. If the situation and resources permit, more than one refrigerator or cool box should be provided. Since kitchens are issued supplies in a unit for preparing menus for an entire day, it is more practical to store supplies as a unit than to separate the components. One day's perishable rations could be stored together in a separate box or refrigerator. If this is not possible, the new rations must be stored under or behind older rations. If possible, odor-imparting foods and odor-absorbing ones should be segregated.

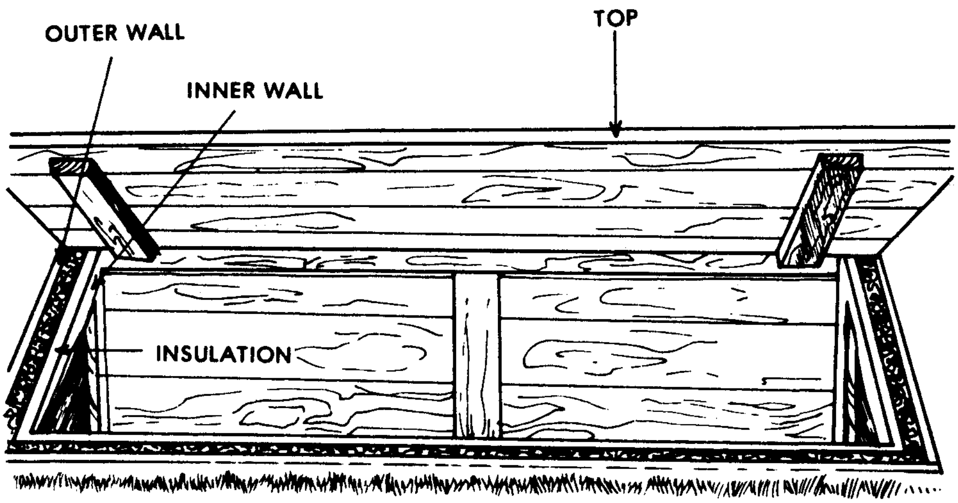


Figure 17-5. Underground food box.

b. Semiperishables. Even though semiperishable items are more durable than perishable ones, they must be stored with the utmost care. Improper storage can result in loss from rodent or insect infestation and from deterioration because of damage from heat, excessive moisture, or freezing.

(1) The seat and truckbed of the kitchen truck (Figure 17-6), can be used for storage. Some items can be stored in selected open areas near the kitchen. These items must be placed on dunnage to allow free circulation of air and to prevent them from becoming contaminated with dirt or moisture.

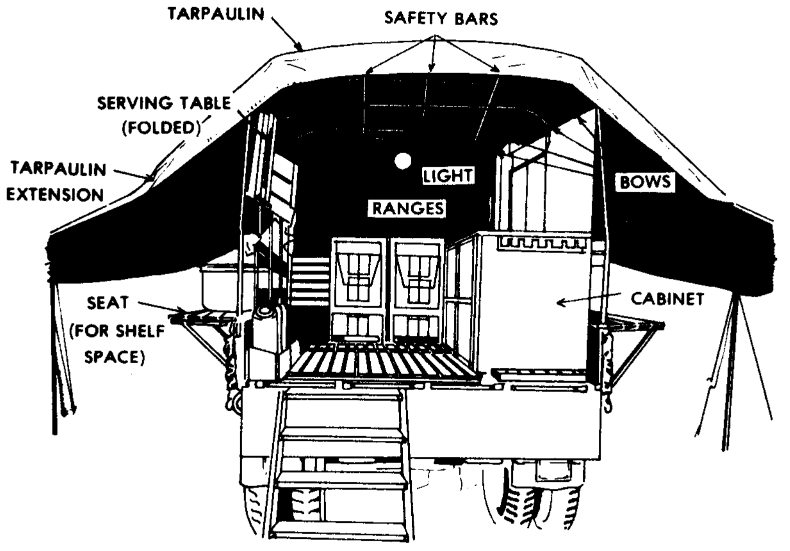


Figure 17-6. Kitchen erected in truck with truck tent fly.

(2) A suspended food box (Figure 17-7) may be used to keep semiperishable items, such as bread, for a short period of time. This is a screened box constructed to allow free air circulation without permitting the entrance of insects and rodents. It must not be used when a considerable amount of dust is in the air. Before food is placed in a suspended food box, it must be wrapped or covered.

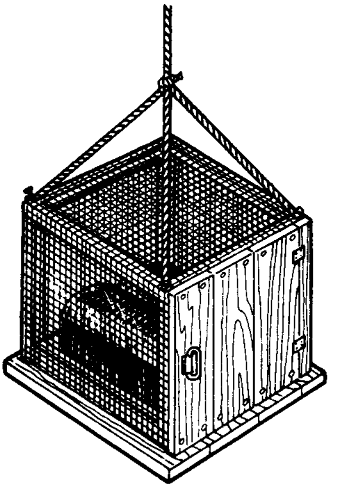


Figure 17-7. Suspended food box.

c. Requirements for Sanitation of Ice. Ice must be made from only potable water. Freezing water does not purify it. Ice used by the Army must be made in facilities approved by the Medical Department. Furthermore, ice must be protected from disease-producing organisms, debris, and trash. Washing the exterior of ice which has become contaminated from improper handling or storage does not make it sanitary. Since ice is porous, disease-producing organisms can penetrate the ice cake.

17-21. Preparing and Serving of Food

a. General. While it is desirable to make food as attractive as possible, it is more important to ensure that sanitary methods are used in preparing and serving food. One of the prime responsibilities of a food service facility supervisor is to train food handlers in the use of sanitary methods in handling food. Conveniently located, well-kept handwashing facilities for food service personnel are an absolute necessity in every kitchen. Handwashing after going to the latrine must become an unfailing practice. Anyone that leaves the food service facility must wash his hands when he returns.

b. Raw Fruit and Vegetables. Fruits and vegetables which are to be eaten raw must be washed thoroughly in potable water before serving. This applies especially to fruits and vegetables contaminated with insecticides or through handling in market places and to leafy and root vegetables, such as lettuce, celery, cabbage, carrots, radishes, and fresh onions, as they are usually contaminated with germs from the soil. Furthermore, in some areas of the world human waste is used as a fertilizer. If it becomes necessary to service produce grown in such areas, it must first be washed in potable water and thoroughly disinfected by one of the following methods:

(1) Immerse them in 160°F water for 1 minute;

(2) Immerse them in a solution of Disinfectant, Food Service, for 30 minutes;

(3) Immerse them in a 250 mg/l chlorine solution for 30 minutes.

c. Food Service Disinfectant Preparation. The water used for preparing the disinfectant solution should be from a potable source.

(1) If possible, use Disinfectant, Food Service, as specified on the label.

(2) In an emergency, use three level mess kit spoonsful of calcium hypochlorite in 32 gallons of water or use one canteen cup of 5 percent liquid chlorine bleach in 32 gallons of water.

d. Milk. Fresh milk used by the Army must be pasteurized. It must be procured only from dairies approved by the Medical Department. Milk is an ideal culture medium for germs. When the temperature of milk is above 45°F, germs will grow and multiply rapidly. It is therefore necessary to observe the strictest sanitary control in the handling of milk. Milk for beverage purposes should be served in the original containers (1/2 gallon or smaller) as received from the distributor or from a bulk container through an approved dispenser. Unused milk left either in the opened original container (1/2 gallon or smaller) or in an individual's drinking receptacle must be disposed of as food waste.

e. Hash, Chopped Meats, Cream Mixtures, and Salads.

(1) *Preparation.* These foods require considerable handling in their preparation and the chances for contamination are greatly increased. Food service personnel who prepare these foods must take special care to cleanse their hands with soap and warm water immediately before they handle the ingredients. Whenever possible, touching the food with the hands should be avoided. Suitable utensils such as spoons, forks, tongs, and knives should be used to avoid direct contact with the hands. Items which readily support bacterial growth, such as locally prepared sauces, mayonnaise, salad dressings, ham salad, chicken salad, cream filling, cream sauces, custards, and hash (corned-beef excepted) will not be prepared more than 3 hours before serving and always as near serving time as possible. Such foods must not be held over from one meal to another. The ingredients of sandwiches made for box lunches will not contain sauces, mayonnaise, salad dressing, ground meat, or chopped eggs. Processed meats such as bologna, liver sausage, and spiced meats are acceptable.

(2) *Temperature control.* At normal room temperature the bacteria which cause food-borne illness multiply rapidly. If it is not possible to prepare foods which readily support bacterial growth just before serving time, its temperature must be controlled. Food which is to be served cold must be cooled to a temperature of 45°F or below. Food will cool faster if it is placed in shallow pans. Food which is to be served hot must be kept at a temperature of 140°F or above.

f. Cooked Food Items.

(1) *General.* The best safeguards against getting sick from food are thorough cooking and immediate serving. With the exception of those foods which contain chemical poisons or the very common staphylococcus toxin, food can usually be made safe to eat by thorough cooking. It is necessary, however that all parts of the food be heated close to boiling temperature.

(2) *Cooking time and temperature for meat products.* The cooking time and temperature for meat products must be such as to ensure that the center of the meat is adequately cooked. For beef, this can be achieved by cooking it at an oven temperature of 325°F until the thermometer, inserted into the thickest part of the meat, registers 140°F (rare), 160°F (medium), or 170°F (well done). Pork must be cooked at an oven temperature of 350°F until the thermometer, also inserted into the thickest part of the meat, registers 150°F. The longer cooking time for pork is necessary because of the danger of trichinosis, a disease caused by tiny parasitic worms. If meat juices and drippings are saved, they must be refrigerated and then used as soon as possible. Seafood and fowl must also be thoroughly cooked.

(3) *Fowl and meat dressings.* Dressing must not stand at room temperature. It must be prepared just before it is to be cooked and handled as little as possible. Dressing is easily contaminated in preparation. It should be

cooked in shallow pans separately from the carcass. Unless the dressing is to be eaten within 3 hours after it is cooked, it must be refrigerated.

g. Acid Foods. Acid food and beverages such as a citrus fruit drink must NEVER be stored or served in galvanized iron cans; they are capable of dissolving the zinc which will produce chemical poisoning.

h. Leftovers. Meals should be planned so that there is a minimum of leftover food. In the absence of mechanical refrigeration, food left from a meal will not be kept. Even with mechanical refrigeration, foods of the type described in *c* above should never be held from one meal to the next. Other foods must be refrigerated immediately and then not held for more than 24 hours. The only exception to this policy is semiperishable food such as fresh fruit, vegetables and other foods not requiring refrigeration and not subjected to contamination.

17-22. Cleaning Kitchen Facilities

a. General. No one wants to eat from a dirty mess kit. Food particles which are allowed to remain on utensils or anywhere in the food service facility may serve as breeding places for germs. This is the reason for stressing the importance of thoroughly cleaning food service facilities and utensils.

b. Cleaning Food Service Facilities. Floors, tables, ranges, and refrigerators must be kept clean. Covered cans must be placed at convenient places in the kitchen to collect wastes. If the kitchen is in a tent, the ground and surrounding area must be well policed.

(1) *Ranges.* Ranges will be cleaned after each meal; otherwise dirt and grease will accumulate and be baked onto the metal.

(2) *Refrigerators.* Refrigerators must be cleaned frequently with soap and hot water.

(3) *Tables.* Tables, both in the kitchen and the dining area, will be scrubbed after use. Furthermore, tables should have solid tops without cracks or crevices in which food particles can lodge. If material for solid tops is not available, the tops should be made of smooth boards.

c. Cleaning Cooking, Serving, and Eating Utensils. Two procedures which may be used by kitchen personnel in cleaning the cooking, serving, and eating utensils are below:

(1) Procedure to clean cooking and serving utensils when hot water is available:

(a) Scrape utensils free of food particles.

(b) Wash utensils in warm water containing soap or detergent.

(c) Rinse utensils in hot clear water.

(d) Disinfect utensils by immersing them in clear water of 180°F for 30 seconds. If a thermometer is not available, heat the water to the boiling point.

(e) Allow the utensils to air-dry in a place where they are protected against dust, splash, and other sources of contamination.

(2) Procedure to clean cooking and serving utensils when hot water is not available:

(a) Scrape utensils free of food particles.

(b) Wash utensils in water containing soap or detergent.

(c) Rinse utensils with potable water.

(d) Disinfect utensils by immersing them in a chlorine-water solution for at least 30 seconds. This solution is prepared using Disinfectant, Food Service in accordance with the instructions on its container. If this disinfectant is not available, an emergency solution can be prepared by mixing at least one level mess kit spoonful of calcium hypochlorite to each 10 gallons of water (250 mg/l). If liquid chlorine bleach is available, it may be used. About one-third canteen cup of 5 percent chlorine bleach to each 10 gallons of water will provide the same disinfecting strength. Fresh chlorine-water solutions must be made for rinsing and disinfecting utensils for each 100 persons.

(e) Allow the utensils to air-dry in a place where they are protected against dust, splash, and other sources of contamination.

(3) *Individual cleaning of mess kit.* In the field each individual cares for his own mess kit. Proper washing is important; otherwise food particles will remain and become breeding places for disease germs.

(a) *Equipment required.* Four corrugated cans (Figure 17-7) or similar containers, placed in a row, are required for washing mess kits. The first can is used for scraping food particles from the mess kit. Enough water is placed in each of the last three cans to allow at least one quart of water per man, or one wash line of four cans is provided for every 80 men. Large food service facilities may require several washing lines. The second can contains hot water (120°F to 150°F) with soap or detergent; the third and fourth cans contain clear water which is kept boiling throughout the washing period. A long-handled washbrush is also needed. If a water heating device is not available or cannot be improvised, the procedure for using a Disinfectant, Food Service solution should be followed.

(b) *Procedure for cleaning mess kit.*

- Scrape the food particles from the mess kit into the garbage can.

- Wash the kit in the first container of hot (120° to 150°F) soapy water, using the long-handled brush.

- Rinse the kit in the second can of boiling clear water by dripping it up and down several times.

- Disinfect the kit by immersing it in the third container of boiling clear water for 10 seconds.

- Shake the kit to remove the excess water and allow it to dry in the air; then close the kit to keep out dust and vermin.

(c) Rewashing of mess kit prior to use. If a mess kit becomes soiled or contaminated between meals, it should be rewashed prior to use as described above.

(d) When desirable to preheat utensils prior to the meal, a corrugated can with clear boiling water may be placed near the start of the serving line. It is important that such water be maintained at a rolling boil throughout the meal service period.

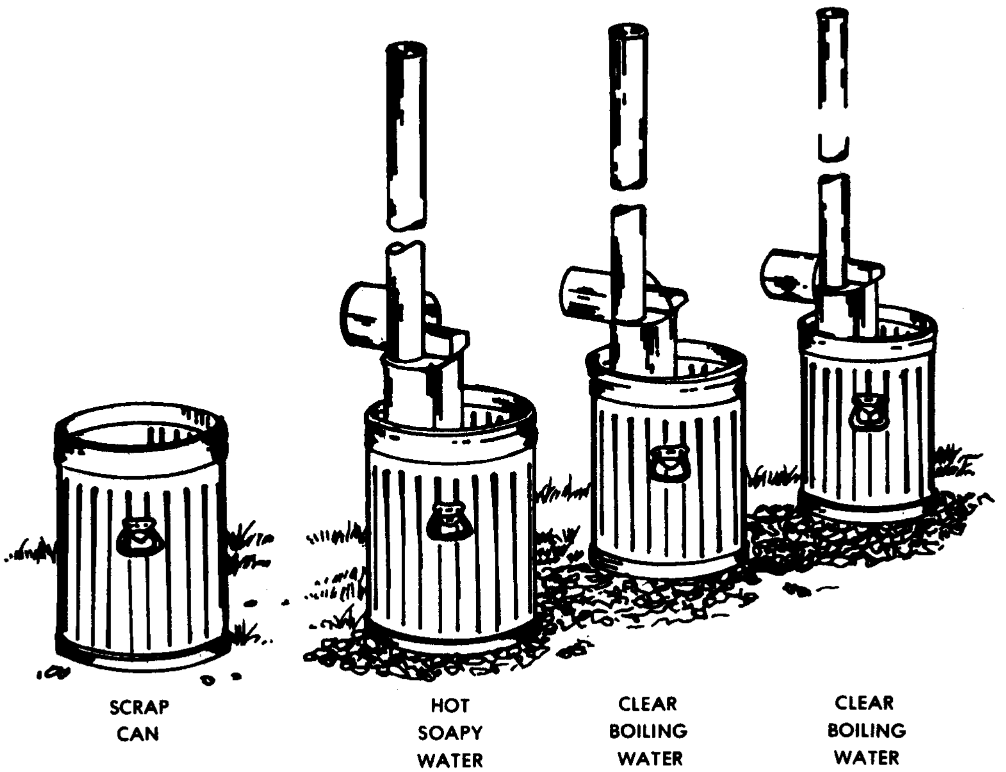


Figure 17-7. Mess Kit Laundry.

17-23. Sanitary Inspection

A guide for sanitary inspection of a field food service facility is provided in Appendix G.

Section V. SANITARY CONTROL OF OTHER ESTABLISHMENTS

17-24. General

In the constant battle against food-borne diseases, sanitary inspections of food service establishments located on military installations are just as important as inspections of Army dining facilities. Such food service establishments may include but not be limited to snackbars, Officer's and NCO clubs, cafeterias, school cafeterias, and vending machines. In addition, the sanitary inspector may be required to conduct off-post inspections of civilian bars and restaurants. In each of these establishments, the inspector may be confronted with problem areas not usually found in the unit dining facility.

17-25. Exchange Cafeterias

a. Cafeteria is defined as a food outlet designed primarily for the sale of complete meals. The meals are either prepared at the cafeteria or at a central kitchen and supplied to the cafeteria. The foods served in an exchange cafeteria must meet the same sanitary standards as those served in a unit facility; they must conform to or exceed the minimum grade specifications established by the Department of Defense for troop feeding. In order to ensure that foods purchased by a cafeteria meet the federal and military specifications, the management of the exchange activity is encouraged to purchase foods from commissaries to the maximum extent possible; these foods have been inspected by the military veterinary service.

b. Exchange officers are required to compare commissary prices of foods with commercial prices every 3 months as a basis for adding or deleting items from commissary purchases. This enables the exchange to purchase foods at the lowest possible price. Commercial (civilian) sources from which the exchange purchases foods must meet the same sanitary standards mentioned in *a* above. The sanitary inspector must, therefore, ensure that these commercial sources are listed in the "Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement." The approved sources are listed in this directory by localities or areas, such as Army areas in CONUS, USAREUR, and Korea.

c. The procedure for conducting a sanitary inspection of an exchange cafeteria and for a unit dining facility is the same (paragraph 17-16), except that additional attention must be given to the sources of supply, proper cleaning of dishes and utensils during rush hours, proper temperature control of foods served, and care and use of leftovers.

(1) Cleaning dishes and utensils during rush hours will be a major problem when the facility being inspected does not have enough plates, cups, and other dishes to serve the customers. This shortage may manifest itself in several ways: clearing tables before customers are completely finished; crashing and banging utensils in the dishwashing area; providing customers wet dishes and utensils; and keeping customers waiting in line for dishes or utensils. Rapid dish and utensil washing usually results in their being inadequately disinfected.

(2) Food temperature control is vitally important in a cafeteria with long service hours. Special methods must be used to ensure that hot foods

are kept hot and that cold foods are kept cold over a long period of time. A scoop of potato salad in a small dish placed upon a bed of ice, for example, is not kept at the needed temperature. That portion of the salad in contact with the plate will be the temperature of the ice, but the top portion of the salad will be close to room temperature. The sanitary inspector must be able to recognize such improper practices and to recommend effective temperature control methods. For example, the potato salad should be kept refrigerated; and individual portions served as they are ordered.

(3) Care and use of leftovers require special attention of an inspector because cafeteria personnel are reluctant to discard food they mistakenly feel is good. Since enterotoxin-producing staphylococci take about 4 hours at room temperature to produce sufficient toxin to cause severe symptoms, 3 hours should be considered as the safe limit to allow foods to remain unrefrigerated. Furthermore, the time is cumulative; 2 hours one time at room temperature and 2 hours later, even with intermittent refrigeration, equal a total of 4 hours of exposure.

17-26. Mobile Food Units

a. Requirements. Mobile food units including pushcarts, except as specifically provided in this paragraph, must comply with all requirements of TB MED 530 manual. The IMA may impose additional requirements, to include prohibiting the sale of some or all PHFs if deemed necessary, to protect consumers against health hazards related to the conduct of mobile food service operations.

b. Restricted operations.

(1) Restricted operations are mobile food units that are limited to the preparation of frankfurters or other similar sausages and non-PHFs.

(2) Mobile food units may serve PHFs that—

- have been prepared, transported, and served under conditions meeting the full requirements of TB MED 530; and
- are packaged in individual servings.

(3) These restricted operation units need not comply with the requirements below pertaining to the necessity of water and liquid waste systems, nor to those requirements pertaining to the in-unit equipment and utensils cleaning and sanitizing. The requirements only apply if the equipment required for cleaning and sanitizing exists at the servicing facility.

c. Single-service Articles. Mobile food units are required to use or provide to the customer single-service articles.

d. Beverages. Only those beverages that are not PHFs will be dispensed. Beverages will be dispensed from individual containers, covered urns, or other similarly protected systems. The use of dippers is prohibited.

e. Ice. The use of chilled, canned, or carton drinks is preferred to the use of drinks to which ice is added.

(1) Only potable ice is used for consumption.

(2) Ice used for cooling foods, beverage lines, or canned drinks will not be offered to the consumer.

(3) Mobile food units that provide ice for consumption and/or self-service by the customer will be equipped with and use covered self-draining ice bins. Ice scoops will be provided. Scoops will be stored outside the ice bin and be protected from contamination.

f. Water System. A mobile food unit requiring an on board water system will have potable water under pressure. The system must be of sufficient capacity to furnish enough hot and cold water for preparing food, cleaning and sanitizing utensils, and handwashing.

g. Waste Retention. If liquid waste results from the operation of a mobile food unit, the waste must be stored in a permanently installed retention tank that is of at least 50 percent larger capacity than the water supply tank. Liquid waste will not be discharged from the retention tank when the mobile food unit is in motion. Connections on the vehicle for servicing mobile food unit waste disposal facilities must be of different size or type than those used for supplying potable water to the mobile food unit. The waste connection must be located lower than the water inlet connection to preclude contamination of the potable water system.

h. Flushing Retention Tanks. Provisions must be made for the retention tank to be thoroughly flushed and drained during the servicing operation. Liquid waste will be discharged to a sanitary wastewater system. The systems must be drained, cleaned, and disinfected at least weekly. Disinfect by filling the system with a 100 ppm free available chlorine solution and holding for 1 minute. Drain and rinse with potable water.

i. Storage Units. Adequate hot and chilled food storage units must be provided.

(1) Refrigeration units must meet the requirements outlined in TB MED 530. However, the use of ice chest cold storage units may be authorized by the IMA.

(2) Hot food holding facilities must meet the general requirements outlined in TB MED 530.

(3) Metal stem-type thermometers must be readily available and used to ensure the proper holding temperatures for PHF.

(4) PHF must be:

- Kept at an internal product temperature of 45°F or below or at an internal product temperature of 140°F or above.

- Prechilled or preheated at the servicing facility to the required internal product temperature before placement in the mobile food unit.

(5) Wet storage of food is prohibited.

(6) The storage of wrapped sandwiches in direct contact with ice is prohibited.

j. Operations. Mobile food units or pushcarts must operate from a servicing facility and must report at least daily to such location for supplies and for cleaning and servicing operations.

k. Servicing Facility.

(1) *Construction.* The servicing facility must be constructed and operated as outlined in TB MED 530.

(2) *Special requirements.*

(a) A separate mobile food unit servicing area must be provided and include at least overhead protection from inclement weather during resupply, cleaning, and servicing operations. A location must be provided for—

- flushing and draining liquid wastes separate from the location(s) provided for water servicing;
- loading and unloading food and related supplies; and
- cleaning and sanitizing mobile food trucks and equipment.

(b) This servicing area is not required where only packaged food is placed on the mobile food unit or pushcart or where mobile food units do not contain waste retention tanks.

(c) The surface of the servicing area must be—

- constructed of a smooth, nonabsorbent material such as concrete or machine-laid asphalt; and
- maintained in good repair, kept clean, and be graded to a drain.

(d) Potable water servicing equipment must be—

- installed in accordance with applicable plumbing codes; and
- stored and handled in a way that protects the potable water supply and equipment from contamination.

l. Servicing Operations.

(1) Mobile food unit food-contact surfaces must be cleaned and sanitized as stated in TB MED 530.

(2) The mobile food unit liquid waste retention tank, where used, will be thoroughly flushed and drained during the servicing operation. All liquid waste will be discharged to a sanitary wastewater system.

17-27. Temporary Food Service Facilities

a. Requirements. Except as otherwise provided in this section, temporary food service facilities must comply with the requirements of TB MED 230. Temporary food service facilities will be inspected and approved by the IMA prior to the start of operations. The IMA may—

- impose additional requirements to protect public health;
- prohibit the sale of some or all PHFs; or
- waive or modify these requirements when no health hazard is likely to result. An example would be waiving requirements for screens and doors when no hazard exists from flies contaminating food.

b. Restricted Operations. Restricted operations are those temporary food service facilities where only PHFs requiring limited preparation, such as hamburgers and frankfurters, are prepared or served. The preparation or service of other PHFs is prohibited. This prohibition does not apply to serving any PHF that—

- has been prepared and packaged under conditions meeting the requirements of TB MED 530;
- is obtained in individual portioned containers or packages from approved sources;
- is stored at an internal product temperature of 45 °F or below, or 140°F or above in facilities meeting the requirements of TB MED 530; or
- is served directly in the unopened, individual serving container or package in which it was obtained. Products held at unsafe temperatures will be discarded as food waste in accordance with TB MED 530.

c. Equipment.

(1) Equipment must be located and installed in a way that prevents food contamination and also facilitates cleaning.

(2) Food-contact surfaces of equipment must be protected from contamination by consumers and other contaminating agents. Effective shields for such equipment must be provided to prevent contamination.

d. Single-service Articles. Temporary food service facilities without adequate facilities for cleaning and sanitizing tableware must provide only single-service articles.

e. Water. Enough potable water must be available in the facility for preparing food, and for cleaning and sanitizing utensils and equipment. A heating facility capable of producing adequate hot water for these purposes must be provided on the premises. If adequate hot water is not available, the scope of food service operations will be limited to preparing and servicing foods that do not require equipment and utensil cleaning and sanitizing. As an alternative, authorization may be granted by the IMA for cleaning and sanitizing equipment and utensils at a permanent approved food service facility.

f. Sewage. Sewage, including liquid waste, will be disposed of in a sanitary wastewater system.

g. Handwashing. A convenient handwashing facility must be available for employee handwashing. This facility will consist of at least running water, soap, and individual paper towels, and if approved by the IMA, may be of field expedient design.

h. Floors. When provided, floors must be constructed of concrete, asphalt, tight wood, or other similar cleanable material and be kept in good repair. When approved by the IMA, dirt or gravel may be used as subflooring provided the floors are graded to drain, and covered with clean, removable platforms, duckboards, or other suitable materials effectively treated to control dust.

i. Walls and ceilings of food preparation areas.

(1) Ceilings must be made of wood, canvas, or other material that protects the interior of the establishment from the weather and dust. Walls and ceilings must be constructed in a way that minimizes the entrance of insects. Screening material used for walls, doors, or windows must be at least 16 mesh to the inch.

(2) Counter-service openings will be no larger than necessary for the particular operation conducted. These openings must be provided with tight-fitting solid or screened doors or windows, or otherwise be protected to restrict the entrance of flying insects.

17-28. School Cafeteria Facilities

Schools located on a post for the children of military personnel usually have a cafeteria which provides the noon meal and in some locations breakfast. This facility, in most cases, is managed by an assigned dining facility steward and is operated in much the same manner as a unit dining facility except that it does not operate on Army funds. It is a nonappropriated fund activity and must make a profit in order to continue operating. It must meet the same sanitary standards as other food service establishments located on the post, including the purchase of foods from approved sources.

17-29. Civilian Restaurants on Post

a. The term *post restaurant* is used to designate the medium through which the installation commander provides necessary commercial-type facilities and services for his civilian employees. On posts where both a post restaurant and an exchange are established, the restaurant will be operated predominantly for civilian employees. This is especially true in areas outside CONUS where local civilians do not have access to exchange facilities. Funds obtained through the operation of a post restaurant will be used primarily for expenses incurred in its operations and secondarily for distribution to civilian welfare activities. These funds cannot be used for any other purpose.

b. The sanitary inspector will face unique problems in inspecting a post restaurant. One problem area will be the sources of food supplies. In most cases the restaurant management is not permitted to purchase food from the commissary. In areas outside CONUS, this entails purchasing food from the local civilian markets. These foods may or may not have been inspected by local health authorities. In a situation of this type, the sanitary inspector may recommend that the restaurant be placed off limits to military personnel; or he may inspect the establishment under the provisions of local health codes. If the latter course is chosen, the IMA will determine whether or not the local health codes meet the standards established by Army Regulations. If they do, military personnel may be permitted to eat in the establishment. If not, military personnel must be warned of the possible danger involved in eating in this facility.

17-30. Vending Machines

a. Most automatic vending machines are installed on a military installation by civilian vendors with permission of the post exchange officer (AR 40-5). The vendors are awarded concessions in exchange for a portion of their gross profits. In accordance with Army Regulations, the Post Exchange Officer periodically apportions the funds received from the vendors to the units and organizations whose personnel patronize the machines.

b. The Army Medical Department is responsible for inspecting vending machines and their contents. Both preventive medicine and veterinary personnel may be involved in these inspections. Food, beverages, and ingredients intended for sale through vending machines must be manufactured, processed, and prepared in establishments maintained and operated in a sanitary manner (AR 40-5). Such establishments must be inspected by the IMA and approved by the commander. In most areas the inspection and approval functions are accomplished by veterinary personnel. The names of the approved establishments are published in the "Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement."

c. A large number of health hazards are inherent in the automatic vending of perishable foods and beverages. The machine cannot differentiate between satisfactory and unsatisfactory merchandise; yet no one is present to supervise delivery of the product to the consumer. A power failure may result in improper temperature control of the food in the machine. If the power should return to normal after a long period of time, an unsuspecting customer may purchase an item which may prove injurious to his health. Protection against insect and rodent contamination cannot be guaranteed. No one can say that contamination has not occurred in the machine even though no evidence of insect or rodent damage has been found. To provide the greatest possible protection against contamination of vending machine food and beverages, the Army Medical Department has formulated a strict code for vending machine operations.

d. Preventive medicine personnel encounter many problems when conducting sanitary inspections of vending machines. Sandwich machines present a special problem. Although vendors of these machines are required to supply fresh sandwiches daily, the inspector cannot assume that this will be done. He and the vendors must, therefore, devise some system for date coding the sandwiches placed in the machine. Frequent cleaning and sanitizing is required for machines dispensing fruit juices, liquid soup concentrates, chocolate syrup, and other readily perishable products. Adding fresh products to residuals remaining in the machine is not condoned. The machine must be emptied, cleaned in a sanitary manner, and then refilled. This must be enforced to ensure that bacteria which may be in the residual will not contaminate the fresh product. Products that must be kept cold must be transported by the vendor in refrigerated trucks. A waste disposal system must be provided for paper cups, candy wrappers, chewing gum wrappers, bread crusts, and other waste generated from the use of vending machines. Preventive medicine personnel must be interested not only in the source and delivery of the products and in the care of the machines but also in the vendors themselves. The vendors must practice good personal hygiene principles; otherwise, they can contaminate their products. Furthermore, they must ensure that each vending machine proponent, owner, manufacturer, distributor, or operator in his particular area of responsibility has obtained a certificate showing that each machine, identified by model number and name, complies with the requirements of AR 40-5 or its counterpart, "The Vending of Foods and Beverages — A Sanitation Code and Ordinance, 1965, recommendations of the Public Health Service." The following agencies are engaged in a sanitary evaluation program leading to a certificate of compliance:

(1) National Sanitation Foundation Testing Laboratories, Inc., Ann Arbor, Michigan 48106.

(2) Indiana University Foundation, Research Division, Bloomington, Indiana 47401.

(3) Michigan State University, Department of Microbiology, East Lansing, Michigan 48823.

(4) Other recognized agencies with equivalent testing programs and testing facilities.

17-31. Off-Post Bars and Restaurants

a. The Pvnt med specialist may be called upon to conduct sanitary inspections in a civilian community. His actions, upon receipt of the order, may determine the effectiveness of the entire preventive medicine program as it relates to adjacent civilian community health programs. Should the specialist receive a report which traces an outbreak of food-borne illness among military personnel to an off-post civilian facility, he must not attempt to initiate an epidemiological investigation of his own, since he would only create ill will toward the military and place himself in an awkward position. Civilian food service establishments are not governed by Army Regulations but by local health codes. These codes provide guidance to the inspector and set forth penalties for the improper operation of food service facilities. The local sanitary inspectors have sole jurisdiction over the establishments located in their areas. The military may conduct inspections or investigations only with the cooperation and supervision of these civilian authorities. Since Army Regulations and local health codes do not, in all instances, coincide, the military must use the local health codes when inspecting an establishment in the civilian community.

b. The Pvnt med specialist should establish and maintain a working liaison with civil health authorities in nearby communities, as soldiers must be protected from health hazards both on and off the post. This working relationship will also facilitate action, should it be needed, against civilian establishments to protect the health of military personnel.

Section VI. INVESTIGATION OF SUSPECTED FOOD-BORNE ILLNESS OUTBREAKS

17-32. General

a. Every outbreak of food-borne disease has a cause. Sometimes this cause is a single event; other times it is a chain of multiple events. An outbreak of food-borne illness may have occurred because a food-handler who is a carrier of salmonella organisms failed to wash his hands after using the latrine; because a food handler with a boil on his hand continued to work; or because the turkey was not cooked long enough before it was served. Only through the investigation of these outbreaks can the predisposing circumstances be learned and, even more important, corrected.

b. The investigation of an outbreak of food-borne disease, like the investigation of any other disease, follows the general principles of epidemiology. It proceeds in an orderly fashion from the start to the finish. Some investigators try to take shortcuts only to find that at the end of their investigation they have gathered either too little data or incorrect data. Not being able to go back and obtain the missing data, they are forced to conclude their efforts without determining the cause of the outbreak.

17-33. Responsibilities in an Investigation

In the event of an outbreak of food-borne illness, the commander provides the investigating team with whatever assistance it needs. This team consists of the preventive medicine officer, appointed by the IMA, and other officers and enlisted personnel, appointed by the preventive medicine officer. The team conducts the investigation in accordance with established standing operating procedures.

17-34. Verification of the Epidemic

The first step in a systematic investigation is to verify that an epidemic has occurred. The number of cases of a disease must far exceed the usual incidence. With most acute outbreaks of gastroenteritis, this step presents no problem, as it is obvious that the number of cases far exceed the usual incidence. However, in diseases with a long incubation period and an insidious onset, this is much more difficult to determine.

17-35. Obtain the Presumptive Diagnosis

This task is delegated to a medical officer who bases his judgment upon the clinical picture of the disease; the histories obtained from the patients; and laboratory tests such as stool cultures. The diagnosis is very valuable to the investigation in that it reflects the usual routes by which the disease was contracted. The investigating approach to an outbreak of staphylococcal intoxication, for example, is quite different from that of a salmonella infection because the epidemiology is different. The absence of a diagnosis, however, does not prevent an investigation; it just makes it more difficult.

17-36. Interviews of Ill Persons

a. As soon as possible after obtaining a presumptive diagnosis, the ill persons must be interviewed. The interviewer obtains the ill persons explanations of symptoms they experienced and the date and time each symptom began. With this information and with knowledge of the diagnosis and the average incubation period of the organisms, the interviewer can calculate back and identify the responsible meal(s). The interviewer also obtains from each ill person the place and approximate time each meal was eaten during the previous 72 hours, and the food items consumed at each meal. For an acute outbreak of gastroenteritis, it is usually not necessary to go back further than 72 hours. Also, this is about the limit of recall for most people. Another factor of utmost importance is the names of the people who ate with each ill person. Later, these individuals should also be interviewed even though they did not become ill. Knowing the food items eaten by individuals who did not become ill may help identify the food items which caused the illness. If samples of the stool or vomitus have not already been obtained from the ill persons by the medical officer, they should be obtained for culturing and further information. A sample questionnaire for conducting an interview is provided in Appendix H.

b. The investigating team is constantly looking for a common denominator to the outbreak, such as a particular time when all of the ill persons may have been together or a particular place where all of them may have eaten at different times. Initially, interviews should be limited to only the number necessary to obtain a reasonable idea as to the type of disease involved, the most likely sources(s) of contaminated food, and the meal(s) most likely responsible. Then, the investigation should be further planned, based upon the situation. For example, the number of interviewers needed will depend upon the number of ill persons.

17-37. Inspection of Facilities

a. As soon as the facility that served the responsible meal is identified, it must be inspected. If the investigating team is unable to pinpoint a single facility, the members of this team must conduct additional case interviews to gain further information. In some outbreaks of food-borne illness, it may be impossible to eliminate all but one facility from the list of possible sources. Therefore, those which cannot be eliminated must be inspected. If a civilian establishment is involved, the local health authorities will be notified, as they are responsible for conducting the inspection. A list of items to be placed in a food-borne illness outbreak investigating kit is shown in Appendix I. This kit, made up beforehand, can then be taken to the facility when conducting the investigation. Appendix J shows the method of collecting and shipping food samples for laboratory analysis.

b. Upon arrival at the food service facility, the investigators must first collect samples of as many food items served at the suspect meal(s) as possible. A water sample will also be taken. Since all the samples are to be cultured, the investigator must take sterile bottles and supplies for collecting them. Containers and utensils from the facility must not be used. All containers should have been sterilized by steam under 15 pounds of pressure for 20 minutes. If sterilization is not possible, dry heat at 320°F (160°C) for 4 hours or complete immersion in boiling water for 30 minutes is satisfactory. After each sample is collected, the container is sealed with gummed tape and labeled to identify it with the facility and the date and time of collection. The samples must be refrigerated as soon as they are collected and remain under refrigeration until they arrive at the laboratory for analysis. If the samples must be shipped to the laboratory, the containers must be placed in an insulated container filled with sufficient dry ice to provide refrigeration during transit and labeled "Foods for Bacteriological Examination — Please Rush." Information regarding symptoms noted by the ill persons, the diagnosis if known, and reasons for suspecting a given food are recorded and sent with the samples to the laboratory, as such data are valuable in determining what test procedures and media should be used. Since a considerable amount of preparation is required before the foods can be cultured, the laboratory should also be informed by telephone of the shipment and pertinent data.

c. A menu of the foods served at the suspected meal(s) should be obtained from the food service facility, since it is valuable in formulating a questionnaire for the ill persons. An individual can indicate what he ate at a particular meal more accurately by looking at a list than by recall.

d. Information is obtained in regard to the source of supply of the foods served and the exact manner in which each food item was prepared. The possibility that food items may have been left unrefrigerated or may have been prepared long in advance of serving time must be explored. The temperature in refrigerators are checked to determine whether or not it is below 45°F (7.22°C).

e. The kitchen personnel are inspected to determine if they are dressed in clean light colored uniforms and have suitable head coverings; have clean hands and nails; are free of open sores, boils, colds, or other signs of illness; and use proper hygiene practices. Deficiencies are recorded.

f. The remainder of the inspection is carried out in a routine manner, checking food handlers' certificates and basic sanitation practices for food operations. Suspect foods are restricted until approved by the surgeon.

17-38. Food Questionnaires

A food history questionnaire is formulated from the menus collected during the inspection. Unless strong evidence indicates that a given meal such as a picnic is responsible for the outbreak, all food items served in the food service facility over the past 72 hours is included. The various food items are grouped by meals and listed so that the person being questioned can place a check mark by each food item he ate. The questionnaire must also ask about symptoms likely to have been experienced, such as nausea, vomiting, stomach cramps, diarrhea, headache, muscle aches, and fever as well as the time of onset and duration of each. General information such as the unit is also included. The questionnaire is given not only to those persons who are ill but to everyone who ate in the food service facility or who ate the suspected meal, if these individuals are known.

17-39. Analysis of Data

a. After all necessary inspections have been completed and the food questionnaires have been returned, the final analysis of the collected data begins. The first step, which is usually performed by the preventive medicine officer or another medical officer, is that of setting up the criteria for determining which individuals are considered to be ill with the disease being investigated. This is necessary to exclude those individuals who are ill from other causes or who have a psychologically induced illness.

b. After the determination is made as to which individuals are considered to be ill with the suspected disease and which ones are to be considered well, a tally is made to obtain the total number of people who ate each item of food and the number of these persons who became ill. For each food item, the number of persons who ate it and became ill is divided by the total number who ate it. The resulting figure is multiplied by one thousand. This gives the attack rate per thousand for those persons who ate each food item (Table 17-2).

c. A tally is then made to obtain the number of persons who did not eat a given food item, and the number of these persons who became ill. For each food item, the number of persons who became ill but did not eat it is divided by the total number who did not eat it. The resulting figure is multiplied by one thousand to give the attack rate per thousand for those persons who *did not* eat each food item (Table 17-2).

d. For each food item, the positive or negative difference between the two attack rates (*b* and *c* above) is determined. For example in Table 17-2, the attack rate for persons who ate spinach is 500. The attack rate for persons who did not eat spinach is 406. The difference is 94. The attack rate for persons who ate baked ham is 470. The attack rate for persons who did not eat baked ham is 514. The difference is -44. The item of food with the largest *positive* difference will generally be the food responsible for the outbreak. This is based on the fact that the food item causing the outbreak should have a high attack rate for those who ate it and a low attack rate for those who did not eat it. The food item having the greatest positive difference in Table 17-2 is potato salad. This food item is, therefore, the one responsible for the food-borne illness outbreak.

e. For the attack rate of persons who ate the food item which caused the outbreak to be 1,000 per 1,000 men or 100 percent would be very unusual because many factors are involved. Some of the people who ate the responsible food item may not have ingested enough to produce the disease. Others may have indicated that they ate the food when in reality they did not. It is also possible that some people may not have considered themselves ill because their symptoms were so mild or were attributed to other causes. Likewise, it is possible to have an attack rate greater than zero for persons who did not eat the responsible food item. This results when people who ate the food do not recall having eaten it at the time they filled out the questionnaire. Such an attack rate can also result when some of the persons who ate at the food service facility contract illnesses completely unrelated to the outbreak.

f. Shortcuts must not be taken in the analysis of the data. To accept a food item with the highest attack rate among persons who ate it as being the responsible item is unacceptable. If such a shortcut had been taken in the analysis illustrated in Table 17-2, cake would have been incorrectly identified as the responsible item. Another error would be to conclude that the food item eaten by the greatest percentage of persons who became ill is the responsible item. This may or may not be true.

g. Further analysis is made by use of an epidemic curve. This curve is formed by plotting the time of disease onset of each case on a graph. Should the curve reflect that all persons became ill over a short period of time such as 6 hours, this is strong evidence that the outbreak was due to a single exposure or meal. If the curve shows that the cases occurred over a number of days and the disease is known to have an incubation period of less than 24 hours, the outbreak was probably propagated. A propagated outbreak is one caused by multiple meals or by spread of disease organisms from person to person. From the epidemic curve, the median time of onset of the disease can be calculated. With knowledge of the diagnosis and thus the incubation period and with evidence that the outbreak is due to a single meal, the specific meal responsible for the outbreak can be determined by calculating backwards. On the other hand, if the responsible meal and the median time of onset are known, the median incubation period can be calculated.

17-40. Correction of Causative Factors

a. After identifying the particular food item responsible for the outbreak by use of the epidemiologic method described above, the laboratory findings of the cultured food item samples should be checked for confirmation. If the laboratory findings confirm those obtained by the epidemiologic method, the preparation, handling, and source of the ingredients of the food item should be checked until the source of contamination is discovered.

b. If the outbreak appears to be caused by a disease carrier, all suspected food handlers must be seen by a medical officer. If sanitary defects are found to be responsible, appropriate action must be taken to correct them.

c. After the causative factors are corrected, a report is prepared. This report will include the type of epidemic; the diagnosis if known; the transmitting vehicle; the source of contamination; the epidemiology; and finally recommendations to prevent similar outbreaks from occurring in the future.

Table 17-2. Analysis of Food-borne Disease Outbreak Data

Food items	Number of persons who ate item	Number of persons who became ill	Attack rate per 1,000	Number of persons who did not eat item	Number of persons who became ill	Attack rate per 1,000	Difference between attack rates
Baked ham	230	108	470	74	38	514	-44
Spinach	240	120	500	64	26	406	94
Potato salad	246	142	577	58	4	69	508
Chicken salad	250	130	520	54	16	296	224
Sliced tomatoes	253	127	502	51	19	372	130
Ice cream	201	98	488	103	48	466	22
Fried crabcakes	235	124	528	69	22	319	209
Lemonade	294	142	484	10	4	286	84
Coffee	240	84	350	64	62	968	-618
Cake	170	102	600	134	44	329	271

Section VII. NUCLEAR, BIOLOGICAL, AND CHEMICAL THREAT TO FOOD SERVICE OPERATIONS

17-41. Protection

Food must be protected from nuclear, biological, and chemical contamination. Consumption of contaminated food may cause illness, injury, or death. Some food items may be decontaminated and consumed. However, decontamination is often a difficult and time-consuming process. The following are means of protecting food from nuclear, biological, and chemical contamination.

a. Nuclear. The two types of nuclear contamination are by induced radiation and by fallout. Food will be contaminated by induced radiation only if it is very close to a nuclear blast. Food may be contaminated by fallout miles away from the blast site. Even though food cannot be protected from induced radiation, it is easy to protect it from fallout. Food that is packaged in cans or other sealed containers is not in danger of contamination by fallout so long as it remains packaged. Foods not packaged in this way, such as fresh fruits and vegetables and fresh meat, can be protected from fallout by putting them in sealed containers. Insulated food containers and refrigerators provide excellent protection from fallout. Containers express (CONEX) and other containers, trucks with covered cargo beds, and vans offer some protection. If this type of protection is not available, a canvas tarp or plastic sheet should be placed over the items; this makes the decontamination effort easier.

b. Biological. Biological weapons cause disease by releasing micro-organisms or toxins into the environment. Food may be contaminated by direct contact with the biological agents and by contact with individuals who become sick. Generally, food in sealed, airtight containers may be consumed after the containers have been decontaminated. Stringent sanitation in preparing and serving food should help reduce biological contamination. Since biological agents may be spread by infected insects and rodents, their control is especially important. Also, it is important that food handlers practice good personal hygiene and that persons who are sick do not handle food.

c. Chemical. Chemical weapons release toxic agents in the form of solids, liquids, gases, or vapors. Food may be protected from chemical contamination by placing it in a sealed, airtight container. Containers must be decontaminated before the food is consumed. Table 17-3 shows what protection food packaging materials offer against chemical agents.

Table 17-3. Degrees of Protection Offered by Various Packaging Materials Against Liquid and Vapor Chemical Agents

PROTECTION	VAPOR	LIQUID
Complete	Airtight, sealed glass bottles; sealed metal cans and foils; sealed wooden barrels; earth or sod; and covered chambers	Airtight, sealed glass bottles and metal cans and foils; and earth or sod
Good	Glass bottles, metal containers, waxed paper, multilayer bags, polyester,* polyvinyl fluoride (PVF), nylon,* cellophane,** and aluminized polythene	Glass bottles, metal containers, polyesters,* PVF, cellophane,** Aluminized polythene, and sealed wooden barrels
Moderate	Wooden barrels, crates, cardboard, polythene, polypropylene, and polyvinyl chloride (PVC)*	Cardboard, polythene, polypropylene, PVC,* waxed paper, and multilayer bags
Poor or none	Paper, canvas, and textiles	Paper, canvas, textiles, wooden barrels, and crates

*No protection against lewisite.
**Wet cellophane offers no protection.

17-42. Inspection

a. General. Food or water which is thought to be contaminated by nuclear fallout or biological or chemical agents must be inspected. If the food or water becomes contaminated, it must not be consumed unless it is first decontaminated. Food and water that are free from contamination may be contaminated by contact with contaminated personnel or equipment. So personnel and equipment must be inspected as well. Methods of inspecting food, water, personnel, and materiel for signs of nuclear, biological, or chemical (NBC) contamination are described below.

b. Nuclear. The AN/PDR-27 radiac meter is used to monitor food, water, personnel, and materiel for possible nuclear contamination. This instrument, commonly known as a Geiger counter. To inspect food, water, personnel, or materiel for nuclear contamination, follow the step-by-step directions in the operator's manual. The radiac set provides an audible signal when radiation is present. Read the meter to determine the level of radioactivity. The command will establish what level is acceptable.

c. Biological. Most Army units have no capability to detect the presence of biological agents. The Pvnt med specialist must be aware of the possibility of biological contamination. All food is inspected by veterinary personnel at the supply activity (see FM 8-27), but food may become contaminated after it has been inspected. Food must be inspected for obvious signs of spoilage, such as slime, discoloration, and odor; however, contaminated food may look, smell, and taste normal. If it is suspected that food has been contaminated by biological agents, have the commander request a veterinary inspection. Units should use water from approved sources for food preparation and drinking. If no water from an approved source is available, units must purify any available water before it is used. Food and water may be contaminated by contact with unsanitary equipment or sick food handlers. All food handlers must be inspected at the beginning of every shift; also, food service operations must be inspected to assure that proper sanitation is being practiced.

d. Chemical. Chemical agents can contaminate food and food containers. Most chemical agents will change the taste, smell, or appearance of food as shown in Table 17-4. However, it is important to remember that food may become very poisonous without any change in appearance, taste, or smell. Units should use chemical agent alarms that will detect the presence of toxic chemicals in an area. Also, units should have chemical agent detector kits (Figure 17-8) that will detect and identify agents on food, personnel, and equipment.

Table 17-4. Chemical Agents and Signs of Contamination

AGENT	INFLUENCE ON		
	Taste	Smell	Color
Arsenical Drugs	Acid	Bad	Discolors meat and vegetables
Cyanogen Agents	Bitter	Bad	None
Irritants	Acid	Bad	None
Mustard	Bad	Bad	Discolors meat
Nerve Agents	Bad	None	None
N-Mustards	Bad	Bad	Does not discolor meat
Phosgene	Acid	None	Unknown
Smoke	Acid	Bad	Unknown
White Phosphorus	Unknown	Unknown	Unknown

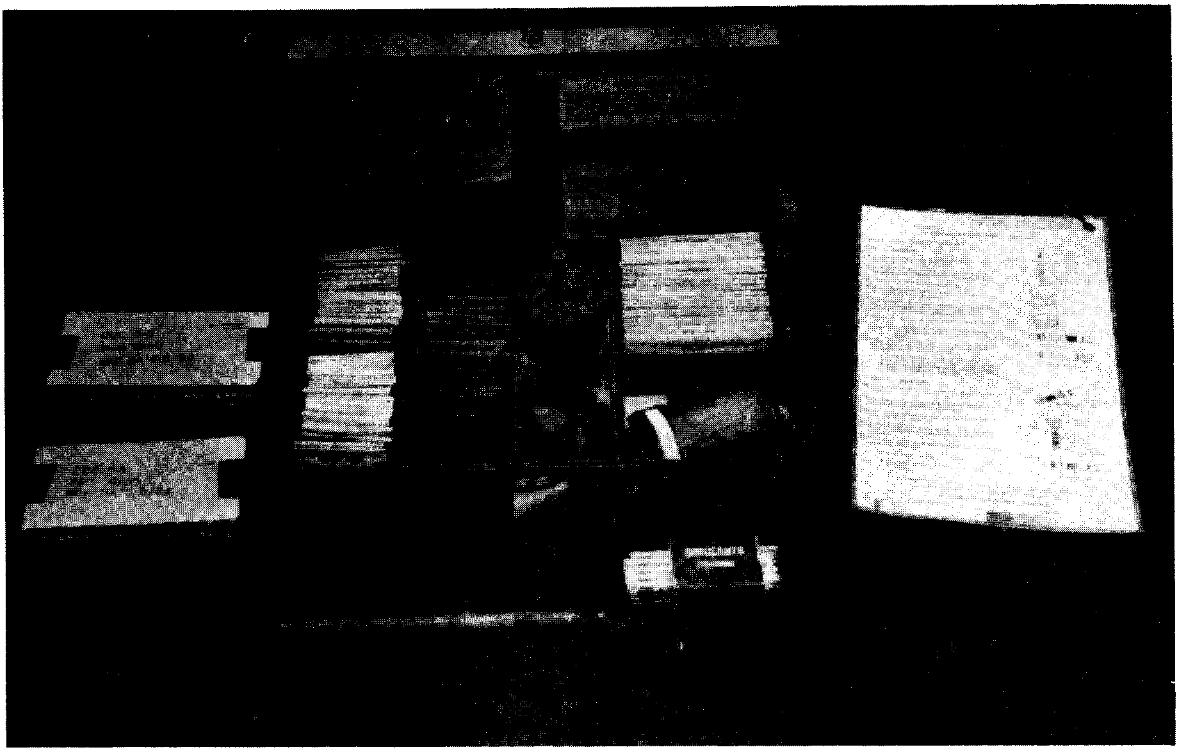


Figure 17-8. Chemical agent detector kit.

17-43. Actions Following an NBC Attack

a. After all personnel are evacuated to an uncontaminated area, the unit commander determines the decontamination priorities and whether subsistence will be provided to the unit. Table 17-5 summarizes methods of decontamination for food, water, personnel, and materials. Food stuffs that cannot be decontaminated must be disposed of in accordance with local laws or military regulations governing the disposal of these hazardous materials. Disposal methods will be determined by supporting NBC personnel. The functions of subsistence supply units in a contaminated area may be temporarily transferred to other support units in noncontaminated areas.

b. Although eating food and drinking water contaminated by radioactive fallout is not an immediate threat to survival, its consumption may cause delayed but lethal effects such as genetic defects, cancers, and leukemia. Every attempt should be made to decontaminate food and water before consumption. Radioactively contaminated foodstuffs should only be consumed under extreme emergency conditions when food is not otherwise available. Food or water containing toxins (biological or chemical origin) *should not be consumed* under any circumstances.

c. *Nuclear.* Decontaminate nuclear-contaminated food and water as follows:

(1) *Food.* Except in rare cases of induced radiation, rations in cans or other sealed containers are not in danger of radiological contamination. Normally, the contamination will be limited to the outer surface of the sealed containers. Decontaminate the outer surface by removing the outer packaging or by washing or scrubbing the container using uncontaminated running water.

