U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
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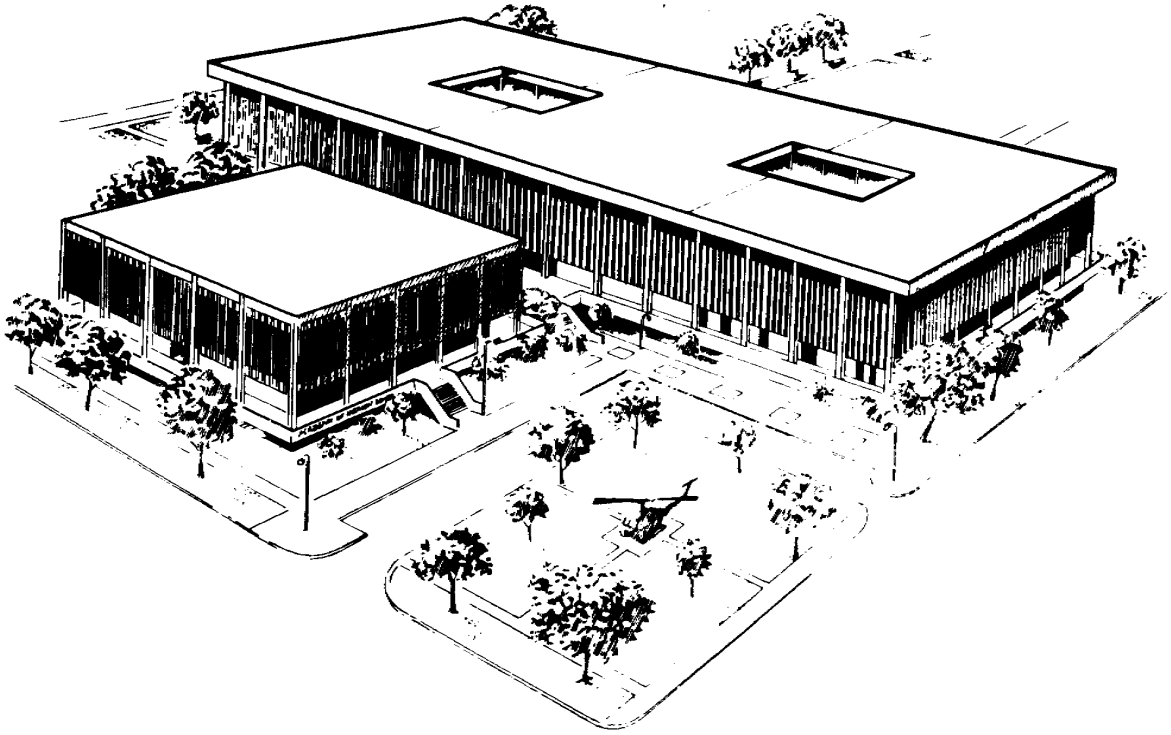

ARTHROPOD CONTROL

SUBCOURSE MD0171 **EDITION 100**

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

When used in this publication, words such as "he," "him," "his," and "men" 'are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

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ADMINISTRATION

Students who desire credit hours for this correspondence subcourse must meet eligibility requirements and must enroll through the Nonresident Instruction Branch of the U.S. Army Medical Department Center and School (AMEDDC&S).

Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application and then follow the on screen instructions.

In general, eligible personnel include enlisted personnel of all components of the U.S. Army who hold an AMEDD MOS or MOS 18D. Officer personnel, members of other branches of the Armed Forces, and civilian employees will be considered eligible based upon their AOC, NEC, AFSC or Job Series which will verify job relevance. Applicants who wish to be considered for a waiver should submit justification to the Nonresident Instruction Branch at e-mail address: accp@amedd.army.mil.

For comments or questions regarding enrollment, student records, or shipments, contact the Nonresident Instruction Branch at DSN 471-5877, commercial (210) 221-5877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail accp@amedd.army.mil, or write to:

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0171

ARTHROPOD CONTROL

INTRODUCTION

Arthropods are bilaterally symmetrical animals that have an exoskeleton and have jointed appendages. They comprise the largest group of animals in the world. However, the importance of this group of animals is not necessarily due to its size, but the diversity that exists among the many species. Because of this great diversity in structure and function, representatives of the arthropod world have been able to live in almost any environment found in the world and have been able to utilize a variety of items as sources of food. Unfortunately, some of these sources of food are often ornamental and food crops, livestock, pets, homes, and even humans. The potential problems are further complicated when we consider that arthropods may be carriers of diseases and may, themselves, be noxious due to irritating substances they produce or the venom they inject. The purpose of this subcourse is to instruct you in preventive and remedial control measures that you may employ to avoid, reduce, or eliminate the harmful effects of arthropods.

Subcourse Components:

This subcourse consists of three lessons and an examination. The lessons are:

Lesson 1, Introduction to Arthropod Control.

Lesson 2, Pesticide Application Techniques.

Lesson 3, Pest Control Equipment.

Credit Awarded:

Upon successful completion of this subcourse, you will be awarded 10 credit hours.

Materials Furnished:

Materials provided include this booklet, an examination answer sheet, and an envelope. Answer sheets are not provided for individual lessons in this subcourse because you are to grade your own lessons. Exercises and solutions for all lessons are contained in this booklet. *You must furnish a #2 pencil*.

Procedures for Subcourse Completion:

You are encouraged to complete the subcourse lesson by lesson. When you have completed all of the lessons to your satisfaction, fill out the examination answer sheet and mail it to the AMEDDC&S, along with the Student Comment Sheet, in the envelope provided. *Be sure that your social security number is on all correspondence sent to the AMEDDC&S*. You will be notified by return mail of the examination results. Your grade on the examination will be your rating for the subcourse.

Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet, which follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

--As you successfully complete each lesson, go on to the next. When you have completed all of the lessons, complete the examination. Mark your answers in this booklet; then transfer your responses to the examination answer sheet using a #2 pencil and mail it to the AMEDDC&S for grading.

Student Comment Sheet:

Be sure to provide us with your suggestions and criticisms by filling out the Student Comment Sheet (found at the back of this booklet) and returning it to us with your examination answer sheet. Please review this comment sheet before studying this subcourse. In this way, you will help us to improve the quality of this subcourse.

LESSON ASSIGNMENT

LESSON 1	Introduction to Arthropod Control.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-9.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

1. Identify various organizational responsibilities for arthropod control.

2. Match nonchemical integrated pest management practices with their definition and/or example.

3. Given an arthropod control problem, select integrated pest management practices that would most likely be effective in controlling the pest.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

INTRODUCTION TO ARTHROPOD CONTROL

Section I. IMPORTANCE OF ARTHROPOD CONTROL

1-1. GENERAL

a. There are many species of arthropod pests that seriously affect military operations by spreading disease, reducing efficiency, and causing property losses. The potential for loss of life and reduction in effective man-hours due to arthropod-borne diseases such as malaria, typhus, dengue, encephalitis, filariasis, Rocky Mountain spotted fever, tularemia, dysentery, cholera, and typhoid fever make an effective vector control program imperative. Current integrated pest management (IPM) practices have reduced the transmission of these diseases to the lowest point in military history; however, only through a continuing program will this record be maintained.

b. Many arthropods, such as cockroaches, have three developmental stages: the egg, the nymph, and the adult. Other arthropods, such as flies and mosquitoes, have four developmental stages: the egg, the larva, the pupa, and the adult. Ticks and mites also have four developmental stages referred to as the egg, the larva, the nymph, and the adult. See Table 1-1.

c. An important characteristic of many arthropods is that the immature stages (larvae and pupae or nymphs) have requirements different from those of the adults. They must have sufficient food for their development. Unless the female arthropod lays her eggs in a suitable place, the eggs will not hatch or the hatching larvae will have insufficient food for their development. Thus, one key to effective arthropod control is to make sure there are no places suitable for their growth.

1-2. RESPONSIBILITIES FOR ARTHROPOD CONTROL

Responsibilities within the Army for various aspects of arthropod control are defined in AR 40-5, AR 420-76, AR 40-574, and other directives.

a. **Commanders.** The commander at each level of command is responsible for the enforcement of regulations, including those designed to protect personnel of his command from animals which may be reservoirs or vectors of disease and which may damage property, equipment, and supplies.