CAUTION

Never open sealed containers until they have been decontaminated and the effectiveness of decontamination is established.

Food that is not protected in sealed containers must be suspected of contamination until it is checked. All foods should be moved from the contaminated area to a clean area. Potatoes and hard-skinned fruits and vegetables can be decontaminated by washing or scrubbing them under running water and then peeling or scraping and washing them again. Running water in a creek or stream should be checked for contamination since it may have come from a source in the fallout area. Induced radiation is radiation near ground zero that results from the capture of neutrons by various substances. This radiation will be found primarily in the soil, but may also be present within foodstuffs. Food which may contain higher levels of induced radiation include dairy products, high salt content foods, dry beans, and raisins. Induced radioactivity may exist throughout this irradiated food item. In addition, semiperishable items, such as flour, sugar, or salt, cannot be easily decontaminated. In general, foods with high levels of induced radioactivity should be set aside to allow natural radioactive decay to reduce the radioactivity to acceptable levels. This usually requires less than 14 days, and since monitoring for radioactivity levels is the determinant, monitoring must include the detection of alpha, beta, and gamma radiation. All visible dirt should be brushed from meats and fish; washing is not recommended. Meat or fish should be monitored with a radiac set. The probe should be open and held approximately 1 centimeter from the surface of the food. If the reading exceeds the command designated level, the food should be decontaminated if possible. A thin layer of meat is removed and the meat is checked again. If the second dose-rate reading is lower, the contamination probably was confined to the surface of the food. The cutting away process can be continued, within reason, until the dose-rate reading is within the command designated standard. When the dose rate is within established limits, the food can be consumed. Since prepared food in open containers probably will be contaminated, it should be buried or disposed of as determined by designated medical personnel.

NOTE

Radiologically contaminated wash water trimmings should also be similarly disposed.

Any food that has been exposed to radiological contamination must be carefully monitored before and after decontamination. Foods contaminated by induced radiation can only be decontaminated by aging. Careful monitoring of these foods will determine the progress of radioactive decay during aging.

(2) *Water.* If water at a food service facility becomes contaminated, have the unit contact the water supply specialist in charge of their designated water point. Normally, this person is in their supporting supply and transportation company or supply and service company, and is responsible for quality control of potable water. If there is no approved source of water available, water must also be inspected as described above. Spring or well water should be used in preference to surface water. *In an emergency only* units may decontaminate water that has been contaminated by fallout. Filter the water through successive layers of leaves, gravel, fine sand, and charcoal; then disinfect it before use.

d. Biological. Food containers that have been exposed to biological agents may be decontaminated as shown in Table 17-5. The threads of jars with screw caps must be decontaminated before the caps are removed. Do not use water from unapproved sources for drinking or preparing food unless no other water is available. If such water must be used, treat it as described in Chapter 16. Disinfection is not effective against toxins or all microorganisms. Contaminated food can be made safe by peeling or paring or by heating unless toxins are present.

(1) *Peeling and paring.* Potatoes and hard-skinned fruits that can be peeled or pared may be decontaminated. First, disinfect the surface of the food as described in Table 17-5. After the surface is disinfected, the food must be peeled or pared, washed, and if appropriate, cooked before it is served.

Table 17-5. Decontamination of Specific Items

SURFACE OR MATERIAL	TYPE OF CONTAMINATION[1] CHEMICAL	BIOLOGICAL	NUCLEAR
Mess gear and canned rations	o Immerse in boiling, soapy water for 30 minutes and rinse. o Immerse in boiling water for 30 minutes. o Spray with DS2, wash immediately in hot, soapy water; rinse and aerate. Note: MRE pouch can be decontaminated using towelettes from M258 kit.	o Wash with soap and water, then immerse in disinfectant solution (disinfecttant, chlorine, food service, or 1/3 canteen cup of household bleach for each 10 gallons of water). o Boil in water for 15 minutes. o Immerse in 2 percent peracetic acid for 10 minutes, rinse, and aerate for 10 to 15 minutes. o Immerse in household bleach solution (1/2 gallon of bleach to 25 gallons of water) for 30 minutes, then rinse. o Immerse in HTH solution (1/2 pound to 25 gallons of water) for 30 minutes, then rinse. o Immerse in STB solution (1 pound STB to 25 gallons of water) for 30 minutes, then rinse.	o Wash with soap and water; rinse. o Brush or wipe contamination from surfaces and containers.

Table 17-5. Decontamination of Specific Items (Cont'd)

SURFACE OR MATERIAL	TYPE OF CONTAMINATION[1] CHEMICAL	BIOLOGICAL	NUCLEAR
Food Canned, bottled, or protected by impermeable container, hard-skinned fruits and vegetables	o Same as for mess gear and canned rations.	o Same as for mess gear and canned rations.	o Same as for mess gear and canned rations.
Fabrics Canvas, covers, tarpaulins, tentage, mask carriers, web gear, and clothing	*Cotton* o Immerse in boiling, soapy water for 1 hour (1 pound soap to 10 gallons of water); stir. o Use 5 percent solution of sodium carbonate for G-agents. o Immerse in boiling water for 1 hour. o Launder by standard methods. o Use slurry. o Weather (except for V-agents). *Woolen*[2] o Immerse in warm (100°F), soapy water for 1 hour or longer with light agitation; dry items slowly (fabric may shrink).	*Cotton* o Boil in water for 15 minutes. o Put in autoclave for 45 minutes at 253°F (123°C). o Immerse in 2 percent household bleach solution for 30 minutes and rinse immediately. o Launder (destroys or inactivates all but highly resistant spores). *Woolen*[2] o Launder (fabric may shrink).	*Cotton and Woolen*[2] o Brushing (removes contaminated dust, but presents dust hazard to personnel). o Launder (most practical procedure; waste must be controlled; fabric may shrink).
Leather Boots, gloves, and other items	o Scrub with hot, soapy water and rinse. o Immerse in soapy water at 120°F for 4 hours and rinse. o Use 5 percent sodium carbonate solution for C-agents. o Aerate.	o Immerse in 2 percent household bleach solution and rinse. o Immerse in 2 percent peracetic acid for 10 minutes, rinse, and aerate for 10 to 15 minutes. o Wipe with 2 percent peracetic acid, and aerate 10 to 15 minutes.	o Brush. o Flush with water or soapy water.
Metals (painted)[3] vehicles, weapons, and equipment	o DS2 (may soften paint). o Wash with hot, soapy water and rinse. o Slurry may be used if it is removed from surface after 1 hour and surface is oiled. o Weather. o Aerate. o Towelettes from M258-series kit may be used for individual weapon decontamination.	o Wash with detergent and high-pressure water stream. o Apply detrochlorite. Leave on 30 minutes, then removed by washing with a stream of water. o Steam clean, using detergent. o Use household bleach solution. o Use 2 percent peracetic acid.	o Brush or wipe. o Wash. o Use organic solvents, caustics (not on aluminum or magnesium surfaces), complexing agents (of small value on weathered surfaces), or abrasives.

Table 17-5. Decontamination of Specific Items (Cont'd)

SURFACE OR MATERIAL	TYPE OF CONTAMINATION[1] CHEMICAL	BIOLOGICAL	NUCLEAR
Personnel	o Use towelettes from M258-series kit on exposed skin known or suspected to be contaminated. o Bathe with soap and hot water, if readily available.	o Bathe with soap and hot water. o Use towelettes from M258-series kit.	o Brush or wipe from skin and hair. o Bathe with soap and hot water.
Plastics (opaque) Insulation, telephones, and panel boards	o Apply DS2 (may soften or damage some plastics). o Wash with hot, soapy water and rinse. o Weather. o Aerate.	o Use M258-series decon 2 wipe, then decon wipe 1 as for the protective mask lenses.	o Wash with detergents. o Flush with water. o Wipe or brush.
Plastics (transparent) Eyepieces and airplane canopies	o Wash with hot, soapy water and rinse. o Weather. o Aerate. o Blot off surface.	o Use M 258-series decon 2 wipe, then decon wipe 1 as for the protective mask lenses.	o Same as for plastics (opaque).
Rubber (impermeable) Aprons, suits, and other items	o Spray with DS2 and rinse after 30 minutes. o Immerse in hot, soapy water (just below boiling point) for 1 hour; do not agitate. Rinse with clear water and hang up to dry. o For G-agents, use 10 percent sodium carbonate solution, rinse, and aerate. o Apply hot, soapy water with brushes and rinse. o Spray with slurry from power-driven decontamination apparatus. After a few minutes, wash off with clear water.	o Same as for leather.	o Brush. o Scrub or flush with water or soapy water.
Rubber (natural and synthetic) Gloves, boots.	o Spray with DS2 and rinse. o Immerse in slurry solution for 4 hours, rinse, and aerate. o Immerse in boiling, soapy[4] water for 2 to 8 hours; do not boil more than 4 times a year. o Use towelettes from M258-series kit in emergencies. o Aerate.	o Same as for leather.	o Same as for impermeable rubber.

Table 17-5. Decontamination of Specific Items (Cont'd)

SURFACE OR MATERIAL	TYPE OF CONTAMINATION[1] CHEMICAL	BIOLOGICAL	NUCLEAR
Tires, hoses, mats, and insulation	o Spray with DS2 and rinse. o Apply thick slurry, allow slurry to remain at least 30 minutes, then flush with clear water (may be left on tires). o Immerse in boiling, soapy water for 2 to 8 hours; do not boil more than 4 times a year. o Aerate. o Weather.	o Use same methods used for chemical decontamination.	o Same as for impermeable rubber.
Mask facepieces and other rubber articles coming in direct contact with the skin	o Use towelettes from M258-series kit in emergencies. o Wash with warm, soapy water.	o Wash in warm, soapy water; rinse in clear water; and dry at room temperature. o Wipe with 2 percent peracetic acid, wipe off excess immediately, and aerate 10 to 15 minutes.	o Wipe or brush off. o Wipe off with water and detergent (avoid wetting mask filters).

NOTES:
[1]The best method of decontamination in a given situation could be any of the methods listed. The order in which the methods are listed does not indicate that one is preferred over another.
[2]DS2 is not recommended for woolen items.
[3]DS2 may soften fresh paint.
[4]Alkaline soaps neutralize G-agent vapors, which are driven out of the rubber during boiling, thereby reducing the hazard to personnel performing the decontamination operation. If there is no alkaline soap, rubber articles can still be decontaminated by boiling in water; however, the hazard to personnel is increased.

(2) *Heating.* Heat is the best way to decontaminate food. Foods may be decontaminated by one of the heat methods in Table 17-6. The type and kind of food as well as the amount of contamination will determine which procedure should be used. Make sure that the heat completely penetrates the food for the time indicated.

Table 17-6. Heat Methods of Decontamination

METHOD	DESCRIPTION
Cooking	Cook items in a pressure-type cooker (autoclave) at 15 pounds pressure at 250°F (121°C) for 15 minutes or cook in a low-pressure cooker at 228°F (190°C) for 1 hour.
Baking	Bake items such as bread or related items in a preparatory stage for 40 minutes at 400°F (205°C). Bake meat at 325°F (162°C) for about 2 hours.
Boiling	Boil certain items for at least 15 minutes as an expedient method when no other method is available.

NOTE: Food such as butter and ice cream will not withstand any of the above treatments, therefore they must be destroyed.

e. Chemical. Food containers which have been exposed to chemical agents may be decontaminated as indicated in Table 17-5. Food that is unprotected or poorly protected and that has been exposed to chemical agents should be discarded unless no other food is available. In an emergency, food that has been exposed to a liquid or vapor agent may be decontaminated as follows:

(1) Trim away surface fat and grossly contaminated areas.

(2) Wash food with water or with a solution of 2 percent sodium bicarbonate.

(3) Boil food in water. This treatment is not effective for food that has been heavily contaminated by droplets of blister agents. Such food should not be used. Table 17-7 gives specific procedures for decontaminating food exposed to different types of chemical agents.

Table 17-7. Recommended Treatment of Food Tainted with Toxic Chemicals

AGENT	TYPE OF FOOD	PROCEDURE
Phosgene	All	Wash, then aerate.
Irritant agents	Dry provisions	Aerate.
Mustard agents* (vapors) and nerve agents	Lean meat	Wash with sodium bicarbonate solution, and rinse with clear water. Then cook items intensively. (Boil lean meat exposed to mustard agent in water for at least one-half hour. Meat exposed to nitrogent mustard agent must be boiled in a solution of 2-percent baking soda. Discard water after the meat is boiled.)
	Dry provisions	Wash with sodium bicarbonate solution, rinse with clear water, and aerate for 24 to 48 hours.

*Do NOT decontaminate food exposed to liquid mustard agents or arsenical blister agents. These items must be completely discarded.

17-44. Operations

Normally, food is not prepared or served in an NBC contaminated environment. Field kitchens must be moved to uncontaminated areas and decontaminated before food service can be resumed. In exceptional situations, it may be necessary to serve food in a contaminated environment. The method of feeding troops in such an environment depends on the type and extent of contamination and on the availability of collective protective shelters. Troops in an area contaminated by chemical agents with no detectable vapor hazard can be fed on a rotating basis. About 25 percent of the troops should be fed at a time. The other 75 percent should remain masked. Care must be taken at all times to avoid contaminating the food. If the troops are in a contaminated area where there is also a vapor hazard, feeding must be done inside a shelter equipped with an overpressure system. The overpressure system fills the shelter with pressurized air that has been filtered to remove NBC contamination. Since these shelters have a limited capacity, the commander must plan to feed the troops in shifts. Entering and exiting these shelters is a complicated procedure that is described in FM 3-4.

CHAPTER 18

WASTE TREATMENT AND DISPOSAL

Section I. GENERAL

18-1. Classification of Waste

Waste is a general term covering all types of refuse resulting from living activities of humans and other animals. The methods for handling and disposing of waste differ considerably. The different types of waste are subdivided as follows:

- *Human Waste.* This includes feces and urine.

- *Liquid Kitchen Waste.* Liquid waste is that originating from food service operations. It may contain particles of food, grease, and soap.

- *Wash Water.* Wash water is wastewater that is the result of cleaning operations. This includes waste from field showers, mess kit operation, laundry waste, and handwashing.

- *Garbage.* Garbage is the solid or semisolid waste incidental to preparing, cooking, and serving food, and cleaning of food service items. It does not include rubbish. Garbage is classified as edible or nonedible. Edible garbage is that part of the garbage which is suitable for animal food such as scrap meat and vegetables. Nonedible garbage is that garbage which cannot be used for animal food, such as coffee grounds, bones, and egg shells.

- *Rubbish or Trash.* Rubbish or trash consists of wastes which originate in food service facilities, barracks, wards, quarters, and offices. It includes items, such as waste paper, plastics, wood, metal, glass, ashes, and broken or damaged crockery. Rubbish may be classified as combustible or noncombustible depending upon whether or not it can be burned.

- *Infectious Waste.* Materials, such as bandages, dressings, surgical waste, tissues, medical laboratory wastes, and food waste from infectious disease wards, are all infectious waste.

- *Hazardous Waste.* Any solid, liquid, semisolid, or contained gaseous material that meets the criteria of a hazardous waste as outlined by the USEPA, state, or local regulatory authority.

- *Wastewater or Sewage.* Water which contains some material which makes it unusable or unsuitable for a particular purpose is termed wastewater or sewage. Wastewater of predominantly domestic origin (human waste, liquid kitchen waste, and wash water) is normally referred to as sewage while wastewater from other sources is simply referred to as wastewater. Typical sources of wastewater are latrines, kitchens, bath facilities, laboratories, industrial operations, washracks, and laundry operations. Wastewater may be classified as sanitary wastewater, industrial wastewater, or storm wastewater.

- *Sanitary or domestic wastewater.* In some publications, it is also termed sanitary or domestic sewage and is water-carried waste derived principally from the sanitary conveniences of buildings, industries, institutions, and factories. It derives its name from the fact that it is transported from its originating points through a closed system of pipes.

- *Industrial wastewater.* Water that has been used in an industrial operation and which may contain contaminants as a result of that usage. Contaminants may include anything from soap and dirt to a simple increase in temperature to toxic chemicals. Some industrial wastes may be collected and treated together with sanitary sewage. Many industrial wastewaters are highly toxic and must be collected and treated separately.

- *Storm wastewater.* Storm wastewater is rainfall that runs off on the surface of the ground and into a storm water collection system.

- *Laboratory Wastes.* Laboratory wastes are those wastes that are produced in laboratories, both medical and otherwise. Laboratory waste, such as sacrificed experimental animals, laboratory tissue specimens, and other infectious waste incident to laboratory operations, must be disposed of by incineration. However, if unusual circumstances preclude disposal by incineration, these wastes may be disposed of in a manner approved by the area surgeon/installation medical authority. Some laboratory waste materials, such as highly toxic material and high level radioactive material, must be disposed of by special methods, whereas others may be safely disposed of through conventional sanitary sewage collection systems.

18-2. Waste-Disease Relationship

Improper treatment and disposal of waste is conducive to the spread of diseases. The more important diseases in this category are dysentery (amoebic and bacillary), typhoid fever, leptospirosis, cholera, plague, endemic typhus, and infectious hepatitis. These diseases are contracted through the ingestion of food or water that has become contaminated with infected human or animal waste, or they may be spread by insect vectors whose principal hosts are rodents and vermin. Conditions created by improper waste disposal provide food and harborage for these hosts. Proper treatment and disposal of wastes will aid in the control of these diseases. The major cause of outbreaks in public systems is contamination of potable water distribution systems primarily via cross-connections and back siphonage.

18-3. Responsibilities for Waste Disposal

a. Commander. Commanders are responsible for the safe disposal of waste from their respective commands. When waste disposal facilities are not otherwise provided, the commander must arrange for their construction and operation. In addition, the commander must ensure that the design, installation, and operation of waste disposal facilities conform to federal, state, and local health standards.

b. Army Medical Department. The Army Medical Department inspects waste disposal facilities and operations, and recommends changes that will aid in protecting the health of the troops, as well as the environment.

c. Corps of Engineers. The Corps of Engineers constructs and operates waste disposal facilities at permanent and semipermanent posts, camps, and stations. In the field, the Corps of Engineers normally does not construct and operate these facilities; this becomes the responsibility of the individual units concerned.

Section II. SEWAGE TREATMENT

18-4. General

The wastewater discussed in this section is predominately of domestic origin. Varying amounts of industrial and laboratory wastewaters may be collected and treated with the sanitary sewage. The primary purpose of the treatment of sewage is to prevent the pollution of the receiving waters. Many techniques have been devised to accomplish this aim for both small and large quantities of sewage. In general, these processes are divided into two stages: *primary (physical) treatment and secondary (biological) treatment.* Complete treatment is necessary involving both the primary and secondary stages. When the effluent from secondary treatment is unacceptable, a third level of treatment, *tertiary treatment* may be employed. There are many basic types of sewage treatment plants employing both primary and secondary treatment stages that are in use today for treating large quantities of sewage.

18-5. Collection System

a. The purpose of a sewage collection system is to remove wastewater from points of origin to a treatment facility or place of disposal. The collection system consists of the sewers (pipes and conduits) and appurtenances necessary to convey sewage from the point(s) of origin to the treatment system or place of disposal. It is necessary that the collection system be designed so that the sewage will reach the treatment system as soon as possible after entering the sewer. If the length of time in the sewers is too long, the sewage will be stale or septic when it reaches the treatment facilities.

b. Sanitary sewage collection systems at Army posts are designed to remove domestic sewage only. Surface drainage is excluded to avoid constructing large sewers and treating large volumes of sewage diluted by rainwater during storms. Sewers which exclude surface drainage are called *sanitary sewers*, and those which collect surface drainage in combination with sanitary sewage are called *combined sewers*.

c. Except for force mains, sewers are laid to permit gravity flow of their contents. Unlike water in a water distribution system, the contents of a sewer do not flow under pressure. Usually the slope is such that a flow rate of 2 feet per second or more is maintained when the line is flowing half full to full. This is a self-cleansing velocity and prevents solids from settling in the sewer pipes. To the maximum extent practical, sewers are laid in straight lines. Corners and sharp bends slow the flow rate, permit clogging, and make line cleaning difficult. Manholes are located on the sewers at each change of direction, change of slope, change in sewer pipe size; or at least every 400 feet on sewers of 18 inches or less in diameter that have no change in direction, slope, or size. Sewers 18 inches or larger are allowed a maximum manhole spacing of 600 feet.

d. Pumping is necessary where the slope of the sewer does not produce the required minimum velocity of 2 feet per second, or where sewage must be lifted to a higher elevation. Sewage can be pumped from pumping stations through pressure lines (force mains) regardless of their slope, or it can be raised to a higher elevation at pumping stations (lift stations), so that gravity flow will again produce the required velocity.

e. For gravity flow lines, sewer pipes of vitrified clay tile, concrete, cement-asbestos, or bituminous-impregnated fiber may be used. For force mains and stream crossings, cast iron or cement-asbestos pipe is used.

f. Removing grease from sewage is essential to the proper functioning of sewage systems. At fixed installations grease is collected by ceramic or cast iron grease interceptors installed at kitchens and other facilities that generate grease and by concrete or brick grease traps outside the building. Approximately 90 percent of the grease will be removed from greasy wastes by properly maintained grease interceptors and traps.

g. Gasoline and oil separators are installed in sewer lines from garages and shops where gas and oil might be accidently spilled. Separators are also installed under washracks to contain the oil in water. In areas where large amounts of volatile material are produced as waste, some other method must be provided. Volatile liquids accumulating in sewers may cause explosions and destroy sewer lines or the treatment plant.

18-6. Trickling Filter System

The most common type treatment system used at military installations where extensive water collection systems handle large quantitites of sewage is the trickling filter system (Figure 18-1). The trickling filter system employs the following units:

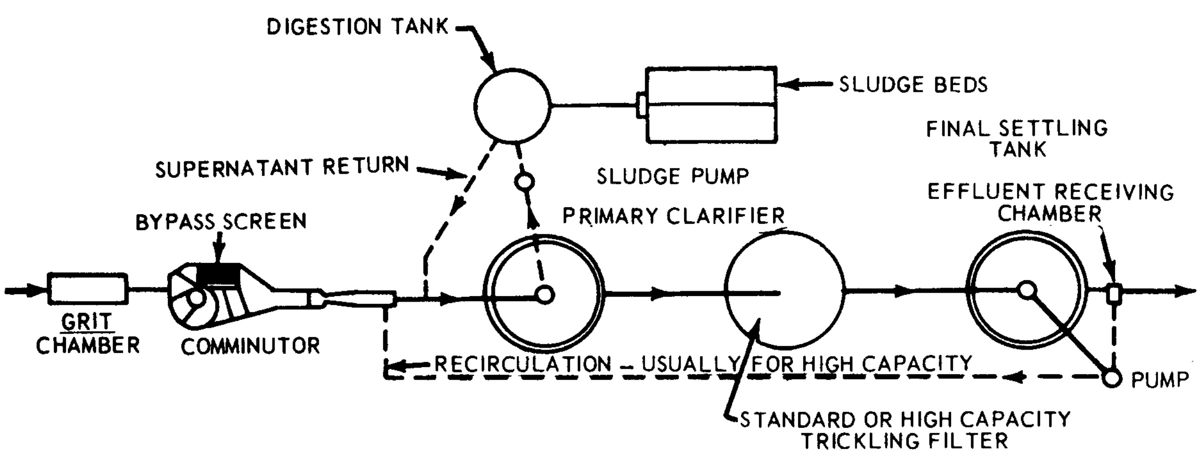


Figure 18-1. Trickling filter system

a. Bar screens. A grating of steel bars spaced about 1 to 1 1/2 inches on centers is placed at an angle to the flow of sewage through an open channel (Figure 18-2). The screen removes coarse and floating solids from the sewage. The screen must be cleaned regularly and the removed solids must be burned, ground and digested, or buried. Many systems may have a grinder known as a comminutor used either with or instead of a bar screen for grinding large particles which might clog the pumps.

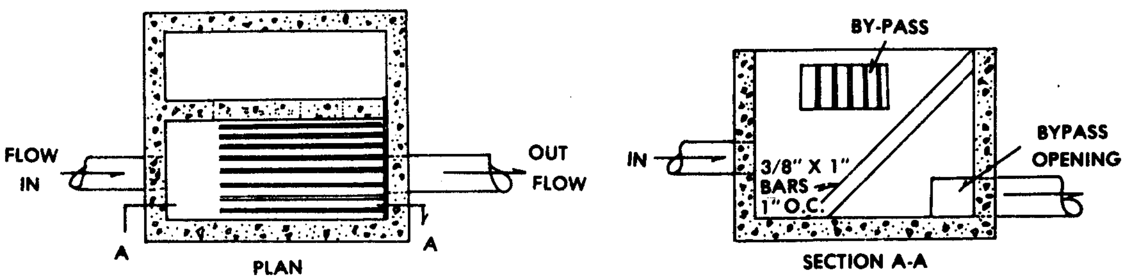


Figure 18-2. Bar screen.

b. Grit chamber. A chamber in which the velocity of waste flow is reduced to a point where the denser sand and other grit will settle out, but the organic solids will remain in suspension. The settled material is buried or used for fill.

c. Primary settling tanks. Large tanks in which the velocity of flow is reduced to about 1 foot per minute so that the suspended material (organic settleable solids) will settle out. The usual detention time is 1 1/2 to 2 1/2 hours. Longer periods usually result in depletion of dissolved oxygen and subsequent anaerobic conditions. Removal of suspended solids ranges from 50 to 65 percent, and a 30 to 40 percent reduction of the 5-day biochemical oxygen demand (BOD) can be expected.

d. Sludge digestors. The sludge which settles in the sedimentation basin is pumped to the sludge digestors where a temperature of 85° to 95°F is maintained. This is the optimum temperature for the anaerobic bacteria. The usual length of digestion is 20 to 30 days but may be much longer during winter months. Continual adding of raw sludge is necessary and only well-digested sludge should be withdrawn, leaving some "ripe" sludge in the digestor to acclimate the incoming raw sludge.

e. Drying beds. Digested sludge is placed on drying beds of sand where the liquid may evaporate or drain into the soil. The dried sludge is a porous humus-like cake which can be used as a fertilizer base.

f. Trickling filters. The liquid effluent from the primary settling tank is passed to the secondary part of the system where aerobic decomposition completes the stabilization. For this purpose, a trickling filter (Figure 18-3) is used. It consists of a bed of crushed rock or slag (4 to 6 feet deep) through which the sewage is allowed to percolate. The stones become coated with a zoogloea film (a jelly-like growth of bacteria, fungi, algae, and protozoa), and air circulates by convection currents through the bed. Most of the biologic action takes place in the upper 2 feet of the bed. Depending on the rate of flow and other factors, the slime will slough off the rocks at periodic intervals or continuously, whenever it becomes too thick to be retained on the stones. A secondary settling basin is necessary to clarify the effluent from the trickling filter. The overall reduction of BOD for a complete trickling filter system averages around 80 to 90 percent.

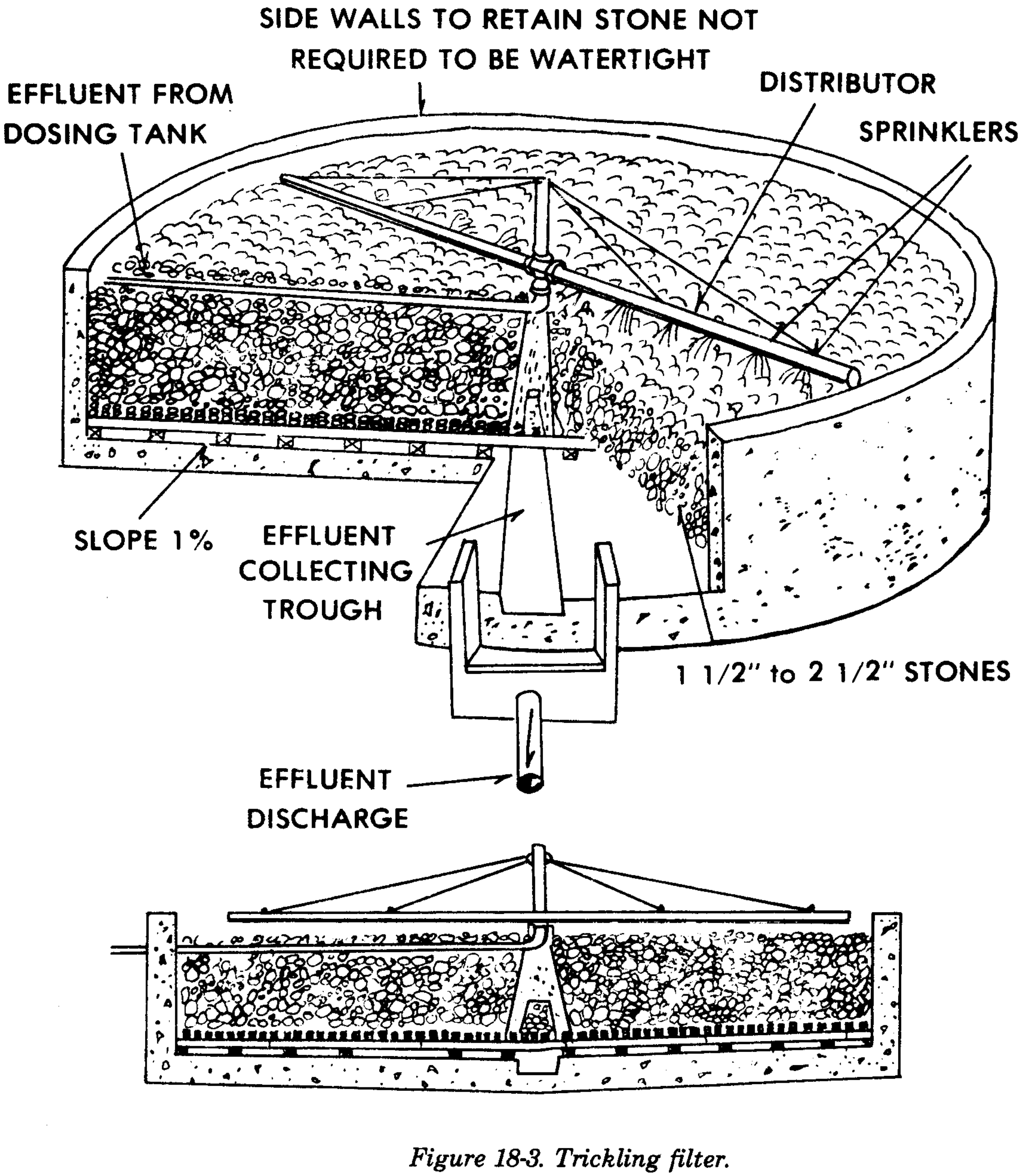


Figure 18-3. Trickling filter.

g. Secondary settling tank. With the majority of the suspended material removed from the sewage, the liquid portion flows over a weir at the surface of the secondary settling tank. Chlorination of the effluent from the secondary settling tank is practiced in accordance with federal, state, and local laws. Depending on the location most laws require that a certain residual be maintained after a 30-minute contact period. This contact period is obtained through the use of chlorine contact chambers which are designed to provide a 30-minute detention time. From the chlorine contact chamber the treated sewage is normally discharged into a receiving body of water.

18-7. Activated Sludge System

The activated sludge systems normally make use of bar screens and/or comminutors, grit chambers, primary settling tanks, secondary settling tanks, and digestors, which are operated in the same manner as those of trickling filter systems. They differ from the trickling filter systems in that they make use of an aeration tank instead of the trickling filter. Compressed air is continually diffused into the sewage as it flows through the aeration tank. This provides both a source of oxygen for the aerobic bacterial floc that forms in the tank and the turbulence necessary to bring the waste and the bacteria into contact. Aerobic bacteria attack the dissolved and finely divided suspended solids not removed by primary sedimentation. Some of the floc is removed with the sewage that flows out of the aeration tank and carried into the secondary settling tank. Here the floc settles to the bottom of the tank, and the liquid portion flows over a weir at the surface of the settling tank to be chlorinated and released to a receiving stream. A portion of the settled floc is pumped to the digestor; the remainder is returned to the aeration tank.

18-8. Rotating Biological Contactor System

Rotating biological contactor systems (Figure 18-4) normally make use of bar screens and/or comminutors, grit chambers, primary settling tanks, secondary tanks, and digestors, which are operated in the same manner as those of trickling filter systems (Figure 18-5). The rotating biological contactor (RBC) is a simple, effective method of providing secondary wastewater treatment. The system consists of biomass media, usually plastic, that is partially immersed in the wastewater. As it slowly rotates, it lifts a film of wastewater into the air. The wastewater trickles down across the media and absorbs oxygen from the air. A living biomass of bacteria, protoza, and other simple organisms attaches and grows on the biomass media. The organisms then remove both DO and organic material from the trickling film of wastewater. Any excess biomass is sloughed off as the media is rotated through the wastewater. This prevents clogging of the media surface and maintains a constant microorganism population. The sloughed off material is removed from the clear water by conventional clarification. The RBC rotates at a speed of 1 to 2 rpm and provides a high degree of organic removal.

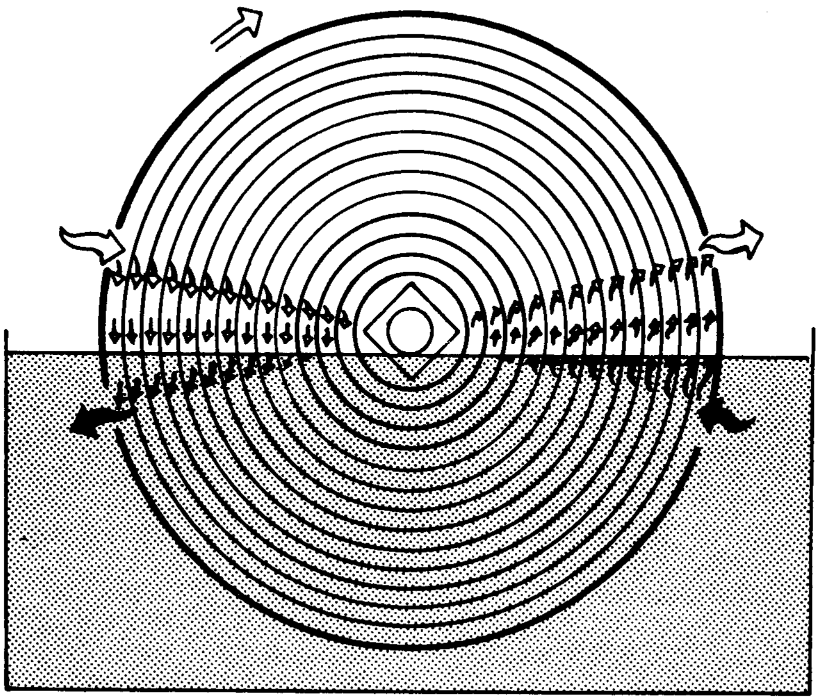


Figure 18-4. Rotating biological contactor.

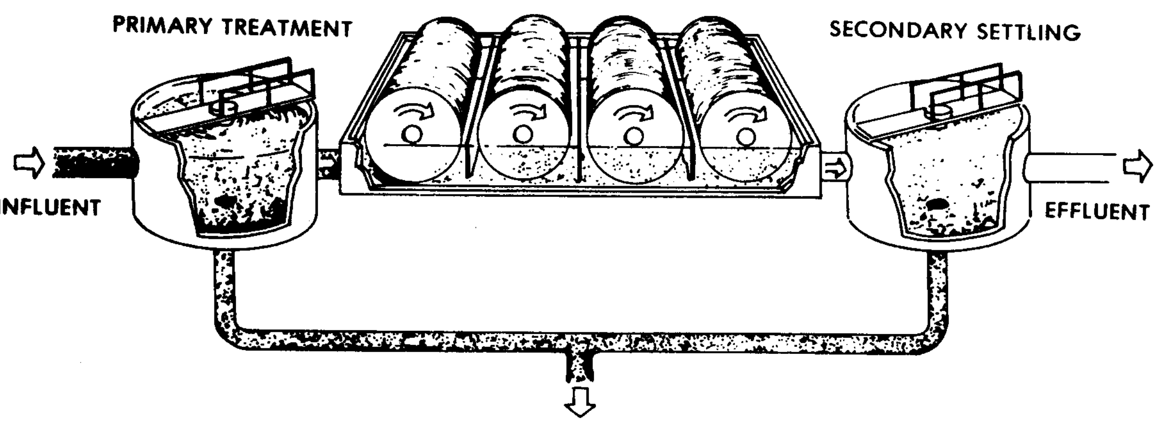


Figure 18-5. Rotating biological contactors preceded by pretreatment and followed by secondary sedimentation.

18-9. Imhoff Tank System

Imhoff tank systems normally make use of bar screens and/or comminutors, grit chambers, primary settling tanks, secondary settling tanks, and digestors, which are operated in the same manner as those of trickling filter systems. An Imhoff tank is a combined sedimentation or settling tank and digestion tank (Figure 18-6). It consists of an upper compartment for settling out solids from slowly flowing sewage and a lower compartment for septic digestion of the sludge. The upper compartment forms a channel with an approximately 8-inch slot in the bottom. Sides of the slot have a 1 horizontal to 1 1/2 vertical slope and are overlapped to prevent gases formed by digesting sludge from escaping into the upper or "flowing-through" compartment. With an average flow, solids settle in the upper compartment in 2 to 2 1/2 hours, pass downward through the slot, and settle to the bottom of the lower compartment where they are digested. Accumulated solids are removed periodically through a sludge draw off pipe having its inlet about 1 foot above the tank bottom. Design of the upper or "flowing-through" compartment is based on the retention period. The lower or digestion compartment is designed to hold 3 cubic feet per capita below a plane 18 inches beneath the bottom of the slot. If sludge from secondary settling is returned to this compartment for digestion, the capacity of the compartment must be increased to 4 1/2 cubic feet per capita.

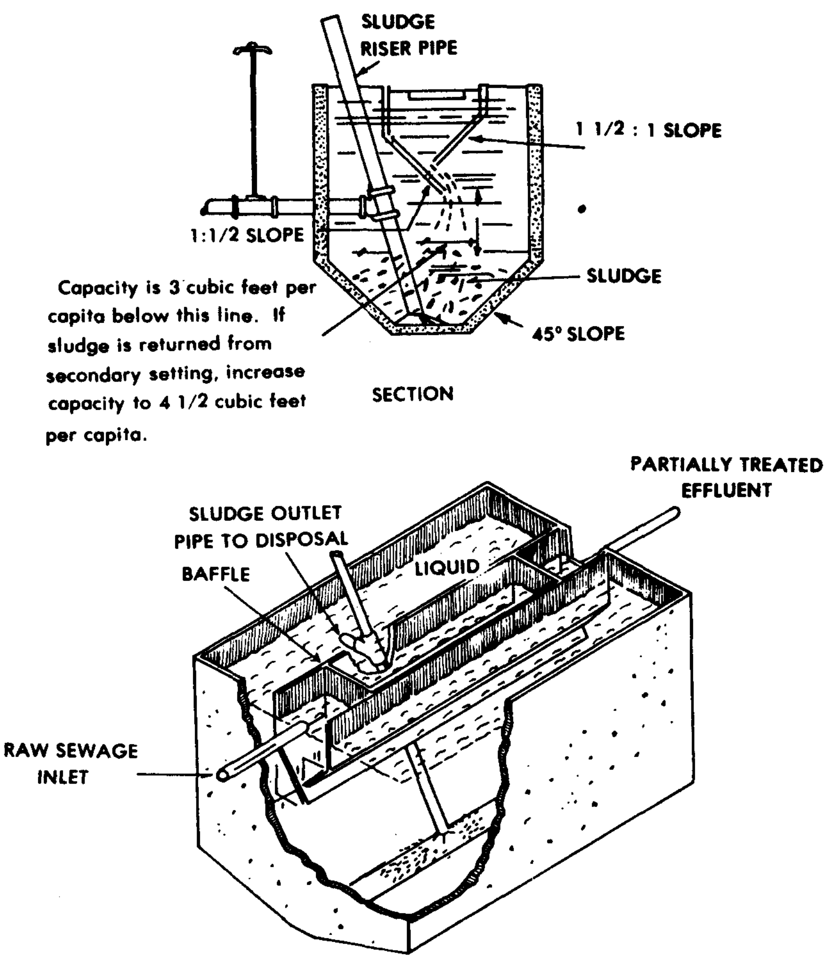


Figure 18-6. Imhoff tank.

18-10. Package Plant Systems

The term "package" as applied to sewage treatment systems usually means a compact, relatively simple-to-operate unit designed to give complete treatment of sewage from a small community. Package plant systems are generally installed where a high degree of biochemical oxygen demand removal is required, but other factors prohibit the use of conventional types of secondary treatment. Although package plant systems are usually custom designed by the equipment manufacturer, and may differ in the scheme of treatment, most package units use the activated sludge process to effectively meet the high BOD removal.

18-11. Sewage Oxidation Ponds

Under certain conditions, sewage oxidation ponds (lagoons) offer economical secondary sewage treatment with a minimum of initial expense. These ponds are 2 1/2 to 4 feet in depth, and may be used singly, in parallel, or in a series following primary treatment. Their use is particularly suited to locations with available land and warm climates. Their ability to absorb shock loads and ease of operation and maintenance make them desirable treatment units. Biological life in ponds uses the organic and mineral matter in the sewage for food to produce more stable products. The products often stimulate abundant growth of algae and other vegetation. Solution of oxygen from the atmosphere, and the ability of vegetation to produce oxygen when exposed to sunlight, help maintain aerobic conditions. The lagoons will develop an odor similar to fresh-water ponds in wooded areas. Allowable loading may vary from 50 persons per acre to 800 persons per acre depending upon the location. Where complete treatment is to be provided by ponding, the cells are known as raw sewage lagoons, with depths of 3 to 5 feet and reduced loading.

18-12. Septic Tank and Tile Drains

a. Septic tanks (Figure 18-7) may be used to serve small installations where the effluent can be disposed of through leaching wells, subsurface tile systems, or artificial subsurface filter systems. When sewage enters a septic tank an equal volume of liquid is discharged from the tank. The primary purpose of the septic tank is to condition the sewage so that the discharged liquid will not clog the disposal system.

b. A septic tank combines two processes. *Sedimentation* takes place in the upper portion of the tank, and the accumulated solids are *digested* by anaerobic decomposition in the lower portion. As sewage from a building enters a septic tank, its rate of flow is reduced so that the heavier solids sink to the bottom and the lighter solids including fats and grease rise to the surface. These solids are retained in the tank, and the clarified effluent is discharged. With good care and efficient operation, removal of solids may be as high as 60 percent, but at times the solid content of the effluent may equal or exceed that of the influent. Clogging of the disposal system will vary directly with the amount of suspended solids contained in the septic tank effluent.

c. Septic tanks do not accomplish a high degree of bacterial removal. Although the sewage undergoes treatment in passing through the tank, this does not mean that the infectious agents will be removed; hence, septic tank effluent cannot be considered safe. The liquid that is discharged from the tank is, in some respects, more objectionable than that which goes in; it is septic and malodorous. This, however, does not detract from the value of the tank. Further treatment of the effluent, including the removal of pathogens, is effected by percolation through the soil.

d. Septic tank capacity should equal a full day's flow plus an allowance of from 15 to 25 percent for sludge capacity. The minimum desirable size of the tank is 500 gallons. The tank's length should not be less than two or three times the width; liquid depth should not be less than 4 feet for small tanks and 6 feet for large tanks. Manholes should be provided over the inlet and outlet pipes for observation and maintenance. Baffles should be located approximately 18 inches from the ends of the tank, and should extend approximately 18 inches below and 12 inches above the flow line (Figure 18-7). Ells or tees may be used in place of wooden baffles. If these are used they should also extend at least 18 inches below the flow line. The elevations of the inlet and outlet pipes should provide free flow through the tank. This can be done by setting the bottom of the inlet pipe 3 inches above the water level. Some sludge from another operating septic tank or several shovels of fresh animal manure should be added to the new septic tank to facilitate its initial operation.

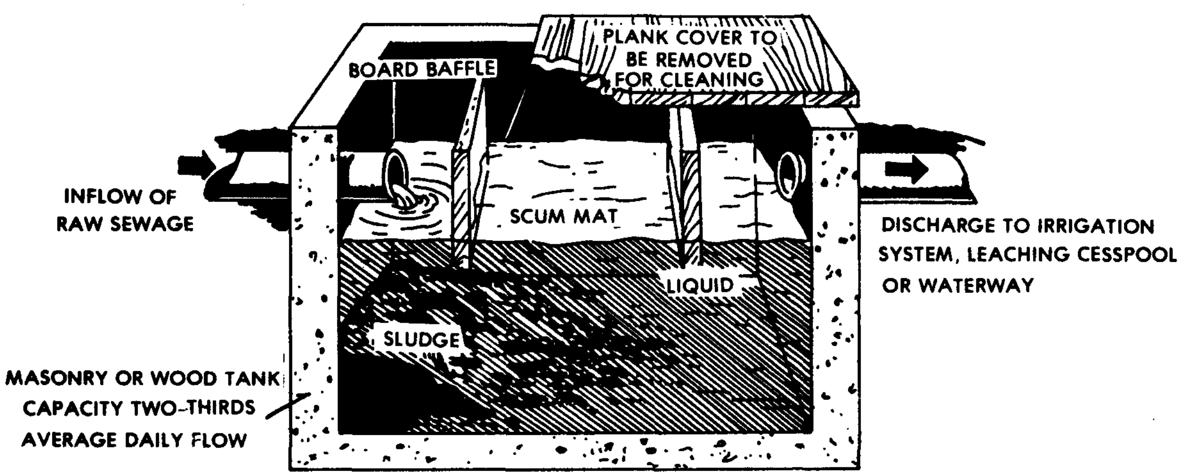


Figure 18-7. Typical septic tank.

e. Tile fields (Figure 18-8) with lines of 2- or 3-foot lengths of cement or clay tile laid at least 18 inches underground with open joints are used to dispose of settled sewage into the ground. Fiber pipe with holes bored in the lower portion to allow drainage may also be used for these drain lines. A distribution box is essential for every absorption-field system to ensure equal distribution of the effluent to the several lateral lines, and to prevent overloading and failure of one line while the others are left empty. At least two lateral lines should lead from the box, and enough additional laterals should be connected to the box to provide the required effective percolation area. The design of the system can be varied to meet most topographic conditions encountered, and to give proper grade and alignment for all laterals. Normally, the individual laterals should not be over 60 feet long, with a maximum length of 100 feet.

The trench bottom and tile distribution lines should be laid at a grade of 2 to 4 inches per 100 feet and never exceed 6 inches per 100 feet. Use of more and shorter laterals is preferred because, if something should happen to disturb one line, most of the field will still be serviceable. Many different designs may be used in laying out subsurface disposal fields. The choice will depend on the size and shape of the available disposal area, the capacity required, and the topography of the disposal area.

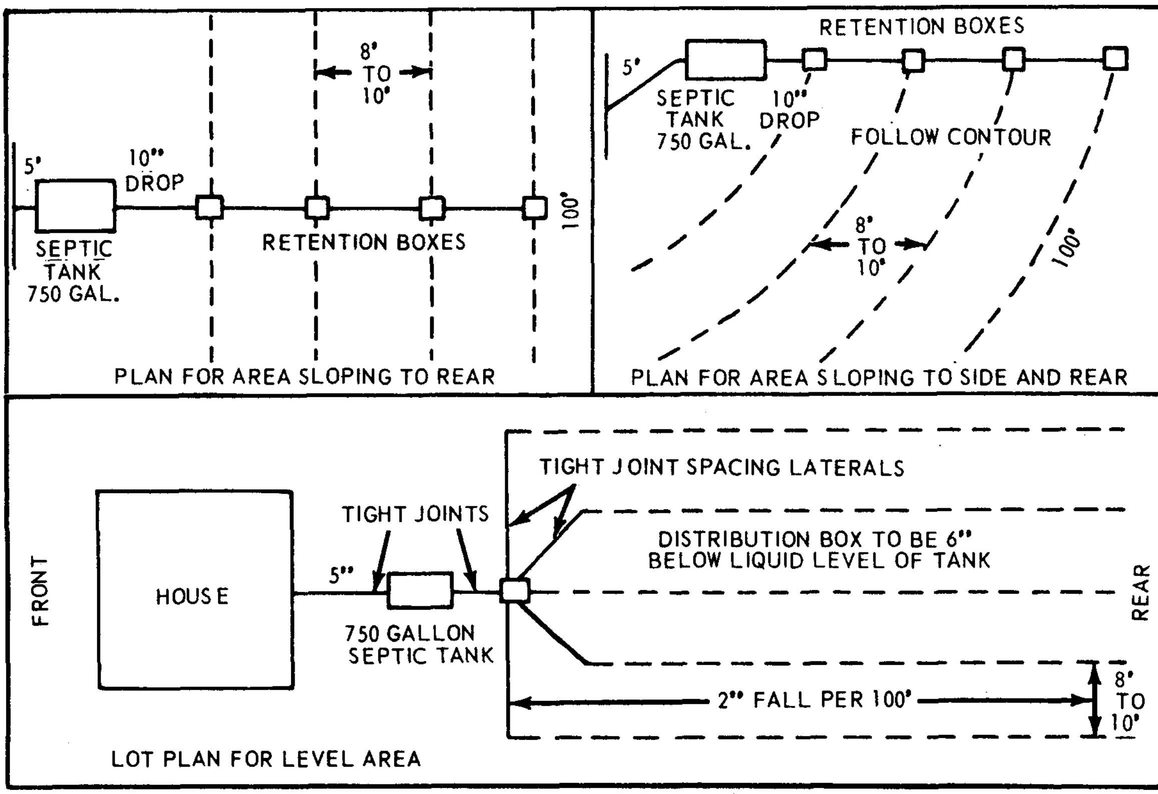


Figure 18-8. Tile field layout.

f. Not all soils are porous enough to permit use of a tile field disposal system. First test the percolation rate of the soil in the proposed tile field area to determine the speed with which the settled sewage will pass into the soil. Also determine the total tile field area required to serve the installation adequately.

g. The required tile field area is determined by the soil percolation test. To perform these tests, six or more uniformly spaced test holes, each 1 foot square, should be dug to the depth of the tile lines. Scrape the sides and bottom of the hole, remove all loose material, and place 2 inches of sand or gravel on the bottom. Fill the holes with water to a depth of 12 inches, and maintain this depth for at least 4 hours to allow for soil swelling. Refill with water to a depth of 6 inches, and from a fixed reference point, measure the drop in water level over a 30-minute period. Using an average percolation rate, the required area may be determined from Table 18-1.

Table 18-1. Soil percolation.

Time for water to fall 1 inch (minutes)	Allowable rate of sewage application in gallons per square foot per day, bottom of trench in tile field
1	4.0
2	3.2
5	2.4
10	1.7
30	0.8
60	0.6

(Soil testing over 60 minutes is not suitable for tile fields.)

h. Once a tile field is constructed, all traffic must be excluded by fencing or posting to prevent crushing the tile. Planting shrubs or trees over the field is not a good practice, since the roots tend to clog the tile lines; however, grass over the lines assists in removing the moisture and keeping the soil open. Freezing rarely occurs in a carefully constructed system kept in continuous operation.

i. Leaching wells, sometimes called dry wells or seepage pits, may be used with a septic tank. Leaching wells usually are dry-laid masonry or brick-lined wells without any masonry at the bottom; the sewage flows from the septic tank into them and leaches out into the soil. Floating solids collect in the top and settling solids in the bottom of the well. The well's leaching capacity is exhausted when the solids accumulate and clog the surrounding soil. The leaching well works on the same principle as the tile field, but leaching is a less desirable method for sewage disposal. Leaching wells are used only where the subsoil is porous to a depth of at least 8 or 10 feet and where the ground-water table is below elevation. When located in fine sand, surrounding the walls with graded gravel increases the leaching area.

j. Where the soil is so dense and impervious that a subsurface tile-trench system is impractical, and where lack of an isolated area prevents use of an open filter, subsurface filter trenches or beds may be required to filter settled sewage. Underdrains from subsurface filter trenches or beds may be discharged freely to the nearest satisfactory point of disposal, such as a small stream, dry streambed, or on land. This effluent requires little chlorination to make it safe. This process requires National Pollution Discharge Elimination System permits.

18-13. Tertiary Treatment

Increasingly, the effluent from secondary treatment systems is unacceptable due to increased recreational, domestic, and industrial requirements on the receiving body of water and more stringent stream standards. In such cases tertiary treatment may be employed to further reduce the solids and organic content of the effluent. This treatment may employ conventional processes with an increased detention time to allow for greater removals, or the operations installed for tertiary treatment may involve more exotic and expensive equipment such as electrodialysis units or ion exchange columns. In tertiary treatment, emphasis is placed on absorptive processes, such as the use of activated carbon; more efficient oxidation, as with ozone; foam separation of impurities; and demineralization using reverse osmosis or distillation.

18-14. Biochemical Oxygen Demand Concept

a. Sewage when "fresh" has a musty odor, a gray color, and contains both organic material and sufficient dissolved oxygen to support the growth of aerobic bacteria. Aerobic bacteria, as do humans, need a food supply and a source of free oxygen to survive. The food supply is furnished by the organic material in sewage, and the free oxygen is available as dissolved oxygen. The dissolved oxygen is depleted as the aerobic bacteria attack the organic material contained in the sewage. Some of the dissolved oxygen may also be depleted through chemical action. The sewage will become "stale" and then "septic" as dissolved oxygen is depleted. Septic sewage contains no dissolved oxygen, and all bacterial action will be anaerobic. The amount of oxygen necessary for the stabilization (decomposition) of organic material in sewage under aerobic conditions is called the biochemical oxygen demand (BOD). It is an important indication of the amount of organic matter present in the sewage. The magnitude of the BOD depends upon the amount of organic matter present. High BOD values are obtained for samples of sewage that are high in organic matter, and low BOD values are obtained for samples that are low in organic matter.

b. Biochemical oxygen demand is normally expressed in parts per million for a specified time and temperature, the standard being 5 days at 20°C. The 5-day, 20°C biochemical oxygen demand does not represent the total demand of a sample for oxygen. About two-thirds of the total oxygen demand of a domestic sewage sample is satisfied in 5 days at 20°C, and almost all of the demand in 20 days at 20°C. It would be very time-consuming to attempt to determine the total demand by incubating samples for 20 or more days. For this reason the 5-day BOD test has been accepted as a practical standard.

c. The 5-day BOD test is used as a control at nearly all sewage treatment facilities. The adequacy and degree of sewage treatment may be judged by the total reduction that occurs in the 5-day BOD of the sewage as it flows through the sewage treatment facility. Also, standards are established by various governmental control agencies which set limits on the 5-day BOD of treated sewage that may be legally discharged into a receiving stream.