General Life Cycle of Some Medically Important Arthropods	Approximate Duration of Life Cycles at 27°C (80°F)		Where Found
Flies (Example: housefly)	egg larvae pupa adult	10 hours 5 days 5 days 30 days	Animal or human waste, garbage, grass, decomposing animals and mud contaminated with organic material.
Mosquitoes (Example: yellow fever mosquito)	egg larvae pupa adult	4 days 10 days 2 days 14 days	Standing water which may be found in ponds, tin cans, old tires, and tree holes.
Fleas (Example: oriental rat flea)	egg larvae pupa adult	7 days 15 days 8 days 365 days	Warm-blooded animals and nests or beds of animals.
Lice… (Example: human body louse)	egg nymph adult	7 days 16 days 30 days	Head hair and clothing of humans.
Cockroaches (Example: German cockroach)	egg nymph adult	3-24 hours 30 days 2,000 days	Cracks and crevices that provide warmth, moisture, and food such as around water, garbage, and food facilities.
Ticks and mites	Life cycle (egg, larva, nymph, adult) completed 6 weeks to 2 years		Tall grass, underbrush, animal watering places, and shady rest areas of animals.

Table 1-1. Life cycle of arthropods.

b. **Medical Authorities.** Medical authorities will provide technical guidance for control of arthropods and other animals affecting the health and morale of Army personnel and occupied area inhabitants. This includes, but is not limited to: assisting unit and command supply personnel and engineers to establish requirements and control levels for pesticides and pesticide dispersal equipment; determining pest control material and operations effectiveness; conducting ecological and biological studies of arthropods and animals servings as vectors and reservoirs of disease; monitoring pesticide levels in the environment; and assisting in the development, standardization,

and use of entomology-oriented equipment. Where facilities engineering responsibilities have been assigned to the Corps of Engineers, the Army Medical Department (AMEDD) may conduct such animal vector and disease reservoir operations as required for training AMEDD personnel. Training operations of this type will be coordinated with the facility engineer to preclude duplication of effort and provide required reporting data. Combat zone and/or communications zone pest management programs will be supervised by entomologists.

c. **Facility Engineers.** Facility engineers will conduct programs for the control of insects, rodents, and other pests, including animal vectors and reservoirs of diseases. Besides planning, supervising, and executing pest control operations, the facilities engineer will:

(1) Investigate the occurrence, abundance, and importance of pests that damage or destroy supplies and property, as well as other pests as required.

(2) Prepare and utilize long range work plans, annual work plans, and schedules of operations for pest control in accordance with the principles of work management, as applicable.

(3) Maintain records of operations (for example, investigations, inspections, utilization of manpower, funds, and pesticides) for analyzing efficiency and economy and for evaluating accomplishment of pest control.

(4) Ensure operating personnel receive on-the-job training and proper certification

(5) Inspect and evaluate the effectiveness and safety of applied control measures.

(6) Cooperate with the Army Medical Department by controlling pests of medical importance and quarantine pests.

(7) Maintain mosquito light traps.

d. **Quartermaster Laundry Units.** Quartermaster laundry units will impregnate clothing with insect repellents whenever recommended by the medical authority.

Section II. INTEGRATED PEST MANAGEMENT

1-3. PRINCIPLES OF ARTHROPOD CONTROL

There are two major principles of control that may be employed in dealing with arthropod problems -- preventive and corrective. Preventive control involves the use of methods to forestall or postpone (insofar as possible) pest infestations. Generally, this type of control is more effective, more economical, permanent, and usually non-chemical in nature. It usually requires high initial expenses and results are not readily apparent. Corrective control involves the use of methods designed to cope with existing infestations; hence, it is a "brush fire" approach. Usually this type of control involves a low initial cost, fast results, and it is the only alternative once prevention fails. This type of control is typically less effective, more expensive in the long run, temporary in nature, and usually chemical.

1-4. INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is defined as the management of pest populations by using all suitable means of control in a compatible manner so as to avoid damage and minimize adverse side effects. Table 1-2 contains an integrated pest management matrix. IPM has been necessitated by pesticide resistance in arthropods, resurgence of pest populations after chemical control programs are stopped, pesticide residues in the environment, secondary pests arising after chemical control programs destroy natural predator populations, destruction of nontarget organisms, chemical hazards to applicators, and the expense of pesticides. Questions which must be considered concerning implementation of IPM are: Is the pest a problem? Where is it a problem? When is it a problem? What is the damage or economic threshold? Is control practical and cost effective? Is this the least disruptive program? How easily is the program implemented? Should temporary or permanent measures be used? IPM can be categorized according to various control methods, including:

a. Mechanical.

b. Physical.

c. Cultural.

d. Biological.

e. Regulatory.

f. Chemical.

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
1. Cockroaches	Unpack supplies before bringing into residence	Good housekeeping	Harborage elimination (corrective) Caulking Remove unused equipment Trapping Cold storage Moisture control Cockroach proof containers	Eliminate harborage and/ or allow access for treatment	Parasitic wasp on American cockroach (Hawaii) (Texas) Parasitic wasp on brown banded cockroach (Hawaii) (California	Sterilization (experimental) Growth regulators	Repellents Insecticides Baits Residual liquids Nonresidual (ULV) Dusts Fumigants CO (hospital cells)	Quarantine
2. Rats/ Mice		Land fill locations Refuse collection Food source removal Water source removal Food storage/ packaging practices (rodent proof containers)	Rodent proofing Harborage elimination Trapping Snap trap Sticky trap Live trap Nest removal Sonic devices not effective			Birth control chemicals (experimental)	Rodenticides anticoagulant Single dose tracking powder Burrow fumigation	Local laws and activity instructions on landfill operations Instructions on handling of retrograde cargo Quarantine regulations
3. Ants	Vegetation removal Use ant proof containers for materials that attract ants	Good housekeeping	Ant proofing Sealing cracks Vacuuming Barrier (water, petroleum jelly) Stickum Soak houseplant pots to drown				Insecticides Baits Residual liquids, dust	Federal and State quarantine (fire ants)
4. Mosquitoes	Avoid placing water containing devices about premises Plant selection (non water trappers)	Empty water from artifical containers to prevent breeding	Screening Remove containers providing breeding site Light traps for surveillance Electrocuting traps not effective	Water management Ditching Ditch maintenance Filling Manipulating water levels	Predatory fish Nematodes Fungi Predatory mosquitoes (Toxorhynchites sp)	Sterilization (A. albimanus only) (Experimental)	Repellents (Personal) Larvacides Insect growth regulators Biodegradable oils Residuals	Coordination with local mosquito abatement districts Quarantine—public health

*NOTE: In this matrix Physical Control is combined with Mechanical Control.

Table 1-2. Types and control involved in installation integrated pest management programs (continued).

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
4. Mosquitoes (Con'd)			Sonic devices not effective Use mosquito nets	Flushing modify containers to prevent holding water	Martins and bats don't significantly reduce mosquito populations. Benefit primarily from public relations point of view		Controlled release Liquids Adulticides Non-residuals (aerosols) Residuals (mists) (sprays) Barrier treatment	
5. Filth Flies		Refuse collection and disposal Breeding source reduction Cleaning refuse containers Good housekeeping	Screening Air curtains Trapping Sticky paper attractant (muscalure) Fly swatters Electric fly grid (indoors)		Parasitic wasp (Spalangia spp)	Sterilization (Stable fly)	Repellents (personal) Insecticides Non-residual (aerosol) Residuals Fly baits	Activity instructions on stable operations (stable flies) Quarantine public health
6. Biting Flies	Schedule activities to reduce exposure	Sanitation (Stable Fly) Breeding source reduction Manure Grass Clippings Seaweed Aquatic weed (emergent) management	Screening Trapping Sticky trap Live trap	Water management (culicoides, black fly) Soil management	Parasitic wasp (Spalangia sp)	Sterilization (Stable fly)	Repellents (personal) Insecticides Non-residuals (aerosol) Residuals	Activity instructions on stable operations (stable flies) Quarantine public health
7. Wasps, Bees, Hornets	Turf management Clover removal	Sanitation Food Source removal	Trapping Screening				Freezing agent aerosols dispenser Repellents Insecticides Non-residual aerosols Residuals Baits	Quarantine USDA, Others

*NOTE: In this matrix Physical Control is combined with Mechanical Control

Table 1-2. Types and control involved in installation integrated pest management programs (continued).