18-15. Sewage Sampling and Analysis

a. General. The purpose of sewage sampling and analysis is to ensure adequacy of sewage treatment or to identify problem areas in its operation. Normally, the Pvnt med specialist will not be equipped to analyze sewage samples, but he must know the purpose of conventional sewage analysis procedures and he must know how to sample.

b. Sampling. Sampling is conducted on the influent to a treatment system and the effluent after treatment. Sampling is also conducted at intermediate points or between components of the entire treatment system. There are two types of sampling techniques.

(1) *Grab sampling.* This is a single sample of sewage taken at any one designated time. It involves nothing more than collecting a designated amount of sewage in a container at a specific point in the system.

(2) *Composite sampling.* Inasmuch as the quantity and quality of sewage vary drastically during a 24-hour period, a grab sample is not a good representation of the characteristics of sewage. The composite is taken by mixing together samples that have been collected at regular intervals (usually 1 hour) over a 24-hour period. Since the quality and quantity of sewage vary throughout this period, the samples should be proportioned in size approximately to the rate of flow at the time they are taken. The actual collection technique for either grab or composite samples is to use a dipper or can at least 2 inches in diameter to collect the sewage at middepth in the sewer or conduit. Composite samples can also be collected automatically. A number of types of automatic samplers are available. Avoid excessive aeration of the composite sample and refrigerate the sample until it can be analyzed. Analysis should be conducted as soon as possible, since sewage characteristics will vary with time.

c. Sewage Analysis.

(1) *Settleable and suspended solids* checks the efficiency of solids removal in treatment units.

(2) *Biochemical oxygen demand* indicates the amount of organic matter in sewage.

(3) *Relative stability* replaces BOD determinations to check small sewage treatment plants.

(4) *Other tests* commonly used to evaluate the adequacy of treatment include chemical oxygen demand (COD), chlorine residual, and dissolved oxygen (DO).

18-16. Pollution

a. Excessive pollution is one of the greatest abuses of natural water resources. All foreign material added to a natural body of water is considered pollution. The principal interest, however, is excessive or unwarranted pollution, such as raw sewage, improperly treated sewage, and industrial wastes, or overloading the natural body of water beyond its reserve or recuperative capacities. The latter may be caused by even properly treated sewage if the volume and velocity of the stream are not sufficient to handle the quantity of effluent being discharged.

b. Every body of water has a limited capacity for receiving sewage and other organic wastes by means of dilution. The full use of this capacity results in a loss of any reserve capacity and produces nuisances or reduces the quality of the stream. These detriments are classified as physical, chemical, and bacterial.

c. The physical nuisances include the offensive odors of organic matter putrefaction; unsightliness of floating solids, oils, grease, scum, and debris; and turbidity and color caused by dissolved and suspended matter. The body of water's ability to neutralize these effects is determined by its volume and velocity. For example, if a stream is flowing swiftly, bulky deposits will not appear, and the larger solids are broken up and carried downstream.

Debris and larger floating solids, however, may still be a problem. Further dilution of these offending wastes as they are carried downstream likewise reduces odor and discoloration. Usually, these physical nuisances are not as important as the other types, and they are prevented by primary sewage treatment. A stream may be heavily overloaded by the effluent from a modern sewage treatment plant however simply because the stream does not have the biological ability to handle the amount of organic matter being discharged from the plant.

d. Chemical detriments to a body of water include the depletion of oxygen in the water by the biochemical oxidation of organic matter. When total exhaustion of the dissolved oxygen occurs, odors and destruction of plant and fish life result. Secondly, other chemicals primarily from industrial wastes may be toxic, attack concrete structures, discolor the waters, destroy paints on boats, and more important, render the water unsuitable as a source of water supply by making it difficult or uneconomical to treat. EXAMPLE: The discharge of phenols into a stream used as a water supply. Normal treatment methods will not remove the phenols, and with chlorination the water is rendered unpalatable by the formation of chlorophenols.

e. The last type of detriment is the bacterial pollution present in the sewage effluent. The most probable number of coliform organisms is of significance, particularly if the body of water is used as a source of water supply or as a bathing area, or if it passes over shellfish areas. A body of water's capacity for this type of pollution also involves dilution, but is primarily a matter of time from the point of discharge to the area of use. It has been found that bacteria appear to die from a lack of food. The numbers of surviving bacteria tend to form a geometrical progression in time; that is, during an interval of time, the bacteria are reduced by a constant proportion of the number existing at the beginning of that interval. This phenomenon is called the *geometric death rate.*

f. In each of the three types of pollution mentioned, physical, chemical, and bacterial, dilution in the stream volume is one indication of the receiving capacity of the stream. Bacterial and organic chemical pollutants, however, are subject to other means of purification, and are the basis for what is known as self-purification of streams.

g. A polluted stream undergoing self-purification can be divided into four zones; zone of degradation, zone of active decomposition, zone of recovery, and zone of cleaner water.

(1) Within the zone of degradation the pollution has recently been introduced. The DO is reduced to less than one-half of its original value; algae and fish life are declining; water is turbid; sludge deposits are forming on the stream bed; and typical bottom worms, together with sewage fungi, appear.

(2) In the zone of active decomposition, the DO may be reduced to zero; fish life is absent; water is darker and grayish in color; odors from putrefaction of organic matter including hydrogen sulfide and methane gases are given off; a scum may appear on the surface; and threadlike organisms of grayish, pink, and cream tints appear.

(3) Through the zone of recovery the DO increases, the water is less turbid with no unpleasant odors given off, algae reappear, fungi disappear, and some of the hardier fish such as carp appear.

(4) Entering the zone of cleaner water, the DO approaches saturation, the natural stream conditions are restored, and trout and other game fish appear.

(5) Although the physical appearance of the stream and the animal and plant life observed are important factors in judging stream pollution, it should be remembered that the indices (primarily the DO, BOD, and suspended solids and nutrients) are the most significant measures of stream pollution.

Section III. GARBAGE AND TRASH COLLECTION AND DISPOSAL

18-17. General

The collection and disposal of refuse is one of the major problems in sanitation for all organizations, fixed installations, or field units. Refuse handling must be approached and analyzed in terms of sound administrative engineering management, and must receive the same (if not more) consideration as do other sanitary facilities. Because physical layouts, volumes of material, salvage requirements, and methods of disposal vary, installations cannot operate identical collection systems. The system which best meets local requirements and fosters good sanitation must be used.

18-18. Garbage and Trash Collection Truck Requirements

a. Frequency of pickup of garbage and other refuse will have a significant impact on the number of vehicles employed in the operation. As a general rule, refuse pickup should be executed twice a week. Twice a week pickup will reduce the fly population by breaking the fly's life cycle. Collection of garbage from all food service facilities and similar subsistence facilities is on a daily basis. All other facilities are on a twice a week basis.

b. At almost all installations, refuse is collected in trucks and other equipment that are designed specially for this purpose. This specialized equipment has many advantages over equipment which is not designed for refuse collection purposes. Such advantages include low loading height, large refuse capacity, complete load envelopment, built-in compaction mechanism, rapid unloading of refuse, and water tightness. From a safety standpoint, these vehicles must be operated only by trained and regularly assigned personnel.

c. In the event that it is necessary to alter other trucks to meet collection requirements, the following alterations must be made:

(1) Truck beds must be made as watertight as possible.

(2) A suitable cover such as canvas or chicken wire must be provided to keep refuse from blowing off.

(3) If desired, the sides of the truck may be built up to increase capacity.

(4) If the truck is converted back for other use, it must be steam-cleaned or cleaned with hot soapy water, and if it is to be used for transporting any food products, it must be disinfected with a 200 mg/l chlorine solution.

18-19. Maintenance of Multiple Containers (Dumpsters)

a. Food service personnel will not be used to clean multiple containers. The multiple container cleaning facility must be centrally located on the route between the disposal facility and the source of refuse materials. It is located where water and sanitary sewer systems are available. It may be more convenient to locate the cleaning facility at the disposal facility. In any case, the facility must have hot water under pressure, and it is desirable to have a steam cleaning system.

b. The facility should be provided with a concrete slab with proper drainage and of adequate size, a booster pump on the hot water line, and if practical, fittings to introduce liquid soap or detergent into the hose stream.

c. Containers used for collection of putrescible materials must be cleaned after each emptying. Other containers should be cleaned on an as-required basis.

d. The same washing facility may also be used at the end of the day for washing the collection vehicles.

18-20. Length of Hauls

Trucks should begin collecting materials at points farthest from disposal facilities, so there is a minimum of travel with a full load. The quantity of refuse accumulated daily within any one collection area may vary. The truck crew may change the length of each route from day to day to allow for variations in quantities and still cover the route adequately.

18-21. Sanitary Landfills and Their Maintenance

a. The principle of the sanitary landfill (Figure 18-9) method of refuse disposal is simple. Refuse is dumped into a trench, compacted, and covered each day. Sanitary landfills are not used to dispose of infectious wastes except under unusual circumstances that require the prior approval of the area IMA and must conform to local and state laws.

b. There should be at least 1 acre per year for each 10,000 personnel when the fill is to be 6 feet deep.

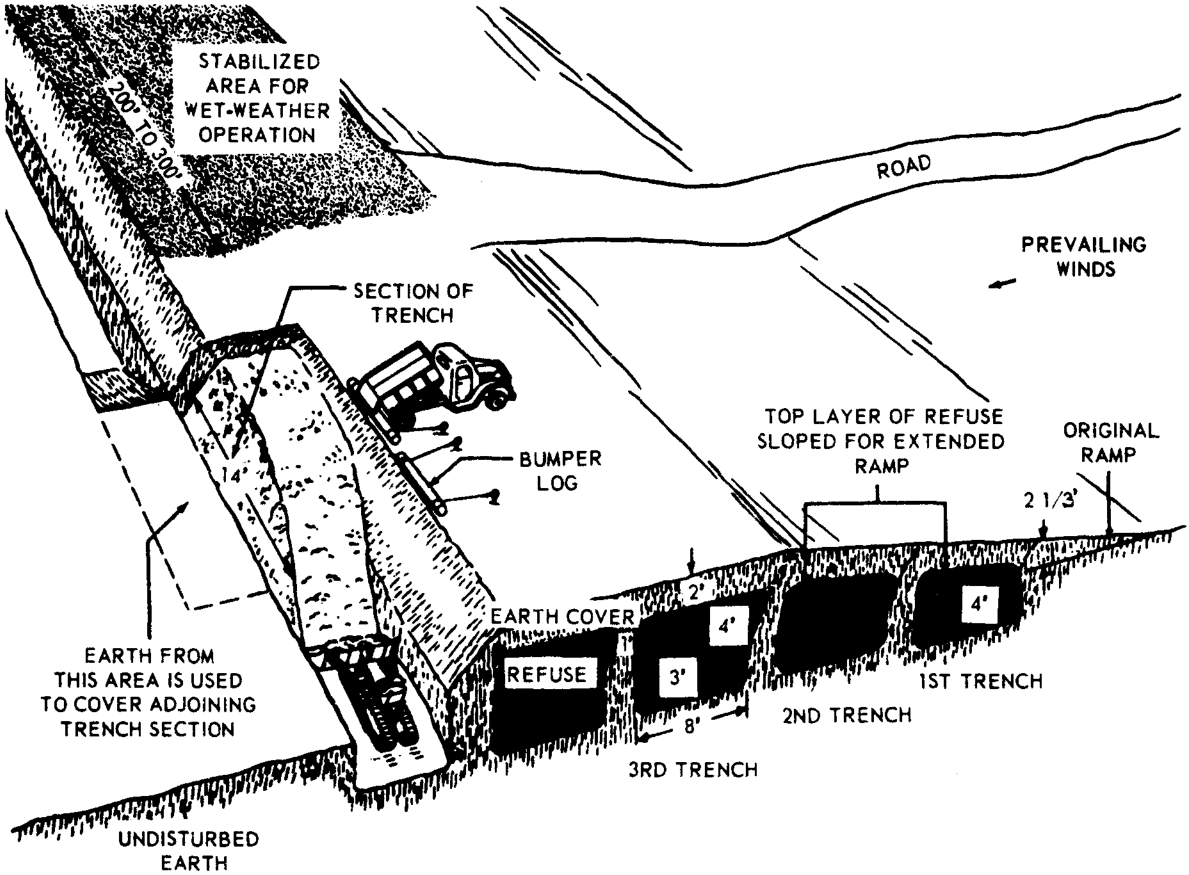


Figure 18-9. Diagram of a sanitary landfill.

c. Sites should be selected where the soil can be excavated to a minimum depth of 6 feet. Claylike soil is preferable, but any soil which will form a seal over the compacted refuse is acceptable. Sites which have surface or subsurface drainage that may pollute a water supply should not be selected.

d. In order for the sanitary landfill to be operated properly, there should be one equipment operator in charge of the entire operation, and it should be planned and supervised by an engineer. This operator prevents unauthorized entry and scavenging, directs trucks to the unloading place, moves bumper logs, places portable fences for control of blowing paper, and directs policing of the fill site. An assistant may be necessary to direct unloading of collection trucks and to police the operating area.

e. Under average operating conditions, a sanitary landfill for an installation of 10,000 strength can be operated with one bulldozer and the occasional use of a dragline for digging trenches ahead of operations. For installations over 10,000 strength, additional equipment should be provided as required; this equipment should be assigned full time to the sanitary landfill.

f. The sanitary landfill is ready for operation when the original trench is dug, the ramp is constructed, and the access road is usable. At the end of each day when a section of trench has been filled and compacted with the bulldozer, the top, side, and end of the section is covered with earth. The top is covered with 2 feet of compacted earth, and the end is covered with just enough compacted fill to contain the refuse and form a seal.

g. At least once each week the compacted refuse must be thoroughly sealed with the final compacted cover. This is done by covering the working face of the trench with at least 1 foot of well compacted earth. The necessity for complete sealing and compacting cannot be overemphasized. Sealing and compacting reduces future settlement, prevents spread of fires, eliminates odors, and precludes insect and rodent problems.

h. It is important to operate a sanitary landfill without scattering paper. The best methods to prevent this are to unload trucks on the windward side of the fill and to erect portable fences at least 6 feet high on the leeward side. The fences are easily moved to the location where they are needed most.

i. Burning combustible material in a sanitary landfill is unacceptable in CONUS operations; however, in oversea areas it may be done provided it does not interfere with the normal operation and smoke odors and fumes do not create an air pollution problem.

18-22. Sale of Edible Garbage and Other Material

At many posts, edible garbage and other material are sold as salvage. Where this is done, the material must be segregated by the discarding unit. When a salvage contract is let, there should be provisions in the contract to ensure that:

- The material being salvaged is picked up and hauled away in a sanitary manner.
- All contract trucks meet the minimum standards as set forth in paragraph 18-18.
- Personnel from the IMA's office are allowed to inspect the trucks as often as is deemed necessary.

Section IV. INFECTIOUS WASTE DISPOSAL

18-23. General

Sanitary disposal of all infectious wastes is essential to prevent the spread of diseases; therefore, the importance of proper handling and disposal of the waste cannot be overemphasized. Commanders of establishments generating infectious wastes are responsible for collecting, storing, and transporting all infectious wastes from generating sources to disposal facilities. The Army Medical Department will provide technical guidance. The preferred method of disposal is by incineration; however, steam sterilization of the waste, followed by landfill disposal, is also an option. Contingency plans should be developed to ensure infectious wastes are properly disposed of should an emergency arise, such as equipment failure.

18-24. Types of Infectious Waste

Refuse containing readily-communicated disease organisms and/or offensive materials, include the following:

a. All wastes from patients with infectious diseases or waste which is potentially infectious (except feces, urine, or vomitus, which are disposed of through waterborne sewage channels). This waste includes paper and sanitary napkins, sputum, food scraps, newspapers, magazines, bandages, dressings, sponges, swabs, tongue blades, bed pads, disposable diapers, and any other contaminated materials.

b. All laboratory refuse or material of a potentially infectious nature including sputum, stool, and urine specimen cups, and culture media that cannot be disposed of in a wastewater collection system.

c. Pathological waste from operating and delivery rooms including tissues, placentas, blood clots, and surgical or autopsy parts of human or animal bodies.

d. All disposable hypodermic needles, live vaccine containers, and syringes from any source.

18-25. Collection System for Infectious Wastes

a. Responsibilities.

(1) *Installation medical authority.* For overall operation of an efficient, safe, sanitary infectious waste collection, storage, and disposal system. The IMA will ensure this program includes—

- Training personnel in handling and disposal of infectious waste and for assigning them to specific waste collection duties throughout the medical facility to ensure efficient collection and disposal of infectious material. All personnel involved in handling infectious wastes are employees of the medical facility and under the control of the facility commander.

- Requisitioning, distinctively marking, repairing or salvaging, cleaning, and disinfecting all cans and vehicles used for infectious wastes.

- Keeping the generating agencies supplied with disposable liners for their infectious waste receptacles, and ensuring their use.

- Providing gloves, masks, and gowns (or other suitable washable protective clothing) for the infectious waste cans handlers.

- Establishing a central collecting point, or intermediate collecting points as required, and for periodic collecting and disposing of these wastes and cleaning the contaminated cans.

- Ensuring that no infectious waste other than placentas are salvaged by anybody for any reason.

(2) *Generating agency.*

(a) For depositing only infectious wastes in the cans designated for this type of waste and forbidding other wastes being placed in the cans.

(b) For transfering the infectious waste from the point of origin to the central collecting point.

b. Procedure.

(1) Disposal of infectious materials incident to laboratory operation, such as cultures, tubes, and petri dishes, will be as follows:

(a) Nondisposable glassware containing culture media will be sterilized by autoclaving or by contact with a chemical disinfectant before washing. After sterilization or disinfection the culture media may be disposed of by any available means.

(b) Following mutilation, the syringes and needles are incinerated.

(2) All combustible disposable waste is segregated from other refuse and garbage and discarded into clearly designated waste receptacles for eventual incineration (see (5) below).

(3) Noncombustible disposable wastes such as glassware will be autoclaved, then disposed of by any convenient means.

(4) Each generating agency will be provided with one or more receptacles which are for infectious waste only. The small quantities of infectious wastes generated from, for example, an individual patient's room or a physician's office, may be placed initially in a small waste can with an opaque disposable liner. This waste will be collected on a periodic basis for final disposal, or placed in a larger receptacle (one that serves an entire ward). The recommended definitive receptacle for infectious wastes is a galvanized iron or heavy plastic can of 32-gallon capacity, having a tight-fitting lid. Infectious waste receptacles will be lined with red impermeable plastic bags. All nonexpendable infectious waste receptacles will have red disposable plastic liners. Plastic liners greatly facilitate waste collection and minimize accidental contamination of the environment. Use of red plastic liners provides a means for identifying infectious waste after removal from the receptacle.

(5) Infectious wastes are placed in designated containers by generating agency personnel who are trained in aseptic techniques and in handling such material. Glove and gown technique will be used as necessary.

Receptacles will not be more than two-thirds full; spillage from overloaded cans will not be tolerated. When two-thirds full, plastic liners will be closed by knotting at the top. Lids will be kept in good repair, tight-fitting, and will be replaced on the container after each deposit.

(6) A schedule is established for the periodic collection of receptacles for transport to a central collection point or incinerator. Handling of infectious wastes at the medical facility is done only by specially trained personnel who are attired in protective clothing to include gloves. These authorized infectious waste handlers will be trained in proper safety procedures and protective personal hygiene measures, and will have current immunizations in accordance with AR 40-562. In place of collecting receptacles, wastes may be collected and transported to an intermediate or central collection point or incinerator in closed red plastic liners, provided precautions are taken to prevent breakage of the liner during transport. At the central collection or disposal point, receptacles will be cleaned as described below, or replaced with a clean empty receptacle, on one-for-one basis.

(7) Infectious waste receptacles will be handled, transported, and cleaned separately from other trash and garbage containers. On emptying, unless plastic insert containers are used, receptacles and lids will be promptly and thoroughly disinfected with steam or hot soapy water and a brush, rinsed, air-dried, and returned for reuse. At medical facilities having integral incinerators, the incinerator, collecting point, and disinfecting and cleaning facilities should be collocated.

18-26. Incineration

a. General. All infectious wastes will be burned in the incinerator under the supervision of the operator on duty.

b. Temperature Range. In full operation, the temperatures in the combustion chamber range from 1,400°F to a maximum of 2,000°F. All combustible materials and odorous gases are consumed at an optimum temperature of 1,600°F. Prolonged higher temperatures damage refractories and castings.

c. Disposal of Ashes. Ashes and other refuse is removed from the incinerator daily, and placed in cans or other suitable containers. The ashes are disposed of in the sanitary landfill at least once each week.

Section V. WASTE DISPOSAL IN THE FIELD

18-27. General

The Pvnt med specialist will be called upon to inspect and make recommendations on field waste disposal facilities. He must be prepared to make sound recommendations as to the construction, maintenance, and operation of disposal methods for the following:

- Human wastes (feces and urine).

- Liquid wastes (kitchen, bath, and wash water).
- Garbage.
- Rubbish.
- Infectious waste.

18-28. Medical Importance

Large quantities of all types of wastes are generated under field conditions. If these materials are not disposed of properly in a camp or bivouac, filth-borne diseases, such as dysentery (amoebic and bacillary), typhoid fever, paratyphoid fever, cholera, plague, and other disease, might become prevalent. Flies, rats, and other vermin would increase and add to the individual's discomfort as well as endanger his health.

18-29. Responsibilities

a. Unit commanders are responsible for the disposal of waste in their unit areas. When waste disposal facilities are not otherwise provided, the commander must arrange for the construction and operation of such facilities.

b. The Army Medical Department inspects waste disposal facilities and operations and recommends changes that aid in protecting the health and welfare of the troops.

18-30. Provisions for Latrines

a. The disposal methods for human waste will vary with the situations. At permanent and semipermanent camps, waterborne sewerage systems like those of our cities are provided; away from these bases, units must provide these facilities. Methods and facilities for field use are—

- On the march, the "cat hole" latrine is used. This latrine is a hole between one-half and 1 foot deep which is covered with earth after use. The individual uses his entrenching tool for digging the "cat hole" latrine (Figure 18-10).

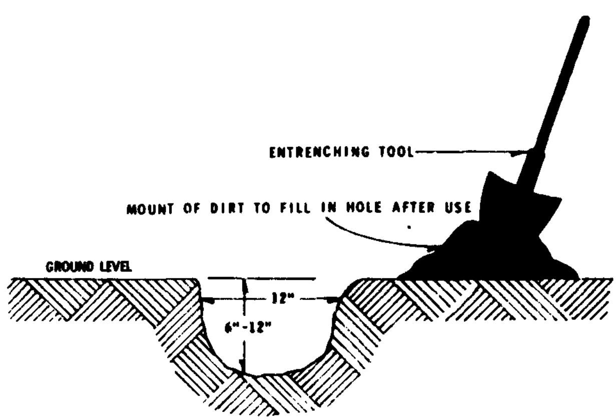


Figure 18-10. Cat hole latrine.

- In bivouacs and in overnight camps, urine and feces are disposed of by the use of straddle trench latrines (paragraph 18-31).

- In temporary camps, deep pit latrines and urine soakage pits are constructed. Until the construction of deep pit latrines has been completed, straddle trench latrines may have to be used, or where the construction of deep pit latrines is not practicable, one of the devices discussed in *b* below may have to be used.

- Troops are occasionally required to camp within urban areas (for example, during riot control operations). In such cases the provision of chemical toilets may be required to obviate the necessity of damaging public parks or other areas objectionable to local officials. When necessary, chemical toilets must be provided to serve at least 2 percent of the unit strength on the day of arrival and 4 percent on the third day. After 7 days the requirement should be reevaluated, based upon the anticipated period of encampment. Daily sanitary maintenance is required.

b. The following general rules apply to the construction of all types of latrines in the field:

- To make sure that food and water is protected from contamination, latrines are built at least 100 yards downwind from the food service facility and 30 yards from the nearest water source. The latrine should not be dug below the ground water level, or in a place where it may drain into a water source. Latrines should be built at least 30 yards from the end of the unit area, but within a reasonable distance for easy access. At night, if the military situation permits, they should be lighted. If lights cannot be used, a piece of cord, rope, or tape may be used to serve as a guide to the latrine.

- Unless there is natural concealment, a brush or canvas screen should be placed around the latrine to provide privacy and a windbreak. In colder climates, the latrine may be enclosed in a tent and heated. For insect control, these shelters should be sprayed with an approved insecticide at least twice each week.

- The number of latrines provided should be sufficient to serve at least 4 percent of the males and 6 percent of the females at one time. Urinals should be provided in the male latrines to prevent soiling the toilet seats.

- On the outside of each latrine inclosure, a simple handwashing device is installed. This device must be kept filled with water and easy to operate (Figure 18-11 and Figure 18-12).

- Latrines must be policed every day. Unit details are assigned the duty of maintaining the latrines.

- When a latrine has been filled to within 1 foot of the surface, or when it is to be abandoned it must be closed. The contents of the pit, the side walls, and the ground surface (to a distance of 2 feet from the side walls) is sprayed with an approved insecticide. The pit is then filled to ground level with successive, 3-inch layers of earth. Each layer is packed down and its surface is sprayed with insecticide before the next layer is added. Then, the latrine pit is mounded over with at least 1 foot of compacted earth. The purpose of this method of closing is to prevent emergence of flies that may hatch in the closed latrine. The location of the latrine should then be plainly marked with a CLOSED LATRINE sign and dated, provided the tactical situation permits.

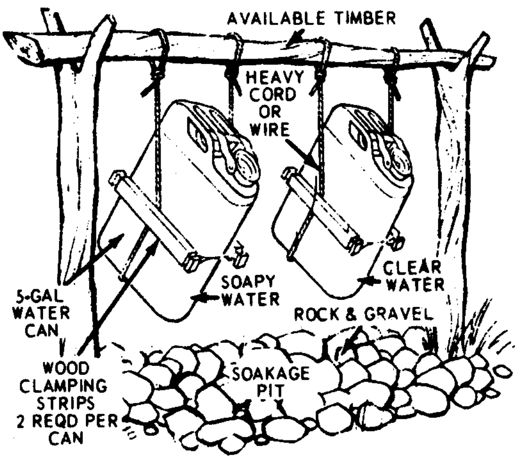


Figure 18-11. Improvised handwashing device (using 5-gallon can).

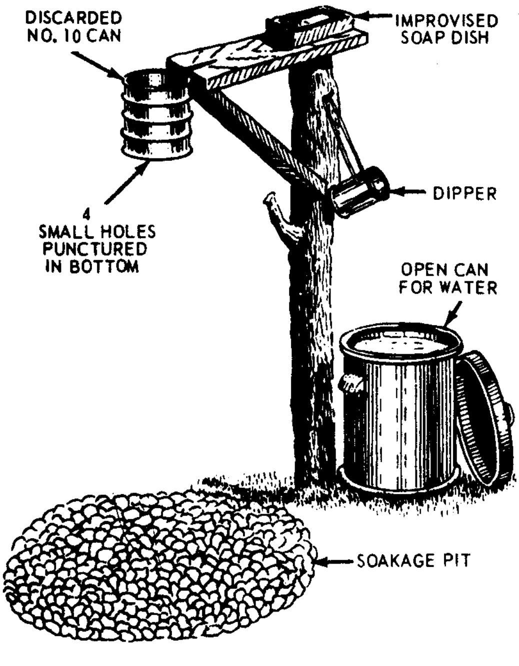


Figure 18-12. Improvised handwashing device (using 10-gallon can).

18-31. Straddle Trench Latrines

Straddle trench latrines (Figure 18-13) are built 1 foot wide, 2 1/2 feet deep, and 4 feet long and will accommodate two men at one time. Boards or rocks may be placed along both sides of the trench to provide better footing. Rolls of toilet paper set on posts are kept dry in bad weather by covering them with cans. Earth removed in digging the trench is piled at one end, and a shovel is provided so that each man can promptly cover his own excreta.

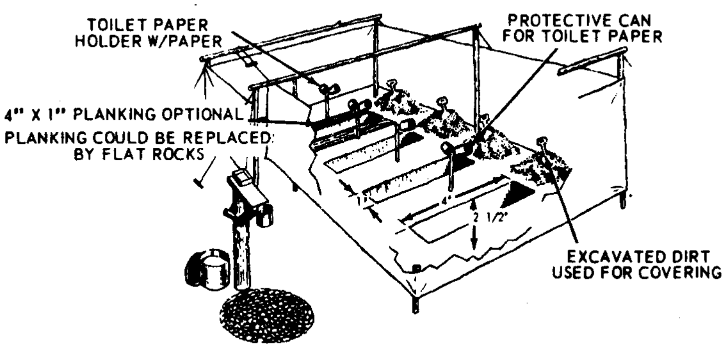


Figure 18-13. Straddle trench.

18-32. Box Latrines

a. The box latrine (Figure 18-14) is used with a latrine box. The standard sized box provides two seats and is 4 feet long and 2 1/2 feet wide at the base. These latrine boxes are items of issue to the unit. If adequate numbers of issue items are not available the unit may construct their own using any type lumber available. The holes should be covered with flyproof self-closing lids. All cracks should be flyproofed with strips of wood or tin nailed over them, and a metal deflector should be placed inside the front of the box to prevent urine soaking into the wood or eroding the supporting earth.

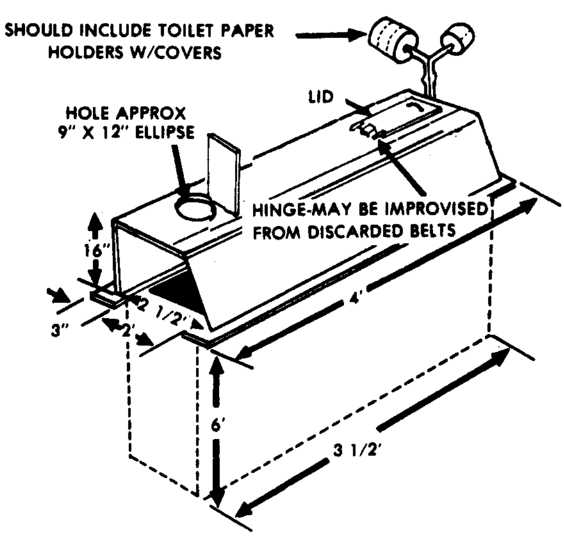


Figure 18-14. Box latrine.

b. The standard size pit for the latrine box is dug 2 feet wide and 3 1/2 feet long. This will give the latrine box 3 inches of support on all sides. The depth of the pit will depend on the estimated length of time the latrine is to be used. As a guide, a depth of 1 foot is allowed for each week of estimated use, plus 1 foot of depth for the dirt cover. However, it is not desirable to dig the pit more than 6 feet deep because of the danger that the walls might cave in. Rocks or high ground water tables often limit the depth of the pit. In some types of soil a support of planking or other material for the sides may be necessary to prevent cave-ins. Earth should be packed tightly around the bottom edges of the box to prevent fly entry.

c. To prevent fly breeding in the pit and to reduce odors, the latrine box must be kept clean, the seat lids closed, and all cracks sealed. The use of lime in the pit, or burning the pit contents is not effective for fly or odor control and is not recommended. The box and the seats should be scrubbed daily with soap and water. When a unit leaves the area, or when box latrines are filled to within 1 foot of the ground surface, the latrine must be closed as prescribed in paragraph 18-30*b*.

18-33. Mound Latrine

a. This type of latrine (Figure 18-15) may be used when a high ground water table, or a rock formation near the ground surface, prevents digging a deep pit. A dirt mound makes it possible to build a deep pit latrine and still not have the pit extend into the water or the rock.

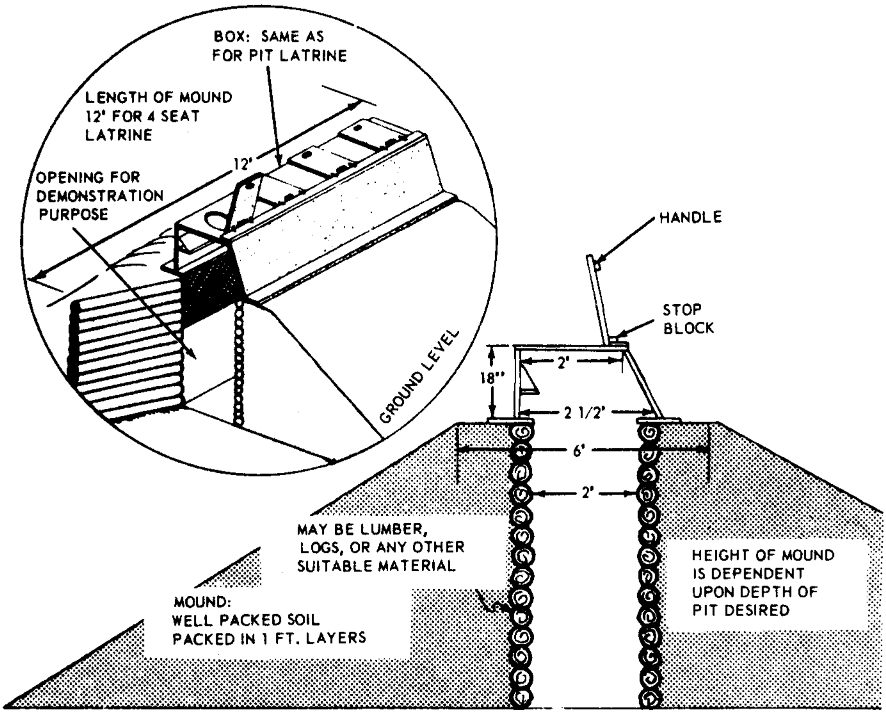


Figure 18-15. Mound latrine.

b. A mound of earth having a top at least 6 feet wide and 8 feet long should be constructed so that an improvised 4-seat latrine box may be placed on its top. The mound should be high enough to meet the pit's requirement for depth, allowing 1 foot from the base of the pit to the water or the rock level. Before the mound is built, the surface of the ground where it is to be built should be broken up to aid in seepage of liquids from the pit. The mound is then built in 1-foot layers. When the desired height has been reached, the pit is dug into the mound. It may be necessary to brace the walls with wood, sand-bags, or other suitable material to prevent cave-ins.

c. The mound latrine must be flyproofed and closed in the same manner as described in paragraph 18-30*b*.

18-34. Burn-Out Latrine

This latrine may also be used where the deep pit latrine is undesirable because soil conditions (hard, frozen, rocky, or a high ground water table) prevent digging a deep pit. The burn-out latrine is made by cutting a 55-gallon drum in half. The open end of the drum is then fitted with a flyproof wooden seat with a self-closing lid (Figure 18-16). Every 18-24 hours or when the latrine is one-half full, a mixture of 4 parts diesel and 1 part gasoline is added to the fecal matter and ignited. This procedure is repeated until only a residue of ash remains. This ash contains no harmful organisms, and may be disposed of by burying, or in some other sanitary manner.

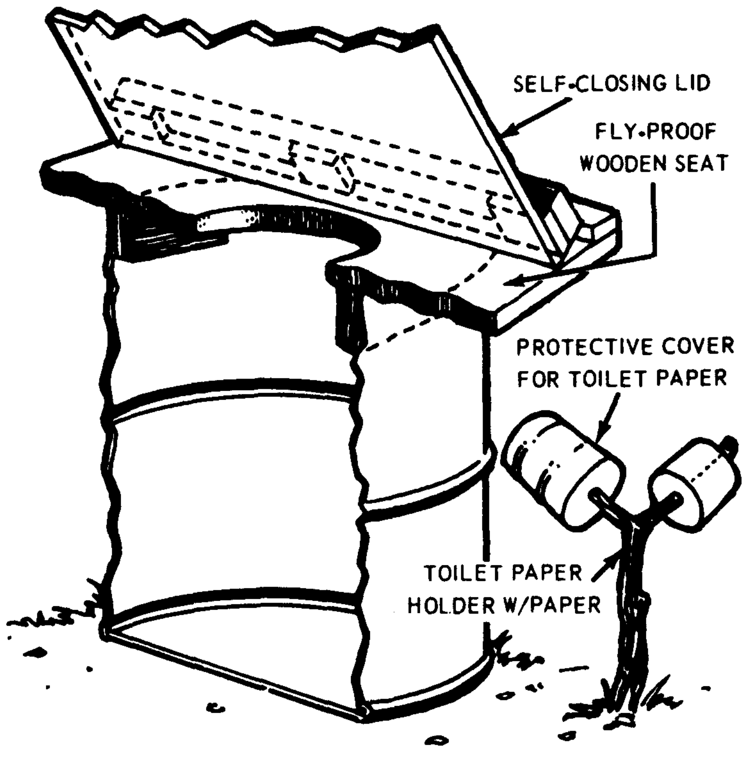


Figure 18-16. Burn-out latrine.

18-35. Bored-Hole Latrine

This type of latrine (Figure 18-17) consists of a hole, about 10 inches in diameter and from 6 to 20 feet deep. A metal drum with both ends removed may be sunk into the ground for use as a box. A flyproof seat cover, with a self-closing lid is made to fit the top of the drum. A one-hole latrine box may also be used to cover the hole.

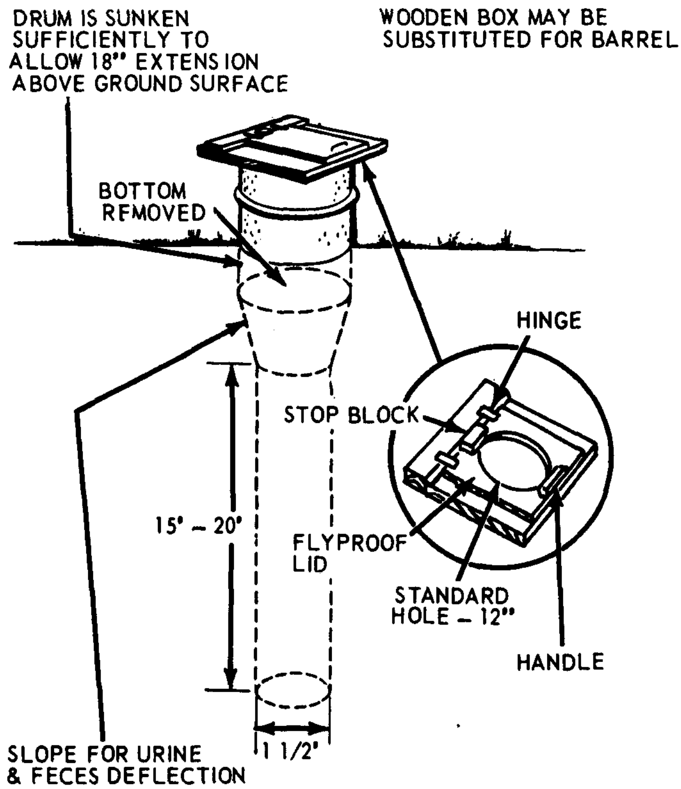


Figure 18-17. Bored-hole latrine.

18-36. Pail Latrine

a. A pail latrine may be built when conditions (populated areas, rocky soil) are such that a dug latrine cannot be used.

b. A standard type latrine box (paragraph 18-32) may be converted for use as a pail latrine by placing hinged doors on the rear of the box, adding a floor, and placing a pail under each seat (Figure 18-18). The seats and rear doors should be self-closing and the entire box made flyproof. The floor of the box should be made of an impervious material (concrete, if possible) and should slope enough toward the rear to facilitate rapid drainage of washing water.

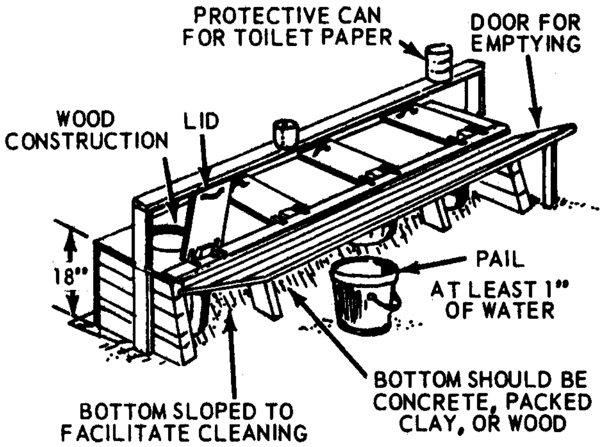


Figure 18-18. Pail latrine.

c. Pails should be cleaned at least once daily; more often, if necessary. The contents may be buried, burned, or disposed of by other sanitary methods. When the pails are replaced after having been cleaned, they should contain 1 inch of disinfectant. Heavy plastic bags may be used in the pails for ease of disposal.

18-37. Urine Disposal Facilities

a. When in the field, separate devices for the disposal of urine may be necessary. These may drain into a pit latrine if the soil is sufficiently porous to absorb the additional liquid.

b. Urine disposal facilities should be collocated with the male latrines. Additional devices may be located throughout the unit area for convenience.

c. The best device for urine disposal in the field is the urine soakage pit. This pit is dug 4 feet square and 4 feet deep. It is then filled with rocks, flattened tin cans, broken bottles, or other coarse material (Figure 18-19). The pipes for the urine soakage pit should be at least 1 inch in diameter. They should be placed at each corner of the pit, and if needed on the sides halfway between the corners. These pipes should extend at least 8 inches below the surface of the pit. A funnel of tar paper, sheet metal, or similar material is placed in the top of each pipe, the upper rim extending about 30 inches above the ground surface. These funnels should be covered with screen wire to keep flies out.

d. If the necessary materials are available and more permanent facilities are desired, a trough urinal may be built. The trough may be either U-or V-shaped and made of sheet metal or wood (Figure 18-20). If made of wood the trough should be lined with tar paper to prevent urine from soaking into the wood. The trough is made 10 feet long, and one end should slope slightly toward the soakage pit.

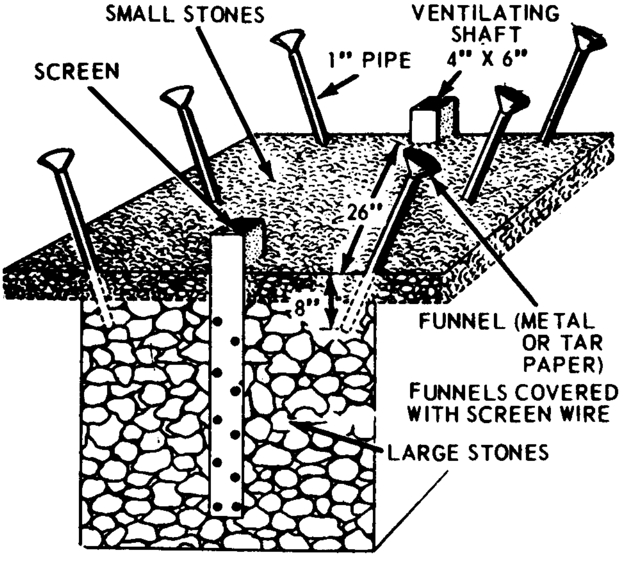


Figure 18-19. Urine soakage pit.

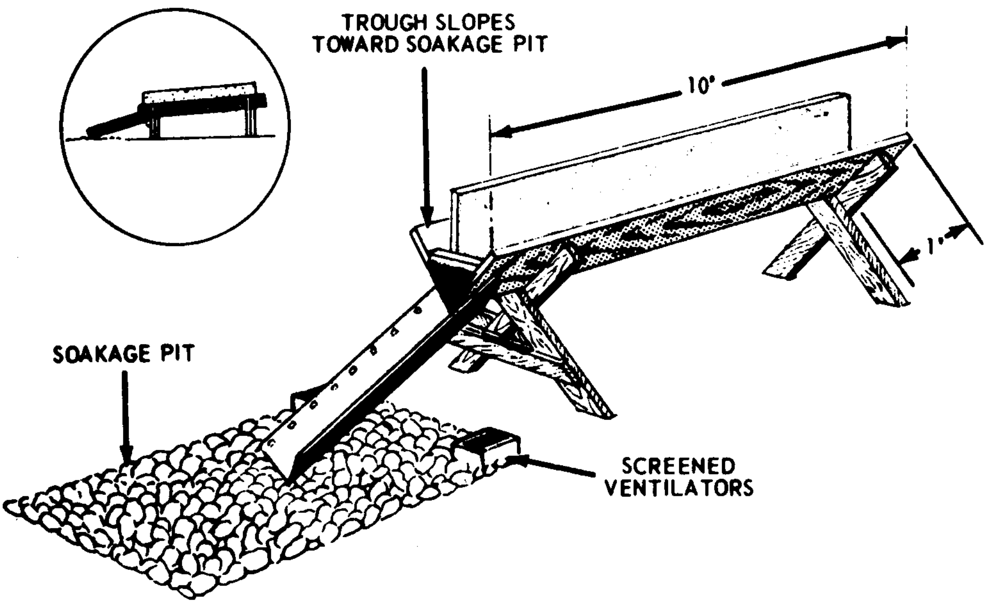


Figure 18-20. Trough urinal.

e. The urinoil (Figures 18-21 and 18-22) is a minimum maintenance, semipermanent device particularly suited to Army needs. Made with commonly salvaged materials, it can operate indefinitely. One urinoil will accommodate four men at a time.

(1) Because urine has a higher specific gravity than oil, it immediately disappears on striking the oil and flows directly to the bottom of the drum. When additional urine is added, the urine overflows through the notch in the 1 1/2-inch pipe and down through the pipe into the soakage pit.

(2) To begin operation of the urinoil place the completed device in position in the pit. Pack dirt around the drum to ground level. Pour at least 1 foot of water into the drum. Then add waste oil (approximately 32 gallons) until it reaches the top of the 3-inch pipe cap.

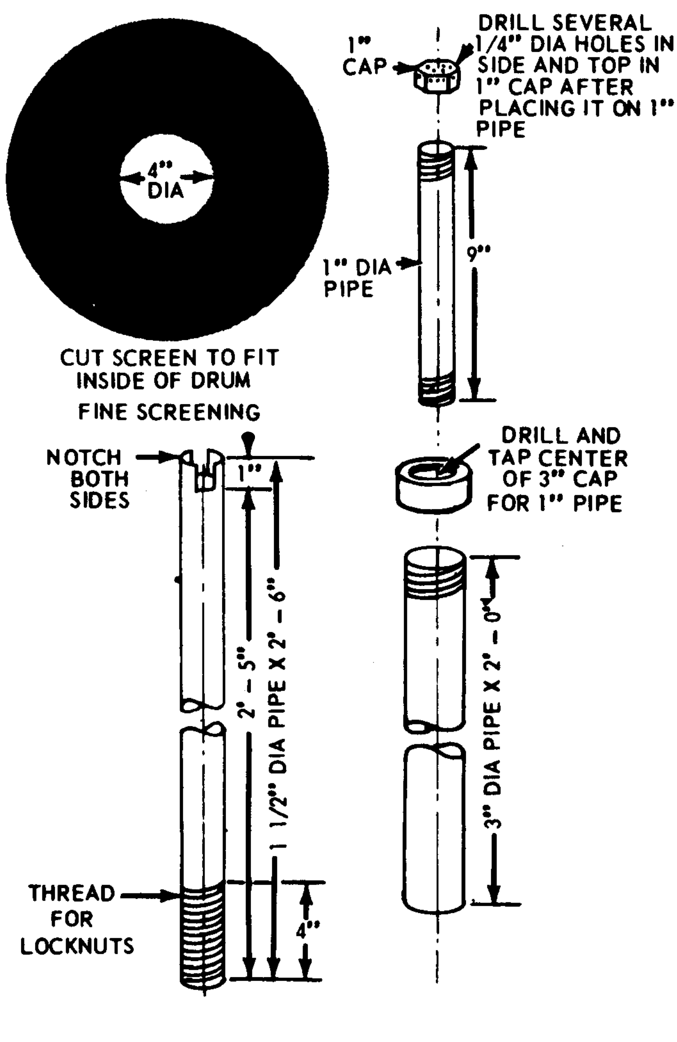


Figure 18-21. Materials for urinoil.

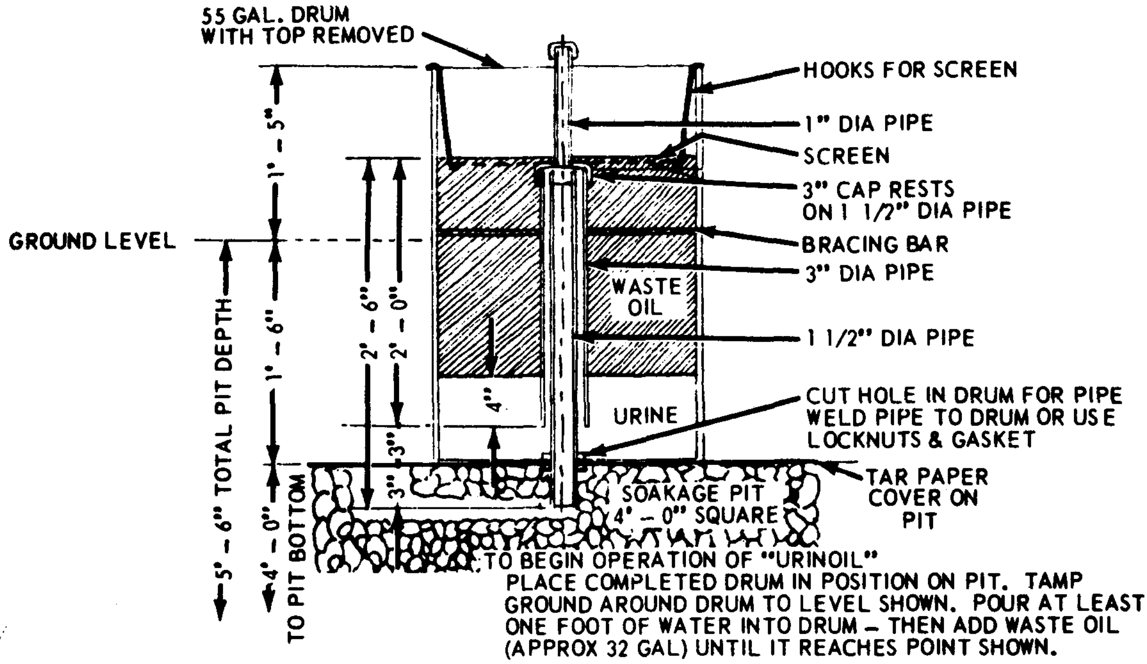


Figure 18-22. Urinoil.

18-38. Operation and Maintenance of Urine Disposal Facilities

In order to ensure the proper operation of these latrine facilities, the following procedures should be observed:

a. Use the trough or the pipes. Do not urinate on the surface of the pit.

b. Wash funnels or trough daily with soap and water.

c. Make sure that pipes convey urine into the interior of the soakage pit, not onto the surface.

d. Do not let oil or grease get into the pit; this will cause the pit to become clogged, thus require digging a new one.

e. The urinoil is a minimum maintenance device. The only routine-maintenance required is to remove debris from the screen periodically to prevent clogging.

f. When a urine soakage pit is to be abandoned, it is sprayed with an approved insecticide and mounded over with a 2-foot covering of compacted earth. The site is marked with a sign labeled CLOSED SOAKAGE PIT and dated, provided the tactical situation permits.

18-39. Infectious Wastes

Infectious wastes in the field, such as surgical dressings, tissues, and materials from infectious diseases wards, should be disposed of by incineration if the situation permits. Land and sea burial are acceptable only when approved by the area surgeon.

18-40. Kitchen Wastes

a. Kitchen waste disposal facilities include soakage pits, grease traps, garbage and rubbish pits, and incinerators. They should be located at least 30 yards from the food service facility, 30 yards from the nearest water source, and reasonably near the edge of the unit area.

b. In temporary camps a soakage pit, constructed like a urine soakage pit, normally will dispose of liquid kitchen wastes for a total of 200 men. The difference between the construction of urine soakage pits and kitchen waste soakage pits is that a grease trap is substituted for the pipes or troughs used in the urine soakage pit. If the camp is used for several weeks, two kitchen waste soakage pits should be constructed. Each pit is used on alternate days, since a rest period helps to prevent clogging. A soakage pit that has become clogged should be closed and a new one constructed. When a pit is to be closed it is covered with 2 feet of compacted earth and the covered site is marked with a sign labeled CLOSED SOAKAGE PIT and dated, provided the tactical situation permits.

c. If the ground water table or a rock formation exists close to the surface, a soakage trench may be used (Figure 18-23). This trench consists of a pit, 2 feet square and 1 foot deep, with a trench radiating outward from each of its corners for a distance of 6 feet or more. Each trench is built 1 foot deep at the central pit to 1 1/2 feet deep at the outer ends of each trench. The pit and trenches are filled with material similar to that used in the soakage pit. Two such devices should be built for every 200 persons fed; each device is used on alternate days. A grease trap is also used with a soakage trench.

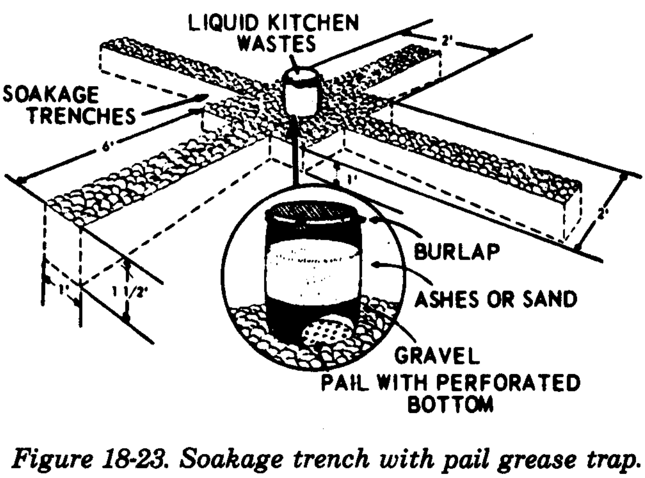


Figure 18-23. Soakage trench with pail grease trap.

d. In places where clay soil prevents the use of standard soakage pits, evaporation beds (Figure 18-24) may be used if the climate is hot and dry.