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
7. Wasps, Bees, Hornets (cont'd)	Nest Removal Swarm removal (honey bees)							
8. Subterranean Termites		Sanitation (pre-construction clearing of all wood material) Removal of wood scraps	Screening	Design (preventive) Termite shield Use treated wood Repair and maintenance (corrective) Moisture control/water drainage	Bait with symbiont-killing antibiotic		Wood Preservatives Insecticides Soil treatment with residuals Bait blocks Repellents	Quarantines Activity instructions requiring annual inspections
9. Non-selective Weed Control	Selective planting Cultivation Burning		Barriers Plastic Gravel Pavement Hand removal				Growth regulators Herbicides Selective Non-selective Short-term Long-term	State regulations on weeds
10. Spiders		Sanitation Harborage Removal (debris)	Removal of webs, adults, eggs (vacuum) Spider proofing Screen Sealing cracks		Prey insect control Wasps		Freezing agent aerosols Insecticides Non-residual aerosols Residual	
11. Stored Product Pests (Insects)	Selection of synthetic cloth Disposal/ survey (last resort) Isolation of infested stores Short storage time Dry cleaning	Sanitation Acceptance inspection Good housekeeping	Sieving Insect proof packaging/storage Cold storage Dehumidification Radiation Heating				Repellents (packaging) Insecticides Non-residual (ULV) Residual Fumigation	Quarantine In transit fumigation requirements

*NOTE: In this matrix Physical Control is combined with Mechanical Control.

Table 1-2. Types and control involved in installation integrated pest management programs (continued).

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
12. Fleas	Management domestic host animals Control of feral host animals Vacumming Remove carpets in public areas	Sanitation Good housekeeping					Insecticides Non-residual aerosols Residuals Flea collars Growth regulators	Quarantine (Derat Certificate)
13. Vertebrate Pests and other Rodents		Sanitation Food source removal	Water Management (aquatic vertebrates) Habitat manipulation Barriers Trapping live Lethal shooting Animal removal Low temperature exposure	Harborage elimination Pest proofing			Repellents Pesticides Anticoagulant baits Single dose baits Fumigation Birth control hormones	Federal and State permits Activity instructions on pet control
14. Insect Pests of Vegetation	Resistant plant varieties Plant care Water sprays Soap sprays		Removal hand picking		Many systems available based on pest species		Pesticides Residual contact and systemics	Quarantine
15. Ticks and Mites	Weed and brush control Management of domestic host animals Control of feral host animals		Hand removal using forceps Adhesive lint rollers				Repellents (personal) Pesticides Residual systemics for animals	Activity instructions on tick exposure and removal
16. Birds		Sanitation Food source removal Landfill location Sewage lagoon location	Nest removal Trapping Shooting Mist nets Scare devices Habitat interruption Distress calls	Design Bird proofing	Predators	Sterilization (Ornitrol-pigeons)	Repellents Avicides Baits Residual liquid and greases	Federal and State permits

* NOTE: In This Matrix Physical Conrol is Combined with Mechanical Control.

Table 1-2. Types and control involved in installation integrated pest management programs (continued).

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
16. Birds (cont'd)			Light and sound emitters not effective Exposure to cold (tergitol) Simulated predator kites (England)					
17. Selective Control (Grasses/ Broad Leaf Weeds/ Brush)	Selective planting Mulching Cultivation Fertilization Grazing Watering practices		Removal/clearing Mowing Cutting Pruning Barriers		Insects on Lantana, musk thistle (exp)		Growth regulator Fruiting inhibition Herbicides Selective pine release Frilling Stump injection	Quarantine
18. Household Pests (Silverfish, Psocids, Bedbugs, Crickets)	Control of feral host animals	Sanitation Good housekeeping Sanitizing/ laundering	Harborage elimination Vacuuming Trapping Sticky Trap Temperature control Humidity control	Pest proofing (crickets)			Repellents Insecticides Baits Non-residual aerosols Residual liquids	
19. Aquatic Weeds	Fertilization		Water management Level Flow restricted Quality (nutrients) Removal Barriers Mowing Cutting	Pond and ditch design	Fish (White Amur) Insect Alligator-Weed Beetle Moth (Alligator-Weed) Weevil		Herbicides	
20. Wood Destroying Insects (Dry-Wood Termites, Beetles, Carpenter Ants and Bees			Exposure to high low temperature (dry-wood termites)	Design Selection of restraint lumber materials Repair/maintenance			Wood Preservatives Insecticides Residual Fumigation	Quarantine Activity instructions requiring annual inspections

*NOTE: In this matrix Physical Control is combined with Mechanical Control

Table 1-2. Types and control involved in installation integrated pest management programs (continued).

PEST	CULTURAL	(SANITATION)	* MECHANICAL	(CONSTRUCTION & MAINTENANCE)	BIOLOGICAL	(GENETIC & REPRODUCTION)	CHEMICAL	REGULATORY
21. Wood Destroying Fungi	Proper storage of wood Vegetation management Selection of resistant lumber			Design Repair/maintenance Ventilation Moisture control, drainage, vapor barrier in crawl spaces Protect stored lumber			Wood preservatives Pressure treatment Brush treatment Dip treatment	Activity instruction requiring annual inspections Quality assurance inspections Require storage protection and pressure treated materials

* NOTE: In this Matrix Physical Control is combined with Mechanical Control.

Table 1-2. Types and control involved in installation integrated pest management programs (concluded).

1-5. MECHANICAL CONTROL

a. **General.** Mechanical control is the removal of pests by hand or by using mechanical means to trap, kill, or keep pests out of an area. The most desirable aspect of mechanical control is that results are usually seen very soon after the specific control practice has been employed. On the other hand, the use of mechanical control can be rather expensive in terms of time and effort. The amount of control attained is quite often limited because this type of control is generally temporary in nature.

b. **Mechanical Control Measures.** Mechanical control measures include hand-picking insect pests, then destroying them. Measures may also be more elaborate and employ screens, bands of heavy oil, or other sticky substances as temporary barriers. A good example is the use of window screens and bednets to prevent flying insects from entering a house or sleeping area. Metallic barriers have also been used to control arthropods. Strips of sheet metal, for example, have been used as fences to protect fields of crops from crawling insects. Another example of metallic barriers used to prevent damage from arthropod pests is the use of termite shields on wooden structures. Other common types of mechanical control are fly swatters, mosquito netting, and various types of traps, some of which kill with electricity.

1-6. PHYSICAL CONTROL

a. **General.** Physical control has many of the advantages and disadvantages of mechanical control. Unlike mechanical control, which involves the use of machinery or manual operations, physical control involves the use of 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.

b. **Manipulation of Temperature.** Under certain circumstances, control of arthropod pests may be effected by the raising or lowering of temperatures. The lowering of temperature is usually not done to kill the pest in question, but to reduce the rate of activity or development of the pest. Consequently, the rate of damage is reduced or stopped. In contrast, the application of heat (120°-180°F) for three to four hours has been used to kill insect pests in stored grain and grain products.

c. **Radiation.** Ionizing, ultraviolet, visible, infrared, and microwave radiation have also been utilized in arthropod control with varying degrees of success. Of these, infrared and microwave have been used to elevate temperature in order to kill pests. Solar radiation, which is made up of several types of radiation, has been used to raise the temperature of grain in some tropical regions. This has been accomplished by spreading the grain out and exposing it to a large sunlit area. Ultraviolet light and visible light have been used to attract insect pests to traps. By contrast, in storage areas where lights are commonly used for security, lights that produce long wavelength visible light (yellow-red) have been useful in reducing or preventing the attraction of insects. The effectiveness of this technique lies in the fact that many insects are unable to detect this light. Although ionizing radiation (alpha and beta particles, neutrons, gamma rays,

and x-rays) is capable of killing arthropods, its employment is impractical for control purposes. However, sublethal doses of ionizing radiation may produce sterility in arthropods (see paragraph 1-6d). Electromagnetic radiation (gamma rays and x-rays) is most useful because it is more penetrating than alpha or beta particles. Neutron radiation possesses a number of undesirable qualities that render this technique impractical.

d. **Ionizing Radiation and the Screwworm Fly.** The most spectacular example of arthropod control through the use of ionizing radiation may be seen in the case of the screwworm fly. Sterilized male flies are released to mate with wild female flies, which mate only once in a lifetime. Either there are no eggs produced or the eggs that are produced are not fertile. The fly population declines as a result. Repetition of the procedure for several generations leads to the eradication of the pest from the area. This could also be considered biological control. The procedure is worthy of mention because it demonstrates the dramatic potential of ionizing radiation in arthropod control. Eradication is a term that, prior to the ionizing radiation control method, had not been used. In the past, the term control meant maintaining populations of arthropod pests at levels that are acceptable from a health, damage, or nuisance standpoint. The very fact that we now use eradication implies that ionizing radiation is indeed a very powerful tool in the control of arthropods; nonetheless, the measure does have its drawbacks.

(1) To execute the program, large numbers of male flies must be reared in laboratory facilities and sterilized with X-rays or gamma rays.

(2) This can become costly in time, space, manpower, and money.

(3) The area to be treated needs to be relatively small and isolated to prevent reinfestation from adjacent areas.

e. **Screwworm Fly Eradication Programs.** The most notable example of screwworm fly eradication programs took place on the island of Curacao off the coast of Venezuela and on the peninsular portion of Florida. The ionizing radiation technique was quite successful. In Florida, for example, the program was carried out during the winter months when the fly population was low and was isolated in the warmer, southern portion of the state.

1-7. CULTURAL CONTROL

Cultural control measures involve careful nonchemical changing of the environment to make it less favorable for a particular pest, thereby managing its population (includes habitat manipulation and sanitation). Some cultural control practices are:

a. Crop rotation.

b. Tilling of the soil.

c. Sanitary clean-up of breeding sites or shelters.

d. Early or late planting of crops to avoid peak populations of arthropod pests.

e. Removal of standing water.

1-8. BIOLOGICAL CONTROL

a. **General.** The reduction of pest populations by using living organisms is encouraged by man (including reproductive and genetic control techniques). Biological control is based, in part, upon the introduction, production, and release of parasites, predators, and diseases that attack and reduce or control populations of harmful arthropods. Included in this method are:

(1) The protection of insectivorous animals and wild birds.

(2) The propagation and spread of disease-producing protozoa, bacteria, fungi, and viruses.

(3) The production and release of diseased arthropods.

(4) Introduction of parasites such as insects, nematodes, and mites.

(5) The release of sterile male insects of the target species.

b. **Importance of Biological Control.** Although biological control of arthropods has had some success in the past, this method of control is still in need of much development and, at present, is of little importance for military purposes. This statement should not suggest, however, that biological control is without merit. There have been some very successful control programs using biological agents against specific pests. For the most part, biological pressures against pests are continually operating in nature, even though we may be unaware of them. For that reason, great care and responsible thought must be exercised whenever employing chemical means against pests. We must not accidentally or needlessly destroy natural pressures that tend to hold pest populations in check. An excellent example of an effective use of biological agents is biological insecticides such as the bacterium *Bacillus turingiensis* var*. israeliensis* (Bti) for mosquito control.

1-9. REGULATORY CONTROL

The legal aspect of control of arthropod pests is mostly based upon quarantine, inspection, and sanitation laws. The military is highly concerned with effective enforcement of quarantine procedures.

a. **Importance.** Ideally, animals and plants exist together in natural balance. Parasites, predators, and diseases all serve to keep biological species from becoming

overabundant. One of the several factors that can upset this "balance of nature" is the introduction of an alien species into an existing biological community. Taken from a competitive environment, the species is usually introduced without its natural enemies. When it is then placed in a suitable environment, there is very little to check a population buildup and the spread of the species. Great damage can result. The Japanese beetle, European corn borer, Hassian fly, gypsy moth, Mediterranean fruit fly, oriental fruit fly, old house borer, Khapra beetle, golden nematode, and Mediterranean white garden snail are a few examples of economic pests that have been accidentally introduced into the United States. Introduced rodents, fleas, mosquitoes, ticks, and domestic animals have been responsible for outbreaks of bubonic plague, yellow fever, filariasis, canine piroplasmosis, and foot and mouth disease.

b. **Quarantine.** The military, in conjunction with other Federal agencies, is active in preventing the introduction of any potential pest into the United States. Government agencies responsible for intercepting such pests are the Animal and Plant Health Inspection Service (APHIS), U.S. Department of Agriculture (USDA), the Public Health Service (PHS) of the Department of Health and Human Services, and the Bureau of Customs of the U.S. Treasury Department. In the Army, "Quarantine Regulations for Vessels and Aircraft of the Armed Forces" are set forth in AR 40-12. These regulations authorize inspectors from the USDA, the Public Health Service, and the Bureau of Customs to board vessels and aircraft of the Armed Forces for thorough examination. The Army maintains a liaison with these Federal agencies and complies with the quarantine measures established by the USDA/PHS.

c. **The Military Retrograde Cargo Program.** The presence of United States military bases and the potential deployment of troops throughout the free world impose special problems and responsibilities upon those concerned with the movement of men and material from country to country. With nations only a few hours away from each other, the risk of accidentally introducing disease vectors, veterinary pests, and agricultural pests into a noninfested area is greater than ever. Disease vectors, veterinary pests, and agricultural pests may be introduced into this country in or on humans, cargo, cargo containers, packing materials, or earth adhering to bags, boxes, vehicles, or military equipment. Disease vectors and other pests may hitch rides into this country on vehicles, ships, or aircraft. Therefore, an intensive surveillance program to prevent the introduction and establishment in the United States of disease and pest organism of foreign origin has been established. The first step on preventing accidental introduction of foreign pests is the cleaning/inspection of equipment being redeployed from a foreign nation. Additionally, commanders of all installations receiving cargo originating outside the United States must establish procedures to detect the presence of quarantine materials and organisms in such cargo and must ensure that pesticide chemicals applied prior to shipment are removed properly.

d. **Responsibilities.** The following individuals are responsible for carrying out the provisions of the Military Retrograde Cargo Program.

(1) Command medical entomologist. The senior medical entomologist serves as project officer for quarantine matters and functions as the director of all medical/quarantine inspections. In the latter capacity, the entomologist directs the activities of all medical quarantine inspectors (MQI) and exercises staff supervision over all United States Department of Agriculture/United States Public Health Service (USDA/PHS) advisors invited to participate in the program.

(2) Military quarantine inspectors (MQI). Military police customs inspectors are specifically trained and certified by USDA/PHS authorities as registered quarantine inspectors. MQI inspect cargo shipments at major processing centers and certify that cargo conforms to appropriate USDA/PHS standards and is acceptable for storage in intransit storage areas. In addition, MQI accomplish other activities required to enforce USDA/PHS/DOD quarantine regulations such as:

(a) Inspecting carrier vessels and cargo items for the presence of soil contamination, plant materials, and insect or rodent infestations.

(b) Certifying and preclearing vessels and shiploads of cargo that conform to appropriate USDA/PHS standards.

(3) Quality control inspectors (QCI). QCI personnel specifically trained in all aspects of cargo processing procedures are nonmedical personnel designated by the military command to certify that all hazardous materials have been removed from cargo and cargo shipments are properly and adequately prepared for shipment.

(4) Engineer entomologist. The professional civilian entomologist, exercising command staff supervision of the facilities engineering pest control programs, is responsible for the training and certification of engineering pest control personnel.

(5) Pest controller. A certified individual employed by the installation facilities engineer, the pest controller applies pesticides in support of the retrograde cargo program.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Who is responsible for impregnating bulk clothing with insect repellent?

   a. Quartermaster laundry units.

   b. Preventive medicine units.

   c. The first sergeant.

   d. None of the above.

2. Who makes sure that cargo coming into the country is uncontaminated and free from insect or rodent infestation?

   a. The pest controller.

   b. The engineer entomologist.

   c. The quality control inspector.

   d. The military quarantine inspector.

3. Medical authorities usually conduct programs for the control of insects, rodents, and other pests that are disease vectors.

   a. True.

   b. False.

4. What are the two major principles of arthropod control?

    a. Preventive and eradication.

    b. Preventive and decisive.

    c. Preventive and corrective.

    d. None of the above.

5. Cultural control includes which of the following?

    a. Sanitation.

    b. Fly swatter, screening.

    c. Radiation, temperature manipulation.

    d. Quarantine, parasite releases.