(1) Sufficient beds, 8 by 10 feet, are constructed to allow 3 square feet of surface area per person per day for kitchen waste and 2 square feet per person per day for wash and bath wastes. The beds are spaced so that the wastes can be distributed to any one of the beds. In the construction of a bed, the top soil is first scraped to the edges, thus forming a small dike around it; then the earth within the bed is spaded to a depth of 10 to 15 inches and raked into a series of rows, making the ridges approximately 6 inches above the depressions. These rows may be formed either lengthwise or crosswise as deemed desirable for best distribution of water.

(2) In operation, one bed is flooded during the day with liquid waste to the top of the ridges, which is equivalent to an average depth of 3 inches over the bed; then the liquid waste is allowed to evaporate and percolate. After 3 or 4 days this bed is usually sufficiently dry for re-spading and re-forming. The other beds are flooded on successive days, and the same sequence of events is followed.

(3) Careful attention must be given to proper rotation, maintenance, and dosage of evaporation beds. It is also essential that the kitchen waste be run through an efficient grease trap (paragraph 18-41) before it is allowed to enter the evaporation beds. If these beds are used properly, they create no insect hazard and only a slight odor. Other modifications of waste disposal methods are possible and should be used when they are more adaptable to the particular situation.

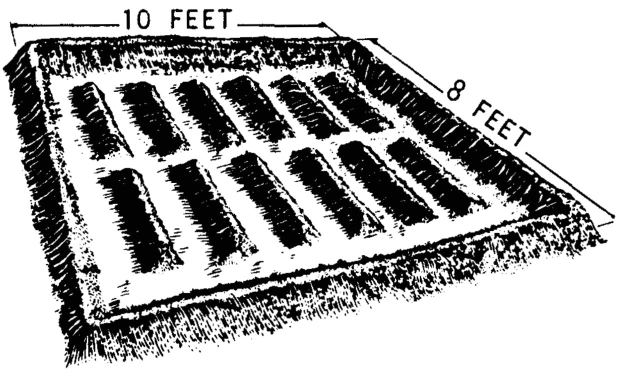


Figure 18-24. Evaporation bed.

18-41. Grease Traps

a. A barrel-type baffle grease trap may be made from a salvaged 55-gallon drum (Figure 18-25). Other materials used in construction of this device are pipe, screen, and scrap lumber. The principle used in this type of grease trap is that the pipe serves as a baffle. Its intake is approximately 3 inches from the bottom of the barrel, and the pressure of the liquid above forces the grease-free water through the pipe and into the soakage pit, with the grease remaining on the top to be skimmed off and disposed of by burning or burying.

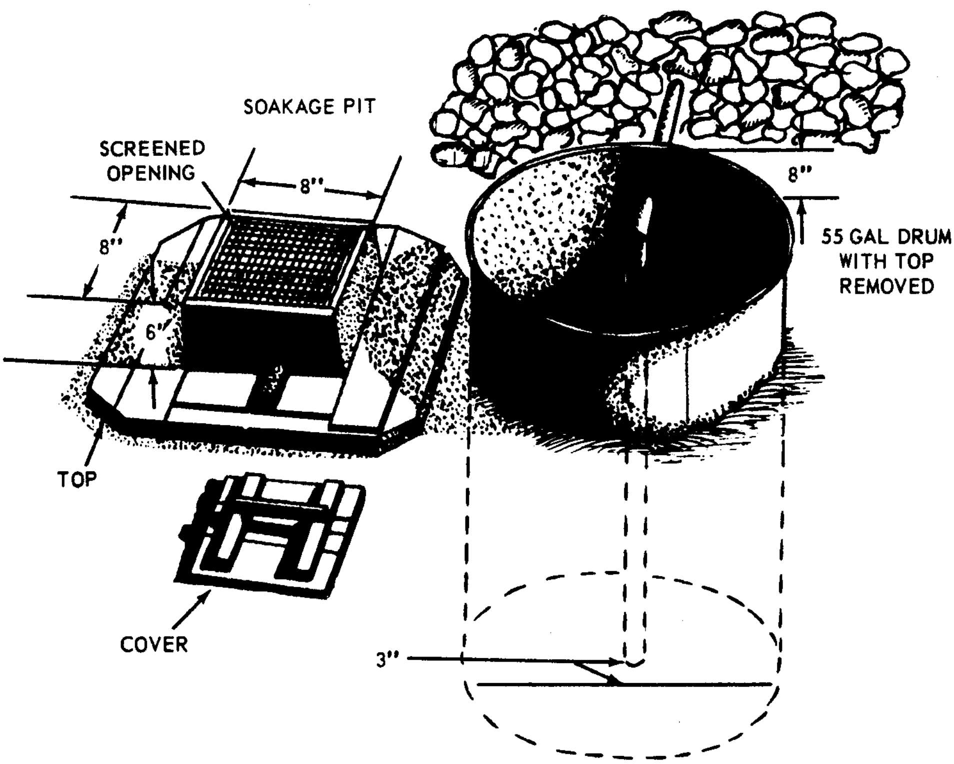


Figure 18-25. Barrel-type baffle grease trap.

b. A box-type baffle grease trap may be constructed from a salvaged wooden box or salvaged lumber (Figure 18-26). The baffle extends to within 1 inch of the bottom of the box and separates the grease and water. The greasy water is poured slowly into the large side of the box; the pressure of the fluid on this side forces the grease-free water under the baffle board and out of the pipe extending from the surface of the smaller section. The grease is skimmed off and disposed of by burning or burying.

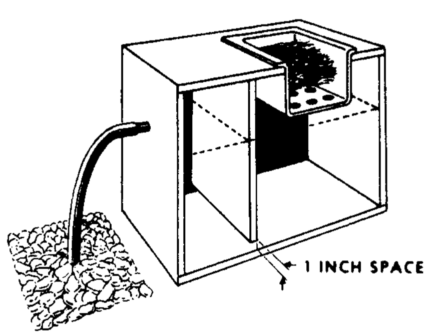


Figure 18-26. Box-type baffle grease trap.

c. Before greasy waste is poured into a grease trap, it should be allowed to cool. Otherwise, the grease will remain uncongealed and will pass through the trap and reduce the soil absorption of the waste water.

d. To ensure proper operation of a grease trap, it must be cleaned frequently. Grease must be removed, the trap drained, and the sediment in the bottom removed. If the grease trap is fitted with a straining device, the strainer must be cleaned daily using soap and water. The grease, sediment, and straining material (when no longer effective) are either burned or buried.

18-42. Bath and Wash Water

These waters are disposed of in the same manner as are the liquid kitchen wastes. These wastes should pass through a grease trap, which will remove the soap before the waste enters the soakage pit. Either the soakage pit or the soakage trench may be used, and is closed in the same manner as the kitchen soakage devices.

18-43. Garbage and Rubbish

a. On the march, in bivouac, or in camps of less than 1-week duration, garbage and rubbish may be buried in pits. For this purpose, a pit 4 feet square and 4 feet deep is suitable for 1 day for a unit of 100 men. Care should be taken to flatten tin cans and break down boxes before they are added to the rubbish.

b. The continuous trench is more adaptable to stays of 2 days or more. The trench is first dug about 2 feet wide, 3 to 4 feet deep, and long enough to accommodate the garbage for the first day. As in the pit method the trench is filled to not more than 1 foot from the top. The trench is extended as required, and the excavated dirt is used to cover and mound the garbage already deposited. This procedure is repeated daily or as often as garbage is dumped. It is a very efficient field expedient for disposing of garbage.

c. If burial is not practicable or if the camp is of a longer duration, garbage and rubbish may be burned, but the burial method is better and should be used whenever possible.

d. The following types of incinerators may be constructed for burning garbage and rubbish in the field.

(1) The barrel incinerator is easily made and will consume small amounts of garbage and combustible rubbish (Figure 18-27). A grate is made of scrap pipe inserted in the holes as shown in the drawing. An alternate method to create a grate is to leave the bottom in the barrel and punch holes in the bottom. The barrel may be supported on bricks or cans filled with dirt, or it may be set on a trench to provide a draft.

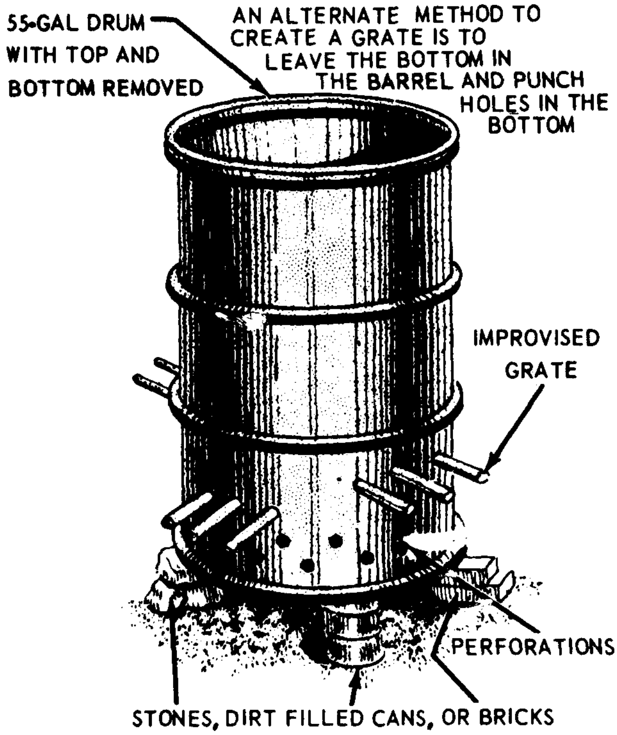


Figure 18-27. Barrel incinerator.

(2) The inclined plane incinerator can be very useful in temporary camps (Figure 18-28). This device is particularly suitable for burning wet garbage and combustible rubbish. To obtain good combustion an auxiliary fire is required at the grate. A vapor burner is an excellent heating device and is constructed as shown in Figure 18-28. The vapor-type burner uses gasoline. The operation of the vapor-type burner depends on the vaporization of the fuel by preheating before burning. Burning the fuel which escapes from the lower pipe of the burner heats the fuel in the upper pipe, causing the fuel to vaporize. This vapor produces pressure in the lower pipe and forces the fuel out through small holes as a spray, thus producing an extremely hot fire. A properly operated burner will produce a blue flame. A yellow flame indicates incomplete burning and may be corrected by lowering the rate of flow in the line with the hand valve on the fuel container.

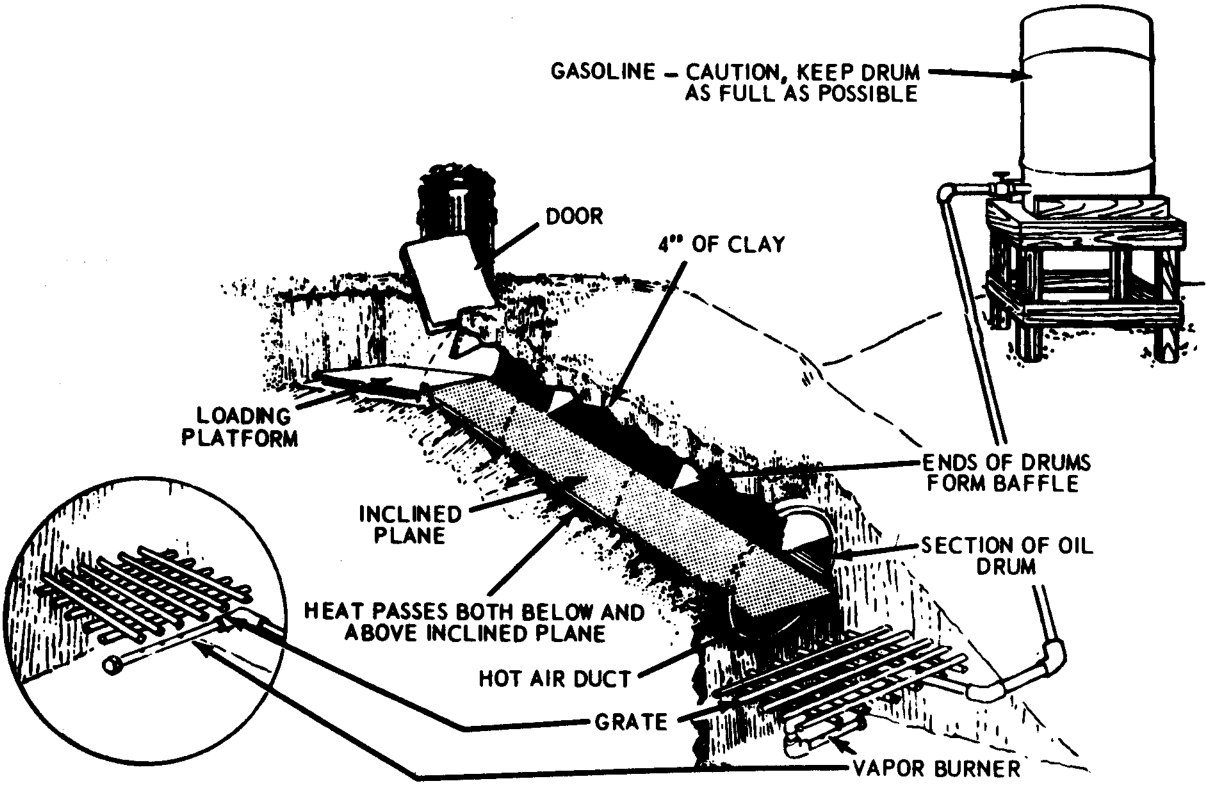


Figure 18-28. Inclined plane incinerator with vapor burner.

CHAPTER 19

SANITARY CONTROL OF HOUSING, SPECIAL SHOPS, AND SWIMMING FACILITIES

Section I. TROOP HOUSING

19-1. General

In a military setting the population tends to be crowded. This crowding occurs in a variety of settings, such as barracks, mobile homes, barber and beauty shops, and swimming pools.

a. Epidemiologic studies have proven that excessive crowding in barracks will result in an increase in the respiratory infection rate in the troops housed there. Epidemiological experience has also shown that in the military there is a much higher susceptibility to respiratory infections in new recruits than in seasoned troops. For these reasons, many of our preventive measures against respiratory infections are directed at controlling the environmental conditions of troop housing. Although the emphasis is placed on recruit housing, it should not stop there since any group of individuals, including "seasoned" troops, will have increased respiratory infection rates if billeted in excessively crowded barracks.

b. The chance for direct transmission of some enteric diseases is also increased under crowded living conditions. Providing suitable shelter, maintaining a high standard of cleanliness, adequate ventilation, and allowing for more than specified minimal floor space per individual are the subjects of this chapter.

19-2. Physical Requirements

a. *Space.*

(1) Basic facilities and space allowances for peacetime missions at Army installations are described in AR 210-20, and AR 415-50. Allowances in the event of an emergency are described in AR 415-50.

(2) To minimize disease transmission, the sleeping space allowance for individuals in basic training is 72 square feet of floor space per individual, exclusive of stairs, halls, latrines, utility rooms, recreation areas, storage rooms, or other administrative areas. All available billeting, including temporary facilities and tents when necessary, will be used to ensure this minimum space allowance.

(3) Troops other than basic trainees may be billeted in less than 72 square feet of floor space. An effort will be made, however, to provide 72 square feet of floor space for each individual. When this cannot be achieved, the minimum area per individual should be at least 55 square feet. During emergencies and temporary peak billeting load periods, troops may be billeted at 40 square feet per person, but commanders authorizing this reduced floor space must recognize and be prepared to accept the increased noneffectiveness resulting from greater incidence of respiratory disease.

b. Lighting.

(1) Lighting should be checked whenever a sanitary inspection is conducted in a barracks. In addition to measuring light intensities, the condition of light fixtures, particularly cleanliness, should be checked. The artificial lighting intensity should be measured at night or during the day with all windows covered. Readings should be taken with the cell face of the light meter parallel to the surface to be measured and about 30 inches from the floor.

(2) Current Army lighting intensity standards and policies are described in AR 420-43, TM 5-683, TM 5-811-2, and the latest edition of the *Illuminating Engineering Societies' (IES) Lighting Handbook.*

c. Plumbing Fixtures.

(1) Plumbing fixture requirements and design are contained in TM 5-810-5, DOD Construction Criteria 4270.1M and the current National Standard Plumbing Code. Table 19-1 contains the recommended standards.

(2) To maintain cleanliness, prevent unnecessary odors, and reduce the potential for disease transmission, all plumbing fixtures should be cleaned daily.

Table 19-1. Number of Persons Per Plumbing Fixture

Fixture	Men	Women
Lavatories	8	6
Water closets	10	6
Urinals	16	0
Showers	16	10
Bathtubs	0	30
Drinking fountains	75	75

d. Ventilation.

(1) The importance of adequate ventilation in troop barracks has been covered in Chapter 5. Ventilation can be provided by either natural or mechanical means, and in some cases, by air conditioning.

(2) Natural ventilation occurs when warm air, being lighter than cool air, rises. Natural circulation is best obtained by admitting cool, fresh air near the floor and allowing it to escape near the ceiling after the air, warmed by the room, rises. The inlets and outlets of air should be on opposite sides of the room, since this permits better mixing of fresh air with the stale air in the room. If properly opened, windows serve the purpose very well. The windows on the windward side should be opened at least 2 inches from the bottom, allowing cool air to enter. Windows on the opposite side, the leeward side, should be opened at least 2 inches from the top allowing the warm air to escape. The rate of air exchange will vary with the wind velocity, temperature outside, and activity within the barracks, and may be regulated by the amount

of open window space. For practical purposes, it is better to open several windows slightly than to open one widely.

(3) Mechanical ventilation consisting of fans and blowers may be used to supplement natural ventilation. Odor masking devices may be used but are not a substitute for maintaining a high standard of sanitation.

(4) See DOD Manual 4270.1M, AR 420-54, and TM 5-785 for additional information on ventilation.

e. Insect and Rodent Control.

(1) The control of insects, rodents, and other animals that harbor or transmit diseases of man or that adversely affect the health or morale of Army personnel is especially critical in troop housing areas because of the tendency toward crowding and the possibility of a concentrated outbreak of disease.

(2) It is the responsibility of the installation engineer to conduct continuing programs for the control of insects, rodents, and other pests, to include a training program adequate to ensure that all engineer personnel engaged in these operations are qualified to perform their assigned duties. The AMEDD will monitor engineer control programs and provide technical guidance, advice, consultation, and recommendations concerning the control measures.

(3) The program for insect and rodent control is discussed in Chapter 12.

Section II. MOBILE HOME/RECREATIONAL VEHICLE PARKS

19-3. General

a. Inspections of mobile home/recreational vehicle (RV) parks on military installations must be included in the overall preventive medicine program.

b. Normally, routine formal inspections will not be required; however, the Pvnt med specialist must maintain liaison with the supervisor of the mobile home/RV park and keep such facilities under surveillance.

c. Army Regulation 40-5 contains detailed guidance on the maintenance of sanitation at these parks.

19-4. Water Supply

a. Normally, the potable water system for these facilities is an extension of the installation system. In this case water samples for bacteriological analysis will be collected as a part of the overall installation sampling program.

b. If these facilities have their own potable water system, water samples for bacteriological and chlorine residual analysis are collected in the same manner and at the same frequency as similar samples at fixed installations; these procedures are described in Chapter 16.

19-5. Waste Disposal

a. Garbage and trash at mobile home/RV parks are handled as is refuse at a fixed installation. The types of refuse as well as the recommended methods of disposal are discussed in Chapter 18.

b. Sewage generated at mobile home parks must be treated at an approved treatment facility. Normally the sewage system for mobile home/RV parks on military installations is an extension of the installation system. Recreational vehicles having waste water holding tanks must discharge this material at approved RV dumping stations.

c. The connection between the waste line of each mobile home and the sanitary sewer (Figure 19-1) should be checked at frequent intervals to ensure that it is still intact.

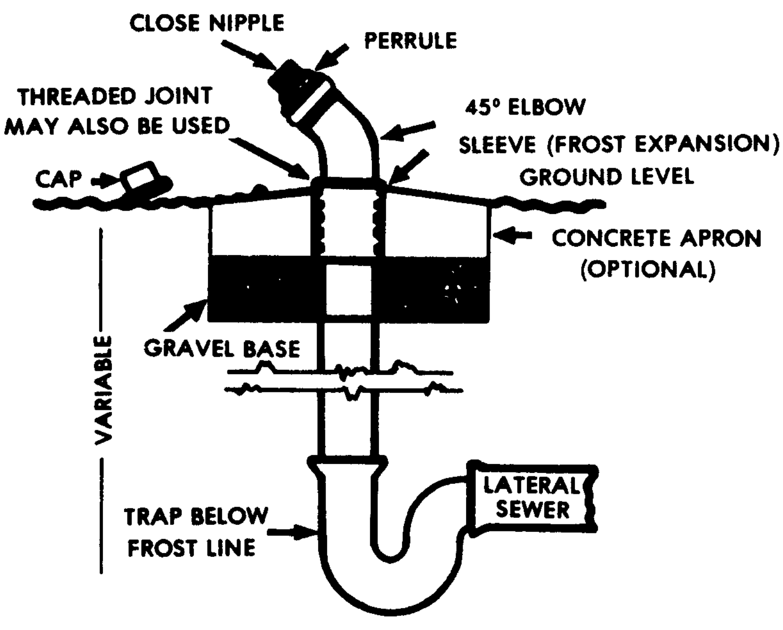


Figure 19-1. Typical sewer connection.

19-6. Service Building

a. A service building in mobile home/RV parks contains toilet, laundry, bath, and other facilities. These buildings should be checked to ensure that a high degree of sanitation is maintained.

b. Army Regulation 40-5, and TM 5-814-1 contain requirements for facilities in service buildings.

c. All sanitary sewerage systems will be designed to discharge the expected peak rate of flow when pipes are running full or less. Regardless of sewage quantity, the minimum pipe size to be used is 6 inch for house connections and 8 inch for all other lines.

Section III. BARBER AND BEAUTY SHOPS

19-7. General

a. Barber and beauty shops on military installations normally are operated for the post exchange by a concessionaire. The concessionaire reports to the post exchange officer and will comply with all directives prescribing sanitary standards for these shops.

b. The Pvnt med specialist will conduct sanitary inspections of barber and beauty shops for the surgeon and make recommendations to prevent unsanitary conditions or practices.

c. AR 40-5 contains a barber and beauty shop inspection checklist.

19-8. Unit Barber Shop

a. The unit barber shop is the exception to the rule that barber shops are operated by a concessionaire. This barber shop may be seen in combat areas, in isolated oversea areas, and on extended field problems. It is equipped with a barbering kit, and someone, preferably with barbering experience, is designated as the unit barber. The barbering kit consists of scissors, combs, razors, and manually-operated hair clippers, but has little of the other equipment and supplies related to barbering as prescribed in AR 40-5.

b. Since personnel in a unit usually have little knowledge of the potentials of spreading skin infections and disease, the Pvnt med specialist's main job will be one of educating these personnel in the disease hazards related to barbering.

c. The lack of barbering supplies in the field can be somewhat alleviated with several field expedients. For example, each individual may be required to furnish his own towel or shirt to place around his neck while his hair is being cut, or he may choose to strip to the waist and shower after his hair is cut.

d. In case the chemicals prescribed by AR 40-5 are not available, barbering equipment may be disinfected by one of several field improvisions:

- Equipment may be boiled in water for 30 seconds; OR

- Equipment may be immersed for 1 minute in a solution consisting of six individual iodine water purification tablets dissolved in 1 quart of water (a disinfecting solution of approximately 48 mg/l of iodine); OR

- Equipment may be immersed for 1 minute in a solution prepared by dissolving one 0.5 gram ampule of calcium hypochlorite in a quart canteen of water and using 5 canteen capfuls of this stock solution in 1 quart of water to make a disinfecting solution of approximately 50 mg/l of chlorine. This solution must be freshly made for each use.

e. After disinfecting barbering equipment in any chemical solution, the equipment should be rinsed in running water and dried with a clean towel or tissue.

f. To expedite washing hands and equipment with hot water after attending each patron in the field, a faucet may be attached to a 5-gallon can and heat applied to the can to heat the water, or hot water may be poured into the can.

19-9. Concessionaire-Operated Barber Shop

a. These shops are found on all installations in CONUS and overseas. Normally, they have adequate equipment and facilities for sanitary operation; however, the equipment and facilities are only as good as the personnel using them. Here, too, the Pvnt med specialist's job is to inspect and instruct.

b. Equipment required for each barber shop or beauty shop chair is listed in AR 40-5, and includes lavatories with hot and cold running water, covered containers for waste materials and soiled linen, an adequate supply of clean linen and towels, and containers for disinfecting solutions, in addition to the instruments actually used in the hair care process.

c. Barber and beauty shops will not be located in food service or sleeping areas.

19-10. Health and Personal Hygiene

a. Each employee of a barber shop or beauty shop may be required to undergo a medical examination before he is employed, before returning to work after an illness, and at any other time deemed necessary by the surgeon. Employees receive the same examination and at the same frequency as do food handlers.

b. Employees of barber shops and beauty shops must keep clean, wear clean clothing, wear clean washable outer coats or uniforms while attending patrons, and wash their hands thoroughly with soap and water before attending each patron.

19-11. Treatment of Instruments

a. Immediately after use on each patron, instruments such as razors, scissors, combs, and brushes, are washed thoroughly with hot water and soap and then dried with a clean towel or disposable tissue. Hair and debris are removed from the exterior surfaces of the clippers with a stiff-bristle brush, which is used for this purpose only.

b. If in the course of the barbering process it is suspected that the patron has a communicable disease or infection, the barbering instruments must be washed and disinfected immediately after use. Disinfection is accomplished by using any chemical disinfectant specifically formulated for use with barbering tools and carrying a label registered with the Department of Agriculture. The disinfectant must be used in accordance with the instructions contained on the label. Other disinfectants may be used upon approval of the surgeon. Disinfecting solutions must be prepared at least once daily and frequently enough to ensure bactericidal effectiveness when used.

Section IV. SWIMMING POOLS AND NATURAL SWIMMING AREAS

19-12. General

This section provides a guide for sanitary control of all swimming pools and natural swimming areas constructed and/or operated with either appropriated or nonappropriated funds. Health hazards encountered and measures necessary for the protection of personnel using such facilities are described more fully in TB MED 575.

19-13. Responsibilities

a. The IMA is responsible for the sanitary supervision of all swimming areas. The Pvnt med specialist, as a representative of the surgeon, will normally conduct routine sanitary inspections of swimming areas.

b. The post engineer is responsible for the construction and maintenance of pools and for the operation of equipment.

c. Management of pools, including the enforcement of sanitary regulations, is the responsibility of the local commander. Special Services operates most appropriated fund pools, and the nonappropriated fund pools are usually operated by officer and noncommissioned officer open messes or other clubs or organizations.

19-14. Disease Hazards

a. Although there is little epidemiological evidence that swimming pools or bathing beaches present major public health hazards, there is reason to believe that bathing in water polluted by sewage, human excrement, or secretions and discharges of bathers is a means of acquiring disease. The principal reasons for providing swimming facilities are recreation and improvement of morale. These objectives can be realized only if safe, healthful, and aesthetically acceptable facilities are provided.

b. Diseases which can be contracted by swimming in polluted water are infections of the skin, eyes, ears, nose, throat, and gastrointestinal tract. Contracting the latter from swimming pool water is very unlikely; however, polluted streams or beaches offer a slightly greater hazard. Because animal-borne parasites may be transmitted at bathing areas; cats, dogs, and other pets should not be permitted to enter these areas.

c. In areas where schistosomiasis is endemic, this disease may be acquired by bathing in natural water. Swimming and unnecessary entrance into untreated water should be prohibited in endemic areas.

d. In any instance where the surgeon finds evidence that disease is being transmitted through swimming pool water, or where bathing facilities constitute a menace to the health of the troops, adequate corrective measures are instituted, or the facility is closed.

19-15. Types of Swimming Pools

a. Recirculation with Filter. In this type of pool, water is withdrawn from the pool, filtered, disinfected, and returned to the pool. The water may receive additional chemical treatment. This is the only type approved for new construction.

b. Flow Through. In this pool, a continuous supply of fresh water enters at one end and an equal amount of used water flows out the other end.

c. Fill and Draw. These pools are filled, used until the water is dirty, emptied, and refilled with clean water. Some pools are equipped to recirculate a small portion of the water for chlorination, but these should not be confused with the recirculation with filter pools.

d. Children's Pools.

(1) *Wading pools.* A wading pool is a pool with a maximum depth of 24 inches. The probability of infection from these pools is greater than it is from large pools. Young children are more likely than adults to contaminate the water and also to drink or otherwise get the contaminated water into their mouths. Wading pools should be small and have a continuous flow of treated water entering them to give a complete change of water once every 2 hours. Overflow should be of the open type, extend completely around the pool, and may be returned to the filtration system. Treatment may be in conjunction with the main swimming pool or separately.

(2) *Spray pools.* These are pools for use by children. Water is sprayed into the pools but not allowed to pond. Treated water is sprayed into the pool and runs to waste or is returned to the filtration system. These pools serve the same purpose as wading pools, but have almost none of the hazards because children do not come in contact with contaminated water. It is generally desirable to convert improperly designed wading pools into spray pools so they can be operated in a sanitary manner.

19-16. General Requirements for Swimming Pools

a. Location. Swimming pools must be located so as to prevent storm water and other surface drainage from entering the pool. The top of the pool should be well above the surrounding ground level and located at a site where dirt, dust, and debris will not be carried or blown into the pool. Trees and shrubbery enhance the appearance of a pool, but should not be located where leaves and blossoms fall into the water.

b. Construction and Design Details.

(1) Swimming pools should be constructed of inert, nontoxic, impervious, permanent, smooth, easily cleaned materials, and should be finished in white or a light color. The depth of the water should be plainly marked at or above the water surface of the pool wall and on the edge of the deck next to the pool. The points of maximum and minimum depth, the points of break between the shallow and deep points, and intermediate 1-foot increments of depth should be marked.

(2) Where water from a potable water system is added to the pool, cross-connections between the water system and the swimming pool water should be eliminated by pumping water from a pump suction well or by admitting water to the pool by means of an air gap connection.

(3) No direct connections to sewers are permitted. All drains from the pool to sewers are constructed with an air gap to prevent sewage from backing up into the pool.

(4) The pool area should be completely fenced with entrance to the pool through the bathhouse. All persons entering the pool area should pass through a shower located at the entrance. Where there are unpaved areas within the pool area, they should be fenced and the entrance to the paved portion of the pool area provided with a shower. No food, bottles, or drinking containers should be allowed in the bathhouse or pool enclosure.

(5) See TB MED 575 for additional details.

c. Bather Load. The maximum bather load is based on the sum of the following three requirements:

(1) One bather for each 15 square feet (1.4 sq m) of shallow, instructional, or wading area.

(2) One bather for each 20 square feet (1.9 sq m) of deep area not counting that area figured as diving area.

(3) One bather for each diving area. Each diving area is defined as 300 square feet (27.9 sq m) of deep area.

d. Treatment of Swimming Pool Water.

(1) All new swimming pools should be designed with provisions for adequate treatment including filtration, disinfection, and recirculation of the swimming pool water. The design capacity of the treatment system should be such that the entire volume of the swimming pool water is treated every 8 hours or three times per day. The filtration equipment should keep the water clear enough so that a black dish 6 inches in diameter on a white field is visible at the deepest point of the pool from a horizontal distance of 10 yards.

(2) Normally eye irritation is caused by a low pH rather than by the amount of chlorine in the swimming pool water. Consequently, the pH

should be maintained above 7.2. Soda-ash can be used to increase the pH to adequate levels.

(3) Free available chlorine residuals of 1.0 to 2.0 mg/l at pH 7.8 to 8.4 or 0.4 to 0.6 mg/l at pH 7.2 to 7.6 should be maintained in the swimming pool water when the pool is open for swimming. Lifeguards should determine the chlorine residuals and the pH at least four times daily during the period that the pool is in use. Findings should be recorded on the Swimming Pool Operation Log, DA Form 3164-R.

(4) Visible dirt on the pool bottom and floating material should be removed at least daily.

(5) Increased turbidity or difficulty in maintaining free available chlorine residuals may indicate inadequate operation of the pool filters. If increased frequency of filter backwashing does not correct the problem, notify the supporting engineer personnel.

e. Bathhouse.

(1) A bathhouse with dressing rooms, clothing storage facilities, showers, and toilets should be located adjacent to the swimming pool.

(2) The bathhouse floors should be made of an impervious, non-slip material and should be scrubbed daily and disinfected as needed with a 50 mg/l chlorine solution to control growth of fungi.

(3) Improperly maintained footbaths do more to enhance the spread of disease than they do to prevent it; therefore, footbaths will not be used at swimming pools and swimming areas.

(4) Required numbers of shower and latrine facilities are based on swimmer load (TB MED 575).

19-17. Standards for Natural Swimming Areas

a. Bathing in streams, rivers, lakes, and tidal waters presents special problems, since the sanitary quality of the water cannot be controlled. Selection of a proper bathing site is the principal factor in ensuring the sanitary suitability of a natural swimming area. Freedom from dangerous pollution is essential. A sanitary survey must be made of each swimming site, and sources of pollution should be identified. In addition, water samples for bacteriological analysis should be collected at the swimming site and the suitability of the site classified in accordance with Table 19-2.

Table 19-2. Bacteriological Water Quality Criteria

Primary contact*	Average of all samples for the last 30 days.	Less than 200 fecal coliforms/100 ml of sample filtered.
	Not more than 10 percent of all samples for the last 30 days should exceed.	400 fecal coliforms/100 ml of sample filtered.
General contact**	Average of all samples for the last 30 days.	Less than 1000 fecal coliforms/100 ml of sample filtered.
	Not more than 10 percent of all samples for the last 30 days should exceed.	2000 fecal coliforms/100 ml of sample filtered.

SOURCE: *Microbiological Methods for Monitoring the Environment, EPA-600/8-78-017, Dec. 78, p. 95.*

*Primary contact recreation is defined as those activities such as swimming and wading where the body or significant parts of the body are in intimate contact with the water source.

**General contact recreation is defined as those activities such as boating or sailing where body contact with the water source is incidental to the activity, and in any case for short duration over small contact areas.

Note. For purposes of simplicity, arithmetic mean (average) is used in comparing bacteriological results with these "standards." Geometric or true mean calculations shall not be used.

b. When shower and latrine facilities are provided at a natural swimming area, an adequate means for the disposal of liquid and human wastes must be provided.

19-18. Sanitary Inspections of Swimming Pools and Natural Swimming Areas

a. A suggested checklist for use when conducting a sanitary inspection of a swimming pool or a natural swimming area is provided in Appendix K.

b. An important part of a sanitary inspection is the collection of water samples for bacteriological analysis.

(1) Samples for bacteriologic examinations are collected at least once weekly and include periods of heaviest swimming loads. Collect samples from both the deep and shallow ends of swimming pools. In natural waters, collect samples about 25 feet from shore in water at least 2 1/2 feet deep and representative of the bathing water. Collect samples from wading pools that are representative of the wading water.

(2) Water sample bottles are described in Chapter 16.

(3) When samples are being collected, the bottle top is removed and held so as to prevent contamination of the top or mouth of the bottle. The bottle is then plunged, mouth down, at least 6 inches below the surface of the water and filled by moving it forward through the water so that no water which has come in contact with the hand or outside of the bottle enters it; do not rinse the bottle. In a stream, the bottle is moved against the current.

(4) At the time the sample is collected, DD Form 686 is completed by entering the sample number, collection site, chlorine residual, pH (if appropriate), date and time of collection, and name of collector.

19-19. Interpretation of Bacteriological Analysis Results

a. General. Bacteriological analysis for coliform organisms is accomplished by either the multiple-tube technique or the membrane-filter technique, both of which are acceptable. The membrane-filter technique is the method of choice for the field with the multiple-tube technique as the back-up method.

b. Swimming Pool Water. When using the membrane filter technique, the arithmetic mean (average) of all samples analyzed for the past 30 days shall be less than or equal to 2.0 coliform organism per 100 ml (total coliform). If the multiple-tube fermentation technique is used, then not more than 15 percent of the samples examined in the past 30 days shall show positive results for coliform organisms in any of the five 10 ml portions of this technique. Five fermentation tubes should be used for each dilution required.

c. Natural Bathing Waters.

(1) Fecal coliform is used as the indicator organism for evaluating the bacteriological suitability of natural bathing water. This determination can be made by using either multiple-tube fermentation or membrane filter technique. Table 19-2 specifies applicable water quality criteria using either technique for both fresh or salt water.

(2) If the multiple-tube fermentation technique is used, three dilutions should be prepared for each sample using five tubes for each dilution. Sample sizes for the three dilutions should be prepared in accordance with the current edition of *Standard Methods for the Examination of Water and Wastewater*.

19-20. Lifesaving Facilities

a. Swimming Pools.

(1) *Lifeguards.* A qualified lifeguard (American Red Cross Advanced Certificate or equivalent) must be on duty at all times when the pool is in use. At least one guard for each 75 swimmers is recommended.

(2) *Lifesaving equipment.* Swimming pools should be furnished with one or more shepherd's crooks, each greater in length than one-half the pool width, capable of extension to all sections of the floor of the pool; one or more "flutter boards"; one or more throwing-ring buoys with lines attached at least equal in length to the maximum width of the pool; a separate throwing rope with a length no less than one-half that of the maximum width of the pool; and first aid kits. These items should be provided on the basis of one each for every 2,000 square feet of pool surface area. Elevated lifeguard platforms or chairs should also be provided on the basis of one per 2,000 square feet of pool surface area or fraction thereof.

(3) *Location of equipment.* Lifesaving equipment should be mounted in conspicuous places, distributed around the pool deck, at lifeguard chairs, or elsewhere. It must be readily accessible and kept in good repair and operating condition.

b. Natural Bathing Areas. It is recommended that natural bathing areas have at least 2 lifeguard towers, 4 lifeguards, and 1 boat per 1,000 feet of beach. Marking signs and buoys should be placed to define the swimming area. Lifesaving equipment, such as grappling hooks and buoys, as well as first aid kits should be readily available to lifeguards.

Section V. CHILD DEVELOPMENT SERVICES FACILITIES

19-21. General

a. Child development services (CDS) facilities are provided on most military installations to reduce the conflict between parental responsibilities and unit mission requirements. Changes in life styles, coupled with an increase in working spouses and unit mission requirements have made CDS facilities a necessity.

b. The Pvnt med specialist conducts sanitary inspections of CDS facilities for the installation medical authority, and makes recommendations to prevent unsanitary conditions or practices. These inspections may be performed individually by the Pvnt med specialist, or as part of an inspection team. Inspection teams for CDS facilities often include a Pvnt med specialist, a community health nurse, a CDS program coordinator, a fire marshal, and safety personnel.

19-22. Types of Facilities

a. Center-based CDS facilities are those services provided through centralized installation facilities. Sanitary inspection of center-based facilities will be conducted in accordance with AR 608-10.

b. Quarters-based CDS facilities are those services provided through a certified child care home located in government quarters. Sanitary inspection of quarters-based CDS facilities are conducted in accordance with AR 608-10 and local directives.

19-23. Staff Health Requirements

All CDS personnel will have a medical examination before employment and/or certification. This evaluation will be as prescribed by the installation medical authority, and is updated annually.

19-24. Food Service Programs

Food service programs in center-based CDS facilities will be conducted in a sanitary manner that adheres to TB MED 530, and all applicable guidance specified by the USDA Child Care Food Program.

Section VI. FAMILY HOUSING

19-25. General

a. The military attempts to provide family housing for married personnel in grades E4 and above. When assigned family housing, the active duty members are responsible for the sanitary condition of their quarters.

b. Normally, routine sanitary inspections will not be required; however, when needed, such inspections are coordinated by the installation housing officer.

19-26. Inspections

a. The exterior of housing units can be inspected unaccompanied, but the interior is surveyed only when requested and accompanied by a representative from the installation housing office. The only exception to this policy is when invited into quarters by the occupant. Further, you should not enter housing units, even if invited, without at least one other witness being present. The installation housing officer should evaluate the circumstances surrounding each inspection request/complaint, and determine if probable cause exists for entry into housing units.

b. AR 210-50 places the responsibility of housekeeping on the quarter's occupant, but no specific sanitary standards for family housing units exist. Written standards may be provided by the appropriate state for foster homes, and can be used if requested to perform this type of inspection by the local health department. When performing sanitary inspections of the interior of quarters, Pvnt med specialists must use their technical judgment and apply common sense while considering the following inspection guidance:

- Recognize the existence of racial, cultural, and personal differences in food preparation and storage, personal cleanliness, and clothing/household sanitation and organization (for example, disorganized vs unsanitary).

- How much of a direct health hazard is presented to neighbors or to the community?

- For the specific purpose of quarters inspection, sanitary condition is defined as — it indicates a state of cleanliness appropriate for intended use but not sterilized or disinfected. Judgment is subjective to the Pvnt med specialist's opinion.

- Appendix M contains a family housing sanitary inspection checklist.

Section VII. CONFINEMENT AND CORRECTIONAL FACILITIES

19-27. General

Army confinement and correctional facilities are operated and administered on a corrective rather than punitive basis. The goal is to help individuals solve their problems, correct their behavior, and improve their attitudes toward themselves and toward society. It is the responsibility of preventive medicine personnel to periodically evaluate these facilities to ensure that individuals are held in an environment which will not impair health or subject the soldier to unreasonable discomfort.

19-28. Detention Cells

a. Detention cells are facilities used to temporarily detain apprehended personnel when necessary to prevent escape or to ensure the safety of the detainee or others. Detention will not exceed 24 hours except in unusual circumstances when approved by a commissioned officer.

b. Sanitary inspection of detention cells will be conducted in accordance with AR 190-38.

19-29. Correctional Facilities

a. Correctional facilities provide correctional treatment and/or motivational training to prepare soldiers for continued productive and honorable service or return to the civilian community as better citizens.

b. Sanitary inspections will be in accordance with AR 190-47.

19-30. Prisoner of War Facilities and Displaced Persons, Refugees, and Evacuees Centers

Prisoner of war (POW) facilities and displaced persons, refugees, and evacuees (DPRE) centers are established and operated by the Military Police during periods of armed conflict. POW facilities and DPRE centers are open for inspection by certain outside agencies such as the International Red Cross which help ensure that prisoners and DPRE personnel are receiving just treatment. Preventive medicine personnel should periodically survey these facilities to evaluate their overall sanitary conditions. Sanitation requirements for POW facilities and DPRE centers are not well defined, but each person should be afforded shelter; bedding; food; water; latrines/other personal hygiene devices; and medical attention of a quality and quantity which will not impair health or subject them to unreasonable discomfort. The sanitary standards for food and water served and for personal hygiene facilities are the same as those for US Forces personnel.

CHAPTER 20

OCCUPATIONAL HEALTH

Section I. OCCUPATIONAL SAFETY AND HEALTH PROGRAM

20-1. General

a. The Army's Occupational Safety and Health (OSH) Program is based on law, policy and regulation. It has the same goal, providing a safe and healthful work place for all workers, as the Occupational Safety and Health Act of 1970. All DA personnel, military and civilian, are included in the program. The OSH Program is divided into safety and health areas at DA staff level with the DA Safety Director having overall program responsibility.

b. The Surgeon General (TSG) has responsibility for the health aspects of the OSH Program (AR 40-5). He develops DA policies and programs for the Army and the PVNTMED program. Occupational health (OH) is an element of the Army PVNTMED Program.

c. Objectives of the Army Occupational Health Program are to—

(1) Assure that all eligible military and civilian personnel are physically, mentally, and psychologically suited to their work at the time of their assignment, and that physical and mental health are monitored to detect early deviations from the norm.

(2) Protect military and civilian personnel against adverse effects of health and safety hazards in the work environment, to include field operation and industrial workplaces.

(3) Reduce economic loss caused by compensation claims due to physical deficiency, sickness, and injury of military and civilian personnel, thereby enhancing combat readiness.

Section II. INDUSTRIAL HYGIENE PROGRAM

20-2. General

Industrial Hygiene (IH) is an essential element of the DA OSH and DA Occupational Health Programs (TB MED 503). This section prescribes the manner in which all phases of the IH Program are established as an integral part of the overall OSH Programs.

20-3. Functions of Industrial Hygiene

Industrial hygiene is that science and art devoted to the *recognition, evaluation,* and *control* of those environmental factors and stresses associated with work and work operations that may cause sickness, impaired health and well being, or significant discomfort and inefficiency among workers or among the citizens of the community.

a. Recognition. Recognition of environmental factors and stresses that influence health requires an understanding of work operations and processes. The categories of stresses most frequently of interest are—

- *Chemical* (in the form of liquid, dust, fumes, mist, vapor, or gas).

- *Physical energy* (such as ionizing and nonionizing radiation, noise and vibration, flying objects, and extremes of temperature and pressure).

- *Biological* (such as arthropods, molds, yeasts, fungi, bacteria, and viruses).

- *Ergonomic* (such as body position in relation to task, monotony, boredom, repetitive motion, worry, work pressure, and fatigue).

b. Evaluation. Evaluation of the magnitude of the environmental factors and stresses arising in or from the workplace is essential in predicting the probable effect on health and well being. By virtue of training and experience, and aided by quantitative measurement of the chemical, physical energy, biological or ergonomic stresses, the preventive medicine specialist can render an opinion as to the "healthfulness" of the work environment, either for short periods or for a lifetime exposure.

c. Control.

(1) When necessary to protect health, control measures are based on the evaluation of the environmental factors or stresses. Control measures most frequently used, in order of preference, are—

- Substituting less harmful material.

- Isolating processes or work operations to reduce the number of persons exposed.

- Altering processes to minimize human contact.

- Ventilating and air cleaning to provide and maintain a safe and healthful atmosphere.

- Reducing exposures by shielding, acoustical partitions, or increasing distance.

- Wetting methods to reduce emission of dusts to the atmosphere (such as in abrasive blasting, lathing, and grinding operations).

- Housekeeping (such as cleanliness of the workplace; proper waste disposal; adequate washing, toilet, and restroom facilities; adequate potable water and eating facilities; and proper control of insects and rodents).

- Maintaining administrative controls to limit exposure time (such as work shifts and time of day).

- Providing personal protective equipment (such as special clothing and eye, hearing, and respiratory protective equipment).

(2) Elimination is a viable control and should be considered if the following exist:

- The operation/process is not critical to the overall production.

- The operation/process cannot be adequately controlled.

- The operation/process can be done through a civilian contractor who has or can obtain the required controls.

20-4. Essential Industrial Hygiene Program Elements

The items listed in this paragraph are the *minimum* essential elements required for an installation IH Program. The elements listed are required by Federal law, DA regulation and policy, or based upon consensus standards and good IH practice.

a. Program Document. The installation IH Program and policies to implement the provisions of AR 40-5 and TB MED 503 will be established in a formal program document.

b. Health Hazard Information Module. The *Health Hazard Information Module (HHIM)* is a portion of the DA Occupational Health Management Information System (OHMIS). The purpose of the HHIM is to identify all health hazards in Army workplaces; identify people working with the hazard; create data storage space and require sampling or evaluation of the hazard severity; and, require the evaluation of control methods necessary to reduce or eliminate the impact of the hazard on human health. The HHIM is the key element of the OH Program and the OHMIS.

(1) The HHIM is updated annually. It encompasses all potentially hazardous workplace operations and is updated continuously throughout the year. Information derived from sampling, monitoring, and evaluating activities is used to supplement and update the annual inventory.

(2) The annual inventory portion of the HHIM is accomplished in conjunction with and in support of the annual inspection and notification procedures described in AR 385-10.

(3) The HHIM is a critical element in the OH Program development and should be used as a source—

- for budget and staffing resource requirements;

- for documentation of IH equipment requirements;

- to define sampling and monitoring activities required for the development of an annual Industrial Hygiene Implementation Plan (IHIP);

- by OH personnel as data input to the OHMIS to identify potential OH hazards requiring job-related medical surveillance.

(4) The HHIM serves as a toxic chemical inventory and may be supplemented by the DOD Hazardous Materials Information System and material safety data sheets maintained locally. A separate toxic chemical inventory compiling all chemicals used is not necessary.

c. *Industrial Hygiene Implementation Plan.* The IHIP is a listing of IH functions, available resources, and priority schedules for accomplishing required tasks. The IHIP includes the update of the HHIM and annual program service requirements, such as sampling, monitoring, and surveying.

d. *Hazard Evaluation.*

(1) Potential occupational health hazards identified during the preliminary surveys require evaluation to determine the degree of hazard severity. Air sampling and ventilation measurements are common means of evaluation. Both are discussed in detail in a later section.

(2) The industrial hygiene staff of the Regional Environmental Hygiene Agency may be contacted for information concerning hazard evaluation or detailed sampling instructions.

e. *Risk Assessment Codes.*

(1) All operations, exposures, and deficient control measures that create a potential for adverse health effects are assigned a risk assessment code (RAC) by OH Program personnel. RACs are used to assign a priority for funding of corrective action at all levels and to reflect a comprehensive evaluation.

(2) Risk assessment codes quantify risk to personnel employed in a facility/plant/operation (AR 385-10). Subdefinitions of risk assessment follow.

(a) Hazard severity. An assessment of the expected consequence, defined by degree of injury or occupational illness, that could occur from a hazard. Hazard categories are assigned by Roman numeral according to the following criteria:

I—Death or permanent total disability.

II—Permanent partial disability or temporary total disability in excess of 3 months.

III—Lost workday accident/compensableinjury/illness.

IV—First aid or minor supportive medical treatment, or simply violation of standard.

(b) Accident probability. An assessment of the likelihood that, given exposure to a hazard, an accident will result. Accident probability is assigned a capital letter according to the following criteria:

A—Likely to occur immediately.

B—Probably will occur in time.

C—Possible to occur in time.

D—Unlikely to occur.

(c) Risk assessment code. An expression of the risk associated with a hazard that combines the hazard severity, accident probability, and personnel exposure into a single Arabic numeral.

1—Critical.

2—Serious.

3—Moderate.

4—Minor.

5—Negligible.

Hazard severity	Accident probability			
	A	B	C	D
I	1	1	2	3
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	5

(3) Identified health hazards with RACs will be submitted for inclusion in the installation hazard abatement plan by written report to the local DA safety manager.

f. Recordkeeping.

(1) *Worker exposure data.*

(a) Preventive medicine personnel record the worker's exposure data. This data is forwarded to the medical records custodian for inclusion in the worker's health record and may be used for evaluating and counseling the worker on his exposure.

(b) Sample data that shows *no worker exposure* is important and is included in the worker's health record.

(2) *Workplace monitoring data.* The medical files that house the IH workplace monitoring records for—

(a) *Civilians* are governed by AR 340-18, file number 922-02.

(b) *Military* are governed by AR 340-18, file number 917-01.

(3) *Survey data.* Industrial hygiene survey files are maintained per AR 340-18.

(4) *Data files.* Preventive medicine data files are maintained per AR 340-18, file number 923-10. Types of records include—

- Health hazard inventories, evaluations of hazard control measures, and recommendations for improvements.

- Ventilation flow rates, noise levels, and process variables should be maintained to show effects of control measures.

g. Design Review.

(1) The installation IH staff will review the physical plant process for operational modifications, as well as new concept, design, or construction projects to ensure potential health hazards are appropriately addressed (AR 420-10).

(2) Highly technical or unusual designs or processes are referred to the supporting activity for assistance or consultation as necessary.

(3) A representative from the preventive medicine staff should be a member of the installation planning board and the installation review board.

(4) A written memorandum of understanding will be formalized between the IMA and the director of engineering and housing for medical/technical review of projects mentioned in (1) above.

h. Worker's Health Education/Training. A program of education and orientation to ensure employees are informed of potential hazards, preventive measures, and proper operation of process and control equipment. Safety personnel should be contacted for assistance in establishing a training program. OH personnel will provide input to installation training programs.

Section III. CHEMICAL HAZARDS

20-5. General

Occupational hazards may be classified as chemical, physical, or biological. Chemicals are found in many areas where toxic materials are produced, used, and stored, or may appear as by-products or impurities in otherwise safe substances.

20-6. Routes of Entry of Toxic Chemicals

Toxic chemicals can enter the body by various routes. The body's response to any toxic chemical may vary markedly depending on the specific route of entry.

- *Inhalation.* Inhalation is the most important route of entry. Some toxic chemicals may produce acute effects that are quickly recognized by the person being exposed. Other chemicals may cause chronic effects that take many years to develop, such as asbestosis from asbestos exposure.

- *Absorption.* The most common occupational disease seen is dermatitis. Contact dermatitis may be caused by irritation or allergic sensitization. Systemic poisoning can also result from skin absorption.

- *Ingestion.* Ingestion occurs as a result of eating or smoking with contaminated hands, utensils, or in contaminated areas. Ingestion of inhaled materials also occurs as a result of the natural cleansing action of the lungs.

- *Injection.* Accidental injection may occur from the use of high pressure air or liquid and from high pressure lines rupturing.

20-7. Classification of Toxic Chemicals

Toxic chemicals are classified according to their physical state or chemical characteristics. Classification is important in determining the route of exposure.

- *Gas.* A state of matter in which material has a very low density and viscosity; can expand and contract greatly in response to changes in temperature and pressure; is easily diffused into other gasses; is readily and uniformly distributed throughout any container. A gas can be changed to a liquid or solid state only by the combined effect of increased pressure and decreased temperature.

- *Liquid.* A state of matter in which the substance is a free flowing formless fluid. A liquid takes many forms depending on the environmental conditions.

o *Vapor.* The gaseous form of substances which are normally in a solid or liquid state at normal room temperature and pressure.

o *Mist.* Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by a liquid breaking up into a dispersed state by splashing, foaming or atomizing.

- *Solids.*

o *Fume.* Airborne dispersion consisting of minute solid particles arising from heating a solid such as lead. This physical change is often accompanied by a chemical reaction, such as oxidation. Fumes flocculate and sometimes coalesce.

o *Dust.* Solid particles generated by handling, crushing, grinding, impacting, detonating and decrepitating materials. Dust does not tend to flocculate, except under electrostatic forces. They do not tend to diffuse in the air, but settle under the influence of gravity.

20-8. Actions and Effects of Toxic Chemicals

a. A detailed discussion of all biological actions of all the toxic chemicals that a Pvnt med specialist may encounter is an impossible undertaking. Instead toxic chemicals will be discussed according to their general biological actions.

- *Irritants.* These materials cause inflammation of mucous membranes with which they come in contact. Many irritants are strong acids or alkalis that are corrosive to nonliving things; however, they cause inflammation to living tissue. Examples are sulfur dioxide, acetic acid, formaldehyde, formic acid, sulfuric acid, iodine, ozone, and oxides of nitrogen.

- *Asphyxiants.* Asphyxiants are materials that deprive the respiratory tissues of oxygen; they do not damage the lungs. Simple asphyxiants are gases, which when present in sufficient quantities, exclude an adequate oxygen supply. Examples are nitrogen, nitrous oxide, carbon dioxide, hydrogen, helium, methane, and ethane. Chemical asphyxiants are materials which have the ability to render the body incapable of using an adequate oxygen supply. Two classic examples are carbon monoxide and cyanide.

- *Anesthetics.* The main toxic action of these materials is their depressant effect upon the central nervous system, particularly the brain. The degree of anesthetic effect depends upon the effective concentration in the brain as well as upon the specific makeup of the contaminant.

- *Systemic poisons.* These materials cause damage to internal organs such as the liver, kidney, central nervous system, or the cardiovascular system. Carbon tetrachloride produces necrosis of the liver.

- *Carcinogens.* These materials have demonstrated they cause cancer or are suspected of causing cancer based upon animal studies. The classic example is cancer of the scrotum from coal tar pitch volatiles which was first recognized as early as 1775 among chimney sweepers.

- *Other effects.* There are a large number of other substances with a wide variety of toxicological action that does not fit into any of the above groups. These materials produce damage to the pulmonary tissue but not by immediate irritant action. Fibrotic changes are produced by materials such as free silica which produces the typical silica nodule. Asbestos also produces damage to lung tissues; possibly even from low level exposure of individuals who are not asbestos workers. Other dusts, such as coal dust, can produce pneumoconiosis. Many dusts of organic origin, such as those arising from cotton or wood, can cause pathological damage to the lungs and/or alteration of the lungs function.

b. Some substances may fit into two or more of the above categories. Many variables determine the effect of hazardous substances with the most important consideration being the dose-response relationship. Dose involves two variables, concentration and duration of exposure. Short term exposures to high concentrations cause acute effects that result in immediate irritation, illness, or death. In contrast to acute effects, chronic illness is characterized by symptoms or disease of long duration or frequent recurrence that slowly develop. The term chronic relates to continued exposure to substances throughout a working lifetime. Safe limits are set so that the combination of concentration and time are below those levels which produce injury or illness. Sufficiently small amounts of most chemicals do not produce injuries. This means there is a threshold of effect or a "no response" level.

20-9. Sampling Techniques

a. The collection and analysis of representative samples of air in the workplace is an important means of determining the nature and extent of occupational hazards or exposures associated with an operation or process. In addition, the effectiveness, or the inadequacy, of existing control measures are demonstrated by appropriate sampling. In this regard, the Pvnt med specialist will frequently be called upon to assist in the collection of samples of potentially contaminated air in a variety of workplaces on Army installations. Often this sampling will be conducted for the purpose of determining *compliance* with DA and OSHA environmental standards. There are a number of important factors which must be considered during the collection of samples if reliable results are to be obtained. Disregarding any of these factors can seriously limit the accuracy of the data collected and can lead to invalid conclusions.

b. Before the sampling technique or method can be selected, the following questions must be answered:

- Where should sampling be done?
- Whom (which workers) should be sampled?
- How long should each sampling period be?
- How many samples will be necessary?
- When should sampling take place?

c. The *sampling location* is governed by the kind of information needed or the type of evaluation desired. It may be one, or a combination, of the following:

- *General room (area or background) air sample.* The general room air sample provides an indication of the total influence of a particular operation or process (and associated contaminant) upon the overall work area. Such sampling gives qualitative data on what contaminants are present in the work area and to some extent indicates if control measures are effective.

- *Breathing zone sample.* The breathing zone sample more definitively determines the workers' exposure to a contaminant. From breathing zone samples, a daily time-weighted average can be determined.

- *Operation/process sample.* This type of sampling is done at the operation or process itself and provides both qualitative and quantitative data; it also identifies the need for local control of the contaminant. It can identify the step in the operation or process which constitutes the greatest hazard and the duration of the hazard.

d. The most effective way to determine exposure is to collect breathing zone samples from all workers. Where this is not feasible, samples should be collected from the maximum risk workers. The maximum risk worker is normally the worker closest to the source of the contaminant. Other considerations are work patterns, work habits, worker mobility and air movement patterns.

e. Depending upon the physical demands of the work, workers inhale from 5 to 20 cubic meters of air during an 8-hour day. However, the volume of the air sample (and hence, the *length of the sampling period)* taken for assessment of contaminant concentration need not equal, or even approach, the volume of air actually inhaled by the worker. All that is needed is a representative sample of the air, large enough to contain sufficient contaminant to be analyzed and identified. Therefore, the volume of the air sample (and the duration of the sampling period) will be dependent upon the threshold limit value (TLV) of the contaminant, sensitivity of the analytical procedure to be used, and the estimated concentration of the contaminant in the workplace atmosphere. The sample volume and flow rate is determined by using the US Army Environmental Hygiene Agency (USAEHA) Sampling Guide. The duration of the sampling run depends on the flow rate of the sampling pump and the volume required. This can be calculated by using the formula:

$$\text{Duration} = \frac{\text{Volume}}{\text{Flow rate}}$$

f. There is no set rule for determining the number of samples needed to evaluate a worker's exposure, provided that the exposure is characterized in time and space. A single sample of a short duration is never sufficient to determine a time-weighted average even if it is believed that the concentration at the time of sampling is maintained throughout the work period. If the indicated concentration is near or above the TLV, sufficient sampling is done to determine a time-weighted average. Ordinarily, contaminants are not generated at uniform rates, so the concentration can vary from time to time. In addition, the type of contaminant will, to some extent, govern the number of samples as well as the type of instrumentation. If the objective is merely to determine the presence of a contaminant, a few samples will suffice. On the other hand, if a comprehensive survey is being conducted, more samples will be required.

g. Before sampling, the purpose of the evaluation must be considered, such as what information is desired and the overall nature of the particular operation or process being evaluated. Since the concentration of contaminant may vary considerably throughout a 24-hour period, it will be necessary to take samples during each shift of operation. In areas which experience wide seasonal variations in temperature, it will be necessary to sample during each of the seasonal extremes.

h. There are four general categories of samples:

(1) *Grab sample.* Grab samples are collected almost instantaneously, that is, usually within a few seconds. Some grab samples may be collected over a period of less than 5 minutes. A grab sample is therefore representative of the atmospheric conditions at the sampling site at a given point in time. Evacuated flasks, Mylar bags, and detector tubes are examples of grab samples. Grab samples are not suitable for determining a time-weighted average. However, they are valuable as a screening device and are often used during the HHIM.

(2) *Partial period samples.* A partial period sample is collected for a portion of a work day or shift. Partial period sampling should not be conducted for less than 70 percent of the work period (Example: 5-1/2 hours of an 8-hour work period).

(3) *Full period samples.* A full period sample is collected continuously throughout the full work period.

(4) *Full period consecutive samples.* Several samples of equal or unequal time are taken for the full work period.

i. For detailed guidance on specific sampling procedures, refer to the industrial hygiene guide published by the USAEHA.

20-10. Sampling Instrumentation and Methods

The purpose of the evaluation, and the nature of the suspected contaminant will influence the choice of sampling technique and/or equipment. Equipment selection will be in one of the following categories.

a. Direct Reading Instruments. These instruments provide immediate quantitative results. The major advantage for these instruments is that the results are immediately available for interpretation.

(1) *Detector tube systems.* Many types of detector tube systems are used but the principle of operation is basically the same (Figure 20-1). Air is drawn through a detector tube by use of a sampling pump. The detector tube is filled with a medium that is impregnated with a chemical. The chemical changes color when exposed to a particular contaminant and the results are read directly off of the detector tube. Actual sampling time is usually less than 5 minutes and results show only the concentration for that small period of time. Always follow the manufacturer's directions when using detector tube systems.

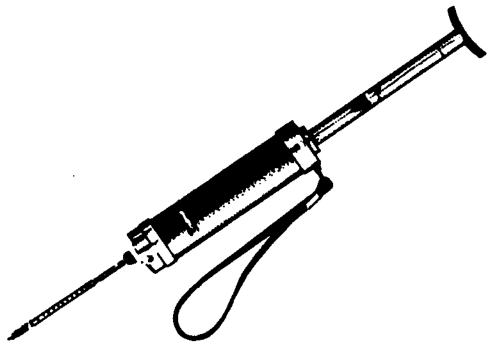


Figure 20-1. Tube detector kit.

(2) *Electrical instruments.* Many instruments are available which sample for specific contaminants and also for combustible gases and oxygen. The most common types of instruments are those used to test for carbon monoxide, mercury, ethylene oxide and nitrous oxide. The instrument commonly used for carbon monoxide sampling has an electrochemical cell to measure the carbon monoxide and displays the results directly on the meter scale in ppm (Figure 20-2). Two types of instruments are used for mercury, one measures the absorption of ultraviolet (UV) light while the other measures the change in the electrical potential of a gold film. Ethylene oxide, nitrous oxide, and many other gases and vapors can be measured with the use of an infrared analyzer (Figure 20-3). Infrared light is passed through a sample cell and the meter measures the amount of infrared light absorption. Filter and scale sets are purchased from the manufacturer for each specific contaminant that is to be sampled. Electrical instruments can sample for any period of time and are often connected to a recorder to provide a permanent record. Alarms are also an integral part of some direct reading instruments and are used to alert workers to hazardous conditions. The manufacturer's directions must be followed.

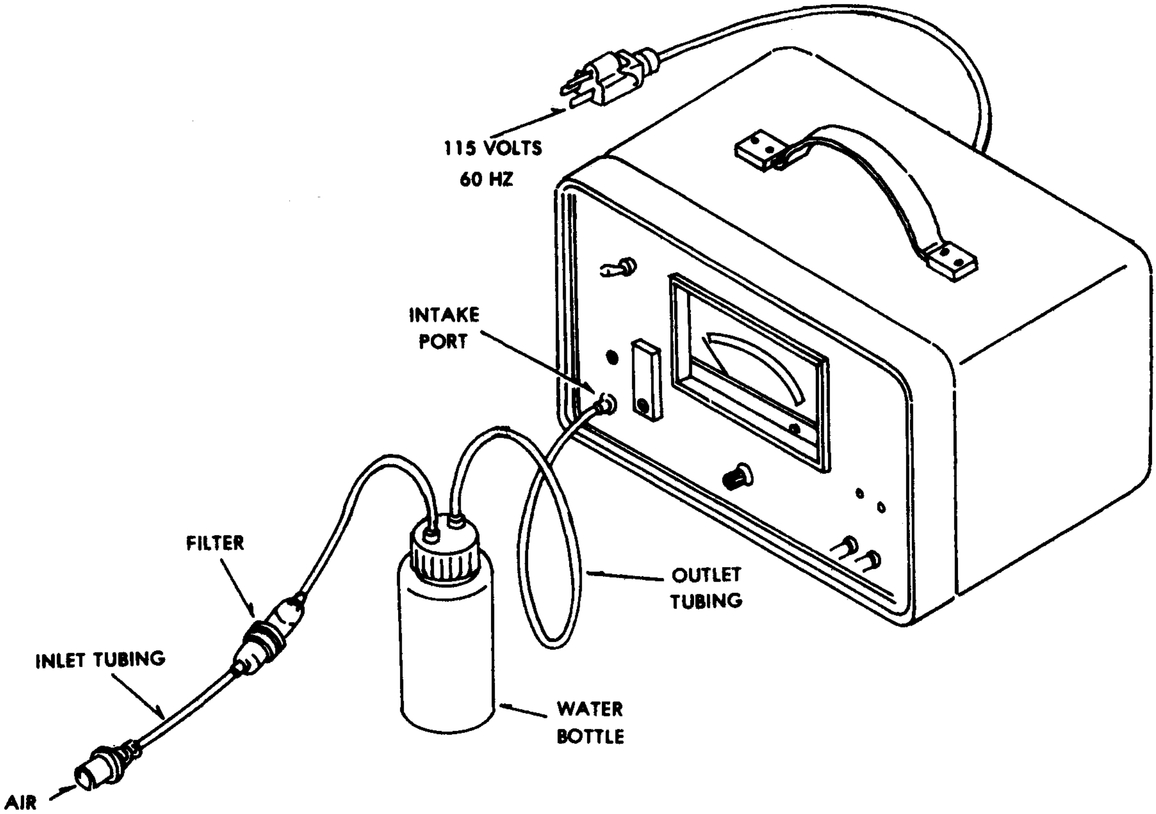


Figure 20-2. Portable carbon monoxide monitor.

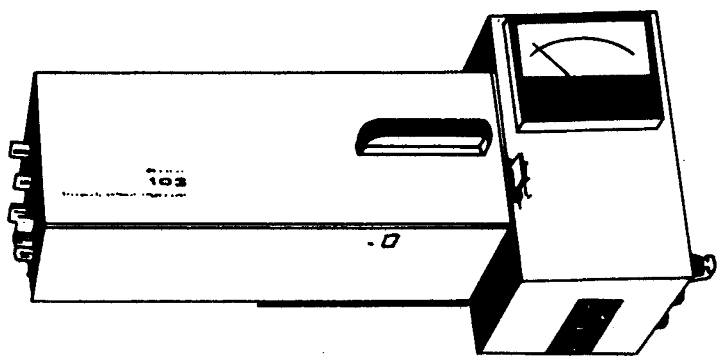


Figure 20-3. Infrared analyzer.

b. Indirect Reading Instruments. In this type of sampling, air is drawn through a sampling medium continuously by means of a sampling pump. The media is then sent to a supporting laboratory for analysis. The major advantage of indirect reading instruments is that many types of atmospheric contaminants can be sampled with a small variety of sampling medias. This eliminates the need to purchase a specific gas analyzer for seldom sampled contaminants.

(1) *Gas and vapors.*

(a) For *soluble* contaminants, samples may be collected by *absorption* devices. These devices concentrate the contaminant by dissolving it in some medium; a fritted bubbler is an example of such a device. It is used with a pump or suction device which captures the air-gas mixture and carries it into the absorption device. With such a device, it is necessary to know the rate at which the air-gas mixture was collected (flow rate) and the duration of the sampling period, in order to determine the volume of air from which the contaminant was extracted.

(b) For *insoluble contaminants, adsorption* devices such as charcoal or silica gel tubes (Figure 20-4) can be used to collect and concentrate the contaminant for further analysis. These devices use a medium to which the contaminant adheres. It is necessary to keep accurate data on the flow rate of the pump and the duration of the sampling period, in order to determine the volume of the sample.

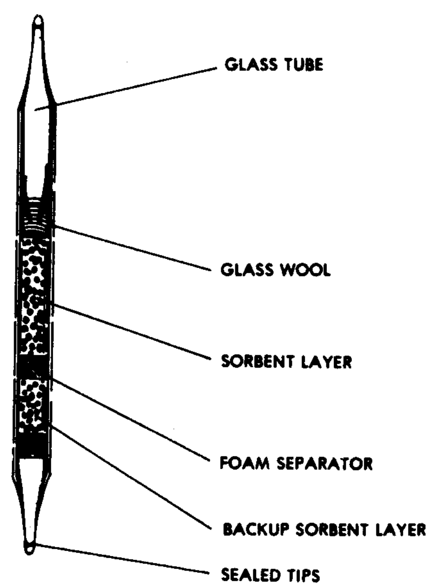


Figure 20-4. Charcoal tube for collecting insoluble contaminants.

(2) *Particulates (dust, mist, fumes, and aerosols).* Contaminants in the form of particulates may be sampled in several ways, depending on the size of the individual particles.

(a) *Impingement or impactors.* These devices require a pump to force the air into the device, where the particles strike various surfaces and are collected by impaction. These devices sometimes have a medium on which the particles impinge and are collected. These devices may be single-stage or multi-stage (Figure 20-5).

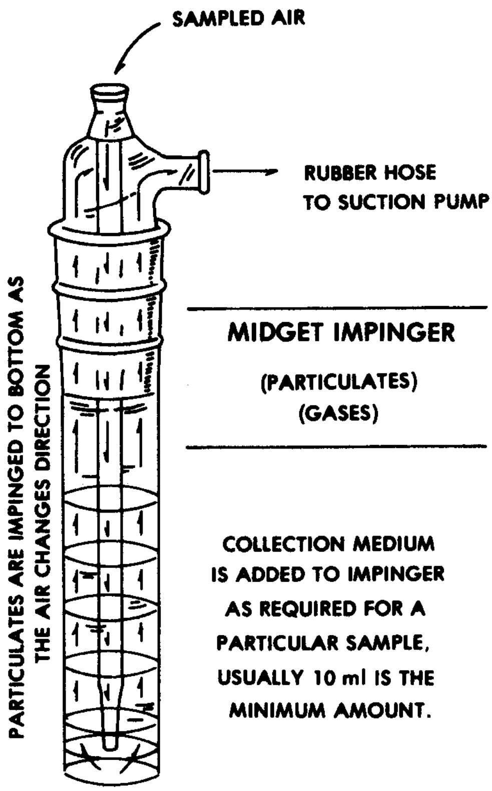


Figure 20-5. Midget impinger.

(b) *Filtration.* Drawing contaminated air through a filter medium and collecting the particulate contaminant is the preferred method. Filtration devices allowing a range of sampling rates (high-volume or low-volume) are available. A variety of filter materials are used, including polyvinylchloride (PVC) and cellulose ester (CE). The filter medium chosen depends on the size of the particles and the method of laboratory analysis.

(c) *Respirable dust sampling.* Some standards are based upon the dust being of respirable size (less than 10 microns). A cyclone is used to precipitate out the larger particles before they reach the filter (Figures 20-6).

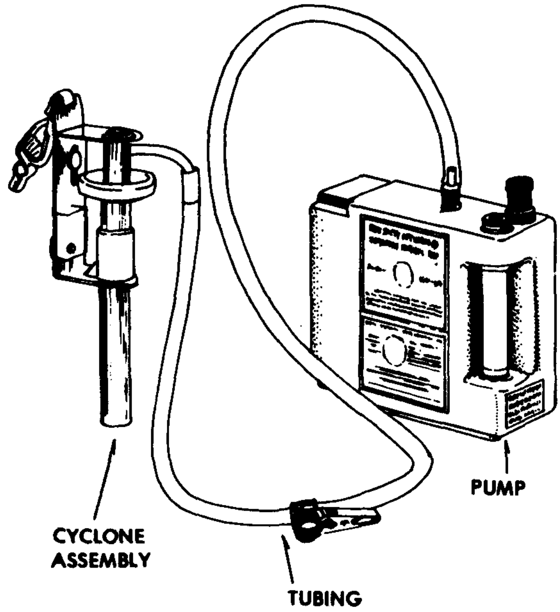


Figure 20-6. Cyclone/filter holder assembly and sampling pump.

c. *Calibration.* The accurate analysis of a contaminant's concentration in the work environment is possible only if the volume of the air sample can be accurately determined and the efficiency of the collection device is maintained at its maximum. For these reasons, frequent calibration of all equipment is essential. Always follow the manufacturer's instructions for calibration.

20-11. Compliance Requirements

The US Army must comply with the standards of Title 29, Code of Federal Regulations (CFR) 1910.1000, for exposures to airborne contaminants. In addition, the Army has adopted the consensus standards developed by the American Conference of Governmental Industrial Hygienists (ACGIH). We must check both sources and use the most stringent of the two standards. The Army and some major commands have published standards for some military unique exposures such as explosives and chemical agents. Specific guidance may be obtained from your supporting laboratory or IMA/surgeon.

a. *Standards.* The standards in 29 CFR 1910.1000 are termed Permissible Exposure Limits (PELs) while those from ACGIH are Threshold Limit Values (TLVs). Whatever they are called the concept is the same. They refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. The standards in 29 CFR 1910.1000 are from the 1968 TLV Booklet and changes are slow and infrequent; however, the TLV Booklet is updated frequently to reflect current data.

b. Terms.

(1) *Threshold Limit Value-Time-Weighted Average (TLV-TWA).* The time-weighted average for a normal 8 hour work day and a 40 hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.

(2) *Threshold Limit Value-Short Term Exposure Limit (TLV-STEL).* The concentration to which workers can be exposed continuously for a short period of time. A STEL is defined as a 15 minute time-weighted average which should not be exceeded at any time during the work day even if the 8 hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than 4 times a day. There will be at least 60 minutes between successive exposures at the STEL; also, the TLV-TWA will not be exceeded.

(3) *Threshold Limit Value-Ceiling (TLV-C).* The concentration that should not be exceeded even instantaneously.

(4) *Excursion limits for substances without a TLV-STEL or TLV-C.* Exposures three times the TLV-TWA should not exceed more than a total of 30 minutes during a work day and should never exceed five times the TLV-TWA value, provided the TLV-TWA for the work day is not exceeded.

c. Computation of a Time-Weighted Average. Exposures must be averaged for the time period of the standard, 15 minutes or 8 hours. Because sampling periods may differ a simple arithmetic average will not yield the true average. The following formulas are used to average results from sampling for atmospheric contaminants:

$$\text{TLV-TWA} = \frac{(T_1 \text{ X } C_1) + (T_2 \text{ X } C_2) + \ldots\ldots (T_n \text{ X } C_n)}{8 \text{ Hour}}$$

T = Time in hours
C = Concentration

$$\text{STEL-TWA} = \frac{(T_1 \text{ X } C_1) + (T_2 \text{ X } C_2) + \ldots\ldots (T_n \text{ X } C_n)}{15 \text{ minutes}}$$

T = Time in minutes
C = Concentration

Section IV. RESPIRATORY PROTECTION

20-12. General

A major route of entry for toxic substances is through inhalation. Almost every industry has some form of respiratory hazard associated with it; industrial-type operations carried out on Army installations are no exception. In the field of industrial hygiene, our primary concern is protecting the worker from exposure to hazardous situations in the work environment. One method of eliminating an inhalation exposure is to place a barrier between the worker's respiratory tract and the hazardous environment.

20-13. Requirements

a. The installation commander is responsible for the respiratory protection program in compliance with TB MED 502.

b. Respirators are acceptable as a control method only when—

- No adequate feasible engineering or work practice control is available.
- The operation is intermittent, nonroutine, and not greater than 1 hr/day for 1 day/week.
- Engineering controls are being designed and installed.
- Emergencies exist which are defined as an unplanned event; or a hazardous atmosphere of unknown chemical or particulate concentration suddenly occurs requiring immediate use of a respirator for escape from or entry into the hazardous atmosphere to carry out maintenance or some other task.

c. The Medical Department must recognize, evaluate, and provide guidance for locations using and requiring respirators.

d. Activity manager/supervisor must provide employees with approved respirators at no cost.

e. Employees must use the respiratory protective device in accordance with training guidance and TB MED 502.

f. Installation safety managers must conduct routine inspections in coordination with the local medical authority.

g. Military Personal Protective Field Mask is prohibited for use in industrial operations, unless it is an approved device (TC number by NIOSH).

20-14. Minimal Elements of an Acceptable Respiratory Protection Program

a. Written SOP governing the selection and use of respirators must be established.

b. Respirators must be selected on the basis of hazards to which the worker is exposed.

c. The user must be instructed and trained in the proper use of respirators and their limitations.

d. Where practicable, the respirators are assigned to individual workers for their exclusive use.

e. Individuals are not assigned to tasks requiring the use of respirators unless it has been determined that they are physically able to perform the work while wearing a respirator.

f. Respirators tested and certified by NIOSH are the only respirators authorized.

g. Respirators must be regularly cleaned and disinfected.

h. Respirators must be stored in a convenient, clean, and sanitary location.

i. Respirators must be inspected regularly.

j. Appropriate surveillance of work area conditions and degree of employee exposure or stress must be maintained.

k. There must be regular inspections and evaluations of the program.

20-15. Respirator Selection

a. Approved respirator. The respirator furnished must provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by the National Institute of Occupational Safety and Health.

b. Considerations. The selection of a respirator for any given situation requires consideration of the following factors:

(1) The nature of the hazard.

- Type of hazard—oxygen deficiency or contaminant.
- Physical properties.
- Chemical properties.
- Physiological effects on the body (skin).
- Actual concentration of the toxic material or airborne radioactivity level.
- Established permissible time-weighted average or peak concentration of the toxic material.

- Whether the hazard is an immediately-dangerous- to-life-or-health concentration.

- Warning properties.

(2) The characteristics of the hazardous operation or process.

(3) The location of the hazardous area with respect to a safe area having respirable air.

(4) The period of time for which respiratory protection is required.

(5) The activity of workers in the hazardous area.

(6) The physical capabilities and limitations of the respirator.

20-16. Types of Respirators

a. Air-Purifying Respirators

(1) *General description.* Half-mask, three-quarter facepiece, full facepiece, or mouthpiece respirators equipped with air-purifying units to remove gases, vapors, and particulate matter from the ambient air prior to its inhalation. Some air-purifying respirators are blower-operated and provide respirable air to the facepiece (or hood) under a slight positive pressure (Figure 20-7).

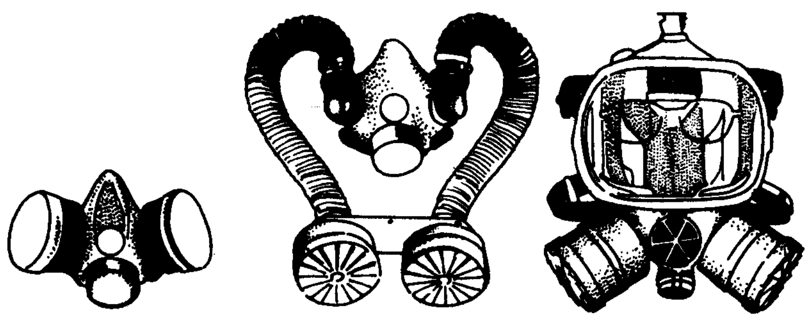


Figure 20-7. Air-purifying respirators.

(2) *General limitations.* Air-purifying respirators do not protect against oxygen-deficient atmospheres; skin irritation; or absorption of airborne contaminants through the skin. The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the designed efficiency and capacity of the cartridge, canister, or filter for the contaminant. Air-purifying respirators should not be used for contaminants that have poor odor warning properties. The maximum concentration for which the air-purifying unit is effective is specified by applicable federal occupational health standards. *Respirators will not provide the maximum design protection specified unless the facepiece is carefully fitted to the wearer's face to prevent inward leakage.*

(3) *Dust, fume, and mist respirators.*

(a) Description. Includes all completely assembled respirators designed for use as respiratory protection during entry into and escape from hazardous particulate atmospheres which contain adequate oxygen to support life. These devices may be attached to a powered blower. Each device may contain the following component parts, as required: facepiece (half-mask or full), mouthpiece with nose clip, hood, helmet, filter unit, harness, attached blower and breathing tube. These devices are further described as follows:

- Respirators, either with replaceable or reusable filters, designed as respiratory protection against dusts, fumes, and mists having maximum acceptable exposure limits not less than 0.05 milligram per cubic meter (mg/m^3) of air.

- Respirators, with replaceable filters, designed as respiratory protection against dust, fumes, and mists having maximum acceptable exposure limits less than 0.05 mg/m^3.

- Respirators, with replaceable filters, designed as respiratory protection against radon daughters, and radon daughters attached to dusts, fumes, and mists.

- Respirators, with replaceable filters, designed as respiratory protection against asbestos-containing dusts and mists.

- Single-use dust respirators designed for protection against pneumoconiosis and fibrous-producing dusts, or dusts and mists, including asbestos.

(b) Limitations. Protect against nonvolatile particles only. No protection against gases and vapors. The filter must be replaced or cleaned when breathing becomes difficult due to clogging. These respirators are not to be used during shot and sand blasting operations.

- *Half-mask facepieces.* Fabric coverings are only permissible in atmospheres of coarse dusts and mists of low toxicity. No protection is provided to the eyes.

- *Mouthpiece respirator.* Nose clip shall be firmly in place to prevent nasal breathing. Mouth breathing prevents the detection of any incidental vapor contaminants by odor. No protection is provided for the eyes.

(4) *Gas and vapor-removing respirators.*

(a) Description. Packed sorbent beds (cartridge or canister) remove single gases or vapors (for example, chlorine gas), a single class of gases or vapors (for example, organic vapors) or a combination of two or more classes of gases and vapors (for example, acid gases, organic vapors, ammonia, and carbon monoxide) by absorption, chemical reaction, or catalysis or a combination of these methods.

(b) Limitations. Protection is not provided against particulate contaminants, unless specified on canister or cartridge label. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. However, this is not a reliable indicator of canister performance. An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

(c) Gas Masks.

1. Description. Includes all completely assembled air-purifying masks which are designed for use as respiratory protection during entry into atmospheres not immediately dangerous to life or health, and escape only from hazardous atmospheres containing adequate oxygen to support life. They are further described according to the types of gases or vapors they are designed to protect against.

2. Limitations. Gas masks are for use only for escape from (not entry into) atmospheres immediately dangerous to life or health; they are not to be used against gases or vapors with poor warning properties or which generate high heats or reaction with sorbent materials in the canister. In addition, eye protection may be required when escape type gas masks are used. See Table 20-1 for a description of the label which is required on the canister of all gas masks, and Table 20-2 for the color code used for gas mask canister.

Table 20-1. Labels for Gas Mask Canisters

1. The following must appear in bold letters on the most conspicuous surface or surfaces of each canister:

Canister for ____________________
(Name for atmospheric contaminant)

In addition, essentially the following wording must appear beneath the appropriate phase on the canister label: "**For respiratory protection in atmospheres containing not more than ______ percent by volume of ______________.**"

2. Canisters having a special high-efficiency filter for protection against radionuclides and other highly toxic particulates must be labeled with a statement of the type and degree of protection afforded by the filter. The label must be affixed to the neck end of, or to the gray stripe which is around and near the top of, the canister. The degree of protection must be marked as the percent of penetration of the canister by a 0.3-micron-diameter dioctyl phthalate (DO) smoke at a flow rate of 85 liters per minute.

3. Each canister must have a label warning that gas masks should be used only in atmospheres that are not oxygen-deficient (at least 19.5 percent oxygen by volume at sea level), since gas mask canisters are only designed to neutralize or remove contaminants from the air.

Table 20-2. Color Codes for Cartridges and Canisters

ATMOSPHERIC CONTAMINANT TO BE PROTECTED AGAINST	COLORS ASSIGNED
Acid gases	White
Hydrocyanic acid gas	White with 1/2-inch green stripe completely around the canister near the bottom.
Chlorine gas	White with 1/2-inch yellow stripe completely around the canister near the bottom.
Organic vapors	Black
Ammonia gas	Green
Acid gases and ammonia gas	Green with 1/2-inch white stripe completely around the canister near the bottom.
Carbon monoxide	Blue
Hydrocyanic acid gas and chloropincrin vapor	Yellow with 1/2-inch blue stripe completely around the canister near the bottom.
Acid gases, organic vapors, and ammonia gases	Brown
Radioactive materials, except tritium and noble gases	Purple (magenta)
Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors	Canister color for contaminant, as designated above, with 1/2-inch gray stripe around the canister near the top.
All of the above contaminants	Red with 1/2-inch gray stripe completely around the canister near the top.

NOTE: Do not assign gray as main color for a canister designed to remove acids or vapors. Use orange (body or stripe color) to represent gases not included in this table.

(d) Chemical cartridge respirators.

1. Description. Includes all completely assembled respirators which are designed for use as respiratory protection during entry into or escape from atmospheres not immediately dangerous to life and health, and are described according to the specific gases or vapors against which they are designed to provide respiratory protection. Each device may contain the following component parts, as appropriate: facepiece (half-mask or full), mouthpiece, hood, or helmet; cartridge; cartridge with filter; harness; breathing tube; attached blower.

2. Limitations. Chemical cartridge respirators will not be used in atmospheres immediately dangerous to life or health, and are limited to the maximum concentration of gases and vapors as specified on the cartridge (also see specific standard for exposure to chemical(s) in question). In addition, the half-mask facepiece, provides no protection for the eyes. Fabric coverings of the facepiece will not be used, as it permits gases and vapors to leak into the mask; and when using the mouthpiece respirator, mouth breathing prevents detection of contaminants by odor. The nose clip must be securely in place to prevent nasal breathing. No protection is provided to the eyes.

(5) *Combination gas, vapor, and particulate-removing respirators.*

(a) Description. Includes all the devices discussed having either canisters or cartridges with filters for protection against dusts, mists, fumes, gases, and vapors. These include respirators which have been tested against lacquer and enamel mists (paint spray respirators).

(b) Limitations. With the exception that these devices protect against gases, vapors, and particulates, the limitations of the other devices also apply to the combination device.

b. Atmosphere-Supplying Respirators.

(1) *General description.* A respirable atmosphere is supplied independent of the ambient air surrounding the wearer. These devices provide protection against oxygen deficiency and most toxic atmospheres.

(2) *General limitations.* Except for the supplied-air suit, no protection is provided against skin irritation by materials such as ammonia and hydrochloric acid (HCl), or against skin absorption of materials such as hydrocyanic acid (HCn), tritium, or organic phosphate pesticides. Facepieces present special problems to individuals required to wear prescription lenses.

(3) *Types.*

(a) Self-contained breathing apparatus.

1. Description. This device is a completely assembled, portable, self-contained breathing apparatus (SCBA) designed for use as respiratory protection during entry into and escape from or escape only from hazardous atmospheres (Figure 20-8).

- *Closed-circuit apparatus.* An apparatus in which the exhalation is rebreathed by the wearer after the carbon dioxide has been effectively removed and a suitable oxygen concentration restored from sources composed of compressed air, or oxygen from chemical, liquid, or an oxygen-generation solid.

- *Open-circuit apparatus.* An apparatus from which exhalation is vented to the atmosphere and not rebreathed. This may be a demand-type apparatus (in which the pressure inside the facepiece in relation to the immediate environment is positive during exhalation and negative during inhalation); or it may be a pressure-demand-type apparatus (in which the pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation).

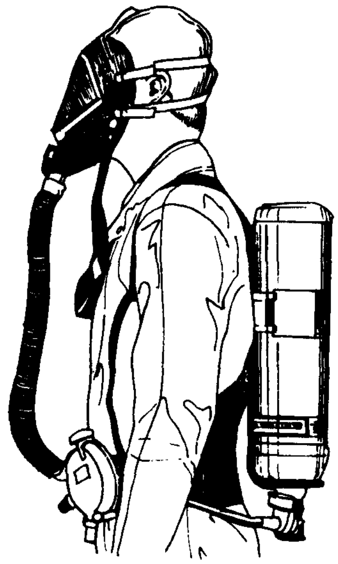


Figure 20-8. Self-contained breathing apparatus

2. Limitations. Use is permissible in atmospheres immediately dangerous to life or health. The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure, and workload. A warning device is provided to indicate to the wearer when the service life has been reduced to a low level. Some SCBA devices have a short service life (few minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere. Chief limitations of SCBA devices are their weight and/or bulk; limited service life; and the training required for their maintenance and safe use.

- *Closed-circuit apparatus.* The closed circuit operation conserves oxygen and permits longer service life.

- *Open-circuit-demand and pressure-demand.* The demand-type produces a negative pressure in the facepiece on inhalation whereas the pressure-demand type maintains a positive pressure in the facepiece and is less apt to permit inward leakage of contaminants.

(b) Supplied-air respirators.

1. Description. Includes all completely assembled respirators designed for use during entry into or escape from hazardous atmospheres. The respirable air supply is not limited to the quantity an individual can carry, thus the devices are lightweight and relatively simple (Figure 20-9).

Figure 20-9. Air-line respirator.

- *Type "A" supplied-air respirator.* A hose mask respirator, for entry into and escape from atmosphere not immediately dangerous to life or health. This respirator consists of a motor-driven or hand-operated blower that permits the free entrance of air when the blower is not operating; a strong large diameter hose having a low resistance to airflow; a harness to which the hose and the lifeline are attached; and a tight-fitting facepiece.

- *Type "B" supplied-air respirator.* A hose mask respirator, for entry into and escape from atmospheres not immediately dangerous to life or health. This respirator consists of a strong large diameter hose with low resistance to airflow through which the user draws inspired air by means of his lungs alone; a harness to which the hose is attached; and a tight-fitting facepiece.

- *Type "C" supplied-air respirator.* An air-line respirator, for entry into and escape from atmospheres not immediately dangerous to life or health. This respirator consists of a source of respirable air; a hose; a detachable coupling; a control valve; an orifice; a demand valve or pressure-demand valve; an arrangement for attaching the hose to the wearer; and a facepiece, hood, or helmet.

- *Types "AE," "BE," and "CE" supplied-air respirators.* Types "A," "B," or "C" supplied-air respirators equipped with additional devices designed to protect the wearer's head and neck against impact and abrasion; shielding material to protect the window(s) of facepieces; hoods and helmets which do not unduly interfere with the wearer's vision and permit easy access to the external surface of such window(s) for cleaning.

2. *Limitations.* The wearer is restricted in movement by the hose or air-line and must return to a respirable atmosphere by retracing his route of entry. The hose or air-line is subject to being severed or pinched off.

- *Type "A" hose mask respirator with blower.* If the blower fails, the units still provide an air supply and sufficient protection to permit the wearer to escape although a negative pressure exists in the facepiece during inhalation. Use is not permissible in atmospheres immediately dangerous to life or health.

- *Type "B" hose mask without blower.* If the air supply fails, no protection is provided the wearer. Limited to use in atmospheres not immediately dangerous to life or health and from which the wearer can escape unharmed without aid of the respirator.

- *Type "C" air-line respirators (continuous flow, demand and pressure-demand types).* The demand-type produces a negative pressure in the facepiece on inhalation whereas continuous flow and pressure-demand types maintain a positive pressure in the facepiece at all times and are less apt to permit inward leakage of contaminants. Demand flow air-line respirators are limited to use in atmospheres immediately dangerous to life or health provided an auxiliary self-contained air supply is worn to permit escape if the air supply fails.

c. *Combination Atmosphere-Supplying and Air-Purifying Respirators.* Combination respirators are usually made up of an atmospheric-supplying respirator with an air-purifying attachment to protect the worker if the atmospheric-supplying respirator should fail; or, they may be air-purifying respirators with small cylinders attached in case contaminant concentrations exceed the capabilities of the air-purifying respirator. In assessing the capabilities of combination respirators, limitations of the respective individual components will determine the overall limitations of the combination. That is, the part (component) with the greater limitation determines the overall limitations, since the wearer may not change over, even if conditions should require it.

20-17. Assignment of Respirators to Personnel

Each job requiring respiratory protection must have the correct respirator as specified for that job. This is assured by the supervisory person most qualified for the task; usually the supervisor responsible for the overall respiratory protection program. The individual issuing respirators to users must be adequately instructed to ensure that the correct respirator is issued. When respirators are permanently assigned, they must be legibly marked with the individual's name. The date of issuance should be centrally recorded and maintained.

20-18. Training/Fit Testing

a. *Training.* Unless the reasons for the use of respirator protective devices and instructions on the proper selection, use, and maintenance are thoroughly understood, and ongoing training provided, the devices may not be used or may not work properly. Both supervisors and workers must be instructed by competent persons knowledgeable in the area of respiratory protection. Training must provide individuals an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and finally to wear it in a test atmosphere. Minimum training must include:

- Instruction in the nature of the hazard, whether acute, chronic, or both, and a frank appraisal of what may happen if the respirator is not used.

- Explanation of why more positive engineering or process-oriented controls are not immediately feasible to reduce or eliminate the need for respirators.

- A discussion of why this is the proper type of respirator for the particular purpose (TB MED 502).

- A discussion of the respirator's capabilities and limitations (TB MED 502).

- Periodic instruction and training in actual use of the respirator (preferably annually for emergency use respirators). Training should also include recognition of the end of the service life of cartridges/canisters or filters, such as smelling organic vapors through the cartridge/canister, manufacturer specified termination date, or an increase in breathing resistance.

- Classroom and field training to recognize and cope with emergency situations.

- Detailed instructions on cleaning and maintenance of the respirator (paragraph 20-21).

- A discussion on the requirements needed to recognize and cope with emergency situations.

- Any special training required for unique uses. Training for use of respiratory protective devices for firefighters will continue to be conducted by fire department personnel in close coordination with the medical authority.

b. Fit Testing. Before initial use, each respirator must be properly fitted, leakage tested, and the facepiece-to-face seal tested in a realistic test situation. Records of fit tests must be locally maintained at the installation level. These records must, as a minimum, contain date of fit test, name of individual tested, make and model of each respirator tested, and the results of each test. Fit testing will be done in accordance with TB MED 502 or current guidance from DOD/DA.

c. Retraining. Each respirator wearer must be retained at least annually.

20-19. Respirator Sealing Problems

Respirators must not be worn when conditions prevent a good face seal. Examples of such conditions are a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces of glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars, or without temple bars, may be taped to the wearer's head. When a worker must wear corrective lenses as part of the facepiece, the facepiece and lenses must be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

CAUTION

Wearing contact lenses in contaminated atmospheres with a respirator must not be allowed.

20-20. Respirator Sealing Tests

To ensure proper facepiece-to-face seal, the wearer must check the seal of the facepiece each time he puts on a respirator. This may be done using procedures recommended by respirator manufacturers or by any of the field tests described in TB MED 502.

20-21. Maintenance and Cleaning

a. Respirators must be cleaned and disinfected as frequently as necessary to ensure that the user is crovided protection. Users must be trained on cleaning procedure, so that they will be confident of always having a clean, disinfected respirator. This is very important when respirators are not individually assigned. All respirators must be cleaned and disinfected after every use.

b. The following cleaning and disinfecting procedures are recommended:

(1) Remove any filters, cartridges, or canisters.

(2) Wash the facepiece and breathing tube in a cleaner-disinfectant or detergent solution. Cleaner-disinfectant solutions are available which effectively clean the respirator and also contain a bactericidal agent. As an alternative, respirators may be washed in a liquid detergent solution and then immersed either in a hypochlorite solution for 2 minutes; or aqueous iodine solution for 2 minutes. A hand brush may be used to aid the removal of dirt. Because some of these disinfecting agents may age rubber parts and corrode metal parts, immersion times should be kept to a minimum.

(3) Rinse completely in clean, warm water. Some disinfectant solutions can damage rubber, elastomer, metal parts, or cause dermatitis if not rinsed completely from the respirator; the importance of thorough rinsing cannot be stressed too strongly.

(4) Air dry the parts in a clean area.

(5) Clean other respirator parts as recommended by the manufacturer.

(6) Inspect valves, headstraps, and other parts for wear and/or damage; replace with new parts if defective.

(7) Insert new filters, cartridges, or canisters; ensure that all seals are tight.

(8) Place in a plastic bag or container for storage.

c. Repairs to respirators or replacement of parts should be done only by experienced personnel, using parts designed for the particular respirator. Repairs, adjustments, or parts replacement beyond the manufacturer's recommendations should not be attempted. Regulators and reducing admission valves are particularly critical parts and should be returned to the manufacturer or to a trained technician for adjustments or repair.

20-22. Inspection

a. Respirators should be inspected routinely before and after each use. Respirators which are not routinely used, such as those kept ready for emergency use, should be inspected after each use and regularly (monthly, at a minimum) to ensure that they are in proper working condition. Self-contained breathing apparatus should also be checked monthly. and air/oxygen cylinders kept fully charged in accordance with manufacturer's specifications. Regulator and warning devices must be checked carefully to ensure that they function correctly. Complete records of inspection dates and findings must be kept for respirators maintained for emergency use.

b. When inspecting respirators, be sure to check the tightness of connectors and the condition of the facepiece, headbands, valves, connecting tubes, and canisters. During the inspection, respirators should also be leak checked. Rubber and elastomer parts must be inspected for pliability and signs of deterioration. Stretch and manipulate rubber and elastomer parts with a massaging action; this keeps them pliable, flexible, and prevents them from assuming an undesirable "set" during storage.

20-23. Storage

a. After respirators are inspected, cleaned, and repaired, they should be properly stored, to protect them against the undesirable effects of dust, sunlight, heat, extreme cold, damaging chemicals, excessive moisture, or mechanical damage. Respirators which are routinely used, such as dust respirators, may be kept in plastic bags between uses. Respirators should not be stored in lockers or tool boxes unless they are in carrying cases or cartons designed expressly for that purpose.

b. Frequently, respirators are kept at work areas or stations for emergency use. In such cases, they should be stored in compartments built for the purpose, quickly accessible at all times, and clearly marked.

c. Respirators should be packed so that the facepiece and exhalation valve will rest in a normal position, thereby preventing the softer materials used in these parts from assuming shapes or positions which might impair their function.

20-24. Program Surveillance and Evaluation

If a program of respiratory protection for workers in hazardous environments is to be effective, there must be continuous surveillance and evaluation of the program. This surveillance and evaluation is a joint responsibility of supervisors and industrial hygiene personnel. It entails active monitoring the issue, storage, maintenance, inspection, and correct use of respirators, as well as the evaluation of the training effectiveness provided to users. Inspection records should be checked periodically to ensure that inspections are being conducted when required and that they are achieving their purpose.

20-25. Medical Examinations

Preemployment medical examinations are normally required for all personnel. Those workers who work in potentially hazardous environments, and especially those who are required to wear respiratory protective devices, should be given additional medical examinations to ensure that the devices are adequately protecting their health. These examinations should be given as frequently as deemed necessary by the medical authority, but should be given at least annually. During the annual examination, in addition to the pulmonary function test, blood and urine should be tested.

20-26. Approving Agencies

At one time, the US Bureau of Mines was the governmental agency responsible for approval of respirators. This responsibility has been assumed by the National Institute for Occupational Safety and Health (NIOSH), an agency of the US Department of Health, Education, and Welfare (HEW). Each respirator is tested to ensure that it is adequate for its intended use. If found to be adequate, a test control (TC) number will be issued to the respirator. Refer to TB MED 502 for a list of approved respiratory protective devices.

Section V. VENTILATION

20-27. General

a. Many industrial operations generate toxic substances, dust, and heat which can be harmful to the worker if they are inhaled or cause severe worker discomfort. To prevent this from happening, various types of ventilation systems have been designed and are used to protect the worker and to create a safe, comfortable working environment.

b. Ventilation is one of the most important control techniques employed to improve or maintain the quality of air in the work area. Generally speaking, ventilation is a method of controlling the environment with air flow.

In industrial work areas, this air flow may be used to achieve one or more of these aims—

- Heating or cooling,
- Removing a contaminant,
- Diluting the concentration of a contaminant, or
- Supplying make-up air.

c. Applications of ventilation usually fall into one of three areas—

- The prevention of fire and explosion;
- The control of atmospheric contaminants to healthful limits; or
- The control of heat and humidity for comfort.

20-28. Types of Ventilation Systems

a. Two methods of ventilation can be employed to control potentially hazardous airborne contaminants:

(1) The first is diluting the concentration of the contaminant before it reaches the worker's breathing zone. This method is referred to as "general ventilation" or "dilution ventilation."

(2) The second involves capturing and removing the contaminant near its source or point of generation, thus preventing the release of the contaminant into the work space. This method is called "local exhaust ventilation."

b. Dilution ventilation does not actually reduce or eliminate the total amount of hazardous material released into the work space. On the other hand, local exhaust ventilation prevents the release of the contaminants into the work space. Normally, local exhaust ventilation is the preferred, more effective, and overall more economical method for contaminant control.

20-29. Dilution Ventilation

a. General Ventilation (Dilution). General ventilation describes a system in which a work space, a room, or an entire building is flushed by supplying and exhausting a large volume of air throughout the area. General ventilation can be quite effective in removing large volumes of heated air or in removing low toxicity from decentralized sources. Dilution ventilation can be achieved by either natural or mechanical means. In actual practice, best results are often achieved through a combination of natural and mechanical air supply coupled with a system of natural and mechanical exhaust.

(1) *Natural General Ventilation.* Natural means by which work spaces or buildings may be ventilated include *wind* and *thermal convection.*

These effects result from natural pressure differences and air density differences, respectively; they each cause natural displacement and infiltration of air through windows, doors, walls, and other opening. If it were adequate, natural ventilation would be more economical than mechanical ventilation, but wind currents and thermal convections are erratic and not predictable. As a result, natural ventilation is unreliable as a primary control method.

(2) *Mechanical General Ventilation.* Modern buildings in which industrial operations are conducted are usually of large-area, low-height design, or, if they are of multi-story design, are of masonry and glass construction. In either case, natural ventilation is virtually nonexistent; therefore, mechanical ventilation must be relied upon completely. Mechanical air supply must be provided all year round to reach interior areas, provide adequate air distribution, and prevent the creation of negative air pressures in the building. In large open industrial buildings, general ventilation can be achieved by roof fans used with or without gravity ventilators. The best method of providing make-up general ventilation in a closed building is to supply air through duct work and distribute it into the work areas in a manner that will provide both humidity and temperature control. Figure 20-10 illustrates, in simplified form, the layout of a general ventilation system.

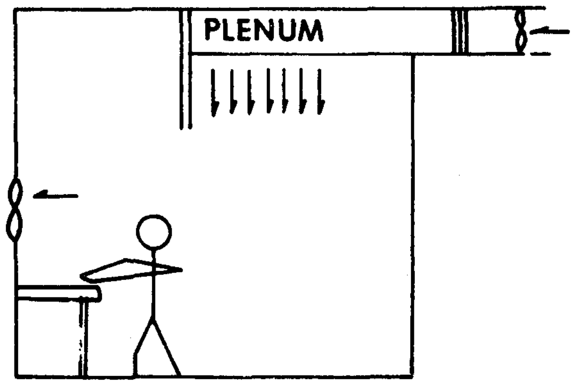


Figure 20-10. Simplified schematic of a general ventilation system.

b. Selection Criteria. When considering whether dilution ventilation would be preferable to a local exhaustion system, there are limiting factors which must be kept in mind.

- The quantity of contaminant generated must not be excessive: if it is, the volume of air required for dilution will be very high.

- The toxicity of the contaminant must be low.

- Workers must be located far enough away from the point of contaminant evolution, or the contaminant must be in low enough concentrations, so that workers do not have exposures which are above acceptable limits.

- The evolution or generation of contaminants must be reasonably uniform.

Considering these factors, dilution ventilation usually is not recommended for control of fumes and dust; because the high toxicities often encountered require excessively large quantities of air; and because the velocity and rate of contaminant evolution are usually quite high, resulting in unacceptably high local concentrations.

c. Advantages of a Dilution Ventilation System. Dilution ventilation systems have several advantages over local exhaust systems. Perhaps the most obvious of these are simplicity of design and low initial cost. However, it would not be wise to choose this system solely because of its low initial cost; because these systems invariably exhaust large volumes of heated air from a building, their use can result in huge operating costs in the form of conditioned make-up air. Over a long period of time, this would make the dilution ventilation system much more expensive.

d. Disadvantages of Dilution Ventilation System. The velocity of the air circulating in a dilution ventilation system is too low to effectively remove high concentrations of contaminants. In addition, dilution ventilation is inadequate for removing contaminants of high toxicity, such as contaminants whose TLV is less than 100 ppm.

20-30. Local Exhaust Ventilation

a. A local exhaust system is one in which the contaminant being controlled is captured at or near the point at which it is created. In contrast to dilution ventilation, local exhaust ventilation places much more reliance on mechanical means of controlling air flow. A typical local exhaust system usually includes the use of hoods or enclosures, duct work leading to an exhaust fan, an air cleaning device for abatement of air pollution, and finally, discharge to the outside air (Figure 20-11 and Figure 20-12). Local exhaust systems usually contain more mechanical components than dilution ventilation systems, require more precise control of their operation, and, as a result, require more maintenance.

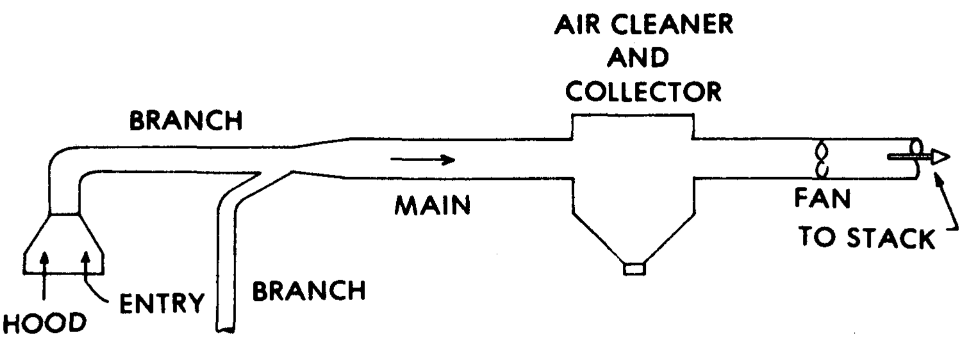


Figure 20-11. Schematic of a local exhaust system.

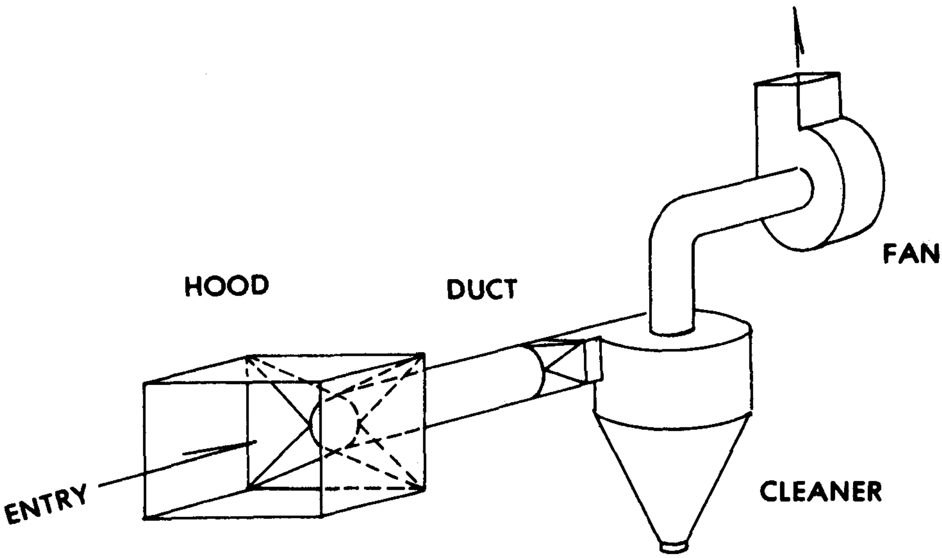


Figure 20-12. Elements of a local exhaust system.

b. When applying local exhaust ventilation to a specific problem, there are several basic principles that must be kept in mind—

- The source of contaminants should be enclosed as completely as practicable,
- The contaminant should be captured with adequate air velocity,
- The contaminant should be kept out of the worker's breathing zone,
- Adequate make-up air must be provided, and
- The exhaust air must be discharged away from air inlet systems.

c. Selection Criteria. Local exhaust ventilation systems are usually specified when the following conditions exist in the work environment:

- The concentration of contaminant is high, or
- The toxicity of the contaminant is high, or
- The worker's position is close to the point of the contaminant's evolution or dispersion, or
- The generation of the contaminant is not uniform.

d. Advantages of Local Exhaust Systems. Local exhaust systems are usually preferred over dilution ventilation systems for these reasons—

- Control of the contaminant can be complete; therefore, the exposure of the worker to the contaminant can be prevented, which results in a much more healthful work environment.