6. Integrated pest management may include chemical control methods as well as nonchemical methods.

    a. True.

    b. False.

7. What type(s) of radiation has/have been useful in attracting insect pests to traps?

    a. Ultraviolet and visible light.

    b. Ultraviolet and infrared light.

    c. Alpha, beta, and gamma.

    d. Microwave.

8. A farmer who uses strips of sheet metal as fences to protect his crops is using:

    a. Physical control.

    b. Mechanical control.

    c. Regulatory control.

    d. None of the above.

9. The Army complies with quarantine measures laid down by:

    a. USDA and PMO.

    b. USDA and NBA.

    c. USDA and PHS.

    d. None of the above.

10. An example of _____ control is the production and release of sterile male arthropods.

    a. Radioactive.

    b. Biological.

    c. Sexual.

    d. Both a and c.

11. Part of _____ control is the prevention of any potential pests from being introduced into the U.S.

    a. Regulatory.

    b. Cultural.

    c. Preventive.

12. What serves to keep biological species from becoming overabundant (commonly referred to as the balance of nature).

    a. Parasites, predators, and old age.

    b. Parasites, predators, and disease.

    c. Sterile males, biological control, and IPM.

    d. None of the above.

SPECIAL INSTRUCTIONS FOR EXERCISES 13 THROUGH 17. Match the pest in the first column with the integrated Pest Management (IPM) practice(s) in the second column which would most effectively control it. More than one practice may be used in an answer and practices may be used more than once.

PEST	IPM PRACTICE
_____ 13. Ticks and mites.	a. Cleaning refuse containers.
_____ 14. Mosquitoes.	b. Weed and brush control.
_____ 15. Stored products pests.	c. Ditching and filling.
_____ 16. Rats and mice.	d. Removal of scraps.
_____ 17. Filth flies.	e. Insect proof packaging.
	f. Anticoagulant rodenticides.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. a (para 1-2d)
2. d (para 1-9d(2)(a))
3. b (para 1-2c)
4. c (para 1-3)
5. a (para 1-7)
6. a (para 1-4)
7. c (para 1-6c)
8. b (para 1-5b)
9. c (para 1-9b)
10. b (para 1-8)
11. a (para 1-9b)
12. b (para 1-9a)
13. b (table 1-2)
14. c (table 1-2)
15. e (table 1-2)
16. a and f (table 1-2)
17. a (table 1-2)

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2 Pesticide Application Techniques.

TEXT ASSIGNMENT Paragraphs 2-1 through 2-13.

LESSON OBJECTIVES After completing this lesson, you should be able to:

1. Identify the types of pesticides used in the military according to their intended use and be able to match them with their characteristics.

2. Identify the types of formulations most frequently used in the military and be able to match them with their characteristics.

3. Select the characteristics of residual, crack and crevice, spot, broadcast, and space treatments.

4. Match the various pesticide dispersal methods with their appropriate characteristics.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

PESTICIDE APPLICATION TECHNIQUES

Section I. BASIC TYPES OF PESTICIDES

2-1. GENERAL

a. The use of chemicals is a major effort on the part of humans to destroy or control arthropods. Arthropod pests not only endanger our health, they destroy crops and stored products. There is a tendency to regard chemicals as a cure-all, which is a serious and expensive mistake. Without routine measures of maintenance and sanitation, used in conjunction with chemical control efforts, the result will be, at best, only temporary and limited.

b. Chemical control encompasses a large array of chemicals and dispersal methods of a highly specialized degree. Today, there are many effective materials from which to choose. The problem is to choose the chemical most efficient against the arthropod being destroyed or controlled. It is important to know that a certain chemical or chemical formulation will rapidly kill one species while another species will not be bothered by it at all. Chemicals used are broken up into types according to their intended uses. Examples of these types are:

(1) Poisons.

(2) Repellents.

(3) Attractants.

(4) Supplementary materials.

2-2. POISONS

There are three types of insecticides when classified according to the mode of entry into the arthropod's body.

a. **Stomach Poisons.** Stomach poisons must be swallowed in order to kill the insect. They are used against insects with chewing, sponging, or lapping mouthparts. These insecticides are usually applied in the form of dusts or sprays to vegetation or other natural foods eaten by the target insect. The insect consumes the insecticide when it eats the foliage or when it cleans appendages to which the insecticide has adhered through contact with treated surfaces. Stomach poisons may also be mixed with baits that are more attractive to the insects than natural foods. A satisfactory stomach poison must be quick acting, inexpensive, and available in large quantities. It

must be palatable to the target insects, or they will avoid it. The insecticides used as stomach poisons are chiefly the inorganic chemicals and some of the chlorinated hydrocarbons.

b. **Contact Poisons.** Contact poisons kill insects by contacting and entering the body directly through the body wall and into the blood, through the mouthparts and into the digestive system, or through the respiratory system. These insecticides are used primarily against insects with sucking mouthparts that would not eat normally applied stomach poisons. However, they are also effective as stomach poisons if eaten by insects with chewing mouthparts. Contact poisons may be applied directly to insects' bodies as sprays or dusts, or they may be applied for residual action on surfaces with which the target insects will come in contact. Contact insecticides in common use include organic as well as synthetic organic compounds.

c. **Fumigants.** Fumigants are volatile chemicals that kill by entering a pest through the respiratory system. They are used in gaseous form, or as solids or liquids which rapidly vaporize forming poisonous gases. They are generally limited to use in tightly sealed containers or enclosures. They are particularly appropriate for killing insects in stored products where the gas will penetrate cracks, crevices, and tightly packed material. They are extremely toxic to all animal life; therefore, they are also effective as rodenticides. Their extreme toxicity makes fumigants particularly hazardous to use; accordingly, their use is restricted to certified personnel.

2-3. REPELLENTS

Repellents are chemical compounds used as liquids, creams, aerosols, or solids to prevent biting or other annoyance by insects or other animal life. Repellents are generally used as a supplement to normal control measures or under conditions where other control methods are not feasible. 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 or to the clothing. A personal repellent should:

a. Not be toxic or irritating to the skin.

b. Give protection for a number of hours under unfavorable conditions.

c. Repel a wide variety of arthropods.

d. Be practically odorless to humans.

e. Not damage clothing.

2-4. ATTRACTANTS

These are substances that attract insects through sensory stimulation. In nature, it is seen in their response to the odor of food, to the opposite sex, to prey, and to sites for egg deposits. Attractants are used in control programs to induce insects to eat poison baits or to lure them into traps either for actual control or for determining population densities.

2-5 SUPPLEMENTARY MATERIALS

There are chemicals that are not primarily toxic, but add to the effectiveness of pesticides. The major types of materials now used are emulsifiers, wetting agents, stickers, solvents, dust carriers, and synergists.

Section II. PESTICIDE FORMULATIONS

2-6. DUSTS (D)

A dust is a dry mixture that usually consists of an active pesticide mixed with talc, clay, or some other inert powder used as a diluent, or carrier. Dusts are usually low in cost, easy to apply, nonstaining, nontoxic to plant life, and generally not readily absorbed through the skin. They may be dangerous, however, if inhaled into respiratory passages. Since they are dry, they are the preferred formulation for use around electrical connections. Due to the small particle size, dust can be used to penetrate small cracks and crevices. Two disadvantages of dusts, in addition to the respiratory hazard, are that they do not adhere well to vertical surfaces and they are easily removed by wind and rain.

2-7. GRANULES (G)

Granules are large particles or pellets varying from 400 to 800 microns in size. The granules are usually impregnated with 5 to 25 percent of the toxicant. The granular form of insecticide is particularly desirable in mosquito breeding areas covered by heavy vegetation that is not easily penetrated by sprays.

2-8. WATER WETTABLE POWDERS (W OR WP)

Suspensions are prepared by diluting water wettable powders with water and thoroughly mixing. A water wettable powder is a toxic ingredient blended with an inert dust to which a wetting agent -- usually a soap or detergent -- is added to facilitate mixing the powder with the water. This forms a suspension in which the fine particles are suspended -- not dissolved -- in the water. Suspensions require constant agitation during application to prevent solid particles from settling to the bottom of the sprayer. They are also more prone to clog the nozzles of sprayers due to their large particle size.