- A local exhaust system can handle more highly toxic contaminants.

- A local exhaust system can handle higher concentrations of contaminants.

- The velocity of the air in the system is high; as a result, performance of the exhaust fan system is not likely to be affected by wind velocity.

e. Disadvantages of Local Exhaust Ventilation Systems.

(1) Local exhaust systems are, as a rule, mechanically complex. This fact results in higher initial costs and a greater requirement for maintenance.

(2) Installation of the enclosures and duct work associated with local exhaust systems results in an inflexible work area.

20-31. Principles of Air Flow in Ventilation Systems

a. The basic laws governing the complete motion of a fluid such as air are complex. In the simple case of moving a layer, or layers, of air (laminar flow), the motion of the air can be computed analytically. However, in most ventilation systems (and especially in local exhaust systems) the air flow is usually turbulent to some degree. As a result, the analytical solution to the motion of air in exhaust systems depends largely on experimental data.

b. A basic consideration in the principles of air flow is conservation of mass, or put another way, the continuity equation. This equation states that the mass rate of flow remains constant along the path taken by a fluid such as air. Therefore, at any two points in the stream of air:

$$Q_1 = Q_2$$

Where Q = the volumetric rate of air flow in cubic feet per minute (cfm).

c. There is a very definite relationship between velocity and volumetric rate of flow, which can be expressed by the equation:

$$Q = AV$$

Where Q = rate of flow in cfm.

V = average linear velocity in ft/min.

and A = cross-sectional area of the duct or hood in ft^2.

(1) From this equation it is possible to calculate quantity (Q) of air flow rate if the velocity (V) and the cross-sectional area (A) are known. For example: If a duct is 12" by 36", and the velocity of the air has been measured four times, with readings of 200, 180, 220, and 190 ft/min, what is the volume of flow?

First, determine the average velocity:

$$V = \frac{200 + 180 + 220 + 190}{4}$$

$$V = \frac{790}{4} = 197.5 \text{ ft/min.}$$

Then, determine cross-sectional area:

$A = 1 \text{ x } 3 = 3 \text{ ft}^2$ (Change inches to feet before computing A.)

$A = 3 \text{ ft}^2$

Finally substitute values in the formula:

$Q = AV$

$Q = 3 \text{ X } 197.5$

$Q = 592.5 \text{ cfm}$

NOTE: For circular ducts, cross-sectional area is determined using the formula for *area of a circle:* $A = \text{Pi } r^2$, where

Pi = 3.1416

$$r = \text{radius of the circle} = \frac{\text{diameter}}{2}$$

(2) From the equation Q = AV it is also possible to find the area or velocity if the other variables are known. For example, if the quantity of air flow at point 1 of a system is 500 cfm with an area of 1 sq ft and the area is changed to 0.5 sq ft at point 2. What is the velocity at point 2? Since $Q_1 = Q_2$, the quantity will be the same at all points of the system if there are no branches or other entries.

First, change $Q = AV$ to $V = \frac{Q}{A}$

Then, substitute values in the formula

$$\frac{500 \text{ cfm}}{0.5 \text{ sq ft}} = 1000 \text{ fpm}$$

(3) If you need a velocity of 2000 fpm at point 3 of this system, what is the area at point 3?

First change Q = AV to $V = \frac{Q}{A}$

Then substitute the formula

$$\frac{500 \text{ cfm}}{2000 \text{ fpm}} = 0.25 \text{ sq ft}$$

d. The purpose of the exhaust system in an industrial work area is to remove the contaminant from the environment. To do this effectively, the air must have sufficient velocity to overcome opposing air currents and particle inertia causing the contaminated air to flow into the enclosure (usually a hood) and there must be sufficient velocity to keep the contaminant from settling out in the duct.

(1) *Capture velocity.* The air velocity at a point within or in front of an exhaust hood necessary to overcome opposing air currents and particle inertia, causing the contaminated air to flow into the hood. The capture velocity can be calculated for a distance (x) from the hood using Figure 20-13.

(2) *Duct velocity.* The air velocity within the duct.

(3) *Face velocity.* The air velocity at a point parallel with the face of the hood.

(4) *Transport velocity.* That velocity required to prevent settling of a contaminant within the duct.

20-32. Evaluating the Performance of Air Flow Systems

a. There are several reasons for evaluating the performance of air flow systems.

(1) To assure adequacy of design and performance.

(2) To assure system performance is maintained.

(3) To determine the feasibility of expanding the system.

(4) To establish improved design parameters for new systems.

(5) To assure compliance with federal, state, or other regulations.

b. Just as there are numerous reasons for evaluating air flow systems, there are differing degrees to which they may need to be evaluated. Instruments and techniques are available which may provide only a minimal evaluation on a part of the system or an in-depth survey of the total system.

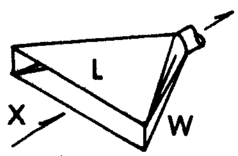
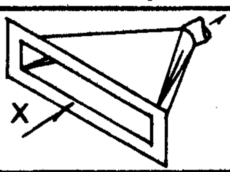
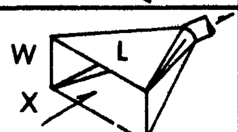
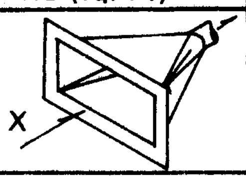
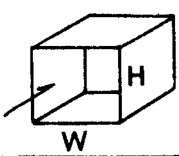
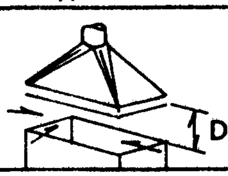
HOOD TYPE	DESCRIPTION	ASPECT RATIO $\frac{W}{L}$	AIR VOLUME
	SLOT	0.2 OR LESS	$Q=3.7\ LVX$
	FLANGED SLOT	0.2 OR LESS	$Q=2.8\ LVX$
	PLAIN OPENING	0.2 OR GREATER AND ROUND	$Q=V\ (10X^2+A)$
	FLANGED OPENING	0.2 OR GREATER AND ROUND	$Q=0.75\ V\ (10X^2+A)$
	BOOTH	TO SUIT WORK	$Q=VA=VWH$
	CANOPY	TO SUIT WORK	$Q=1.4\ PVD$ P=PERIMETER D=HEIGHT

Figure 20-13. Hood capture velocity.

c. Visualization is a technique which can be employed to make a minimal estimate on the performance of a local exhaust system. It employs various methods of generating visual "clouds" which can then be observed to evaluate air flow patterns and air velocities at exhaust entries and supply outlets. There are several chemical devices available for use in the visualization of a system.

(1) *Smoke tubes* is a descriptive term applied to glass tubes containing titanium tetrachloride absorbed on a granular medium. The moisture in the air reacts with the chemical to generate hydrochloric acid "smoke." (CAUTION: Direct inhalation of the "smoke" is extremely irritating to the respiratory system and should be avoided.)

(2) *Smoke candles* are available in a range of sizes and a few colors. They are sized on the basis of volume (cubic feet) of smoke produced or the duration of smoke evolution.

d. *Visualization devices* are best suited for the evaluation of air flow patterns and velocities at exhaust entries and supply outlets.

(1) The smoke tubes are used as an immediate survey type tool in assessing the ability of a local exhaust system to capture airborne contaminants. Smoke should be administered close to the hood entry initially, and then gradually moved away from the entry to observe the area of containment the exhaust system produces. Larger quantities of smoke can be generated inside the hood or enclosure to estimate the rate of clearance as well as to check for eddy currents, reverse air flows, and escaping contaminants. Small amounts of smoke can be used to estimate the force and direction of air from outlets as well as a qualitative check on the performance of return air outlets.

(2) Smoke candles can be used to estimate clearance rates and containment of large hoods such as paint spray booths, laboratory hoods, or other high volume exhaust systems. The system must be operating at minimal performance levels before igniting a smoke candle to insure removal of the smoke. Smoke candles can be held by forceps and moved across hood face openings to estimate the air distribution at the face. Colored smoke can be introduced in ventilation systems to check for leaks.

(3) Always inform the Fire Department before using excessive amounts of smoke to prevent false fire alarms.

e. There are two distinct limitations on the use of visualization techniques.

(1) Visualization is strictly qualitative and does not provide any information in terms of design or performance specifications.

(2) The materials used can be hazardous or at the very least a nuisance, thus their use in occupied work areas should be somewhat restricted.

20-33. Quantitative Measurement of Air Flow and Velocity

a. The purpose of a local exhaust system is to capture and convey airborne contaminants from the source through an air cleaner to the atmosphere. Precise measurements of face velocities as well as estimates of exhaust or supply volumes can be made at the point where the air flow system interacts with the work environment. To calculate the rate of air flow, the formula introduced in paragraph 20-35 is used:

$$Q = AV$$

Where Q = rate of flow in cfm.

V = average linear velocity in ft/min.

A = cross-sectional area of hood or duct in ft^2.

To use this formula, it will be necessary to determine the measurements of the duct or hood, and to make velocity measurements.

b. When using any of the various air flow instruments (anemometers), take multiple measurements of a given slot, hood, or diffuser. Only by making a traverse of the opening being evaluated will you be able to arrive at a satisfactory average velocity for calculating air flow. The manufacturer's directions must be followed when doing velocity measurements.

(1) The *rotating-vane anemometer* is comprised of a vane or propeller on a shaft connected to gears. The air movement causes the vane to rotate, turning the gears which register the revolutions on the instrument dial as linear feet. Readings are taken for one-minute periods, thus giving air velocity in linear feet per minute. (These instruments are best suited for determining air velocities and estimating air flow through large openings such as mine shafts and air supply and discharge grills. Follow the instrument operating instructions for correction factors in calculating actual air flow rates. These instruments must be handled with extreme care; they require the use of a timing device and must be frequently calibrated. They should be used in relatively clean air.

(2) The *swinging-vane anemometer* indicates air velocity as a function of pressure exerted by the air stream on a spring-loaded swinging-vane. They are portable and used extensively in the field. They are used primarily for measuring velocities of exhaust or supply openings. Some brands of swinging anemometers can be used to measure static pressures. It is important to follow the instructions carefully, use the recommended correction factors and calibrate the instrument periodically. Figure 20-14 illustrates several applications of a swinging-vane anemometer.

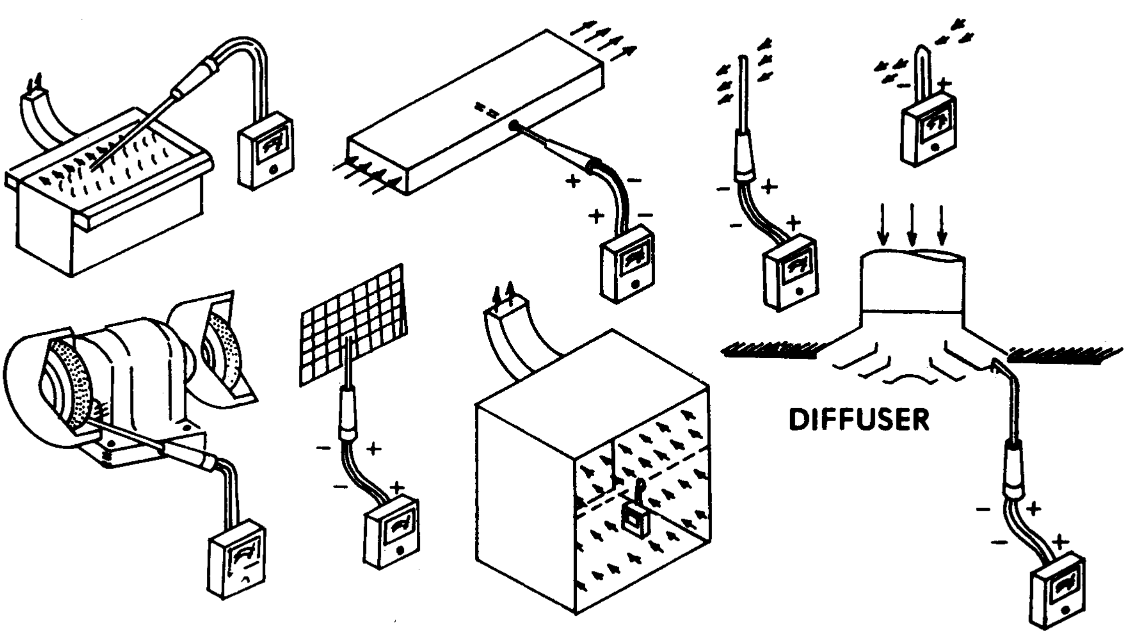


Figure 20-14. Applications of a swinging-vane anemometer.

(3) *Heated wire anemometers* depend upon the change in resistance of a wire with a change in temperature. The degree of temperature change is proportional to the velocity of air passing the wire. Velocity is read directly on a meter which is actuated by a change in voltage, resulting from the temperature change. These instruments are usually comprised of a single probe connected to an operating unit housing circuitry, meter, and batteries, and are about the size of a cigar box. They are portable and commercially available. Problems with these instruments are primarily maintaining the integrity of the probe. Heavy dust loadings or corrosive materials, as well as mechanical shock, can damage the delicate wires in the probe. These instruments also require periodic calibration. Figure 20-15 illustrates a typical heated wire anemometer.

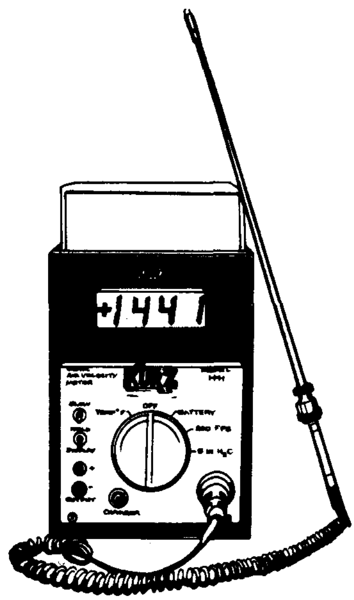


Figure 20-15. A typical heated-wire anemometer.

20-34. Measurements Within the System

a. Frequently it is necessary to determine precise measurements which characterize the performance of an air flow within the system. Instead of measuring the velocity of air going into exhaust hoods or coming from air outlets, measurements are made inside the duct work leading to the point of entry or discharge. Such measurements are usually made to determine pressure drops associated with hood entries, ducts, and across air cleaners, as well as velocity pressures. The instruments discussed will be primarily those used to measure pressure in terms of *inches of water*. (NOTE: An *inch of water* is a unit of pressure equal to the pressure exerted by a column of liquid one inch high at a standard temperature.)

b. Air in motion exerts a pressure called *velocity pressure*, which maintains air velocity and which may be thought of as kinetic energy. This pressure exists only when air is in motion, and only in the direction of the air flow. It is always a positive pressure.

c. Another important aspect of air flow principles is static pressure. *Static pressure* actually produces initial air velocity; it also overcomes the resistance in a system caused by friction of the air against the duct walls and overcomes turbulence and shock caused by a change in direction or velocity of air movement. Static pressure may be thought of as the pressure exerted on the sides of the duct. It is potential energy; it exists even when there is no air motion and acts equally in all directions.

d. The driving force for air flow is actually a pressure difference. Pressure is required to start and maintain flow. This pressure is called *total pressure* and has two components: velocity pressure and static pressure. Static pressure, velocity pressure, and total pressure are all interrelated, as shown by the formula:

$$SP + VP = TP$$

20-35. Pressure Losses in Ventilation Systems

a. Pressure losses in air flow systems are caused by a variety of factors. *Friction losses* result from the air in motion encountering resistance along any surface confining the flow. Some of the air energy is given up in overcoming this friction and is transformed into heat. The rougher the surface confining the flow or the higher the flow rate, the higher the frictional losses will be.

b. Dynamic losses are those energy losses in air flow which result from turbulence caused by a change in direction or velocity within a duct. The pressure drop in a duct system due to dynamic losses increases with the number of elbows or angles and the number of velocity changes within the system.

c. The *Pitot tube* is the standard instrument for measuring the velocity pressure of air in ducts. The Pitot tube consists of two concentric tubes. The opening of the inner tube is axial to the flow of air and measures total pressure, while the large tube with circumferential openings measures static pressure. The difference between the total pressure and the static pressure is the velocity pressure. Figure 20-16 shows the relationships between the various pressures in an exhaust system, while Figure 20-17 illustrates the construction of a standard Pitot tube. The major disadvantage of the Pitot tube is that it is not direct reading.

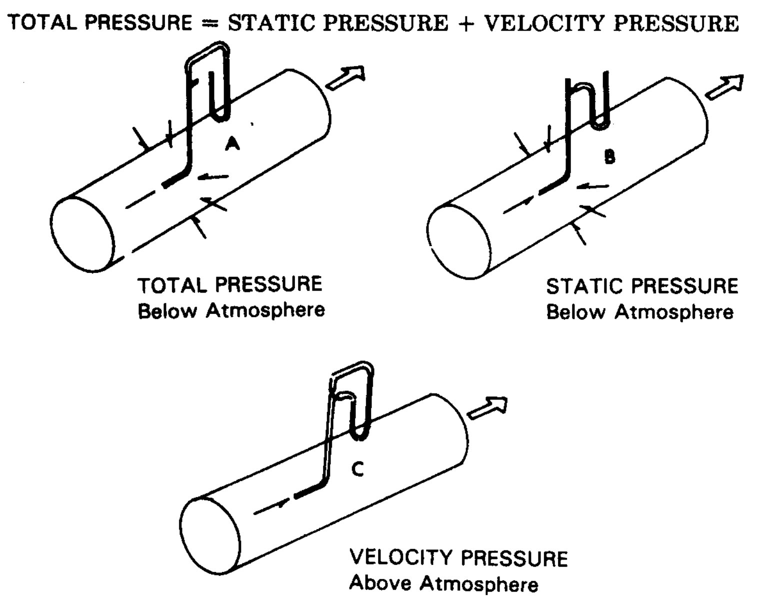


Figure 20-16. Relationships between the pressures in an exhausting system.

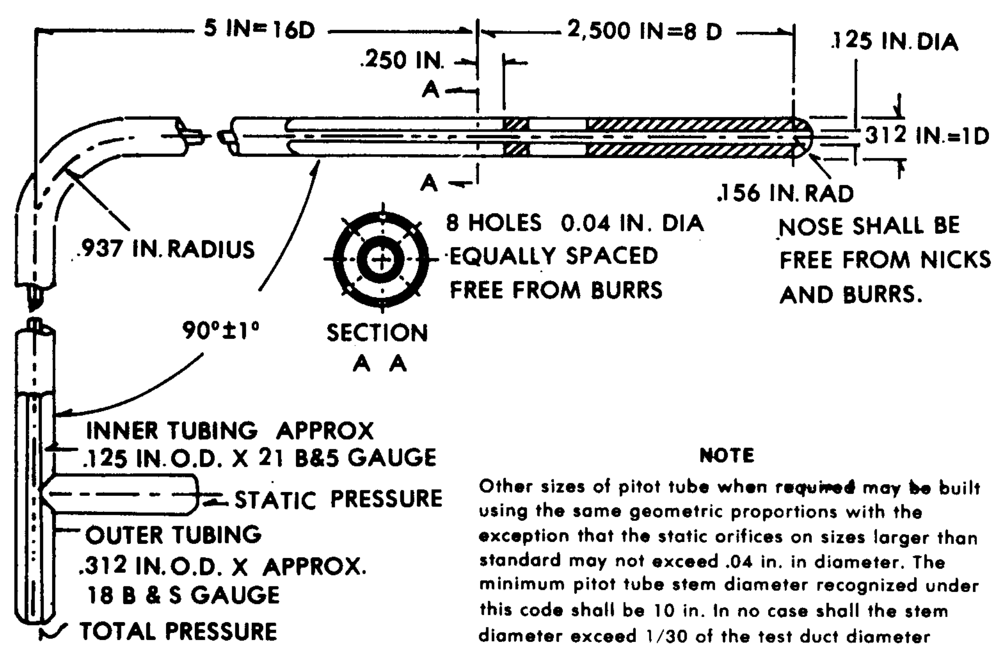


Figure 20-17. Standard Pitot tube.

d. Pitot tubes are used to determine the velocity pressure contours inside ducts. These measurements are obtained by connecting the static and total pressure taps of the Pitot tubes to a manometer, which is an instrument for measuring gas (air) pressure (see Figure 20-18). Inclined manometers are normally used since they increase the accuracy and precision, especially for air velocities below 2,000 feet per minute.

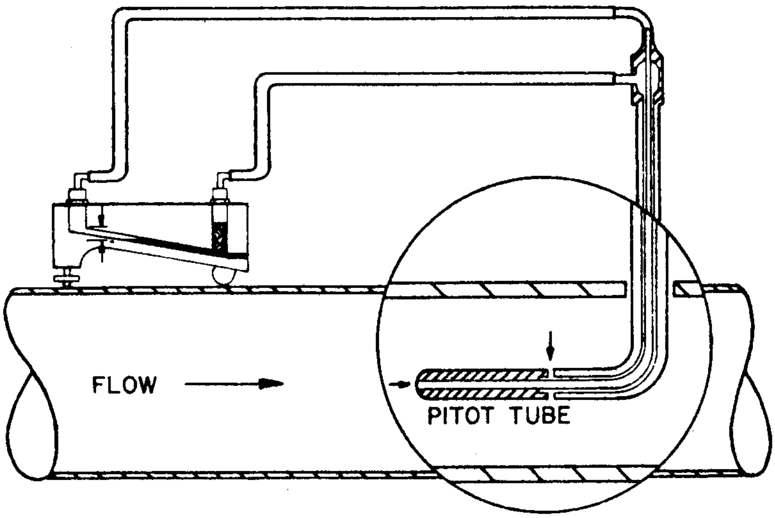


Figure 20-18. Pitot tube connected to an inclined manometer.

e. The most significant requirement in making valid velocity or air flow measurements is the location selected the measurements and the traverse of that location. The reason for these requirements is that air flow is not uniform in the cross section of a duct. This is especially true near such interferences as elbows, and entries. Therefore, for greater accuracy, measurements should be taken at least 7.5 diameters or more of straight run downstream or 1.5 diameters upstream from any interference. Once a location is selected, a Pitot traverse can be conducted.

f. There are fewer limitations for Pitot tubes than for other air velocity measuring devices. Although they can be used in corrosive or variable temperature conditions, the impact and static openings can become clogged with particulate matter. Also, as with other instruments, corrections will have to be made if the temperature is plus or minus 30°F from the standard; if the altitude is greater than 10,000 feet, or if the moisture content is 0.02 pound per pound or higher. They cannot be used to measure low velocities (less than 600 fpm). They require an inclined manometer which must be level and free of vibration. They are not applicable for use in small diameter ducts (less than 3 inches) or in orifice type openings.

g. In addition to the inclined manometer, there are other instruments available for measurements within an exhaust system.

(1) *Aneroid gauges.* The most common and best known of the aneroid gauges is the Magnehelic gauge. Aneroid gauges can be used for total, static, and velocity pressure measurements. They are small, extremely portable, and not as sensitive to vibration and leveling as liquid filled manometers.

(2) *Manometers.* Manometers range from the simple U-tube to the inclined manometers mentioned earlier. A range of sizes and varieties of U-tube manometers is available and they may be filled with a variety of media ranging from alcohol to mercury. Figure 20-18 illustrates an inclined manometer used with a Pitot tube.

h. Instruments used to take static pressure measurements within a ventilation system include the static leg of the Pitot tube as well as any pressure-measuring device connected to a hole in the side of a duct. U-tube manometers and Magnehelic gauges are quite acceptable. The exact location of the hole is not extremely critical, but the type of hole is. Generally, the holes should not be located in points where there is some basis for turbulence of nonlinear flow such as the heel of an elbow. Holes should be flush with the inside of the duct, with no projections or burrs. Holes should be drilled and not punched. The location of holes 90 degrees apart allows for averaging multiple readings to provide an improved estimate of static pressure. Taps can vary in complexity from a simple soft rubber hose held tightly against a 1/16th-inch hole, to soldered petcocks for use in high pressure systems.

i. Static pressure measurements at strategic points in a system provide invaluable information on the performance of the system. These measurements are neither difficult to obtain nor do they require expensive or delicate instrumentation.

20-36. Air Flow System Surveys

a. System Start-up vs. System Design Basis. Any ventilation system, be it local exhaust for contaminant control or general ventilation for comfort, is designed in terms of removing or redistributing a specified quantity of air at a specific velocity at a total system pressure which is the sum of the parts. An initial survey of the system is the only time a valid comparison can be made between the design basis and the optimum system performance.

(1) *Sketch of the system.* A sketch not necessarily to scale but representative of dimensions should be drawn noting such items as hoods, elbows, branchings, air cleaner, fan and stack. Supply ducts, plenums, and diffusers should be shown for general ventilation systems. Sketches of systems should be considered as part of the permanent record on which future changes in the system may be recorded.

(2) *Specific air flow measurements.* Measurements in terms of air flow, velocity, and static pressure must be made to determine that the system is adequately balanced and performing to the design basis. These measurements include:

(a) Air flow in cfm at hoods (face velocity), branches and mains (Pitot tube), and up and downstream of fan (Pitot tube).

(b) Static pressure measurements at hoods, up and downstream of the air cleaner, and up and downstream of the fan.

(c) Supply (make-up), and duct velocities at diffuser outlets (supply velocity), face or opening of hood (face velocity), and branches and mains (transport velocity).

(3) *Records.* The locations of the measurements must be identified on the sketch and a record kept for future comparisons.

NOTE

The measurements obtained should agree within 10 percent of the design basis. If they do not, the system will have to be modified until it meets design criteria.

(4) *Other Checks.* Local exhaust systems are installed for the singular purpose of removing a contaminant from the work environment. Visualization techniques using smoke tubes or candles are most helpful in verifying that the system exerts a sphere of control over a sufficient area to prevent excessive exposures to operating personnel. Air examination for specific contaminants is also performed to verify that the system controls contaminants to levels that are safe. Air samples taken in the breathing zones of operating personnel aid in assessing the adequacy of contaminant control. Photographic records of smoke tests and the results of evaluation tests should be maintained for future reference.

b. System Operation vs. System Start-up. Once systems are started up and determined to perform satisfactorily, the degree of evaluation can be reduced as long as good records of start-up or initial conditions have been made. Experience with air flow systems clearly indicates that periodic surveys are required to assure that system performance is adequate. Operating personnel cannot be relied upon as an "indicator" of system performance. Also, ventilation systems are rarely an integral part of the operation in terms of quality and production, and all too often receive inadequate maintenance. For most systems, simple velocity measurements at exhaust hoods and supply ducts will provide an indication of system performance when compared with start-up evaluations. For local exhaust systems, the face velocity of exhaust hoods and the static pressure differentials for air cleaners and fans will suffice in confirming that the system is performing satisfactorily. A reduction in face velocity provides valuable information, such as an indication that there has been—

- An accumulation of material in an elbow, branch, or main, thus clogging or restricting air flow. Build-up in elbows results from impaction, while build-up in straight runs results from insufficient conveying velocity or from overloading the system.

- A change in blast gate settings, if the system is balanced using blast gates.

- Additional branches and hoods added to the system. "Adding on" to a system is always a real temptation; however, it is not sound economics when it renders the whole system deficient.

- Excessive build-up on the filter. It is best to monitor filter build-up by attaching a static pressure measuring device across the filter.

- Reduced fan output resulting from belt slippage, damaged, or worn rotor, or build-up on the fan blades.

c. *Data Handling and Recording.* The sketch of the system made at start-up or for the initial evaluations survey must be recorded and filed so that future air flow surveys can be conducted in a similar manner. The frequency of air flow surveys can be determined only by such conditions as:

(1) *Nature of the materials being controlled.* The more hazardous the materials, the more frequently the system should be checked.

(2) *Nature of the system.* A blast gate system requires more frequent checks than other systems.

(3) *The level of maintenance.* Air flow systems can be used to indicate the need for more frequent and improved maintenance.

Section VI. OCCUPATIONAL VISION AND ILLUMINATION

20-37. General

An integral part of a comprehensive occupational health program is an occupational vision program. Authorization and guides for establishing a vision program are contained in AR 40-5 and TB MED 506.

a. Vision is one of the senses of man which is most vulnerable to occupational environmental hazards. Because of this sensitivity we must take special precautions to insure the practice of vision conservation, if we are to reduce or eliminate vision loss or injuries. Part of this job is education.

b. The eye is the organ of sight. Sight is the sense of detecting light energy by sensitive nerves, collectively called the retina. This "sensing" is transmitted by the optic nerve to the brain for interpretation. Visible light, with a wavelength between 380 and 760 millimicrons, enters through the cornea and iris, and is focused by the lens onto the retina. The cornea is a transparent "window", and if clouded or injured, it affects the amount of light entering the eye and consequently the visual acuteness of the individual.

20-38. Effects of Improper Lighting

Because of the sensitivity of the eye and its vulnerability, special consideration must be given to problems in illumination, as part of a vision conservation program. There is little evidence that poor illumination will produce damage to the eyes, but there is ample evidence that good illumination is essential for acuteness of vision; for maximum speed of seeing; for prevention of eye fatigue and eye strain; and, thus, for efficient work and prevention of accidents. The character of illumination also affects the psychological reactions and may, therefore, affect morale.

20-39. Terminology

Terminology or units for expressing the amount of light are as follows:

a. Candle. The National Bureau of Standards maintains a light source which serves as a measure for the standard unit of luminous intensity—the candle. Candlepower is luminous intensity expressed in candles.

b. Luminaire. A luminaire is a complete lighting unit including lamp or lamps, reflector, refractor, housing, and such support as is integral with the housing designed to distribute the light.

c. Direct Lighting. This is a lighting system in which practically all of the light of the luminaires (90 to 100 percent) is directed downward, that is, directly toward the working areas.

d. Fenestration. An opening or series of openings for the admission of daylight into a building; some medium for control usually fills the opening.

e. Foot-Candle. The foot-candle (fc) is the unit for measuring the amount of illumination which falls on a surface at any one point; and the values obtained with instruments for measuring illumination are expressed in terms of fcs.

f. Foot-Lambert. The foot-lambert (ftL) is a unit for measuring brightness. Actually, it is not the illumination falling on the surface that is important for vision, but the amount of light reaching the eye from the surface. This amount or brightness depends on the fc of light falling on the components of the surface. The amount of light emitted directly from the surface of a light source also is measured in terms of ftLs. Brightness, either of reflected or emitted light, can be expressed as candles per square inch. One candle per square inch is equal to 452 ftLs.

g. Glare. When the brightness level of a surface is sufficiently higher than the general brightness level as to cause discomfort, annoyance, interference with vision, or eye fatigue, the disturbing factor is referred to as glare.

h. Indirect Lighting. As the name implies, 90 to 100 percent of the light from the luminaries is first directed to the ceiling and upper walls from which it is reflected diffusely to all parts of the room.

i. Lumen. The lumen is the unit of luminous flux. It is equal to the flux on a unit surface, all points of which are at unit distance from a uniform point source of one candle.

j. Luminance Ratio. Luminance ratio is the ratio of brightness of any two surfaces.

k. Reflectance. The reflectance is the ratio of the flux reflected by a surface or medium to the incident flux from the incident side. Reflectance is usually expressed in percent and is therefore called the reflection factor. The fcs required at any task are determined from the task brightness divided by the reflectance. Tasks having lower reflectances will require much higher fc levels for this reason.

20-40. Illumination Requirements

a. Amount of Illumination. Authorities have long differed on the amount of illumination necessary for vision. The ability to see clearly and the speed of vision increase markedly with an increase in illumination up to about 20 fcs then more slowly up to 30 fcs when the object viewed is standard black print on a white background. Hence, 20 fcs can be accepted as the basic minimum level of illumination, when the maximum contrast exists between the specific object and the background, such as black print on white ground. When the reflection factor is reduced, as when one is working on dark colors, or when the contrast in color between the object and the background is reduced, higher levels of illumination are required. Higher levels also are essential for continuous fine work and for employees with eye defects. A minimum of 30 fcs is recommended where any close eye work is required, and higher levels are necessary under certain conditions. Inadequate or excess lighting contributes to inefficient and uncomfortable visual performance. This often contributes to creating hazardous environments. The national safety council estimates that insufficient lighting is the sole cause of 5 percent of industrial accidents.

(1) In 1974 the General Services Administration (GSA) implemented illumination standards that are generally adequate for most working environments (40 CFR 101-20.116-2). During working hours overhead lighting shall be reduced to no more than—

- 50 fc at work stations.
- 30 fc in work areas.
- 10 fc in nonworking areas (but not less than 1 fc).

(2) These standards may need to be supplemented with auxiliary lighting when certain critical tasks are undertaken or when the work force is made up of older individuals who require higher light levels. Reference should be made to the Illuminating Engineering Society's (IES) Lighting Handbook for guidance on special task requirements. DOD guidelines require that illumination levels not exceed those recommended in the IES Lighting Handbook.

b. Brightness. Contrasts in illumination within the work area interfere with good vision. The illumination should be general throughout the work area rather than confined to the central field of vision as in local spot lighting. The ability to see clearly is greatest when the surrounding area has the same brightness as the central field of vision and poorest when the surrounding area is brighter than the central field of vision. Where general diffuse lighting cannot provide sufficient illumination on the work, supplementary spot lighting may be provided, but the brightness in the central field of vision should not be more than ten times that of the surrounding brightness and preferably not over five.

c. Glare. Bright light sources and bright reflections from shiny surfaces must be avoided, because they not only produce discomfort but may also interfere with vision.

d. Contrast in Illumination Between One Area and Another. Hallways and other such areas must be supplied with adequate illumination even though close work is not required. When a person passes from a brightly lighted area to one with a low level of illumination, his vision becomes exceedingly poor until adaptation is complete, which requires about one-half hour. Accidents are likely to occur unless halls, stairways, and other passages, are properly illuminated. Lighting in these areas should be at least one-fifth of the level in adjacent areas.

e. Color and Reflection. A contrast in color between the object and the background is important. Higher levels of illumination are required when the contrast is low. The color of walls, ceiling and machinery is important for maximum reflection of light.

20-41. Types of Lighting

a. Artificial Lighting Units. General lighting units which give good diffuse illumination throughout the area without glare and shadows are recommended, but under some circumstances supplementary local units are necessary. General lighting units may be classified as—

(1) Indirect units, which reflect all (90 to 100 percent of total output) of the illumination that reaches the work area from the ceiling and directs none downward to the work area from the unit. These units meet all of the desirable requirements but are inefficient, require frequent cleaning, cannot be used where ceilings are high or dark, and sometimes do not give sufficient illumination without producing glare from the reflecting surfaces.

(2) Direct units, which direct all (90 to 100 percent of total output) of the light downward to the work area, tend to produce glare, shadows, and spotting rather than diffuse lighting but are economical and efficient. They must be used when ceilings are high and/or dark.

(3) Enclosed units, which give diffuse lighting but may produce glare.

(4) Semidirect and semi-indirect units, which give both direct and reflected light. They are the most desirable type of lighting units and should be used where it is feasible. They are more efficient than the indirect units and do not give as much glare and shadows as do the direct units. The long tubular lamps offer many advantages over the concentrated round bulb lamps because the candlepower per square inch is less although the total illumination is high, thus reducing the glare and extending the illumination over a wider area. These lamps can often be used bare where high ceilings exist and can be used very advantageously with so-called "egg crate" louvers when placed lower. For best

environmental conditions, the maximum brightness of the luminaire should be less than one candle per square inch in the shielded zone.

b. Natural Lighting.

(1) Natural lighting may be supplied by sidewall windows or overhead fenestration. The intensity of daylight varies with time and weather conditions. The amount of light entering the room depends on the size, the position, and the transmission of the glazing medium.

(2) The amount of illumination from a side window decreases rapidly as the distance from the window increases. Light entering the upper part of the window is most effective. Doubling the height of a window is much more effective than doubling the width. Shades or other means of shielding must be provided to prevent excessive glare from the windows, especially from sunlight. Where windows face walls on the interior, additional illumination may be obtained by painting the walls a light color.

(3) Daylight also may be supplied in one-story buildings by overhead sawtooth or monitor construction. Standards have been suggested for the desirable ratio of fenestration to floor area and space. Because of the variation in natural lighting, artificial illumination should be available at all times.

20-42. Vision Conservation Program

a. Good visual acuity on the job, obtained by properly conducted vision conservation programs, can go a long way toward elimination or reduction of accidents caused by faulty vision. It also improves the morale of workers and reduces fatigue and eyestrain on the job. Good vision can increase production and eliminate waste caused by defective vision. The vision conservation program is designed to evaluate the ability of a prospective employee to perform the type of work for which he is being considered and to eliminate, or at least reduce, the number of eye injuries. Vision programs are designed to improve lighting to the point where workers can see the work they are doing without undue stress and also to provide eye protective devices for those jobs that present eye hazards to the workers engaged in them. Eye examination, both preplacement and periodic, if performed properly, can also detect eye defects that might become grounds for employee compensation and thus cost the government a considerable amount of money. Eye examinations will often reveal visual defects or eye diseases which are not even known to the individual worker involved. All comprehensive vision conservation programs include eye hazard determinations for all work areas, processes, and occupations in the particular installation in which they are operated.

b. The essential elements that insure an effective occupational vision program are—

- Determining the degree of eye hazard for each job or work area.

- Analyzing job classes to determine the required visual skills (visual acuity, depth perception, muscle balance, and color perception) necessary for optimal job performance.

- Developing a local guide listing vision standards and eye-protection requirements for each job title.

- Vision screening to determine whether workers possess the visual skills indicated by the job analysis including—

  - o Preplacement and biannual job-related vision screening examinations of personnel employed in occupations with laser, microwave, or high intensity light hazards.

  - o Preplacement and biennial vision screening for workers in all other potentially eye hazardous occupations.

  - o Elective periodic vision screening for employees in noneye-hazardous occupations may be provided, resources permitting, at least once every 3 years.

- Referring of employees not possessing the desired visual skills for a complete professional clinical vision evaluation and recommended therapy. Military personnel obtain the examination at the appropriate MTF. Civilian employees in the required category, who require a prescription change (as determined by vision screening) or have not previously worn prescription glasses, are provided this service at Government expense, either at an MTF or through reimbursement (AR 40-3, AR 40-5, and 40-63). Those civilian employees in the voluntary category shall obtain such examinations at their own expense as well as civilian employees in the required category who do not meet the criteria for examinations at Government expense.

- Supervising eye protection (industrial safety eyewear) and eye hygiene by an occupational optometrist or physician, safety personnel, and by supervisors.

- Providing first aid and immediate care, plus follow-up care, of occupational eye injury and disease.

- Providing worker health education with respect to proper eye protection and the benefits of an occupational vision program. Worker education should be developed by a multidisciplinary team to include supervisors, the occupational health nurse, occupational health physician, occupational optometrist, industrial hygienist, safety personnel, and other concerned disciplines.

- Performing periodic surveys of work areas to—

  - o Promote adequate illumination by the occupational optometrist, industrial hygienist and safety manager.

  - o Evaluate other aspects of the work environment to insure safe, comfortable and efficient visual performance.

- Reviewing contact lens usage. Contact lenses do not provide eye protection in the industrial sense and shall not be worn in a hazardous environment without appropriate protective eyewear.

c. The element of the vision conservation program which consists of continuous supervision and surveillance of the environment is one in which the Pvnt med specialist performs an important function. The survey is the tool used to evaluate the adequacy of illumination and in part to determine specific illumination needs for specialized tasks. The specialist may be called on to perform this necessary task. Usually,intensity measurements are obtained at the task site or operator location, though occasionally it is necessary to make a complete survey to determine the average illumination in an entire work area. Excessive brightness, inadequacy of existing lighting, or interference of construction is often the findings of a survey.

Section VII. NOISE HAZARDS

20-43. General

a. It has been long recognized that continuing exposure to high sound pressure noise may cause permanent loss of hearing, which can affect combat efficiency. It is also well established that noise-induced hearing loss is the most prevalent occupational health hazards in the military as well as in industry. It is a disability which is, in most instances, preventable. The Pvnt med specialist should therefore, be familiar with the effects of noise on hearing and with the measures that will prevent the injury. The Hearing Conservation Program is an integral part of the total Army OSH Program.

b. One of the Pvnt med specialist's duties is to conduct noise surveys as part of the Army Hearing Conservation Program. On-the-job training in the hearing conservation program will acquaint you with the necessary equipment and sqrvey techniques. Guidance for conducting a hearing conservation program are outlined in AR 40-5 and TB MED 501.

20-44. Noise and Its Effects on Hearing

a. Noise is primarily transmitted to the ear through the air. Under certain conditions, it may permanently injure the hearing mechanism. The hazard from steady noise depends primarily on the frequency and sound pressure of the noise, whether the exposure is intermittent or continuous, and the duration of exposure. The hazard from impulse noise depends on various factors including peak pressure, rise time and duration of individual impulses, and the number of impulses in an exposure period. The effects on the hearing mechanism from both steady and impulse noise may vary among individuals, the hearing of some being more susceptible to damage than that of others.

b. Noise-induced hearing loss may be temporary or permanent. The former is commonly referred to as temporary threshold shift (TTS), and the latter as permanent threshold shift (PTS). Permanent loss is usually the result of damage to the end organ of hearing, the corti located in the inner ear and is not treatable. Recovery from TTS is seldom complete. The accumulative effect of repeated exposure to loud noise results in a gradually increasing PTS.

c. The early stages of noise-induced hearing loss are characterized by reduced hearing sensitivity at frequencies above 2000 Hz. Other symptoms may include complaints of tinnitus (a ringing sensation), a temporary muffling of sound after exposure to noise, and/or a sensation of fullness in the ears. Individuals are usually not aware of any impairment of hearing until their hearing threshold levels above 1000 Hz become significantly impaired. Continued unprotected exposure to hazardous noise will result in a progression of hearing loss in the lower frequencies with a marked loss of communication ability.

20-45. Terms

The subjects of hearing conservation and noise involve many technical terms. The following are those most commonly used:

a. *Audiogram.* An audiogram (or audiometric recording chart) is a record of the threshold of audibility of each ear for each of a number of pure-tone test frequencies.

b. *Audiometer.* An audiometer is an instrument for measuring hearing thresholds. Only audiometers that conform to the requirements and specifications of ANSI Standard S3.6-1969 (R 1973) are used by DA.

c. *Deafness.* Deafness is the otological condition in which the hearing threshold level for speech, or the average hearing threshold level for tones of 500, 1000 and 2000 Hz, is at least 93 decibels (re: ANSI S3.6-1969) or 82 decibels (re: ASA-195). This condition is generally accepted as representing 100 percent hearing handicap for hearing everyday speech.

d. *Decibel (dB).* A unit used to express sound pressure level. The decibel level of a sound is related to the logarithm of the ratio of sound pressure to a reference pressure. The dB has meaning only when the reference quantity is known. The internationally accepted reference pressure in acoustics is 20 micro Pascals (uPa) which corresponds to 0 dB. A decibel is equal to 20 Log *sound pressure/reference pressure*.

e. *dBA.* Sound level A, or dBA, is the sound pressure level in decibels measured with a sound level meter using the A-weighting network and slow meter response. The A-weighting network closely approximates the human hearing response to sound at low dB levels.

f. *dBC.* The unit used to express the sound level measured through the C-weighting network of a sound level meter. This approximates the human hearing response to sound at high dB levels.

g. *dBP.* The unit used to express peak sound pressure level of impulse noise. The peak instantaneous pressure is expressed in decibels, using a reference level of 20 uPa.

h. *Frequency.* Frequency is the number of repetitions or cycles of pressure variations of a sound per unit of time.

i. Hearing Threshold Level. Hearing Threshold Level (HTL) is the hearing level in decibels at a specified test frequency by which the threshold of audibility for an ear exceeds a standard audiometric threshold. This level is reported as dBHTL on the audiogram.

j. Hertz. Hertz (Hz) is the international symbol for cycles per second and is the unit of measurement for the frequency of tones.

k. Impulse Noise. Impulse noise (also referred to as impact noise or as blast overpressure), such as that produced by weapons, punch presses, and drop hammers, consists of a short burst of acoustical energy. Impulse noise is characterized by a rapid rise time of not more than 35 milliseconds to a peak pressure. The total duration of a single impulse is not more than 500 milliseconds. When the interval between peaks is one-half second or less, it is best to consider the noise source as "steady noise" for sound survey purposes.

l. Noise. Noise, in the nontechnical sense, is any unwanted sound. Noise may be steady, either a pure tone or a complex of tones, or it may consist of one or more impulses. The term is usually applied to sounds having a complex character with numerous separate frequency components extending over a wide range of frequencies and not generated to convey meaning or information.

m. Reference Audiogram. A reference audiogram is the first audiogram obtained (and available) upon entrance to military service or employment with the Department of the Army. For instance, if available, the audiogram taken at the Military Entrance Processing Station (MEPS) will be the reference.

n. Sound Spectrum. A sound spectrum is the distribution pattern of energy or sound pressure in different bands along the scale of audible frequencies. The spectrum can be determined by measuring the sound pressure in each of 10 bands one octave in width, covering the audible frequencies. The center frequencies of these bands are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 Hz. These 10 bands are called the preferred series of octave bands, and the measurement is called an octave band analysis.

o. Steady Noise. Steady noise is a periodic or random variation in atmospheric pressure at audible frequencies. It may be continuous, intermittent or fluctuating, with the sound level varying over a wide range. For example, high sound pressure steady noise is commonly found in the interiors of tanks, personnel carriers, and truck cabs; near field electrical generator sets; in machine shops, carpenter shops, and engine repair and testing shops; in any area where air-driven tools are used; near or inside aircraft in operation on the ground or in flight, and near aircraft engines operated on stands.

p. Tone. A tone is an acoustic wave whose pressure varies in a completely periodic manner. If there is a pressure variation of only one component in a simple sinusoidal manner, it is termed a "pure tone"; if it can be analyzed into several such components, it is termed a "complex tone."

q. Trained AMEDD Personnel. For hearing conservation purposes, trained personnel are medical, industrial hygiene, environmental science or engineering personnel with approved training in the areas of hearing conservation (that is, Council on Accreditation for Occupational Hearing Conservation or equivalent civilian or military training).

20-46. Characteristics of Sound

a. General.

(1) To understand sound measurement it is necessary to understand the properties of sound that are to be measured. Frequency and sound pressure levels are the measurable characteristics of sound that affect humans by causing damage to hearing, annoyance, and interference with speech communications. Since sound is a physical condition, its physical characteristics can be measured and evaluated.

(2) Noise is measured in two dimensions, sound pressure level and frequency.

b. Sound Pressure Level.

(1) Sound intensity produces pressure; to measure this pressure it has been necessary to establish a reference level. This is set at 20 micro Pascals (0.0002 microbars), which is the effective sound pressure in the air that exists for the sound of a 1000 Hz pure tone that can just be heard by a person with acute hearing. This level is the reference point at which the decibel scale begins or "O" dB.

(2) Measurements of hearing have shown that the normal ear is capable of receiving an incredibly large range of sound pressures. In addition, the ear constitutes a sensitive sound analyzer in that, as sounds are heard, the brain sorts them into high, medium, or low, and all intermediate frequencies. The two ears also constitute a sensitive system for efficiently locating a sound source. The loudest sound the ear can hear *without a sensation of pain* has about ten million times the pressure of the faintest audible sound.

(3) Alternating sound pressures of 0.0002 to 2 billion (2×10^9) micro Pascals exist in the air for the usual range of audible sounds. Because of the difficulty which would arise in using numbers of this range to describe physical conditions of sound, the decibel notation has come into general use. Using it to describe sound pressure conditions, sound pressures of 0.0002 and 2000 microbars represent sound pressure levels of 0 and 140 dB, respectively (Table 20-3).

(4) The decibel scale is a logarithmic ratio of a sound to the reference, 20 micro Pascals. Specifically, the dB equivalent of a particular sound pressure ratio is 20 times the logarithm to the base 10 of that ratio. Since dBs are logarithmic units, they cannot be added by ordinary arithmetic means. Example: if a single aircraft engine produced 90 dB at a particular location, two identical engines would not produce 180 dB. To add 90 dB and 90 dB, add 3 dB to give 93 dB. Although a 3 dB increment in sound pressure represents a doubling for two sounds differing by 3 dB the higher level does not sound twice as high as the lower. A difference of about 10 dB represents a subjective

doubling of loudness. (As a historical footnote, the word decibel is derived from the word bel [and decibel is equal to one-tenth of a bel], a logarithmic unit named after Alexander Graham Bell.)

(5) To illustrate the sound pressure levels of some common sounds, examples are presented in Table 20-3. The threshold of audibility near the bottom of the scale is the level of the faintest sound the ear can hear. The exact value varies somewhat between individuals but the average for normal ears is a few decibels above 0 dB in the midfrequency range. The threshold of discomfort is the sound pressure level at which the sound is so loud that it begins to cause a harsh sensation to the normal ear. The average value of this sound pressure level is approximately 120 dB, which means that the sound pressure is about one million times the sound pressure of 0 dB. The average valve which begins to cause pain is 140 dB or 10 million times the sound pressure of 0 dB.

Table 20-3. Tabulation of Common Sounds with Their Intensities

Decibels	Adjective rating	Pressure in micro Pascals	Example
160	Deafening	$2X10^9$	Rupture of eardrum. M-14 rifle full automatic. Operator's right ear.
140	Deafening	$2X10^8$	Threshold of pain.
120	Deafening	$2X10^7$	Threshold of discomfort (interior of APC).
110	Deafening		Airplane engine at close range.
100	Deafening	$2X10^6$	Lawn mower
90	Very loud	$2X10^5$	Cab of 2.5 ton truck.
80	Very loud	$2X10^5$	Heavy street traffic.
70	Loud	----	Busy city traffic.
60	Loud	$2X10^4$	Ordinary conversation.
50	Moderate	----	Business office. Quiet dwelling.
40	Moderate	2000 ($2X10^3$)	Subdued conversation.
30	Faint	----	Very quiet office.
20	Faint	200	Very quiet room.
10	Very faint	----	Whisper 5 feet away.
0	Very faint	20	Threshold of hearing (minimum detectable sound.

c. Frequencies. Frequency is the other important element of sound or noise in addition to sound pressure. Both values must be considered. In acoustics, frequencies are described in octaves. The term "octave," taken from musical terminology is defined as the interval between any two sounds having a frequency ratio of 2:1. The series of frequencies commonly used in acoustical analyses and measurements are 250, 500, 1000, 2000, 4000 and 8000 Hz.

d. Range of Frequencies. The range of audible frequencies is from approximately 20 Hz to 15,000 Hz for the average person with normal hearing although some people, especially children, can distinguish frequencies between 20 and 20,000 Hz. The frequencies important for speech to be understood are between approximately 200 and 6000 Hz. The speech area is further divided into the vowel and consonant frequencies, the vowels lying between approximately 200 and 1500 Hz, and the consonant frequencies between approximately 1500 and 6000 Hz.

e. Measurements of Sound. The ear perceives the physical properties of sound. Sound pressure is perceived by the ear as loudness. One of the difficult goals of acoustical scientists is to devise a meter that will agree with the ear in these measurements. The ear does not respond the same to all frequencies: that is, the loudness of sound as interpreted by the ear does not have a direct relationship to the sound pressure level as measured in dB at the various frequencies.

f. Distribution of Sound Intensity. Generally speaking, higher frequency noises (that is, above 1000 Hz) are more damaging, produce greater masking of speech, and are more annoying than are low frequency noises. Octave band analyses make it possible to discover the frequency band, or bands, that are contributing most to the total sound pressure. Different parts of machines contribute different components to the whole noise spectrum. If it is known which frequencies contribute most to the overall sound pressure, the machine can be studied to determine which parts are the sources of the most noise.

20-47. Sound Level Meter Characteristics

a. Sound level meters use weighting circuits to provide correlation with human hearing and meter responses when measuring sound.

b. Weighting Circuits.

(1) *A weighting/dBA.* The sound "A" weighting circuit filters out some of the lower frequencies. This corresponds to human hearing at 55 dB and below. This weighting circuit is used for steady state noise surveys.

(2) *B Weighting/dBB.* The "B" weighting circuit filters out less of the low frequencies than the "A" circuit. This corresponds to human hearing at 55 to 85 dB.

(3) *C weighting/dBC.* The "C" weighting circuit has essentially a flat (linear) response, filtering out only sound outside of the human hearing range. This corresponds to human hearing at 85 dB and above.

(4) *Flat (linear/dBP).* The sound level meter measures actual sound pressure levels within the capabilities of the microphone. This circuit is used for impulse noise surveys and octave band analysis.

c. Meter Response Circuits.

(1) *Slow.* The sound level meter does root mean square (rms) averaging over a period of time. The sound level meter displays a slow meter response. This circuit is used for steady state noise surveys and octave band analysis.

(2) *Fast.* The sound level meter does rms averaging over a short period of time. The sound level meter displays a fast meter response.

(3) *Peak.* The sound level meter measures the actual peak of the sound wave. This circuit is used for impulse/impact noise surveys.