These characteristics are the principal disadvantages of suspensions. The major advantage of the suspension is the low-cost and easily obtainable diluent (water). Suspensions are also relatively safe to apply since they are generally not easily absorbed through the skin and will not cause burning of the plant foliage. Suspensions usually have less odor than solutions or emulsions because of the water diluent, as opposed to an organic solvent. They are especially valuable for treating outbuildings, adobe, concrete, and thatch structures because the active material is deposited on the surface. Solutions and emulsions, on the other hand, tend to penetrate such materials and lose much of their residual effectiveness.

2-9. SOLUTIONS (S)

A solution is a liquid formulation consisting of a solution concentrate dissolved in a diluent or solvent. The ideal solution would be one using water as the solvent for reasons of economy as well as convenience. However, most of the synthetic pesticides are relatively insoluble in water. Therefore, the solvents most commonly used are No. 2 fuel oil (used in domestic heating), diesel oil, or kerosene. Other solvents sometimes used are xylene, benzene, and other organic liquids. The solvent selected must be one in which the concentrate is soluble. An advantage of the solution is that constant agitation is not necessary, which facilitates the use of spraying equipment. It is effective as a contact insecticide as the oil base easily wets and penetrates the insect cuticle (outer covering). In residual spraying, the solvent evaporates from treated surfaces, leaving a deposit of the insecticide in relatively pure form. Disadvantages of solutions are that they are readily absorbed through the skin; the solvents are flammable and relatively expensive; they are staining; and they are, in general, toxic to vegetation.

2-10. EMULSIONS (EC)

Emulsions are prepared by diluting emulsifiable concentrates with water and thoroughly mixing. The emulsifiable concentrate is a concentrated solution of the toxic agent in a solvent to which an emulsifying agent (wetting agent), such as soap or a detergent, has been added. The emulsifying agent enables the small droplets of solvent carrying the toxicant to remain dispersed through the water, much like the fat globules in homogenized milk. The emulsion, like the solution, does not need to be constantly agitated. This advantage, combined with that of a cheap, readily available diluent (water), makes the emulsion a commonly used pesticide formulation in the Army. Emulsions are similar to solutions in their effects on insects, and they can be used for most residual sprayings. They do not usually stain surfaces. Their principal disadvantages are that they are readily absorbed through the skin and that they may be toxic to plants.

Section III. APPLICATION TECHNIQUES

2-11. GENERAL

a. Pest control is not new. It is an occupation that has been with us since humans first became bothered by insects. Pest control equipment may be very simple, or it may be so complex that only specially trained personnel may operate it effectively. Every year, many new pieces of control equipment are put on the market. Some of them are effective, while others are ineffective. There are three basic types of pest control equipment: hand-operated equipment, power-operated equipment, and aerial control equipment.

b. There are different types of pest control equipment designed to perform various types of jobs in the control of arthropods. These pieces of equipment are selected based on type of pest, type of area/surface, size of area, availability of equipment/materials, and type of formulation available. There are basically two types of pesticide treatments -- residual and space. These types of treatments can be made through various dispersal methods such as spraying, misting, aerosoling, fumigation, dusting, granules, etc.

2-12. TYPES OF PESTICIDE TREATMENT

a. **Residual.** This involves the application of a pesticide to surfaces where it is expected to stay so that the pest either comes in contact with it or ingests it. This treatment offers many advantages -- the pest does not have to be present at the time of application; the pesticide remains for long periods of effective control; and it cuts down on repeated treatment (saving time and money). The major disadvantage of this treatment method is its hazard to nontarget organisms. Residual treatment is subdivided into the three following categories,

(1) Crack and crevice. Sprays, dusts, or baits are placed directly into cracks and crevices in which insects hide or through which that enter buildings. A fine pin stream nozzle or nozzle equipped with an extension tube is used to make spray applications.

(2) Spot. The pesticide is applied to small areas where pests rest or feed and is limited to noncontiguous (not touching) spots of two square feet or less. A flat fan nozzle is used for this type of treatment.

(3) General or broadcast. This involves spreading a pesticide over a large area where the pest lives. This can be accomplished by ground dispersal equipment such as a boom or hydraulic sprayer or by aerial spraying.

b. **Space.** In this type of treatment, the pesticide is applied to the air space through which the pest travels so the pest cannot escape. The advantages of this type

of treatment include quick knockdown without use of a residual and quick killing effect. It is effective against flying insects and pests that cannot be seen.

2-13. PESTICIDE DISPERSAL METHODS

a. **Spraying.** Spraying was originally defined as the application of liquid pesticides, but, with recent developments, it is now defined as application of liquids atomized into droplets 100 microns in diameter or greater. Sprays can be further classified into fine sprays (100-400 microns in diameter) and coarse sprays (400 microns in diameter or greater). Due to the larger size of the droplet, sprays fall out of the air rapidly; hence, they can be used under a wide range of weather conditions. Generally, sprays are applied in low concentrations and under low pressure. Spraying is used to apply residual pesticides to surfaces, either body surfaces (of pests) or surfaces that pests will contact or ingest at a later time.

b. **Misting.** Misting is the dispersal of liquid pesticides with a droplet size of 50 to 100 microns in diameter. These droplets are still heavy enough to settle out; however, they remain airborne longer than sprays. Mists are usually applied at higher concentrations and penetrate better than sprays. They are effective both as an outside residual and space treatment and are occasionally used indoors.

c. **Aerosoling.** Aerosoling is a method for dispersing suspensions of solid or liquid particles that are less than 50 microns in diameter. This can be accomplished either through thermal or cold aerosoling techniques. Thermal fogging (aerosoling) uses either hot gases or super heated steam, which gives the distinct appearance of dense white fog. Cold aerosoling is accomplished by combining the pesticides with a liquid that boils at a low temperature and discharging the mixture by its vapor pressure through a small orifice or by using mechanical shearing. Ultra-low volume (ULV) and ultra-low dosage (ULD) are included in this dispersal method; however, their particle size range is usually 5-30 microns. Aerosoling is an effective method of dispersing space sprays since it leaves virtually no residual and remains airborne for longer periods of time. Aerosols have excellent penetration and, due to their small particle size, are significantly influenced by weather conditions. Because of the latter fact, ULV dispersal can be accomplished only under certain weather conditions: air temperature less than ground temperature; air temperature between 40° and 85°F; and wind speed less than 10 mph. ULD aerosols are used indoors for control of flying insects and exposed stages of crawling insects (stored product pests, cockroaches, flies, etc.). ULV aerosols are used outdoors for control of mosquitoes and biting flies. This method of dispersal may be repeated as often as necessary because there is no residual.

d. **Fumigation.** This method of dispersal involves the use of gaseous poisons that are molecular in size. Since these gases are hazardous to all life forms, they must be used with extreme care. Gases are able to penetrate packaged commodities, clothing, and structures inaccessible to sprays, mists, and aerosols and, therefore, must be confined under a tarp or other impermeable enclosure. The two major advantages of this dispersal method are that the molecules pass directly through the pest's body wall

or enter directly through the respiratory system and leave no residue in or on the product. Because of this, the commodity is subject to immediate reinfestation. Fumigation should only be used when other methods of control are ineffective or where thorough penetration is required. It is to control various pests in stored subsistence, rodent burrows, wooden structures, and soil.

e. **Dusting.** This is the application of pesticides in the form of solid particles extending in size over the same range as liquids. Dusts are classified as being less than 400 microns in diameter. Dusts provide good residuals, remain airborne a long time, and provide good penetration. One of the biggest problems with dusts is drift since they do not adhere well to surfaces and can be blown away by the first wind. Dusts are effective against crawling insects, in ectoparasite control, and in and around electrical appliances.

f. **Granules and Pellets.** Granules and pellets possess many characteristics of dusts except that they are greater than 400 microns in diameter; are subject to little or no drift; and can be effectively dispersed by air because of their excellent vertical penetration. Granules may be used in aquatic habitants for mosquito larvae control, in areas inaccessible to wheeled vehicles, and where repeated treatment is not desirable or practical.

g. **Miscellaneous.** Many miscellaneous dispersal methods (such as painting, swabbing, dragging, and baiting) are also available. These applications are fairly specific will not be discussed here.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. These volatile pesticides, extremely toxic to animal life, are also effective as rodenticides.

   a. Stomach poisons.

   b. Contact poisons.

   c. Fumigants.

   d. Repellents.

2. Suspensions are prepared by mixing water and a(n):

   a. Dust.

   b. Water wettable powder.

   c. Granule.

   d. Emulsion.