20-48. Exposure Criteria

a. Steady Noise. Levels of steady noise of 85 dBA or greater are considered hazardous regardless of the duration of exposure for the purpose of administering a hearing conservation program. Hearing conservation measures must be initiated when personnel are exposed to levels 85 dBA or greater. This criterion affords the advantage of increasing the overall efficiency of the program by: simplifying its administrative aspects; and eliminating the requirement for dosimetry to determine a cumulative measure of varying noise levels and exposure durations. It will also better protect those individuals who are more susceptible to the effects of noise. Although the requirements of the program demand the initiation of hearing conservation measures when levels are 85 dBA or greater, the use of all available measures may not be necessary in every case. For example, visitors to noise-hazardous areas are required to wear hearing protective devices, but the requirement for hearing evaluations does not apply to the visitors. There may also be unique situations where noise levels rise infrequently and unpredictably to 85 dBA or greater for very short durations so that wearing hearing protective devices is impractical or unnecessary. Decisions to waive wearing hearing protective devices or any other requirement of the program must not be made arbitrarily. Such decisions may be made by trained AMEDD personnel who perform a thorough evaluation using approved instrumentation and who consider all factors relative to the potential for a given exposure to cause hearing impairment. Refer to TB MED 501 for guidance in establishing the existence of noise hazards when noise levels are 81 dBA to 84 dBA for exposures in excess of an 8-hour workday.

b. Impulse Noise. Levels that exceed 140 dBP are considered hazardous. The measurement of impulse noise requires the use of special instrumentation and must be done only by specially trained AMEDD personnel. All weapons used by the Army produce impulse noise levels above 140 dBP. Hearing conservation measures must be instituted and enforced when firing weapons during training. Impulse noise between 120 and 140 dBP is uncomfortable and wearing hearing protection is advisable.

20-49. Essentials of A Hearing Conservation Program.

Preventing hearing loss from exposure to noise involves—

- Conducting noise-hazard evaluations;

- Posting noise-hazardous areas and equipment;
- Engineering control measures;
- Using hearing protective devices;
- Monitoring audiometry;
- Providing health education, supervision, and discipline to personnel.

20-50. Noise-Hazard Evaluation (Noise Survey) and Exposure Criteria

a. Hazard Evaluation—Steady Noise. Initiation of hearing conservation programs must be preceded by noise surveys at all locations where noise makes it difficult for two persons with good hearing to converse at close range or wherever a noise hazard is otherwise suspected.

(1) *Sound level meter.* A sound level meter that meets or exceeds requirements for a Type 2 sound level meter as specified in ANSI Standard S1.4-1983 must be employed using the A-weighting network and slow meter response. Determine the readings at the approximate position of the worker's most exposed ear. A sufficient number of readings should be made to reflect variations in noise levels resulting from changes in operating schedules or work procedures.

(2) *Acoustical calibrator.* An acoustical calibrator (pistonphone) must also be used to verify the before-and-after calibration of the sound level meter on the day measurements are taken.

(3) *Annual comprehensive calibration.* The sound level meter and the acoustical calibrator must receive an annual comprehensive calibration to include checks of frequency response, internal noise, meter circuits, microphone and amplifier sensitivity.

(4) *Noise-hazardous areas.* All noise-hazardous areas must be surveyed at least once a year and within 30 days of any change in the operation affecting noise levels.

(5) *Records.* Noise survey records are kept on DD Form 2214, Noise Survey, as outlined in TB MED 501.

(6) *List of personnel.* A list of personnel routinely working in noise-hazardous areas is maintained to provide identification of those individuals requiring monitoring audiometry.

b. Risk Assessment Code. A risk assessment code described in terms of hazard severity and mishap probability is assigned to noise-hazardous operations. These codes are used to assist in establishing priorities for available resources in implementing acoustical engineering controls. Risk assessment codes are assigned on the basis of personnel exposure as related to noise level and duration of exposure. See TB MED 501 for a further explanation of risk assessment codes and limiting values for total daily noise exposures. The noise attenuation provided by personal hearing protective devices will not be deducted from noise levels when assigning a risk assessment code. In addition, the assignment of risk assessment codes is not required for military unique equipment, systems and operations. Examples of military unique noise hazards include artillery, tanks, tactical vehicles, missiles, and military aircraft.

20-51. Posting of Noise-Hazardous Areas and Equipment

To identify noise-hazardous areas and/or equipment, color-coded signs and decals that describe the hazard involved and the required protective actions are conspicuously posted. These signs and decals alert the worker and visitor that a noise hazard exists and that proper precautions are to be taken.

a. Warning signs are positioned at entrances to, or on the periphery of noise-hazardous areas, where they are most visible to personnel entering or working. Wherever applicable 85 dBA and 140 dBP noise contours are established and designated around noise-hazardous areas. Lettering will be of a size that insures legibility at the required reading distances (AR 385-30). The provision, erection, and maintenance of these signs are the responsibilities of the facilities engineer (see AR 420-70).

b. Warning decals, designed for individual pieces of equipment, are available in the Federal supply system.

20-52. Engineering Control Measures

Effective engineering noise control is the most desirable hearing conservation measure since it can eliminate the hazard and render other elements of the program unnecessary. Whenever feasible, engineering control methods are used to reduce steady noise levels below 85¼dBA and impulse noise levels below 140 dBP or to the maximum extent possible.

a. Engineering noise control is deemed feasible if implementation is technologically and operationally practicable and cost effective. Since engineering noise control measures may involve significant expenditures, installation planners must establish priorities so that available funds will yield the greatest benefits. Such priorities must be based on factors such as the number of personnel exposed to a particular noise source, future intended use of the facility and the risk assessment code assigned to that source.

b. New equipment will be purchased or designed with the lowest possible noise emission levels. Such new equipment, whether purchased through commercial sources, the Federal supply system or designed within the Department of the Army, should conform to acoustical noise limits as prescribed in MIL STD 1474B. In addition, engineering control measures must be considered in the design of new facilities where there is potential for hazardous noise.

c. Noise reduction by engineering means is based mainly on the application of known principles relating to the science of sound. The solution of complex noise control problems usually requires the services of an acoustical engineer. However, the industrial hygienist, audiologist, environmental science officer, or preventive medicine officer with a general understanding of acoustical principles can recommend measures which will often control many noise problems. General categories of such measures include changes in the design or layout of an operation; equipment maintenance; substitution of quieter equipment, processes and materials; modifications of the noise source; and modification of the sound wave in various ways after it leaves the source.

20-53. Personal Hearing Protective Devices

a. Hearing protective devices consist of earplugs, ear muffs, noise-attenuating helmets or a combination of these (Table 20-4). They must be worn in steady noise when levels are 85 dBA or greater. Personal hearing protective devices are issued free to all personnel who work in designated noise hazardous areas. Earplugs, protective helmets or ear muffs may attenuate steady noise from approximately 15 dB in the lower frequencies to approximately 35 dB in the higher frequencies. When personnel are exposed to steady noise levels above 108 dBA, earplugs and ear muffs must be worn together. This combination provides approximately 5 to 10 dB more attenuation at most frequencies. Exposure to steady noise levels above 118 dBA requires that hearing protection be worn in combination and that daily exposure time be limited. The trade-off rate between noise level and allowable daily exposure with hearing protection worn in combination is 4 dB (on the A-scale) for every halving of time. For example, exposures at 122 dBA should be less than 4 hours per day, at 126 dBA less than 2 hours, at 130 dBA less than 1 hour, at 134 dBA less than 1/2 hour, and at 138 dBA less than 15 minutes. Exposures of personnel to steady noise levels above 138 dBA must be avoided regardless of the duration of exposure. If personnel must be exposed to steady noise levels above 138 dBA, specific approval must be obtained from the Office of The Surgeon General (DASG-PSP).

b. Measures for protection against impulse noise are the same as for steady noise. Protective devices must be worn when impulse noise levels exceed 140 dBP except during actual combat. Exposure to impulse noise in excess of 165 dBP requires wearing earplugs in combination with either ear muffs or a noise-attenuating helmet. Exposures of personnel to impulse noise levels above limit Z in Figure 5, MIL STD 1474B, must be avoided. If personnel must be exposed to impulse noise levels above limit Z, specific approval must be obtained from the Office of The Surgeon General (DASG-PSP). The officer-in-charge of each firing range, together with other range personnel, is responsible for enforcing the wearing of hearing protective devices (AR 385-63). Protective devices can and should be worn when actually in combat. The reduced hearing sensitivity associated with wearing protective devices can be restored immediately by removing the devices. On the other hand, the loss of hearing which results from the action of hazardous noise on the unprotected ear requires many hours for recovery to normal hearing sensitivity, provided that the structures of the inner ear are not damaged. If these structures are damaged, the hearing loss is permanent.

Table 20-4. Table of Currently Available Hearing Protective Devices

EARPLUGS

Plug, Ear, Hearing Protection, Single-Flange, 24S

Sizes: Extra small, white
Small, green
Medium, international orange
Large, blue
Extra large, red

Plug, Hearing Protection, Triple-Flange, 24S
Sizes: Small, green
Regular, international orange
Large, blue

Plug, Ear, Hearing Protection
Universal Size: Yellow/White, 400S

Plug, Ear, Silicone Rubber, Hearing Protection
Cylindrical, Disposable, 48S and 200S

EAR-CANAL CAPS

Plug, Ear, Plastic, Hearing Protection, Single-Flange
Universal Size

Plug, Ear, Hearing Protection
Universal Size, 12S

EAR MUFFS

Aural Protector, Sound, Type II

HELMETS

Helmet, Flyers, Crash Type (SPH-4)

Sizes: Regular
Extra large

Helmet, Combat Vehicle Crewmans (DH-132)
Sizes: Small
Medium
Large

c. Properly fitted earplugs will not cause damage to the normal ear canal provided the plugs are kept reasonably clean. Preformed earplugs (single- and triple-flange) and yellow/white foam earplugs must be cleaned with a mild soap solution and rinsed thoroughly. Additionally, plugs must be dry before being returned to the case. Preformed earplugs must be fitted for each ear under medical supervision. Occasionally an individual's ear canals will be of different sizes, each requiring a different size plug. A good seal between the earplug and the ear canal is essential. Some initial minor discomfort may be noted in obtaining a good seal. Personnel must understand the importance of the regular use of protective devices, as hearing loss progresses with continued exposure to noise. Because of improper inserting, seating, and cleaning techniques, there is a potential for variance in the protection afforded by earplugs as they are worn in the workplace. Thorough and repetitious instructions to personnel are required on the use and care of earplugs.

d. All military personnel are exposed to hazardous noise levels at some time during their military duties. All individuals entering active duty must be fitted with and retain possession of a pair of earplugs as an item of individual equipment. Personnel on active duty not having a pair of approved, preformed earplugs in their possession will be fitted with and issued earplugs. Civilian personnel scheduled for employment in noise-hazardous areas or operations will be fitted at the time of their preplacement audiometric evaluation or before beginning their duties. An earplug case with inserter must be provided with each set of preformed earplugs issued. A case will also be available for storage of handformed earplugs. Five types of earplugs can be requisitioned under the nomenclature PLUG, EAR, HEARING PROTECTION, as listed in Federal Supply Catalog C-6515-IL and CTA 8-100. The hearing protectors listed in Table 20-4 have been approved by The Surgeon General for use by Department of the Army personnel. These hearing protectors have been thoroughly tested for attenuation characteristics, durability, and possible toxic effects. From this selection, personnel will be permitted freedom of choice unless the selected protector is medically contraindicated or inadequate for a particular noise-hazardous area or operation. Hearing protectors from nonstandard sources are not recommended since not all have been found to provide adequate attenuation, or to be free from toxic effects. All three sizes of the triple-flange and all five sizes of the single-flange earplugs must be available for fitting and issue. Both types of plugs are color-coded according to size. The other two earplugs are handformed, disposable types (silicone plug, and yellow/white foam plug). Silicone plugs are used only once or twice. If cleaned regularly, yellow/white foam plugs can be used until discoloration or disfiguration occurs. The yellow/white foam plug must not be used in those situations where hazardous chemicals or vapors could be absorbed into the plug. Adequate supplies of at least one type of the handformed earplug will be maintained aboard aircraft, at firing ranges, airfields, and other noise-hazardous areas, for visitors or individuals who do not have preformed earplugs or ear muffs in their possession. Unlike preformed earplugs, handformed earplugs do not require medical fitting, or an inventory of multiple sizes. Cutting handformed plugs in halves must be avoided since this will result in an inadequate mass and markedly reduced noise attenuation. For hygienic reasons, hands must be relatively clean when preparing handformed earplugs for insertion.

e. There is no single best technique for fitting earplugs. Newly assigned persons should receive on-the-job training by an experienced fitter. The first step is a well-lighted inspection of each ear. The ear canal is best viewed by grasping the back of the ear with the thumb and index finger and pulling it gently but firmly straight out from the head. With the canal open as described, a plug of proper size is held between the thumb and index finger of the other hand and inserted with the tab (when present) towards the rear of the ear. The ear is released, and the plug is seated by pressing it gently but firmly toward the rear-center of the head. To assist in fitting the single- and triple-flange earplugs, an ear gauge can be requisitioned.

f. Essentially the same procedure is used by the wearer to insert the plugs. To open the canal of the left ear, the wearer may reach behind his head with his right hand, grasp the back of the left ear and pull outward, and insert and seat the plug with his left hand. To insert the triple-flange earplug using the earplug inserter (lid of the earplug case), insert the stem of the plug into the open end of the case lid. Push and wiggle the plug toward the rear center of your head. For single-flange earplugs, insert the earplug into the ear canal with your fingers; then use the pointed end of the case lid to improve the snug fit.

g. Ear-canal caps are available under the nomenclature PLUG, EAR, HEARING PROTECTION, UNIVERSAL SIZE (Table 20-4). Ear-canal caps are listed in Federal Supply Catalog C-6515-IL and CTA 8-100. Ear-canal caps are designed to be worn with the suspension system over the head, in back of the head or under the chin. Ear-canal caps are recommended only for very short-term exposures, such as where ear muffs are too warm or bulky.

h. Ear muffs are available under the nomenclature AURAL PROTECTORS, SOUND (Table 20-4). Type II ear muffs are designed to be worn with the suspension system over the head, in back of the head or under the chin. Ear muffs are often more suitable for intermittent exposures, and supervisory personnel can readily observe if workers are using the required protection. There are, however, some situations in which wearing ear muffs is impractical. For example, ear muffs are incompatible with some types of required headgear and are unsatisfactory when worn in excessively warm areas or in areas with limited head space. The earplugs or ear canal caps are more desirable in these situations. When ear muffs are used, the headband must be properly adjusted to insure a snug fit. A crown strap is provided with Type II ear muffs and should be worn over the head whenever these muffs are worn with the suspension system in back of the head or under the chin. When eyeglasses are worn with ear muffs, it is important that the earcup seals of the muffs fit well around the temples of the glasses since even a small "leak" defeats the purpose of wearing the muffs. Ear muffs with built-in radios that are designed for recreational listening (AM or FM) must not be used in place of approved hearing protective devices. Sound levels from such radio earphones may pose a potential auditory hazard and pose a safety hazard since warning signals may not be heard.

i. The aviator's helmet (SPH-4), and the combat vehicle crewman's (tanker's) helmet (DH-132) are designed for head protection and maximum noise attenuation provided the chin straps are securely fastened. These helmets are available under the nomenclature listed in Table 20-4. Both helmets are also listed in SB 700-20 and the AMDF.

j. Ear muffs and noise-attenuating helmets in the Federal supply system are equipped with replaceable earcup seals. If the seals become torn, punctured, or hardened (from age or the user's perspiration), they become uncomfortable and do not provide adequate noise attenuation. Therefore, inspect these devices periodically to determine their serviceability and replace unserviceable seals. Most ear muffs are shipped with one additional set of earcup seals. Replacement earmuff seals are also available from the manufacturer. Replacement seals for the SPH-4 and DH-132 helmets can be requisitioned under the nomenclature, SEAL, PLAIN, as listed in the AMDF for SPH-4, or DH-132.

20-54. Monitoring Audiometry

Monitoring audiometry is used to evaluate the effectiveness of a hearing conservation program by detecting changes in hearing sensitivity. With monitoring audiometry, it is possible to determine if hearing protective devices are being used faithfully and properly and to identify individuals who are highly susceptible to noise-induced hearing loss. This should not be confused with differential diagnostic audiometry or screening type (pass-fail) audiometry; however, the threshold of hearing is measured with the same accuracy that is required in differential diagnostic audiometry. Only pure-tone, air-conduction threshold tests are required. Required test frequencies for reference and periodic audiometric tests are 500, 1000, 2000, 3000, 4000, and 6000 Hz. Consult TB MED 501 for specific guidance.

20-55. Health Education, Supervision, and Discipline

Continued emphasis on the health education, supervision, and discipline aspects of a hearing conservation program is essential for the prevention of noise-induced hearing loss.

a. Personnel performing duties in hazardous noise must be informed of the effects of noise on hearing and taught how to avoid overexposure through the use of their hearing protective devices. The symptoms they may experience before permanent hearing loss occurs should be explained. Also explain the importance of early medical evaluation if such symptoms occur. Because the ear is commonly considered by lay personnel to consist of only the external ear, in health education activities you should refer to hearing protection and hearing protectors (rather than ear protectors) when discussing protective measures and equipment.

b. A very effective Army training film, "Prevention of Hearing Loss" (TF 8-4602), can be requested through local audiovisual support centers. Another film more applicable to a civilian population, "The Sound of Sound" (MF 8-5810), is also available. Other health education materials which include posters, pamphlets and technical guides are available by request from the Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-OB, Aberdeen Proving Ground, MD 21010-5422.

c. Command and all supervisory personnel must be instructed in the aspects of the complete hearing conservation program and charged with carrying out their responsibilities to assure success of the program, including the use of disciplinary measures if indicated. In situations where health education measures fail, a wide variety of disciplinary actions are available. When civilian employees of the Army deliberately or carelessly violate regulations regarding wearing hearing protective devices, provisions of Civilian Personnel Regulation 700 may be applicable. In the case of military personnel, disciplinary action in accordance with appropriate regulations may be required.

Section VIII. OTHER OCCUPATIONAL HAZARDS

20-56. Heat Hazards

There are two types of heat which are of importance in discussing heat stress associated with the occupational environment. One is the heat generated by the metabolic processes within the body, and the other is that externally imposed on man by his environment. Metabolic heat processes are discussed in another section of the manual; therefore, this section will contain information dealing only with the industrial environmental aspects. The metabolic heat produced by the body is exchanged with the ambient environment by the processes of convection, conduction, radiation, and evaporation. Interference with these processes may result in insufficient heat exchange from the body to the environment. Consequences may range from discomfort to more serious physiological responses, such as dehydration, heat cramps, and heat exhaustion. Personal preventive measures include acclimatizing to operations involving unusual heat levels; adequate intake of fluids; decreasing the time exposed to heat; and wearing various types of insulated clothing. There are several devices available for air-conditioned protective suits. Engineering controls include shielding heat sources to protect nearby personnel against radiant and conductive heat. Mechanical controls for humidity and ventilation are applicable in some cases, and in some extreme situations remote controlled operations may be necessary. When addressing heat hazards in an indoor environment and industrial operations, refer to the ACGIH-TLV booklet's section on heat stress or TB MED 507.

20-57. Biological Hazards

Disease-producing organisms are an occupational hazard to those persons involved in the disposal of infectious wastes. Safety precautions and sanitary measures can prevent occupation-induced disease from these sources. Methods of prevention and control of biological hazards are covered elsewhere in this manual.

20-58. Mechanical Hazards

Mechanical hazards lead to many industrial injuries. Guards on chain or gear drives, safety eyewear, proper shielding, and other measures have reduced the number of mechanical hazards; however, inattention, recklessness, and violation of safety rules continue to cause accidents. Education on the reason for and the value of safe working habits is the first step in an accident prevention program.

Section IX. RADIATION HAZARDS

20-59. General

Two categories of radiation in the military environment which concern Pvnt med specialists are ionizing and nonionizing radiation.

a. Ionizing radiations have the capability to remove electrons from neutral atoms. This process, known as ionization, results in the formation of ion pairs. An ion pair consists of a positive ion and a free electron. Ionizing radiation can be particulate, such as alpha or beta, or electromagnetic, such as X or gamma radiation.

b. Nonionizing radiations are electromagnetic in nature, but not of sufficient energy to cause ionization. Nonionizing radiations cause damage primarily through molecular rearrangements and heating effects. Typical nonionizing radiations include both conventional and laser sources of microwave, ultraviolet, infrared, and visible light.

20-60. Ionizing Radiation

a. Sources. Humans have always been exposed to low level, naturally occurring ionizing radiations from a variety of sources, including radioactive materials in rocks and soil, internal radionuclides, and cosmic radiation. Increasingly, man is being exposed to man-made sources of radiation, including medical radiation, consumer products, and the nuclear fuel cycle.

- Diagnostic x-ray machines are a potential radiation hazard at many military installations. X-rays are formed when electrons are accelerated across a vacuum tube into a tungsten or molybdenum target. The electrical current (mA) applied to the vacuum tube filament controls the number of x-rays produced, while the voltage applied to the tube (kVp) determines the maximum energy of the x-rays. X-rays are produced in a broad spectrum of energies; the less energetic x-rays ("soft" x-rays) generally do not contribute to diagnostic quality, but increase patient dose. The more energetic ("hard") x-rays are used in imaging the patient.

- Diagnostic x-ray machines are employed in two ways; fluoroscopy and radiography. Fluoroscopy produces a continuous, "live time" image for the radiologist. Radiography provides a permanent film record of the body part which is imaged.

b. Exposure. External exposure occurs when a person enters a radiation field, such as an x-ray beam, or comes into proximity with a radioactive source. Gamma and x-radiations provide the greatest external hazard, as opposed to alphas and betas which are less penetrating.

- When a worker gets radioactive material on his clothing, skin, or hair, he is said to be contaminated. He will sustain the effects of external irradiation until he removes the contamination. In general, removal of contaminated clothing and washing with soap and water will effect decontamination.

- Radioactive material which has been introduced into the body through inhalation, ingestion, or a break in the skin is termed internal contamination. Internal contaminants irradiate internal tissues until they are cleared by normal body processes, or become stable through radioactive decay. Alpha particles, and to a lesser extent, beta particles, are hazardous when emitted within the body tissue. Gamma rays and x-rays are less hazardous as internal radiations because they travel long distances in the body before interacting. In some cases the clearance time of internal contaminants can be decreased (under medical supervision) through the use of diuretics, chelating agents, or lavage techniques.

c. Protection and Control.

(1) External sources. The three cardinal principles of radiation protection from external sources are time, distance, and shielding. The protection of radiation workers and the control of radiation dose involves decreasing the duration of exposure; increasing the distance between the worker and the source of radiation; or shielding the worker from the source. Dense shielding materials are used for X or gamma radiation; less dense materials for beta particles. Alpha particles can be shielded by as little as a piece of paper.

(2) *Internal sources.* The best protective measure against internal contamination is to prevent introducing radioactive materials into the body. Good housekeeping practices, proper ventilation, adherence to standing operating procedures, and, when applicable, respiratory protection, will help achieve this goal.

d. Risk. The risk of exposure to occupational levels of ionizing radiation is thought to be low. In fact, the risk of occupational disease or injury to a radiation worker is often less than the risk to workers in other fields. There is, however, a potential for adverse effects to those who have been exposed even to low level radiation for long periods. These adverse effects include among others an increased risk of cancer, cataracts, and lifespan shortening.

e. Surveys. Organizations which use radioactive materials or radiation producing machines are required to designate a Radiation Protection Officer (RPO). If the RPO has sufficient expertise, he will conduct required surveys of radioactive sources or radiation devices. Requests for technical assistance and comprehensive surveys and studies should be directed through appropriate command channels from the requesting activity to Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-RH, Aberdeen Proving Ground, MD 21010-5422.

20-61. Radio Frequency Radiation

a. General. Radio frequency radiation (RFR) is widely used throughout the military in communications and radar systems. It is also used in food cooking devices and in medical diagnostic, therapeutic and surgical devices. Radio frequency radiation is nonionizing electromagnetic energy with wavelengths ranging from 30 kilometers to 1 millimeter with corresponding frequencies of 10 kilohertz (kHz) to 300,000 megahertz (MHz). Its power is expressed in watts (W) or kilowatts (kW). And its power density in milliwatts per square centimeter (mW/Cm^2).

b. Effects.

(1) The biological effect of RFR is the production of heat in tissue where the energy is absorbed. The depth of penetration and the magnitude of heating is dependent on several factors, one of which is the radiation frequency. When the frequency is below 1000 MHz, heating occurs mainly in deep tissues. Heating occurs mainly in superficial tissue when the frequency is above 3000 MHz; however, it may be conducted to deeper tissues. A combination of effects occurs in the range between 1000 and 3000 MHz. Absorption of radio frequency energy and the resulting biological effect on the body is dynamic. The natural body mechanism for dissipating heat by means of the circulatory system tends to neutralize the heating effect of the radio frequency energy; however, power densities may be reached where this protective mechanism is overburdened and irreversible damage results. This is particularly true in the eye,due to the limited circulation in the lens of the eye, heating is very poorly tolerated and cataract formation can result.

(2) Brief mention should be made that x-ray production in microwave generating equipment also presents a hazard. Radio frequency energy itself does not have the potential for producing ionization of atoms; however, voltages in excess of 10 kilovolts (kV) required to operate some electronic tubes used in RFR generating equipment results in x-radiation as a by-product.

c. Protection and Control.

(1) The maximum permissible exposure limit (PEL) or threshold level valve (TLV) for radiation protection control of RFR varies with frequency (See AR 40-583). At power density levels below the PEL or TLV which are based on an average radiation output and continuous exposure, detectable bodily injury to an individual is not expected clude electrical shock, exposure to gases such as ozone, burns from contact with cryogenics, and explosions of various parts of the system.

(2) Protective clothing is available; however, its use is normally limited to maintenance personnel who must work on RFR equipment while it is in operation. Procedures for evaluation of RFR producing facilities and application of control measures are contained in AR 40-5, AR 40-583, and TB MED 523.

(3) A limitation on emissions from microwave ovens issued as a standard under the Federal Radiation Control for Health and Safety Act applies to home or commercial ovens manufactured after 6 October 1971. These ovens may not emit radiation in excess of 1 milliwatt per square centimeter prior to sale and may not emit radiation in excess of 5 milliwatts per square centimeter throughout the useful life of the oven. Power density measurements for compliance with these limits may be determined at 5 centimeters from any external surface of the oven.

(4) Request for technical assistance, comprehensive surveys, and studies should be directed through appropriate command channels to the Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-RL, Aberdeen Proving Ground, MD 21010-5422.

20-62. LASER Radiation

a. General.

(1) The term LASER (Light Amplification by Stimulated Emission of Radiation) is given to devices which amplify light waves to produce a coherent, monochromatic, and highly directional light beam.

(2) Recent developments in LASER technology have resulted in an increase in the use of these devices for military applications. Along with the increased use of the LASER devices, comes the increased probability of personnel exposure to injurious intensities of LASER radiation.

b. Effects.

(1) LASER radiation is nonionizing radiation, although extremely high power intensities can produce ionization of air and in some cases ionization of various materials. The biological effects of LASER radiation are essentially the same as light generated by more conventional ultraviolet, infrared, and visible light sources; however, due to the high intensity of the light, the severity of the biological damage can be far greater than that of the more conventional forms. Several factors enter into the magnitude of damage which may be inflicted by LASER radiation, such as the intensity and frequency of the emitted energy; whether the beam is focused or unfocused; whether it is a pulsed or continuous wave emission; and the duration of the exposure determine to a varying degree the severity of the biological reaction to LASER radiation.

(2) The eye is particularly sensitive to most LASER radiation due to the optical gain of the eye which results in high radiances on the retina. Skin damage may range from mild reddening to blistering and charring, depending on the amount of energy transferred.

c. Protection and Control.

(1) Hazard evaluations have been based on safe exposure levels applicable to the eye, since this structure is most sensitive to LASER damage. Maximum permissible exposures to LASER radiation are expressed in joules per square centimeter and depend on the operational parameters of the LASER device.

(2) The engineering control methods of exposure to LASERS are based upon the same principles applied to other electromagnetic radiation. The basic means of control is to prevent personnel exposure to the primary beam or any energy from reflected surfaces. Safety eyewear of an appropriate optical density should be worn during the firing of Class IIIb and IV LASERS and should be labeled to prevent their use with LASERS of wavelengths different from those for which the eyewear was designed. Visual and/or audible

signals and safety interlocks may be necessary in some cases. Special precautions are required in some facilities, with the exact precautions dependent upon the type of LASER system in operation.

(3) Potential occupational hazards incidental to the use of LASERS should be recognized. These include electrical shock, exposure to gases such as ozone, burns from contact with cryogenics, and explosions of various parts of the system.

(4) In all cases, strict adherence to established safety rules and standing operating procedures is essential to prevent injury to personnel.

(5) Requests for technical assistance and comprehensive surveys should be sent to the US Army Environmental Hygiene Agency.

20-63. Ultraviolet, Infrared, and Intense Visible Radiation

a. General.

(1) One of the most prevalent sources of industrial exposure to ultraviolet (UV) radiation is welding operations. Ultraviolet radiation is produced as a by-product of the welding operation, whereas UV is intentionally produced in some processes for germicidal action. The spectral range of ultraviolet radiation begins at a wavelength of about 200 nanometers (nm) and continues to about 400 nm. This range is divided into two sections—the long wavelengths, which are adjacent to the visible light spectrum and extend from about 315 nm to about 400 nm; and the short wavelengths, which extend from 200 nm to 315 nm. A portion of the electromagnetic spectrum that ranges from about 315 nm to 410 nm is known as the "black light" portion of the ultraviolet spectrum. Although the "black light" portion does not fall entirely within the ultraviolet range, the peak transmission of "black light" occurs at about 367 nm, which is within the ultraviolet range.

(2) Infrared radiation is produced in the industrial environment as a by-product of hot metal operations such as welding and smelting. Processes in which infrared is intentionally produced by lamps include drying and baking protective coatings, heating and conditioning surfaces for application of adhesives, and dehydrating operations. The infrared radiation spectral range is broken into near infrared; intermediate infrared; and far infrared wavelength bands. The near band is adjacent to the long wavelength end of thevisible spectrum and ranges from about 750 nm to 1400 nm. The intermediate band ranges from 1400 nm to 3000 nm, and the far infrared band ranges from 3000 nm to about 1 mm.

(3) The visible light spectrum is in the range of about 380 nm to 760 nm. It contains an overlap of ultraviolet radiation at the low end and an overlap in infrared at the high end. The color bands range from violet at the low end to red at the high end with maximum visibility at 556 nm.

b. Effects.

(1) Long ultraviolet wavelengths, above 310 nm, penetrate deeper into the skin than do the shorter rays, but exert little biological effect.

Short rays below 230 nm have practically no penetration. It is in the range between 310 nm and 230 nm that most biological reactions occur due to UV exposure. Ultraviolet radiation only penetrates the body tissues a few millimeters, even at the longer wavelengths; therefore, they exert direct effect on the superficial organs of the body, such as the skin and outer portions of the eye. The two physiological effects from exposure to ultraviolet are the photochemical effect, which causes "suntan," and the more damaging cellular effects, which result in tissue blistering and swelling. Exposure to UV in the range between 340 nm to 280 nm over prolonged periods may cause skin cancer in individuals. UV wavelengths below 295 nm are absorbed entirely by the outer surfaces of the eye, the cornea and conjunctiva, and can result in conjunctivitis accompanied by photophobia (sensitivity to light). More severe exposures may cause ulcers of the cornea, which usually clear up in several days. The lens completely absorbs the wavelengths between 295 nm and 315 nm and partially absorbs those between 315 nm and 380 nm. If intensities are sufficient in this range, severe lens damage may occur.

(2) Infrared radiation causes heating in tissues with maximum skin penetration of about 3 millimeters. Exposure of the eye to wavelengths below 1400 nm causes heat coagulation of the retina, which could result in scotoma (blind spots) if the source is intense enough. Infrared wavelengths longer than 1400 nm are entirely absorbed by the anterior portions of the eye.

(3) There is no evidence available to indicate that permanent damage results from exposure to a high intensity flux of visible light, below exposure limits. Exposure to high intensities will produce a temporary loss of vision which disappears as the light absorbing cells regenerate pigment. The loss of vision for varying lengths of time is a potential safety hazard in the associated operation.

c. Protection and Control. Protection of individuals from exposure to sources of ultraviolet, infrared, or intense visible radiation is based primarily on shielding. Engineering controls such as structural shielding, either of a permanent or portable nature, may be used to shield the source and prevent personnel not involved with the operation from exposure. Personnel who must be in close proximity to the source, due to the nature of the operation, may have to resort to shielding by means of personal protective devices. Personal protective devices available include filtering lenses, thermal absorbing clothing, and reflective clothing.

d. Request for Technical Assistance. Requests for technical assistance, comprehensive surveys, and studies should be directed through appropriate channels to the Commander, US Army Environmental Hygiene Agency, ATTN: HSBL-RL, Aberdeen Proving Ground, MD 21010-5422.

APPENDIX A

TABLES OF EQUIVALENTS AND MATHEMATICAL CALCULATIONS USED IN THE APPLICATION OF PESTICIDES

A-1. Tables of Equivalents

Tables of equivalents for use in basic computations will be found in Table A-1. Other equivalents should be obtained from a standard Handbook of Chemistry and Physics.

Table A-1. Tables of Equivalents

Weight:

1 ounce (oz) (avoirdupois)	= 28.3495 grams
1 pound (lb) (avoirdupois)	= 16 ounces = 453.50 grams
1 ton (U.S. short)	= 2,000 pounds = 907.185 kilograms = .893 tons (U.S. long)
1 ton (U.S. long)	= 2,240 pounds = 1,016.047 kilograms = 1.12 tons (U.S.short)
1 gamma	= 1 microgram = 0.001 milligram
1 milligram	= 1,000 gammas—.001 gram
1 gram (gm)	= 1,000 milligrams
1 kilogram (kg)	= 1,000 grams = 2.205 pounds (avoirdupois)
1 ton (metric)	= 1,000 kilograms — 2,205 pounds = .984 tons (U.S. long) = 1.102 tons (U.S. short)

Volume or Capacity Measure (Liquid):

1 fluid ounce (U.S.)	= 29.57 milliliters
1 pint (pt)	= 16 fluid ounces
1 quart (qt) (U.S.)	= 2 pints = 0.9463 liter
1 gallon (gal) (U.S.)	= 4 quarts = .8327 gallon (Imperial or British) = 231 cubic inches = 0.1337 cubic foot = 3.785 liters
1 gallon (Brit)	= 1.2009 gallons (U.S.) = 4.546 liters
1 liter	= 1,000 milliliters = 1.057 quarts

At all temperatures up to 100 °F., one gallon of water weighs approximately 8.3 pounds, and one gallon of kerosene weighs approximately 6.8 pounds.

Volume or Capacity Measure (Dry):

1 quart (U.S.)	= 2 pints = 1.1012 liters
1 bushel (bu) (U.S.)	= 32 quarts = 4 pecks = 1.244 cubic feet — .969 British bushel
1 bushel (Brit)	= 1.2843 cubic feet = 36.368 liters = 1.032 U.S. bushel
1 liter	= 0.9081 dry quart (U.S.)

Volume or Capacity Measure (Cubic):

1 cubic inch	= 16.387 cubic centimeters
1 cubic foot	= 1,728 cubic inches = 29.922 U.S. liquid quarts = 7.481 U.S. liquid gallons = 25.714 U.S. dry quarts = 0.80357 U.S. bushels = 28.316 liters
1 cubic yard	= 27 cubic feet = 0.7646 cubic meter
1 cubic millimeter	= 0.001 cubic centimeter
1 cubic centimeter	= 0.061 cubic inch

Linear Measure (Length):

1 inch (in)	= 2.54 centimeters = 25.4 millimeters
1 foot (ft)	= 12 inches = 30.5 centimeters =0.3048 meter
1 yard (yd)	= 3 feet = 0.9144 meter
1 rod (rd)	= 5.5 yards = 16.5 feet = 5.029 meters
1 mile (mi)	= 320 rods = 1.760 yards = 5,280 feet = 1.6094 kilometers
1 micron (u)	= 0.001 millimeter
1 millimeter	= 0.0394 inch
1 centimeter	= 10 millimeters = 0.394 inch
1 meter	= 100 centimeters = 3.28 feet = 39.37 inches
1 kilometer	= 1.000 meters = 0.6214 mile

Table A-1. Table of Equivalents (Continued)

Square Measure (Area):	
1 square foot	= 144 square inches = 0.0929 square meter
1 square yard	= 9 square feet = 0.8361 square meter
1 square rod	= 272.25 square feet = 30.25 square yards = 25.923 square meters
1 acre	= 43,560 square feet = 4,840 square yards = 160 square rods = 0.4047 hectare
1 square mile	= 640 acres — 259 hectares
1 square meter	= 1,550 square inches = 1.196 square yards = 10.76 square feet
1 hectare	= 2.471 acres = 10,000 square meters

A-2. Mathematical Calculations Employed in the Field Application of Pesticides

By employing the formulas that follow, one can determine the precise unknown values encountered in the application of pesticides. Use simple substitution of appropriate known values, then perform the required basic mathematics function.

Formulas Pertaining to Rectangles and Squares:

Perimeter (linear measurement) = (2 x length) + (2 x width)

Area (square measurement) = length x width

Volume (cubic measurement) = length x width x height

Formula Petaining to Circles:

Area (square measurement) = Pi R^2

Pi = 3.14; R = 1/2 diameter; R^2 = R x R

Dilution Formulas:

Q = Quantity (gals, lbs) of concentrate required

S = Strength (%) active ingredient in finished spray or dust

A = Amount (gals, lbs) of total finished spray or dust

D = Density (lbs/gal) of diluent (water - 8.34 lbs/gal; kerosene = 6.6 lbs gal)

C = Concentrate % active ingredient

W = Weight (lbs/gal) active ingredient per gallon of concentrate

When mixing solid with solid (dusts) or liquid with liquid (emulsions, solutions) use:

$$Q = \frac{S \times A}{C} \text{ or } C \times Q = S \times A$$

Example: How much 95% concentrate will you use to obtain 100 gallons of 1% malathion solution to be diluted with kerosene?

$$Q = \frac{S \times A}{C} = \frac{100 \text{ gal} \times 1\%}{95\%} = \frac{100 \text{ gal} \times 1}{95} = \frac{100 \text{ gal}}{95} =$$

1.1 gallons = 1 gallon, 13 ounces

When mixing solid with liquid (WWP, suspensions), use:

$$Q = \frac{S \times A \times D}{C} \text{ or } C \times Q = S \times A \times D$$

Example: How many pounds of 80% carbaryl WWP will you use to make 15 gallons of 2% carbaryl suspension?

$$Q = \frac{S \times A \times D}{C} = \frac{2\% \times 15 \text{ gal} \times 8.3 \text{ lbs/gal}}{80\%} = \frac{2 \times 15 \times 8.3 \text{ lbs}}{80} =$$

$$\frac{30 \times 8.3 \text{ lbs}}{80} = \frac{249 \text{ lbs}}{80} = 3.1 \text{ lbs} = 3 \text{ pounds, 2 ounces}$$

When mixing liquids with concentrates whose concentrates is expressed in pounds of pesticide per gallon, assume 100% concentration and use:

$$Q = \frac{S \times A \times D}{C \times W} \text{ or } C \times W \times Q = S \times A \times D$$

Example: You are to mix 10 gallons of a 2% emulsion from emulsifiable concentrate containing 8 lbs/gal active ingredient.

$$Q = \frac{S \times A \times D}{C \times W} = \frac{2\% \times 10 \text{ gal} \times 8.3 \text{ lbs/gal}}{100\% \times 8 \text{ lbs/gal}} = \frac{2 \times 10 \text{ gal} \times 8.3}{100 \times 8} =$$

$$\frac{20 \text{ gal} \times 8.3}{800} = \frac{166 \text{ gal}}{800} = 0.21 \text{ gal} = 26.88 \text{ ounces}$$

A-3. Conversion of Fahrenheit Temperature Reading to Centigrade Temperature Reading and Vice Versa

Since a large majority of the temperatures ordinarily encountered in entomology lie between 32°F and 130°F, a chart enabling sight conversion from Fahrenheit to Centigrade and vice versa, within this range is furnished in Table A-2.

Table A-2. Relationship Between Fahrenheit and Centigrade Temperature Scales

Fahrenheit	Celsius	Fahrenheit	Celsius	Fahrenheit	Celsius	Fahrenheit	Celsius
-20	-28.89	38	3.33	96	35.56	154	67.78
-19	-28.34	39	3.89	97	36.11	155	68.34
-18	-27.78	40	4.44	98	36.67	156	68.89
-17	-27.22	41	5.00	99	37.23	157	69.45
-16	-26.67	42	5.56	100	37.78	158	70.01
-15	-26.11	43	6.11	101	38.34	159	70.56
-14	-25.56	44	6.67	102	38.89	160	70.12
-13	-25.00	45	7.22	103	39.45	161	71.67
-12	-24.45	46	7.78	104	40.00	162	72.23
-11	-23.89	47	8.33	105	40.56	163	72.78
-10	-23.34	48	8.89	106	41.11	164	73.34
-9	-22.78	49	9.45	107	41.67	165	73.89
-8	-22.22	50	10.00	108	42.23	166	74.45
-7	-21.67	51	10.56	109	42.78	167	75.01
-6	-21.11	52	11.11	110	43.34	168	75.56
-5	-20.56	53	11.67	111	43.89	169	76.12
-4	-20.00	54	12.22	112	44.45	170	76.67
-3	-19.45	55	12.78	113	45.00	171	77.23
-2	-18.89	56	13.33	114	45.56	172	77.78
-1	-18.33	57	13.89	115	46.11	173	78.34
0	-17.78	58	14.45	116	46.67	174	78.90
1	-17.22	59	15.00	117	47.23	175	79.45
2	-16.67	60	15.56	118	47.78	176	80.01
3	-16.11	61	16.11	119	48.34	177	80.56
4	-15.56	62	16.67	120	48.89	178	81.12
5	-15.00	63	17.22	121	49.45	179	81.67
6	-14.45	64	17.78	122	50.00	180	82.23
7	-13.89	65	18.33	123	50.56	181	82.78
8	-13.33	66	18.89	124	51.12	182	83.34
9	-12.78	67	19.45	125	51.67	183	80.90
10	-12.22	68	20.00	126	52.23	184	84.45
11	-11.67	69	20.56	127	52.78	185	85.01
12	-11.11	70	21.11	128	53.34	186	85.56
13	-10.56	71	21.67	129	53.89	187	86.12
14	-10.00	72	22.22	130	54.45	188	86.67
15	-9.45	73	22.78	131	55.00	189	87.23
16	-8.89	74	23.34	132	55.56	190	87.78
17	-8.33	75	23.89	133	56.12	191	88.34
18	-7.78	76	24.45	134	56.67	192	88.90
19	-7.22	77	25.00	135	57.23	193	89.45
20	-6.67	78	25.56	136	57.78	194	90.01
21	-6.11	79	26.11	137	58.34	195	90.56
22	-5.56	80	26.67	138	58.89	196	91.12
23	-5.00	81	27.22	139	59.45	197	91.67
24	-4.44	82	27.78	140	60.00	198	92.23
25	-3.89	83	28.37	141	60.56	199	92.79
26	-3.33	84	28.89	142	61.12	200	93.34
27	-2.78	85	29.45	143	61.67	201	93.90
28	-2.22	86	30.00	144	62.23	202	94.45
29	-1.67	87	30.56	145	62.78	203	95.01
30	-1.11	88	31.11	146	63.34	204	95.56
31	-.56	89	31.67	147	63.89	205	96.12
32	0	90	32.22	148	64.45	206	96.67
33	.56	91	32.78	149	65.01	207	97.23
34	1.11	92	33.34	150	65.56	208	97.78
35	1.67	93	33.89	151	66.12	209	98.34
36	2.22	94	34.45	152	66.67	210	98.90
37	2.78	95	35.00	153	67.23	211	99.45
						212	100.00

APPENDIX B
MEMBRANE FILTER TECHNIQUE

B-1. Preparation of Equipment

a. Bacteriological Water Testing Kit (Figure B-1). The bacteriological water testing kit is a standard item. It has a portable incubator heated by direct current from a 6-, 12-, or 24-volt battery or by 115-or 230-volt, 50- to 60-cycle alternating current. It contains the following equipment:

(1) Funnel and filter-support assembly.

(2) Hand suction pump.

(3) Measuring cup.

(4) Forceps.

(5) Petri culture dishes.

(6) Absorbent pads.

(7) Membrane filter disks.

(8) Culture media or endo broth.

(9) Methanol.

(10) Distilled water.

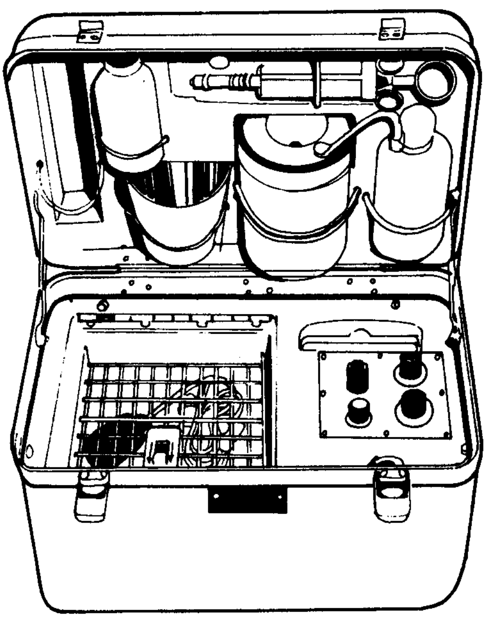


Figure B-1. Bacteriological water testing kit.

b. Sterilization of Equipment.

(1) *Funnel and filter-support assembly.*

(a) The funnel and filter-support assembly should be sterile at the beginning of each filtration series. It is not necessary to sterilize this assembly between successive filtrations or between successive filtrations of a series of samples unless an interruption of 30 or more minutes occurs between them. The probability of contaminating each succeeding sample with bacteria present in the previous one is reduced by properly flushing the funnel walls with sterile buffered dilution water.

(b) The preferred method for sterilizing the funnel and filter-support assembly is in an autoclave. The funnel and filter holder should be wrapped separately in kraft paper and sterilized in the autoclave at 121°C (249.8°F) for 15 minutes. At the end of the 15 minute holding period, the steam pressure should be released rapidly to promote drying.

(c) The funnel and filter holder may be sterilized in a flowing steam sterilizer for a 30 minute holding period.

(d) In an emergency or in the field when an autoclave or sterilizer is not available the funnel and filter holder may be sterilized by keeping it immersed in boiling water for 10 minutes.

(e) The funnel and filter-support assembly may also be sterilized with formaldhyde gas. This method consists of putting methyl alcohol on a wick in the base of the assembly, igniting the methyl alcohol, and closing the unit. Since the methyl alcohol is incompletely oxidized in the closed unit, formaldehyde gas, which is bactericidal, is generated. The unit is kept closed for at least 15 minutes; then it is rinsed with sterile water before it is used. This formaldehyde gas method is recommended for emergency or field use only.

(f) When the funnel and filter-support assembly is heavily contaminated, it should be washed thoroughly prior to sterilization.

(2) *Membrane filters and absorbent pads.*

(a) The membrane filters and absorbent pads are supplied in separate envelopes with 10 to a package. These filters and pads must be sterilized in the envelopes in an autoclave for 10 minutes at 121°C. After the sterilization period, the steam pressure should be released as rapidly as possible; then the packages should be removed from the autoclave.

(b) Membrane filter and absorbent pads for use in the field should be sterilized in advance.

(3) *Plastic petri dishes.* Since plastic petri dishes are manufactured by use of high temperature, packaged, and sealed, they are considered sterile. The disposable-type petri dishes should be used once and discarded. Should reuse of plastic dishes become necessary in an emergency, they should be sterilized as described below, as they will not withstand heat sterilization:

(a) Wash them thoroughly; then completely immerse them in a solution of 70 percent ethanol and 30 percent water for a minimum period of 30 minutes.

(b) Remove the dish halves aseptically; then invert them on a dry sterile towel and let them drain and air-dry thoroughly.

(c) Using sterile techniques, close the dishes and store them in a dustproof container.

(4) *Glass petri dishes.* If glass petri dishes are used, 10 dishes may be rolled in paper or metal foil and sterilized in an autoclave at 121°C (249.8°F) for 15 minutes.

(5) *Pipette and graduated cylinders.*

(a) Pipettes and graduated cylinders to be used in the field should be sterilized in the laboratory.

(b) Dry heat sterilization at 170°C (338°F) for at least 1 hour is preferred for most glassware. Pipettes can be placed in cans or wrapped individually in paper for sterilization. The openings of graduated cylinders should be covered with metal foil or kraft paper before sterilization.

(c) Sterilization in the autoclave at 121°C (249.8°F) for 15 minutes is satisfactory for glassware.

B-2. Preparation of Materials

a. Sterile Buffered Dilution Water.

(1) Stock phosphate buffer solution is prepared by dissolving 34.0 grams of potassium dihydrogen phosphate (KH_2PO_4) in 500 milliliters of distilled water. The pH is then adjusted to 7.2 with a solution of 40 grams per liter of sodium hydroxide (NaOH) and distilled water added to increase the volume of the solution to 1 liter.

(2) Sterile buffered dilution water is made by adding 1.25 milliliters of the stock phosphate buffer solution to 1 liter of distilled water and autoclaving it at 121°C (249.8°F) for 15 minutes.

b. Culture Media.

(1) *Ampuled M-Endo Medium.* An ampule of M-Endo medium is sufficient for one analysis. Ampuled medium, which has a limited shelf life, should be discarded after the expiration date indicated on the ampule box. Furthermore, it should not be used unless it is pink. Keeping ampuled medium refrigerated (4°C) helps to reduce deterioration.

(2) *Laboratory-prepared M-Endo Medium.* This medium should be used whenever possible. It may be prepared from dehydrated medium such as Difco M-Endo MF or BBL M-Coliform MF. This medium must be prepared

on the same day that it is to be used in making the water analysis. The directions for preparation are on the container of the dehydrated medium. In the field it is desirable to put proportional quantities of the dehydrated medium, based upon the number of water samples to be analyzed, in sterile screwcap vials; then on the day that the medium is to be used, the proper amount of distilled water and ethanol can be added. The vials must then be placed in a boiling water bath and heated until the medium reaches the boiling point. The screwcaps on the vials must be loosened during heating and tightened when the vials are removed from the water bath. This medium must be allowed to cool to room temperature before it is used.

B-3. Determination of the Quantity of Water Sample to be Filtered

The quantity of water sample to be filtered is governed by the expected bacterial density. Sample volumes should be chosen by the expected bacterial density. Sample volumes should be chosen to obtain at least one membrane filter with 20 to 60 coliform colonies. The total number of colonies of all types should not exceed 200.

a. If bacteriological data is available from previous tests, water sample filtration volumes can be computed as follows:

(1) First, determine the arithmetic mean of the coliform counts; then determine the volume of sample which, on the average, may be expected to produce 20 coliform colonies. This is known as the Basic Filtering Volume (BFV).

Example: Previous data shows that a given source has an average coliform density of 160 coliform colonies per 100 milliliters.

$$\frac{20}{\text{Average coliforms per 100 ml.}} \times 100 = \text{BFV}$$

$$\frac{20}{160} \times 100 = 12.5 \text{ ml. BFV}$$

(2) If three sample volumes are to be filtered, as is preferred, then filter one-third of the BFV, the BFV, and three times the BFV. (The computed amounts for filtration in the example ((1) above) would be 4.2, 12.5, and 37.5 milliliters. For convenience in measurement, the samples should be filtered in the amounts of 4, 10, and 40 milliliters.)

(3) If two sample volumes are to be filtered, filter one-half of the BFV and one and one-half times the BFV. (The computed amounts for filtration in the example ((1) above) would be 6.25 and 18.75 milliliters. For convenience in measurement, the sample should be filtered in amounts of 6 and 20 milliliters.)

(4) If only one filtration is to be made (generally not recommended), filter the BFV. (In the example ((1) above), the amount for filtration would be 12.5 milliliters or 10 milliliters for convenience in measurement.)

b. In the absence of previous bacteriological data, the following water sample volumes should be filtered:

(1) *Potable waters:*

(a) Municipal: 100 milliliters.

(b) Untreated supplies: 50 or 100 milliliters.

(c) Water from mains before resumption of service repairs or from new mains: 100 milliliters.

(2) *Raw water sources:*

(a) Unpolluted surface water: 5 to 50 milliliters.

(b) Polluted surface water: 0.01 to 10 milliliters.

B-4. Procedures for Sample Filtration and Incubation

The following practices and procedures are desirable for effective application of the membrane filter technique.

a. Clean the work area with water; then allow the surface to dry.

b. Prepare fresh media for the day's testing. If ampuled media are used, one ampule is required for each sample filtration.

c. Arrange and prepare certain equipment and supplies from the bacteriological water testing kit (Figure B-1) for use as follows:

(1) Open the bottle of methanol and place forceps in it so that the tips are immersed approximately 1 inch.

(2) Position the Bunsen or alcohol burner. It will be used to burn the alcohol off the tips of the forceps before they are used.

(3) Label the petri dishes to correspond with the sample number shown on DD Form 686 and position them on the work area.

(4) Place one sterile absorbent pad in each petri dish, using the forceps to manipulate it. Before using the forceps, be sure to burn the alcohol off their tips. Do not hold the forceps in the flame any longer than necessary to ignite the alcohol, as excessive heat will damage the forceps.

(5) Using a sterile pipette, deliver enough laboratory prepared culture media to saturate each absorbent pad or empty the contents of one ampule of media on each absorbent pad (Figure B-2). The amount of culture media required for each absorbent pad is approximately 2 milliliters. The amount should be sufficient to allow a large drop to drain from the pad freely when the petri dish is tipped. Adequate medium is necessary for the organisms

filtered out of the water to grow properly and provide valid results. On the other hand, the use of excess media must be avoided, as this causes the colonies to run together.

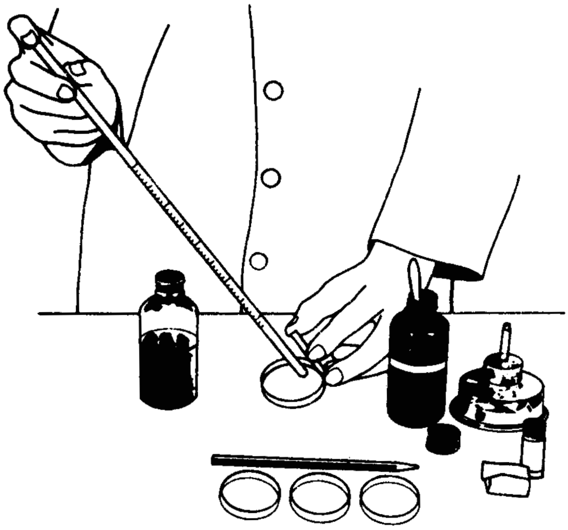


Figure B-2. Delivering culture media to absorbent pad.