3. The two types of pesticide treatments are _____, and _____.

4. Liquid pesticide dispersed in droplet sizes greater than 100 microns are _____.

5. Poisons are classified into _____, _____, and _____ poisons according to how they enter the insect's body.

6. Which of the following formulations are dry when they are applied, and therefore less likely to stick to surfaces? (More than one response may be correct.)

   a. Dusts.

   b. Water wettable powder.

   c. Solutions.

   d. Granules.

7. Which of the following dispersal methods is most subject to drift due to its smaller droplet/particle size?

   a. Spray.

   b. Aerosol.

   c. Mist.

   d. Granules.

8. What dispersal method produces molecular size particles that are able to penetrate packaged food products?

   a. Misting.

   b. Fumigation.

   c. Ultra-low volume.

   d. Ultra-low dosage.

9. The three types of residual treatments are _____, _____, and _____.

10. The three most frequently used solvents for making solutions are _____, _____ and, _____.

11. What type of chemical that is applied to the skin is designed to prevent biting or annoyance by insects or other animal life?

    a. Attractants.

    b. Poisons.

    c. Repellents.

SPECIAL INSTRUCTIONS FOR EXERCISES 12 THROUGH 16. Match the type of pesticide treatment or dispersal method listed in the first column with the correct characteristic listed in the second column.

____ 12.	Spot treatment	a.	Dispersal method for dry formulations greater than 400 microns in diameter.
____ 13.	Granules	b.	Includes ULD and ULV dispersal methods.
____ 14.	Spraying	c.	Dispersal of liquid pesticides 50-100 microns in diameter.
____ 15.	Broadcast treatment	d.	Residual treatment limited to 2 square feet.
____ 16.	Misting	e.	Liquid dispersal method that produces the largest droplets.
		f.	Residual treatment over large areas such as aerial dispersal.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. c (para 2-2c)
2. b (para 2-8)
3. Residual, space (para 2-12)
4. Sprays (para 2-13a)
5. Stomach, contact, fumigant (para 2-2)
6. a, d (paras 2-6 and 2-7)
7. b (para 2-13c)
8. b (para 2-13d)
9. Crack and crevice, spot, general or broadcast (para 2-12)
10. Kerosene, diesel oil, and No. 2 fuel oil (para 2-9)
11. c (para 2-3)
12. d (para 2-12a(2))
13. a (para 2-13f)
14. e (para 2-13a)
15. f (para 2-12a(3))
16. c (para 2-13b)

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Pest Control Equipment.
TEXT ASSIGNMENT	Paragraphs 3-1 through 3-7.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

1. Select the proper piece of equipment for a given arthropod problem.
2. Identify the specifications and use of standard military pest control equipment.
3. Identify the requirements for operating a given piece of pest control equipment.
4. Identify preventive maintenance procedures for a given piece of pest control equipment.
5. Identify advantages, limitations, and hazards involved in aerial dispersal and the Army's policy concerning aerial dispersal of pesticides.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

PEST CONTROL EQUIPMENT

Section I. GROUND DISPERSAL

3-1. GENERAL

a. **Equipment.** Many different models of pesticide dispersal equipment are available to conduct pest control operations. Choice of the proper piece of equipment is important. The relatively small number of items approved for use at military installations represent the results of thorough research and development programs. The approved items best meet the needs for insecticide application at military installations. Ground dispersal of insecticides is carried out by means of hand-operated or power-operated equipment.

b. **Personnel and Training.**

(1) Department of Defense standards for insect control require that pesticide dispersal and other insect control operations be accomplished by trained and certified personnel. If correctly used, pesticides are quite safe. If mishandled, they may present a considerable danger to the user, to human bystanders, or to nontarget organisms. Within the past few years, hundreds of new pesticides have been developed and still newer pesticides are being tested. These new chemicals permit new approaches to pest control through their residual and other actions. To obtain maximum effectiveness from these newer pesticides, it is necessary to know the biology of the pests encountered so that pesticides can be applied at the right time and at the right place. These newer pesticides present a wide range of hazard in their use.

(2) Specialized equipment has been and is being developed to disperse these newer materials in a more effective and economical manner. New control techniques are always being devised. Because of these complexities, only trained pest controllers should be assigned to pest control programs. Pest control personnel must be able to demonstrate their capabilities by qualifying for certification in accordance with the Federal Environmental Pesticide Control Act of 1972. Because of the rapidity of developments in chemicals, equipment, and techniques, pest controllers must be periodically reexamined and recertified.

3-2. MANUAL EQUIPMENT FOR DISPENSING LIQUID AND DRY FORMULATIONS

a. **Insecticide Aerosol Can, NSN 6840-01-067-6674.** Push-button, self-pressured aerosol cans are used to control flying insects in enclosed tents, rooms, or dugouts. The insecticide solution is dissolved in a liquefied gas. The mixture is

discharged under its own pressure to form a fine aerosol. As with any pesticide product, read the label thoroughly and follow label instructions.

b. **Compressed Air Sprayers (2-gallon) NSN 3740-00-641-4719.** Two-gallon sprayers (see figure 3-1) are used to apply residual sprays in and around buildings and for spot treatment of outdoor areas such as latrines. They may also be used to apply repellents to the clothing of troops in the field and for emergency decontamination of biological warfare (BW) agents. In operation, the quantity of insecticide used is two-thirds to three-fourths of the capacity of the tank. Air is pumped into the tank with built-in pump until the desired pressure is attained. Newer sprayers are equipped with a pressure gauge; existing sprayers should have a gauge retrofitted (see table 3-1 for NSN). During use, frequent pumping is required to maintain adequate spraying pressure. When emulsion sprays are used, the sprayer should be shaken frequently. These sprayers can be used to apply wettable powder suspensions, but the

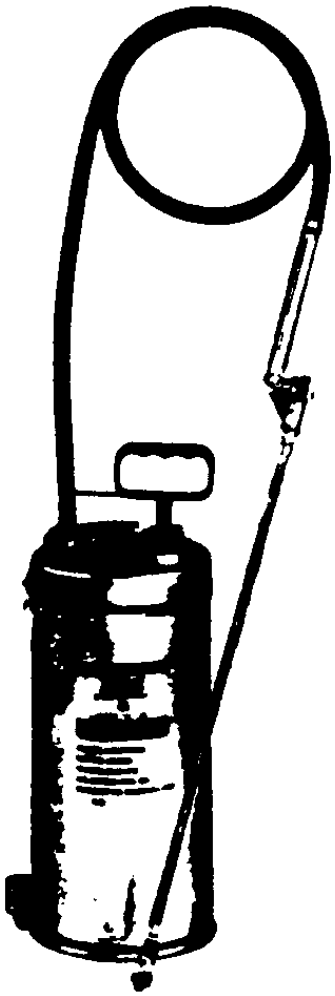

Figure 3-1. Two-gallon compressed air sprayer.

suspensions require frequent agitation. When the sprayer is not in use, particularly if it is left standing where the temperature exceeds 90°F, the pressure in the tank should be released by unscrewing the pump cap slowly until air is heard escaping through the air relief holes in the side of the pump cap. Once all excess pressure is released from the tank, the pump cap may be safely unscrewed from the tank. Figure 3-2 shows all the parts of the 2-gallon sprayer and table 3-1 gives the identification of each part.