(6) Place a sterile membrane filter disk with the grid side up on the filter base and center it over the porous part of the membrane support plate (Figure B-3). A membrane filter is easily damaged. Using sterile forceps, always grasp the *outer* part of the membrane filter to prevent damage to the part through which the sample is to be filtered.

Figure B-3. Placing sterile membrane filter on filter holder.

(7) Attach the funnel element to the filter holder. To avoid damage to the membrane filter, never turn or twist the funnel element as you seat and lock it to the filter holder. In securing the funnel element to a filter holder which has a bayonet joint and locking ring, take special care to turn the locking ring sufficiently to give a snug fit but not to tighten it excessively.

d. Filter the first water sample. Pour the measured water sample into the funnel (Figure B-4); then enter in the appropriate space on DD Form 686 the volume of sample being filtered. Since the primary objectives in this step are accurate measurement of sample and optimum distribution of colonies on the filter, the methods of measuring the sample and putting it into the funnel vary, depending upon the volume.

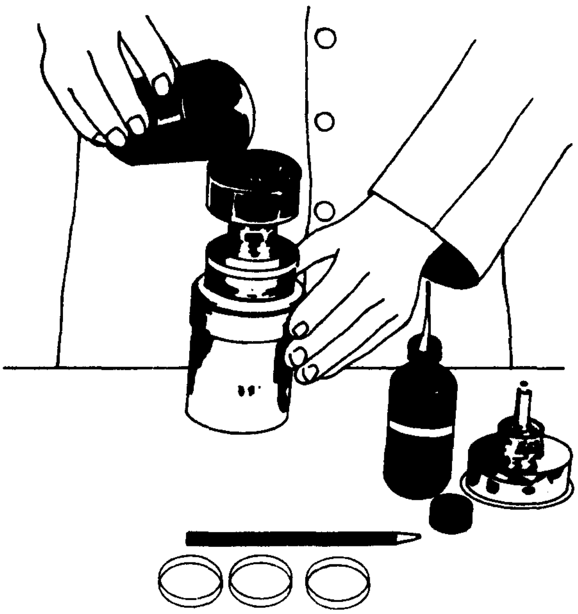


Figure B-4. Pouring the measured water sample into the funnel.

(1) Sample greater than 20 milliliters: Use a sterile graduated cylinder to measure the sample and pour it into the funnel.

(2) Sample of 2 to 20 milliliters: Pour about 30 milliliters of sterile buffered dilution water into the funnel; then using a sterile 10- or 20-milliliter pipette, measure the sample and put it into the funnel.

(3) Sample of 0.5 to 2 milliliters: Pour about 30 milliliters of sterile buffered dilution water into the funnel; then using a sterile 1- or 2-milliliter pipette, measure the sample and put it into the funnel.

e. Connect the hand suction pump to the filter base and withdraw air by means of a pumping action, thus aiding the sample to pass through the filter (Figure B-5).

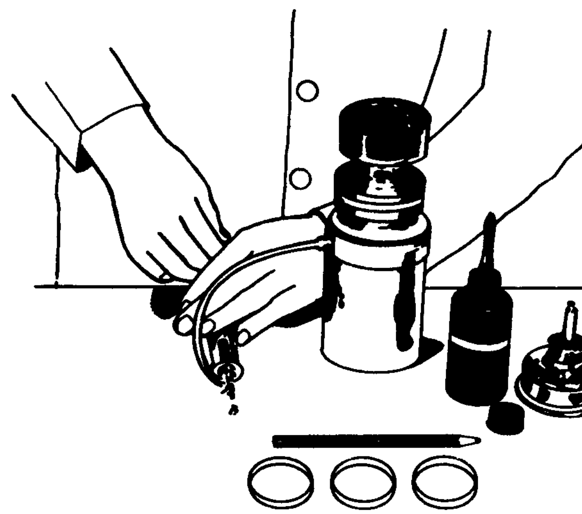


Figure B-5. Applying suction to the filter holder.

f. After all of the sample has passed through the membrane filter, rinse down funnel walls with at least 20 milliliters of sterile buffered dilution water (Figure B-6). Repeat the rinse twice after all the first rinse has passed through the filter. Since the funnel is not routinely sterilized between successive filtrations of a series of samples, minute droplets must be removed from the funnel walls to prevent contamination of subsequent samples. Cut off suction on the filter assembly as soon as all of the water has been filtered for any sample. Continued suction with no sample may introduce unnecessary airborne contamination.

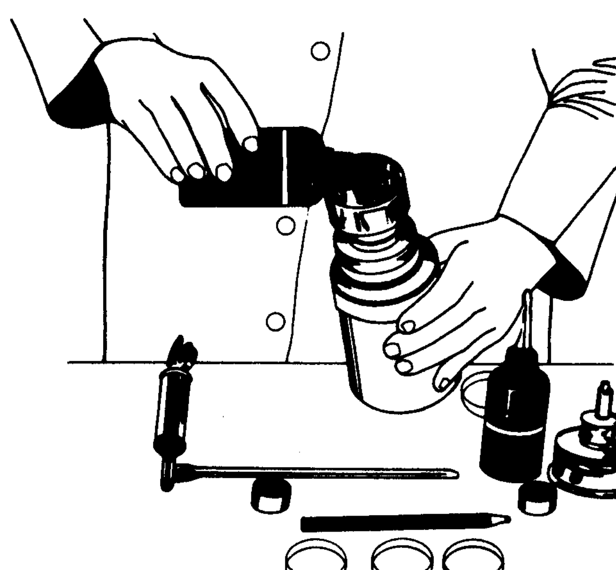


Figure B-6. Rinsing down funnel walls.

g. Remove the funnel from the filter holder.

h. Using sterile forceps, remove the membrane filter from the filter holder (Figure B-7) and carefully place it with the grid side up on the pad saturated with culture media, taking care not to trap air bubbles between it and the pad (Figure B-8); then close the petri dish. Air bubbles interfere with the diffusion of the culture media through the membrane filter. Entrapment of air bubbles can be minimized by having adequate culture media on the absorbent pad and by rolling the membrane filter into position. If necessary, reseat the filter on the absorbent pad to eliminate bubbles.

Figure B-7. Removing the membrane filter from the filter holder.

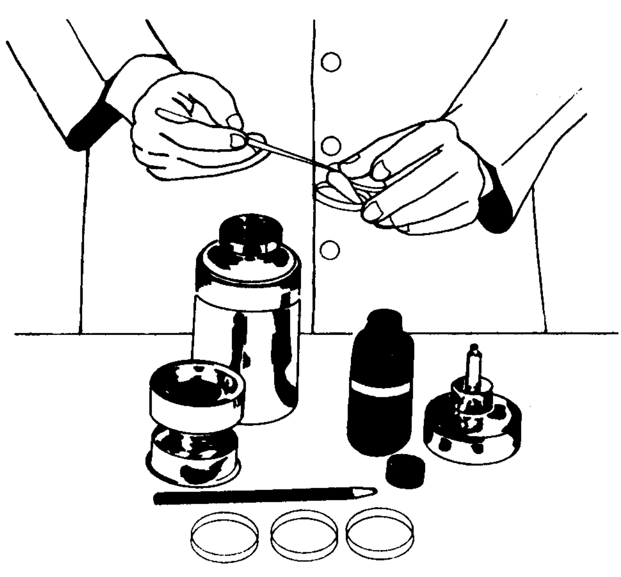


Figure B-8. Placing membrane filter on the absorbent pad saturated with culture media.

i. After all membrane filters have been placed in petri dishes, place the petri dishes, grid-side down, in the incubator and incubate at 35°C ± 0.5° for 22 to 26 hours. A high level of humidity (approximately 90 percent relative humidity) must be maintained in the incubator. This can be accomplished by placing a wet sponge in the incubator.

j. After incubation, remove the cultures from the incubator.

B-5. Procedure for Counting Colonies

Coliform colonies are dark, usually with a purplish-green metallic sheen.

a. The following equipment is most desirable in counting the coliform colonies:

(1) A wide field binocular dissecting microscope or a simple lens with magnification of 5 to 10 times.

(2) A light source directly above the membrane filter. A small fluorescent lamp is ideal for this purpose.

b. The colonies are counted by using one of the two following procedures:

(1) Remove membrane filter from the petri dish and dry it for about 1 hour on absorbent filter paper. Using a magnifying apparatus and light source (*a* above), count the colonies that have the characteristic metallic sheen (generally purplish-green). The dried membrane filter may be held flat by placing it between two 2- by 2-inch glass slides. This counting procedure is preferred to the one described in (2) below.

(2) With the top of the petri dish removed, place the dish containing the absorbent pad and filter membrane under the magnifying apparatus and light source. Count the colonies that show the characteristic metallic sheen.

c. Enter the colony count for each membrane filter in the space provided on DD Form 686; then determine and enter the coliform count per 100 milliliters of the water sample, using the following computation:

Number colonies per 100 ml. =

$$\frac{\text{Number of coliform colonies counted} \times 100}{\text{ml of sample filtered}}$$

APPENDIX C

REMEDIAL ACTIONS TO BE TAKEN IN EVENT CONTAMINATED WATER SAMPLES ARE FOUND

	Condition	Possible cause	Recommendations
C-1.	No known sanitary defects, health hazards, or incidents of gastro-intestinal disease.	The contaminated samples might indicate a localized situation within the piping of the building where the sample was collected, or a faulty sample technique.	*a.* Collect repeat samples promptly at the points of previous collection. *b.* Expedite shipment of samples so that a prompt report may be obtained from the laboratory. *c.* Make an immediate investigation to determine if any unusual conditions have occurred, such as repairs to the water mains, faucets, or piping within the building, or in the vicinity of the sampling point. *d.* Test for chlorine at various outlets so as to insure the proper dosage. *e.* If the investigation (*c* above) indicates the necessity, flush that portion of the water system by opening outlets until a proper chlorine residual is recorded, and carry out localized chlorination if deemed necessary. *f.* If coliform colonies exceed 4 coliforms per 100 milliliters, daily samples should be collected until results obtained reveal less than 1 coliform per 100 milliliters for 2 consecutive days.
C-2.	Occurrence of a major disaster, such as the inundation of the source, breakdown in treatment plant units, gross contamination of the system through a cross connection, failure of an underwater crossing, and damage from an earthquake.	Evident.	*a.* Immediate rejection of the water supply system and institution of an emergency treatment supply system. Treat all drinking water and water used for culinary purposes. *b.* After the necessary repairs have been completed, chlorinate and flush the entire system. *c.* Collect samples from representative points throughout the entire system until negative bacteriological results are obtained on at least two consecutive sets of standard samples collected on different days. *d.* Remove restrictions on the use of water.
C-3.	Occurrence of an outbreak of waterborne disease.	Contamination of the water system at the source, in reservoirs, treatment plant facilities, or distribution system and not generally apparent at the onset of the outbreak.	*a.* Carry out recommendations under Condition 1 with special emphasis on the investigation of the source, reservoirs, treatment processes, and distribution system. *b.* Increase the chlorine dosage and residual in the system. *c.* If the conditions contributing to the contamination are found to be serious, such as a direct contamination with sewage, reject the supply and institute emergency treatment until the condition is corrected.

APPENDIX D

GUIDE FOR WATER POINT INSPECTION

A sanitary inspection of a water point by the preventive medicine specialist should include the following:

D-1. General

a. Water point number.

b. Location of the water point.

c. Type of purification equipment.

d. Name of unit operating the water point.

e. Name of person in charge.

f. Date and time of inspection.

g. Name and unit of person making the inspection.

D-2. Source

a. Type (ground, river, lake, etc.) and name of source.

b. Sources of pollution.

c. Appearance of the raw water.

d. Approximate quantity of water.

D-3. Coagulation

a. Chemicals used.

b. Method of adding chemicals (batch, mechanical, or feeder).

c. Condition of feeder(s), if used.

D-4. Filtration

a. Condition of filter(s).

b. Number of pounds of diatomaceous earth used to precoat each filter.

c. Effectiveness of operation of filters (satisfactory or not satisfactory) and reason if operation is not satisfactory.

d. Whether or not diatomaceous earth is fed continuously during the filter cycle.

e. Frequency of backwash.

f. If a reverse osmosis water purification unit is in use, check all three filters—

- Cartridge filter.
- Multimedia filter.
- Reverse osmosis element.

D-5. Chlorination

a. Chemical used.

b. Chlorine demand of raw water.

c. Free available chlorine residual at time of distribution and pH of finished water.

d. Method used by operator to determine chlorine residual.

e. Condition of chlorine residual comparator.

f. Method of chlorination (batch, mechanical, or feeder).

D-6. Storage and Distribution

a. Type, number, and volume of storage containers.

b. Average daily quantity (gallons per day) distributed.

c. Condition of standpipe.

d. Whether or not safety nozzles touch the ground or incoming vehicles.

D-7. Bacteriological Analysis

a. Raw water sample number(s).

b. Potable water sample number(s).

c. Results of analysis.

D-8. Chemical Analysis

a. Raw water sample number(s).

b. Potable water sample number(s).

c. Results (DD Form 710).

D-9. Layout and Sanitation

a. Location of sleeping areas.

b. Location of food service facilities.

c. Location of latrines.

d. Drainage.

e. Police of area.

f. Waste disposal procedures

APPENDIX E

DIETHYL-P-PHENYLENEDIAMINE TEST FOR CHLORINE RESIDUAL IN WATER

E-1. General

The instructions for the *Wallace and Tiernan Kit and the LaMotte Kit* are presented below. Other kits can be used in lieu of these kits; consult manufacturer's specific instructions as required.

E-2. Procedure

a. Wallace and Tiernan.

(1) Place the chlorine color comparator disc in the comparator.

(2) Thoroughly rinse two test tubes with water to be tested and fill one tube with water to the 15 ml mark. Insert this tube in the right hand cell space of the comparator.

(3) Collect just enough water to cover the bottom of the second cell.

(4) Add two DPD free residual chlorine (No. 1) tablets and crush them with a plastic/glass rod.

(5) Fill this cell to the 15 ml mark with water under test and insert it in the left hand cell.

(6) Hold the comparator close to your eye and face a good light source (daylight but not direct sunlight, daylight illuminator, or artificial light reflected from a white surface). Be sure your fingers do not cover the light window in the back of the comparator. Rotate the chlorine comparator disc until a color on the disc matches the color of the sample (left) tube. The reading is made directly from the round window in front of the comparator. The value is expressed in mg/l or ppm.

(7) If the color of the indicator tube is between two colors on the chlorine comparator disc, interpolation between the two valves is necessary.

(8) Color matching should be completed as soon as possible after the addition of DPD tablets (step 4). It is important that the reading be made within 1 minute.

b. LaMotte Kit.

(1) Rinse the test tube with the test sample, then fill to mark.

(2) Add one DPD No. 1 tablet.

(3) Cap the test tube and shake to dissolve the tablet.

(4) Immediately insert the test tube in the comparator and match the color of the sample with the color standards. Color matching should be completed within 1 minute once the tablet has been added.

E-3. Total Chlorine and Combined Available Chlorine Determinations

a. Total chlorine is measured using the same procedures as presented in E-2 above, substituting the No. 4 DPD TAC tablets for the No. 1 DPD FAC tablets.

b. To determine combined available chlorine, subtract the findings of the free available chlorine from the Total Available Chlorine: CAC = TAC — FAC. Combine available chlorine is a measure of disinfecting chlorine residual attributable to chloramine compounds.

E-4. Precautions

a. General. As with all chemicals, caution should be exercised in handling DPD tablets. To ensure greatest accuracy, several other precautions should be followed.

(1) When taking samples, adding tablets, and mixing in the sample tubes, be sure that your hands are free of all traces of chemicals so that the sample is not contaminated. Any contamination of the samples produces erroneous results.

(2) Sunlight. Do not allow direct sunlight to fall on the samples being tested. Sunlight causes the color developed by the tablets to fade.

(3) Color and turbidity. With the Wallace and Tiernan Kit, to eliminate errors due to natural color and turbidity of the sample, make sure that water under test is added to the right-hand tube before making color comparison. Do not add DPD tablets to this tube.

APPENDIX F

TESTING FOR pH

F-1. Equipment

Several comparators can be used to measure pH. They may have a wide-range color disc or several discs covering smaller ranges. Each disc has a corresponding indicator solution (Figure F-1).

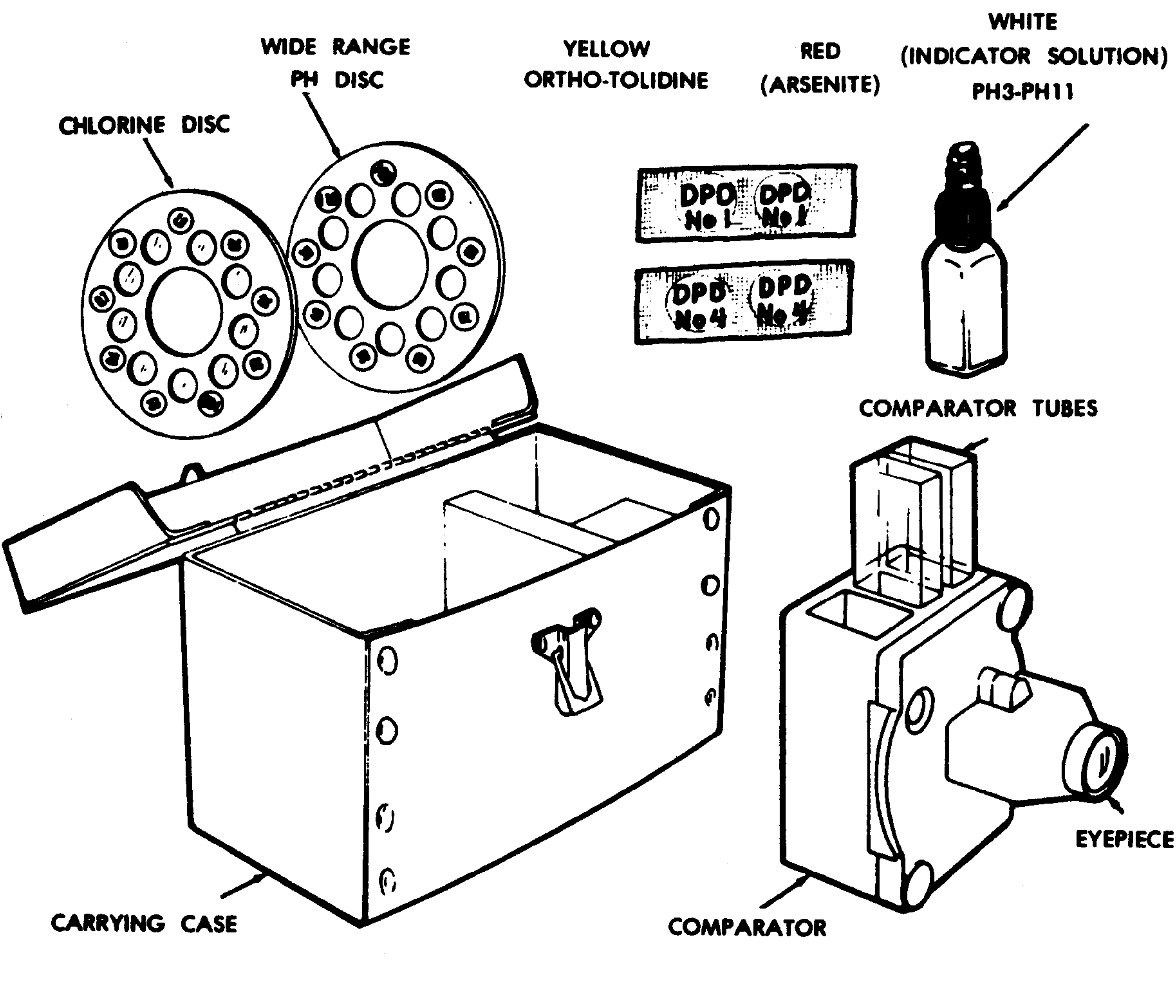


Figure F-1. Color comparator for pH determination.

F-2. Procedure

The test for determining pH is performed as described below.

a. Place the pH color disc into the comparator. Thoroughly rinse out two sample cells with the water to be tested. Fill both sample cells to the etched mark with the water to be tested and place them in the comparator.

b. Fill the dropper of the wide-range indicator solution bottle to the 0.50 ml mark. Forcefully squirt the indicator solution into the cell on the *left opening only*. (Water sample without indicator solution in right opening compensates for color and turbidity.) Be careful to avoid touching the sample or the cell with the dropper. Never place the pH dropper on a laboratory bench or other surface because the slightest amount of acid or alkali adhering to the dropper will produce erroneous results.

c. Push both tubes down until the tops of the sample cells are flush with the top of the comparator. Hold the comparator close to your eye and face a good light source, but not direct sunlight. Be sure your fingers do not cover the light window in the back of the comparator. Rotate color disc until a color on the disc matches the color of the sample in the tube. If the color of the cell in the left opening is between two colors on the pH color disc, the value must be estimated.

d. When test has been completed, empty the samples and rinse the cells with clean water.

APPENDIX G

GUIDE FOR SANITARY INSPECTION OF A FIELD FOOD SERVICE FACILITY

G-1. Personal

a. Food handlers' certificates.

b. Personal hygiene.

c. Daily inspections.

G-2. Kitchen

a. Location.

b. Insect and Rodent Control.

c. Equipment.

(1) Ranges.

(2) Work tables and cutting boards.

(3) Utensils.

(4) Refrigerators, ice chests, or underground food boxes.

(a) Cleanliness.

(b) Source of ice.

(c) Temperature.

(5) Handwashing devices.

(a) Location.

(b) Adequacy (type and number).

(c) Presence of soap and hand towels.

d. Perishable Foods.

(1) Source (fruits, vegetables, et cetera).

(2) Disinfection method (fruits and vegetables).

G-3. Utensil Washing

a. Cooking and serving utensils.

b. Mess kits.

c. Emergency disinfection materials on hand.

G-4. Waste Disposal

a. Soaking Pit with Grease Trap.

b. Garbage Disposal.

c. Trash Disposal.

d. Garbage and Trash Cans.

G-5. Water Supply

a. Trailer or Other Containers.

b. Chlorine Residual.

c. Sanitary Surveillance of Supplied Water.

G-6. Other Deficiencies and Remarks

APPENDIX H

SAMPLE QUESTIONNAIRE FOR CONDUCTING THE PATIENT INTERVIEW IN A FOOD-POISONING OUTBREAK

Date and time of interview: ______________________________

Name of interviewer: ______________________________

Person interviewed: ______________________________

Unit ______________ Grade or SSN ______________

H-1. What symptoms did you experience when the illness started: When did each symptom begin (date and time): If the patient states any of the following symptoms, indicate the date and time.

	Date	Time
Nausea		
Vomiting		
Cramps		
Diarrhea		
Headache		
Muscle aches		
Fever		
Chills		

H-2. Where did you eat the last four meals before the onset of symptoms? Begin with most recent one. What are the names of other persons who ate at these eating establishments?

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

H-3. What was the date and time of each of these four meals and what food items, including beverages, did you consume at each of them?

a. Last meal before the onset of symptoms.

Date and time: ______________________________

Food and beverages consumed: ______________________________

____

b. Next to last meal before the onset of symptoms.

Date and time: ____________________

Food and beverages consumed: ____________________

c. Second to last meal before the onset of symptoms.

Date and time: ____________________

Food and beverages consumed: ____________________

____

d. Third to last meal before onset of symptoms.

Date and time: ____________________

Food and beverages consumed: ____________________

____

e. Fourth to last meal before onset of symptoms.

Date and time: ____________________

Food and beverages consumed: ____________________

H-4. Enter other information pertinent to the investigation such as laboratory findings and final diagnosis.

APPENDIX I

FOOD-POISONING OUTBREAK INVESTIGATION KIT

I-1. Sterile Supplies

a. 18 bottles, wide mouth, 4 to 6 ounces, with screwcaps.

b. 1 sharp butcher knife, wrapped and labeled.

c. 6 tablespoons, wrapped and labeled.

d. 2 pair of large forceps, wrapped and labeled.

e. 12 cotton swabs, wrapped and labeled.

f. 12 tubes of phosphate buffered solution.

g. 3 bottles for water samples, 120 milliliters.

I-2. Miscellaneous Supplies

a. 1 roll of 3-inch adhesive tape.

b. 2 dial thermometers.

c. 50 rubber bands.

d. 5 wax pencils, black or red.

e. 2 wood pencils, black.

f. 2 wood pencils, red.

g. 100 SF 553, Microbiology I, or locally produced request form.

h. 1 pad of DD Form 686, Bacteriological Examination of Water.

i. 200 questionnaires for use in collecting information from patients.

j. Ice, wet or dry (to be added to the kit to maintain refreigeration of samples as required).

APPENDIX J

COLLECTION OF FOOD SAMPLES FOR LABORATORY ANALYSIS

Type of food	Quantity	Collection	Shipment*
Liquid and semisolids.......	At least 100 grams or approximately 4 ounces.	If possible, leave in original container or transfer to sterile widemouth screwcapped jar, 1/2 or 1-pint size.	Identify sample. Seal cap with plastic, adhesive, or masking tape. Pack in leakproof container and place in shipping case with wet ice in plastic bags. Do not freeze.
Dried foods....................	100 to 200 grams or 4 to 6 ounces.	Original package or transfer to sterile aluminum foil or sterile plastic bags. If possible, obtain unbroken package also.	Identify sample. Pack in strong cardboard box with instructions on outside. Do not expose to extreme heat or cold. Ice only if indicated by producer on package.
Meats...........................	At least 100 gram	Use sterile kitchen knives to cut portions and place in aluminum foil or plastic bags. For ground meat, use sterile spoon or tongue depressor.	Identify sample. Place bags in leakproof can (1-gallon paint can, if convenient), secure top, then place in shipping case with wet ice in plastic bags. Do not freeze.
Shellfish,			
in shell.......................	Minimum of 12 Shellfish	Collect in waterproof paper bags, cardboard cartons, or tin cans.	Identify clearly. Seal containers and pack in metal container with wet ice in plastic bags. Ship to assure arrival at laboratory within 24 hours after collection. Do not freeze.
shucked.....................	200 grams		
Frozen foods.................	100 to 200 grams.	If thawed, transfer to sterile sterile widemouth screwcapped jar. Also obtain small unbroken frozen packages.	Identify and pack with wet ice as described above. Identify and pack in dry ice sufficient to keep material frozen during transit to laboratory.

*When food samples are shipped, the laboratory should be notified by wire or telephone as to expected time of arrival. All food samples should be sent by AIR EXPRESS unless surface service is faster.

APPENDIX K

SWIMMING POOL INSPECTION CHECKLIST

____

(DATE)

K-1. A sanitary inspection was conducted at ____________ Swimming Pool at
(Name)

______________ by ________________. ________________________was
(Time & Date) (Inspector's Name) (Pool Supervisor's Name)

present at time of inspection.

K-2. The following conditions were noted:

	Satisfactory	Unsatisfactory
a. Water:		
(1) Free available chlorine residual PPM	________	________
(2) pH	________	________
(3) Turbidity	________	________
(4) Collect water sample for bacteriological analysis at shallow and deep ends	________	________
b. General:		
(1) Bather load	________	________
(2) Pool clean	________	________
(3) Surface drainage	________	________
(4) Pool properly enclosed	________	________
(5) Area clean	________	________
(6) Lifeguards	________	________
(7) Lifesaving equipment	________	________
(8) Pool regulations posted and enforced	________	________
(9) Operating Records	________	________
c. Pool Construction:		
(1) Smooth, easily cleaned surfaces	________	________
(2) Depth markings	________	________

	Satisfactory	Unsatisfactory
(3) Steps and ladders	______	______
(4) Overflow gutters or skimmers	______	______
(5) Water inlets and drains	______	______
(6) No cross connections	______	______
d. Chlorination Room:		
(1) Gas mask	______	______
(2) Proper ventilation	______	______
(3) Chlorine cylinders secured	______	______
(4) Operation	______	______
(5) Room clean	______	______
e. Bathhouse:		
(1) Properly cleaned	______	______
(2) Construction	______	______
(3) Ventilation and lighting	______	______
(4) Bathers properly routed	______	______
(5) Toilet and shower facilities	______	______

K-3. Remarks and Recommendations:

APPENDIX L

STANDARDIZATION AGREEMENTS

NATO UNCLASSIFIED

DETAILS OF AGREEMENT (DofA)

MINIMUM REQUIREMENTS OF WATER POTABILITY FOR SHORT TERM ISSUE

Annex: A (DofA). Comparative Table of National Standards for Water Potability in the Field (for information)

AGREEMENT

1. The NATO Armed Forces agree, when operating on land, to adopt the following minimum standards for potability of drinking water to be issued to troops in combat zones or in any other strict emergency situation.

2. They also accept the following premises and criteria which have been taken into account in arriving at the said minimum potability standards.

GENERAL

3. The water shall be obtained from the best available source. It should afford an acceptable standard of safety required for water to be drunk by the troops for the period and in the quantity shown below.

4. The physical, chemical, bacteriological and radiological tests to establish the degree of potability shall be carried out according to the techniques of each nation and to the extent permitted by field equipment.

5. Should the results of these tests be unfavourable the water shall be adequately treated to render it acceptable.

6. Where one of the NATO Forces is unable to meet the standards prescribed herein, the other NATO Forces participating in mutual logistical water support will be notified.

CRITERIA

7. The term "drinking water" applies only to water to be used for quenching thirst and for nutritional purposes.

8. For logistical purposes the minimum daily issue of drinking water, in emergency conditions, shall be calculated at 5 litres per man.

NATO UNCLASSIFIED

9. In view of the fact that emergency situations, and among them combat condition, do not, as a general rule, last very long for the individual, the following minimum standards of potability have been established for a quantity of 5 litres of drinking water per man per day for a maximum period of 7 days (i.e., short term of 1 to 7 days).

MINIMUM STANDARDS FOR ESTABLISHING POTABILITY

10. The water to be issued for consumption must have the following characteristics:

a. Physical Standards

(1) Turbidity — The water must be reasonably clear.

(2) Colour — The water should be as colourless as possible.

(3) Odour and taste — The water must be reasonably free from odours and tastes.

b. Bacteriological Standards

No drinking water should be drunk by troops without having first undergone an appropriate, collective or individual, purification process by physical or chemical means so as to ensure that pathogenic microbes, protozoan and protozoic cysts, intestinal worms and worm eggs, which could be present in water, are destroyed.

c. Chemical Standards

(1) Drinking water should have:

—pH: not less than 5 and not more than 9.2.

—Total solids: as a general rule, not above 1500 mg/l.

(2) Toxic substances:

Drinking water must not contain more of the following substances than the quantity shown against each:

Substance:	mg/l
Arsenic (expressed as As)	2
The cyanides (including Cyanogen Chloride)	20
Mustard Gas	2
Nerve Agents (GA, GB, VX, etc.)	0.02 (1)

Note. (1) Interim pending completion of more exacting studies.

(3) Water which has been deliberately contaminated with toxic substances must in no case be used for consumption or other purposes. Deviation from this restriction is permissible when the agent concentration can, through proper processing, be reduced to a level which meets the standards established by this STANAG.

d. Radiological Standards: For short term consumption (1 to 7 days) no absolute maximum tolerance is recommended or considered necessary. This is based on the consideration that if the risk of external radiation is such as to allow the source to be used, then the water will be suitable for drinking during occupancy not exceeding one week.

IMPLEMENTATION OF THE AGREEMENT

11. This STANAG will be considered to have been implemented when the necessary orders/instructions to use the information contained in this Agreement have been issued to the Forces concerned.

APPENDIX M

FAMILY HOUSING SANITARY INSPECTION CHECKLIST

DATE: ____________ QUARTERS NUMBER: ______

INSPECTOR: ____________ REQUESTED BY: ________

ACCOMPANIED BY: __________ RATING: __________

A sanitary inspection was conducted of the quarters and on the date above. The following is a report of this inspection:

	Satisfactory	Unsatisfactory
M-1. BUILDING: (Outside condition.)	________	________
M-2. LIGHTING:	________	________
M-3. VENTILATION: (Adequate and filters clean.)	________	________
M-4. CLEANLINESS OF QUARTERS: (Floors, walls and windows.)	________	________
M-5. CLEANLINESS OF FURNISHINGS: (Furniture covers, mattresses, and linens.)	________	________
M-6. KITCHEN: (Adequate, clean, with hot and cold running water.)	________	________
M-7. BATHROOM(s): (Adequate, clean, with hot and cold running water.)	________	________
M-8. WASTE CONTAINERS: (Adequate, clean, and proper removal inside and outside.)	________	________
M-9. ARTHROPOD AND RODENT PROBLEMS:	________	________
M-10. STORAGE OF CLEANING SUPPLIES, MEDICATION, AND OTHER TOXIC MATERIALS: (Away from sight and reach of children.)	________	________
M-11. PROHIBITED ITEMS: (Unused, unsecured refrigerators, and freezers.)	________	________
M-12. PETS: (Animal wastes clean-up, litter boxes, and foul odors.)	________	________

M-13. REMARKS AND RECOMMENDATIONS*:

*NOTE: Structure damage, fire/safety hazards, utility/energy conservation, quality of life, and effect of conditions on children are beyond the scope of a sanitary inspection, and should be referred to other appropriate activities for comment.

GLOSSARY

Section I. ABBREVIATIONS AND ACRONYMS

AC	alternating current
ACGIH	American Conference of Governmental Industrial Hygienists
ADAPCP	Alcohol and Drug Abuse Prevention and Control Program
AFDCB	Armed Forces Disciplinary Control Board
alum	aluminum sulfate
AM	amplitude modulation
AMC	Army Materiel Command
AMDF	Army Master Data File
AMEDD	Army Medical Department
ANC	Army Nurse Corps
ANSI	American National Standards Institute, Inc.
APC	armored personnel carrier
AR	Army Regulation
ARD	acute respiratory disease
aval	available
BCG	bacillus Calmette Guerin
BFV	basic filtering volume
BOD	biochemical oxygen demand
C	Centigrade
CAC	combined available chlorine
cc	cubic centimeter
Cd	cadmium
CDC	Center for Disease Control
CDS	child development services
CE	cellulose ester

cfm	cubic feet per minute
CFR	Code of Federal Regulations
Cl^-	chloride
cm	centimeter
CN^-	cyanide
CO	commanding officer
CO_2	carbon dioxide
COD	chemical oxygen demand
CONEX	container express
CONUS	Continental United States
COSCOM	Corps Support Command
CPO	Civilian Personnel Officer
Cr	chromium
CTA	Common Table of Allowances
Cu	copper
DA	Department of the Army
DARCOM	US Army Material Development and Readiness Command
dB	decibel
dBa	decibel sound A
dBc	decibel measured through C-weighing network
dBp	unit used to express peak sound pressure level of impulse noise
DD	Department of Defense
DEET	75 percent N, N-diethyl-M-tolumide (insect repellent)
DFAE	Director of Facilities engineering
DHS	Director of Health Services
DIO	Director of Industrial Operations

Dir	directive
DO	dissolved oxygen
DOD	Department of Defense
DofA	Details of Agreement
DOT	Department of Transportation
DPD	diethyl-p-phenylendiamine
DPDS-M	Defense Property Disposal System-Manual
DPOD	Defense Property Disposal Officer
DPRE	displaced persons, refugees, and evacuees
DS	decontaminating solution
EM	enlisted member
EPA	Environmental Protection Agency
ERDLATORS	Engineer Research and Development Laboratory
f	frequency
F	Fahrenheit
FAC	free available chlorine
FAWPSS	forward area water point supply system
fc	foot-candle
floc	heavy gelatinous mass
FM	field manual
FM	frequency modulation
fpm	feet per minute
ft	foot/feet
ft^2	feet square
ftL	foot-lambert
ft/min	feet per minute
gal	gallon

gm	gram
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
GSA	General Services Administration
GT	general technical
HCl	compound hydrochloric acid
Hep	hepatitis
HHIM	health hazard information module
HOCl	hypochlorous acid
HQDA	Headquarters, Department of the Army
hr/hrs	hour(s)
HSA	health service area
HSC	Health Services Command
HTH	calcium hypochlorite, 70%
HTL	hearing threshold level
Hz	hertz
IAW	in accordance with
IES	Illuminating Engineering Societies
IH	industrial hygiene
IHIP	industrial hygiene implementation plan
IMA	installation medical authority
in	inch(es)
IPS	internal pressure system
kg	kilogram
kHz	kilohertz
KOH	potassium hydroxide

KP	kitchen police
kV	kilovolts
kVp	kilovolt peak
kW	kilowatts
l	liter
LASER	light amplification by stimulated emission of radiation
lb/lbs	pound(s)
LD_{50}	lethal dose for 50% of test insects
mA	milliamps
MACOM	major Army command
MC	Medical Corps
mcg	micrograms
MCL	maximum contaminant level
MEDCEN	Army Medical Center
MEDCOM	Medical Command
MEDDAC	Army Medical Department Activity
MEPS	Military Entrance Processing Station
MF	miscellaneous film
Mg/mg	milligram
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MH_Z	megahertz
MIL STD/Mil Std	military standard
mi	mile
min	minute
ml	milliliter

mm	millimeter
mo	month
MOPP	Mission Oriented Protective Posture
MPH/mph	miles per hour
MPN	most probable number
MPPD	maximum permissible power density
MRE	meal ready to eat
MSC	Medical Service Corps
MTF	medical treatment facility(ies)
mu	millimicrons
mW/Cm^2	milliwatts per square centimeter
NATO	North Atlantic Treaty Organizations
NANB	hepatitis non-A and non-B
NBC	nuclear, biological, and chemical
NCO	noncommissioned officer
NCOIC	noncommissioned officer-in-charge
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NIPDWR	national interim primary drinking water regulations
nm	nanometer
NMSO	Nuclear Medical Science Officer
No.	number
NSDWR	National Secondary Drinking Water Regulations
NSF	National Sanitation Foundation
NSN	National Stock Number
OCl	hypochlorite ion
OH	occupational health

OHP	Occupational Health Program
OHMIS	Occupational Health Management Information System
OJT	on-the-job training
OSH	occupational safety and health
OSHA	Occupational Safety and Health Agency
oz	ounce
OTSG	Office of The Surgeon General
PAP	Primary Atypical Pneumonia
PAS	para-aminosalicylic acid
PEL	permissible exposure limits
pH	symbol relating the hydrogen concentration to that of a given standard solution
PHF	potentially hazardous food
PHS	Public Health Service
POW	prisoner of war
ppm	parts per million
psi	pounds per square inch
pt	pint
PTS	permanent threshold shift
PVC	polyvinylchloride
PVF	polyvinyl fluoride
PVNTMED/Pvnt med	preventive medicine
QSTAG	Quadripartite Standardization Agreement
qt	quart
RAC	risk assessment code
RBC	rotating biological contactor
Rd	rod

ROTC	Reserve Officer Training Corps
ROWPU	reverse osmosis water purification unit
rpm	revolutions per minute
RPO	radiation protection officer
RPP	reduced pressure principle
RV	recreational vehicle
S	strength
SAE	Society of Automotive Engineers
SCBA	self-contained breathing apparatus
sec	second
SF	standard form
SIDPER	Standard Installation/Division Personnel System
SOP	standing operating procedures
spp	species
sq	square
sq ft	square foot
sq m	square meter
SSI	specialty skill identifier
SSN	social security number
SSO	safety/security officer
STANAG	Standardization Agreement
STB	supertropical bleach
STD	sexually transmitted disease
STREP	streptococcal
STEL	short term exposure limit
STEL-TWA	short term exposure limit-time-weighted average
TA	theater Army

TB	tuberculosis
TB MED	technical bulletin medical
TC	test control
TDA	Table of Distribution and Allowance
TDS	total dissolved solids
TF	training film
THM	trihalomethanes
TLV	threshold limit values
TLV-C	threshold limit values-ceiling
TLV-STEL	threshold limit values-short term exposure limit
TLV-TWA	threshold limit values-time weighing average
TM	technical manual
TOE	Table of Organization and Equipment
TSG	The Surgeon General
TTS	temporary threshold shift
ug/l	microgram per liter
ULV	ultra-low-volume
uPa	micropascals
US	United States
USAEHA	US Army Environmental Hygiene Agency
USAREUR	US Army Europe
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
UV	ultraviolet
w	watt
WBGT	wet bulb globe temperature
WHO	World Health Organization

WWP	water wettable powder
yd	yard

Section II. DEFINITIONS

Abdomen—The posterior division of the three main body divisions (Insecta); the second and last body division of a spider (Arachnida).

Aerosol—An atomized fluid in which the fluid particles are very small; an aerosol usually appears as a fog or smoke.

Anal—Pertaining to the last abdominal segment (which bears the anus); the posterior basal cell of the wing.

Bisexual—With males and females.

Cannibalistic—Feeding on other individuals of the same species.

Carnivorous—Feed on other animals.

Caste—A form or type of adult in a social insect such as termites and ants.

Cephalothorax—A body region consisting of the head and thoracic segments. (Crustacea and Arachnida.)

Chelicera—The anterior pair of appendages in arachnids.

Class—A subdivision of a phylum or subphylum, containing a group of related orders.

Clubbed—With the distal part (or segments) enlarged such as clubbed antennae.

Cocoon—A silken case inside which the pupa is formed.

Commensalism—A living together of two or more species, none of which is injured thereby, and at least one of which is benefited.

Compound eye—An eye composed of many individual elements or ommatidia, each of which is represented externally by a facet; the external surface of such an eye consists of circular facets which are very close together, or of facets which are in contact and more or less hexagonal in shape.

Compressed—Flattened from side to side.

Coxa—The basal segment of the leg.

Depressed—Flattened dorsoventrally.

Distal—Near or toward the free end of an appendage; that part of a segment or appendage farthest from the body.

Dirunal—Active during the daytime.

Dorsal—Top or uppermost; pertaining to the back or upper side.

Dorsoventral—From top to bottom, or from the upper to the lower surface.

Dorsum—The back or top (dorsal) side.

Ectoparasite—A parasite that lives on the outside of its host.

Endoparasite—A parasite that lives inside its host.

Endoskeleton—A skeleton or supporting structure on the inside of the body.

Exoskeleton—A skeleton or supporting structure on the outside of the body.

External—The outside; that part away from the center of the body.

Family—A subdivision of an order, suborder, or superfamily, and containing a group of related genera, tribes, or subfamilies. Family names end in -idae.

Feces—Excrement, the material passed from the alimentary tract through the anus.

Femur—The third leg segment, located between the trochanter and the tibia.

Foregut—The anterior portion of the alimentary tract, from the mouth to the midgut.

Frass—Wood fragments made of a wood-boring insect, usually mixed with excrement.

Frons—That portion of the face between the antennae, eyes, and ocelli; the front.

Genal comb—A row of strong spines borne on the anteroventral border of the head such as some fleas.

Generation—From any given stage in the life cycle to the same stage in the offspring.

Genus—A group of closely related species; the first name in a binomial or trinomial scientific name. Genus names are Latinized, capitalized, and when printed, are italicized.

Gregarious—Living in groups.

Haltere (or Halter)—A small knobbed structure on each side of the metathorax in place of hind wings.

Haustellum—A part of the proboscis (Diptera).

Head—The anterior body region, which bears the eyes, antennae, and mouth parts.

Herbivorous—Feeding on plants.

Hindgut—The posterior portion of the alimentary tract, between the midgut and anus.

Host—The organism in or on which a parasite lives; the plant in or on which an insect feeds.

Hyperparasite—A parasite whose host is another parasite.

Instar—The form of an insect between successive molts such as the first instar being the stage between hatching and the first molt.

Labium—One of the mouth part structures; the lower lip.

Labrum—The upper lip.

Larva—The immature stages between the egg and pupa, of an insect having complete metamorphosis; the six-legged first instar of Acarina.

Lateral—Toward the side, away from the midline of the body.

Mandible—Jaw; one of the paired mouth part structures immediately posterior the mandibles.

Membrane—A thin film of tissue, usually transparent; that part of the wing surface between the veins; the thin apical part of a hemelytron (Hemiptera).

Mesonotum—The dorsal sclerite of the mesothorax.

Mesothorax—The middle or second segment of the thorax.

Metamorphosis—A change in form during development.

Metatarsus—The basal segment of the tarsus.

Metathorax—The third or posterior segment of the thorax.

Midgut—The mesenteron, or middle portion of the alimentary tract.

Millimeter—0.0001 meter, or 0.03937 inch (about 1/25 inch).

Minute—Very small; an insect a few millimeters in length or less would be considered minute.

Molt—A process of shedding the skin; ecdysis.

Myiasis—A disease caused by the invasion of dipterous larvae.

Nocturnal—Active at night.

Nymph—An immature state (following hatching) of an insect that does not have a pupal stage; the immature stages of Acarina that have eight legs.

Oral—Pertaining to the mouth.

Order—A subdivision of a class or subclass, containing a group of related families.

Ovary—The egg-producing organ of the female.

Oviduct—The tube leading away from the ovary through which the eggs pass.

Oviparous—Reproducing by eggs laid by the female.

Ovipositor—The egg-laying apparatus; the external genitalia of the female.

Ovoviviparous—Insect which deposits living young instead of eggs.

Palpus—A segmented process (telopodite) borne by the maxillae or labium.

Parasite—An animal that lives in or on the body of another living animal, at least during a part of its life cycle.

Pecten—A comblike or rakelike structure.

Pedicel—The second segment of the antenna; the stem of the abdomen, between the thorax and the abdomen (spiders).

Pedipalps—The second pair of appendages of an arachnid.

Petiole—A stalk or stem; the narrow stalk or stem by which the abdomen is attached to the thorax (Hymenopetera).

Pharynx—The anterior part of the foregut, between the mouth and the esophagus.

Phylum—One of the dozen or so major divisions of the animal kingdom.

Posterior—Hind or rear.

Postnotum—A notal plate behind the scutellum, often present in wing bearing segments.

Predaceous—Feeding as a predator.

Predator—An animal that attacks and feeds on other animals, usually animals smaller or less powerful than itself.

Proboscis—The extended beaklike mouth parts.

Pupate—Transform to a pupa.

Rectum—The posterior of the hindgut.

Recurved—Curved upward or backward.

Retractible—Capable of being pushed out and drawn back in.

Rudimentary—Reduced in size, poorly developed, vestigial.

Scavenger—An animal that feeds on dead plants or animals, on decaying materials, or on animal wastes.

Sclerite—A hardened body wall plate bounded by sutures or membranous areas.

Scutellum—A sclerite of a thoracic notum; the mesoscutellum, appearing as a triangle sclerite behind the pronotum (Hemiptera, Homoptera, Coleoptera).

Scutum—The middle division of a thoracic notum; anterior to the scutellum.

Segment—A subdivision of the body or of an appendage such as between joints or articulations.

Serrate—Toothed along the edge like a saw; serrate antenna.

Seta—A hairlike external process.

Species—A group of individuals or populations that are similar in structure and physiology and are capable of interbreeding and producing fertile offspring, and which are different in structure and/or physiology from other groups and normally do not interbreed with them.

Spine—A thornlike process extending from the exoskeleton.

Spiracle—An external opening of the tracheal system; a breathing pore.

Spiracular Bristle—A bristle very close to a spiracle (Diptera).

Stadium—The period between molts in a developing insect.

Stigma—A thickening of the wing membrane along the costal border of the wing near the apex; a spiracle or breathing port.

Stylet—A needlelike structure

Symmetry—A definite pattern of body organism; bilateral symmetry, a type of body organization in which the various parts are arranged more or less symmetrically on either side of a medium vertical plane such as where the right and left sides of the body are essentially similar.

Tarsus—The part of the leg beyond the tibia; the tarsus consists of one or more segments or subdivisions.

Taxonomy—Classification into categories of various ranks based on similarities and differences, and the describing and naming of these categories; systematics of identification.

Tergite—A dorsal sclerite of the tergum such as a dorsal sclerite of an abdominal segment.

Terminal—At the end; at the posterior end (of the abdomen); the last of a series.

Terrestrial—Living on land.

Thorax—The body region bearing the legs and wings located between the head and abdomen.

Tibia—The fourth segment of the leg, between the femur and the tarsus.

Trachea—A tube of the respiratory system, lined with taenidia, ending externally at the spiracle, and terminating internally in the tracheoles.

Tracheoles—The fine terminal branches of the respiratory tubes which lack taenidia.

Translucent—Allowing light to pass through, but not necessarily transparent.

Transverse—Across, at right angles to the longitudinal axis.

Trochanter—The second segment of the leg, between the coxa and the femur.

Tubercle—A small knoblike or rounded protuberance.

Unisexual—Consisting of, or involving only, one sex such as only females.

Vein—A thickened line in the wing.

Ventral—Lower or underneath; pertaining to the underside of the body.

Viviparous—Giving birth to living young; not laying eggs but depositing larvae which were nourished by the female.

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40-4	Army Medical Department Facilities/Activities
40-5	Preventive Medicine
40-12	Medical and Agricultural Foreign and Domestic Quarantine Regulations for Vessels, Aircraft, and Other Transports of the Armed Forces.
40-14	Control and Recording Procedures, for Exposure to Ionizing Radiation and Radioactive Materials
40-15	Medical Warning Tag and Emergency Medical Identification Symbol
40-46	Control of Health Hazards from Lasers and Other High Intensity Optical, Sources
40-226	Annual Historical Report—AMEDD Activities (RCS MED 41(R4))
40-400	Patient Administration
40-554	Prevention and Control of Communicable Disease of Man: Venereal Diseases
40-562	Immunization Requirements and Procedures
40-574	Aerial Dispersal of Pesticides Operation and Maintenance
40-579	Liaison with Public Health Service
40-583	Control of Potential Hazards to Health from Microwave and Radio Frequency Radiation
40-657	Veterinary/Medical Food Inspection

190-24	Armed Forces Disciplinary Control Board and Off-Installation Military Enforcement
190-38	Detention Cell Standards
190-47	The US Army Correctional System
210-20	Master Planning for Army Installations
210-50	Family Housing Management
340-15	Preparing Correspondence
340-18	The Army Functional File System
385-10	Army Safety Program
385-11	Ionizing Radiation Protection
385-30	Safety Color Code Markings and Signs
385-32	Protective Clothing and Equipment
385-63	Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat
415-50	Basic Facilities and Space Criteria for Construction; at United States Installations in Event of Emergency
420-10	Facilities Engineering, General Provisions, Organizations, Functions, and Personnel
420-43	Electrical Service
420-46	Water and Sewerage
420-47	Solid and Hazardous Waste Management
420-54	Air-Conditioning, Evaporative Cooling, Dehumidification, and Mechanical Ventilation
420-70	Buildings and Structures
420-76	Pest Management Program
600-30	Chaplain Support Activities
608-10	Child Development Services
611-201	Enlisted Career Management Fields and Military Occupational Specialties

700-93	Processing and Shipping DOD Sponsored Retrograde Material Destined for Shipment to the United States, its Territories, Trusts, and Possessions
700-135	Mobile Field Laundry and Bath Operations
700-136	Land Based Water Resources Management in Contingency Operations

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108-4	Index of Army Motion Pictures for Public Nonprofit Use
310-Series	Military Publications
351-4	US Army Formal Schools Catalog
385-3	Protective Clothing and Equipment

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3-3	NBC Contamination Avoidance
3-4	NBC Protection
3-5	NBC Decontamination (DECON)
3-100	NBC Operations
8-9	NATO Handbook on the Medical Aspects of NBC Defensive Operations
8-10	Health Service Support in a Theater of Operations
8-15	Medical Support in Divisions, Separate Brigades, and the Armored Cavalry Regiment
8-27	Veterinary Service
8-33	Control of Communicable Diseases in Man
8-34	Food Sanitation for the Supervisor
8-230	Medical Specialist
10-52	Field Water Supply
10-280	Field Laundry Clothing Exchange and Bath Operations
21-10	Field Hygiene and Sanitation
21-11	First Aid for Soldiers

21-26	Map Reading
21-30	Military Symbols
22-5	Drill and Ceremonies
22-100	Military Leadership

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5-3740-211-14	Operator's Organizational, and Direct Support and General Support Maintenance Manual for Sprayer, Insecticide, Aircraft-Mounted W/Pump
5-3740-214-14	Operator's Organizational, Direct Support and General Support Maintenance Manual for Aerosol Generator, Non-Thermal, Insecticide, Ultra-Low-Volume (Model XKA)
5-632	Military Entomology Operational Handbook
5-634	Refuse Collection and Disposal
5-660	Operation of Water Supply and Treatment Facilities at Fixed Army Installations
5-665	Operation of Sewerage and Sewage Treatment Facilities at Fixed Army Installations
5-683	Facilities Engineering: Electrical Interior Facilities
5-785	Engineering Weather Data
5-811-2	Water Supply: Water Resources
5-814-1	Sanitary and Industrial Wastewater Collection, Gravity Sewers and Appurtenances
8-215	Nuclear Handbook for Medical Service Personnel

Common Tables of Allowances (CTA)

8-100	Army Medical Department Expendable/Durable Items—Common Items of Nonexpendable Material
50-900	Clothing and Individual Equipment (Active Army, Reserve Components and DA Civilian Employees).

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MED 114	Immunization

MED 141	Nutritional Value and Characteristics of Operational Rations, Certain Ration Supplements, Meals and Food Packets
MED 164	Malaria
MED 243	Interviewer's Aid for Venereal Disease: Contact Investigation
MED 501	Hearing Conservation
MED 502	Respiratory Protection Program
MED 503	Occupational and Environmental Health—The Army Industrial Hygiene Program
MED 506	Occupational Vision
MED 507	Prevention, Treatment and Control of Heat Injury
MED 508	Cold Injury
MED 521	Management and Control of Diagnostic X-Ray, Therapeutic X-Ray and Gamma Beam Equipment
MED 523	Control of Hazards to Health from Microwave and Radio Frequency Radiation and Ultrasound
MED 524	Control of Hazards to Health From LASER Radiation
MED 530	Food Service Sanitation
MED 575	Swimming Pools and Bathing Facilities
MED 576	Sanitary Control and Surveillance of Water Supplies at Fixed Installations
MED 577	Sanitary Control and Surveillance of Water Supplies at Field Installations

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8-620HO	Medical Department Organization Area and Unit Medical Support Teams

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8-3	Field Sanitation Team Training

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Title 21

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Title 40

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8-4602 Prevention of Hearing Loss

8-5810 The Sound of Sound

Others

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