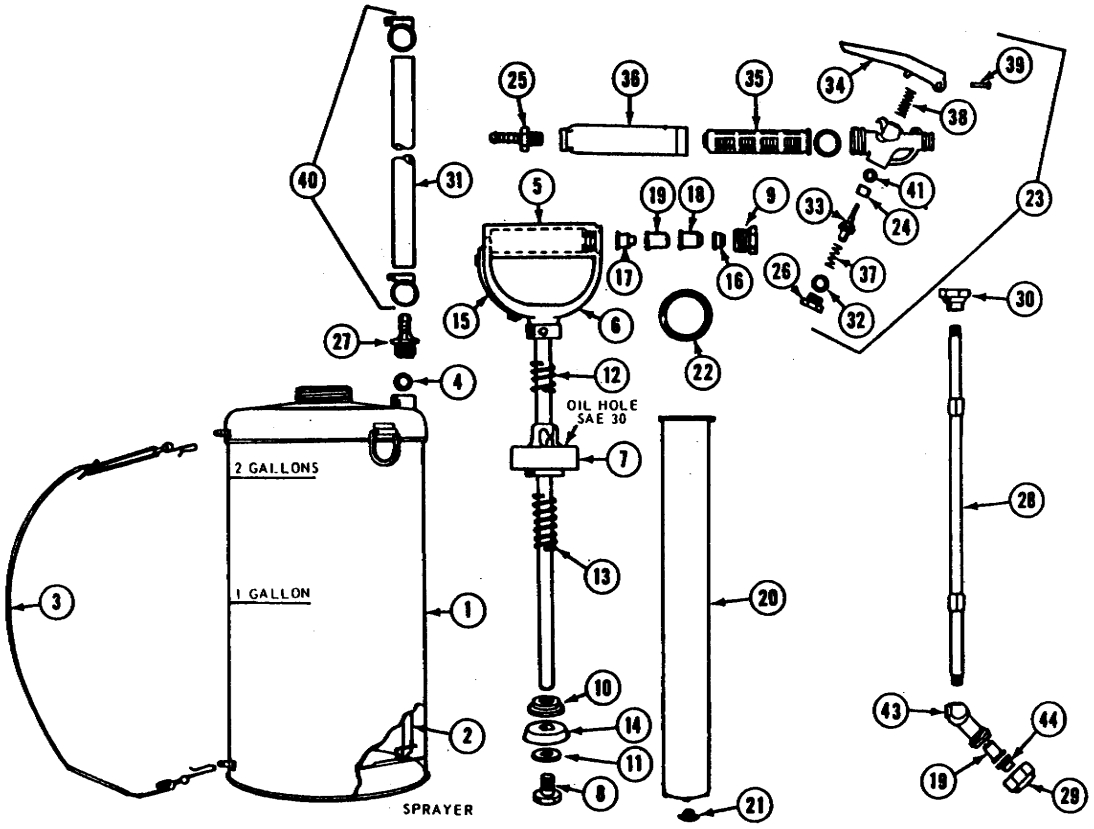

Figure 3-2. Two-gallon compressed air sprayer showing all parts and the identification (table 3-1) of each.

A. LIST OF SPARE PARTS

SUPPLY TANK AND PARTS

1. Tank only for 6700MS Sprayer
2. Supply Tube
3. Shoulder Strap Assembly
4. Supply Tube Gasket

PLUNGER ASSEMBLY AND PARTS

5. Plunger Assembly, complete
6. Plunger Tube and Handle Assembly, only
7. Pump cap, only
8. Retainer Nut
9. End Plug
10. Back Disc
11. Front Disc
12. Locking Spring
13. Bumper Spring
14. Leather Cup
15. Identification Plate
16. Nozzle Tip, Solid Stream
17. Nozzle Tip, Full Cone
18. Nozzle Tip, Hollow Cone
19. Nozzle Strainer Assembly

PUMP CYLINDER ASSEMBLY AND PARTS

20. Pump Cylinder Assembly, complete
21. Pump Cylinder Bottom Valve
22. Pump Cylinder Gasket

DISCHARGE ASSEMBLY AND PARTS

23. Shut-off Assembly, complete
24. Shut-off Valve Pin Bushing
25. Shut-off Hose Connector
26. Shut-off Packing Nut
27. Hose connector
28. Extension Tube, only
29. Nozzle Body Cap
30. Extension Tube Adaptor
31. Hose, only
32. Shut-off Copper Gasket
33. Shut-off Valve Pin Assembly
34. Shut-off Operating Lever Assembly
34. Shut-off Operating Lever Assembly
35. Shut-off Strainer Assembly, only
36. Shut-off Strainer Housing,
37. Shut-off Valve Pin Spring
38. Shut-off Operating Lever Spring
39. Shut-off Operating Lever Rivet
40. Hose Clamp (153-208)
41. Shut-off Valve Pin O Ring
42. Shut-off Strainer Gasket, only
43. Angle Nozzle Body
44. Nozzle Tip, Flat Fan

B. SPARE PARTS OFTEN NEEDED

NSN	Part No.	Item name	Illustrated reference
5330-00-599-0927	267-NB-327	O-Ring	22
3740-00-896-8736		Nozzle Set	16, 17, 18, 19, 44
3740-00-925-2199	72-121	Cup, Piston	14
3740-00-924-2079	72-134	Valve Button	21
3740-00-945-4697	43-3010	Strainer	35
3740-00-924-2078	30-3000	Shut-off assembly	23
3740-01-332-8746		Gauge, Pressure, Pesticide Sprayer - for retrofit	
4330-01-332-1639		Filter Gauge Pesticide Sprayer also required for retrofit of gauge	

Table 3-1. Identification of the 2-gallon compressed air sprayer parts shown in figure 3-2.

(1) Types of nozzles for the 2-gallon sprayer.

(a) Solid stream. This nozzle is used for crack and crevice treatment. See figure 3-3.

Figure 3-3. Solid stream nozzle.

(b) Hollow cone. This nozzle is used for applying pesticides to irregular surfaces such as foliage, edges of water with emergent vegetation, mosquito larviciding, and making broadcast and spot application. See figure 3-4.

(c) Full or solid cone. This nozzle is used for applying treatments to irregular surfaces where high volume is required (foliage, adobe walls, etc.). See figure 3-5.

Figure 3-4. Hollow cone nozzle.

Figure 3-5. Full or solid cone nozzle.

(d) Flat fan. This nozzle is used to make an even broadcast or spot treatment to a smooth surface. See figure 3-6. Nozzle numbers (usually six digits) on a flat fan nozzle provide two items of information. The first two digits indicate the spray angle and the last group of digits indicate the nozzle capacity in gallons per minute (GPM) at 40 pounds per square inch (psi). A decimal point is placed after the third digit. See figure 3-7 for an example of interpreting the nozzle number.

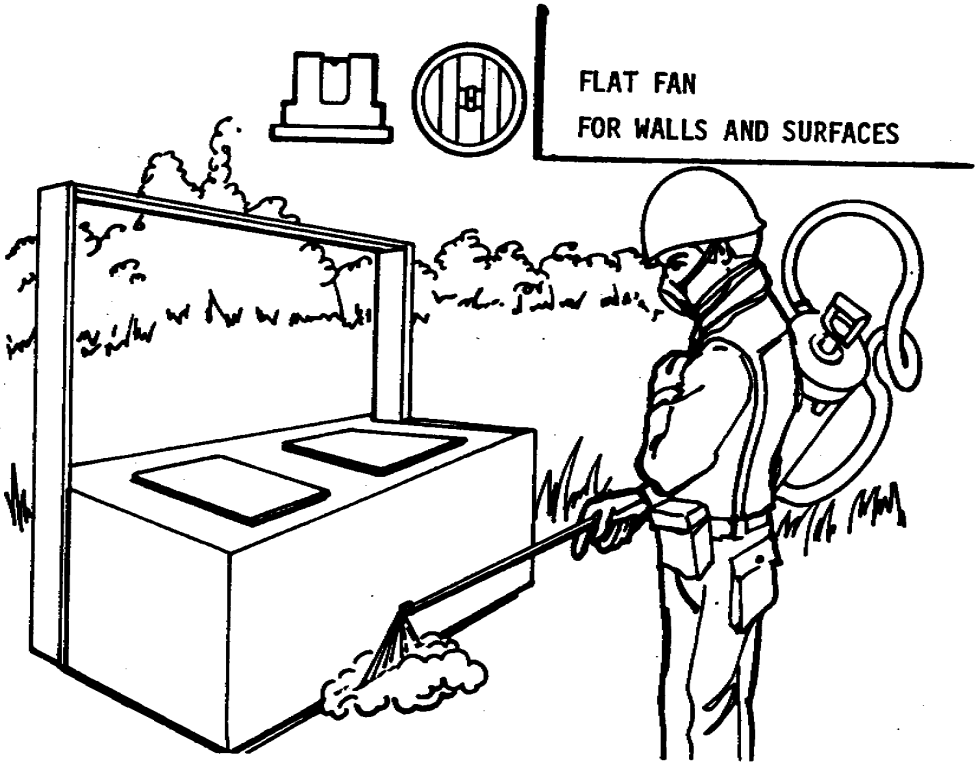

Figure 3-6. Flat fan nozzle.

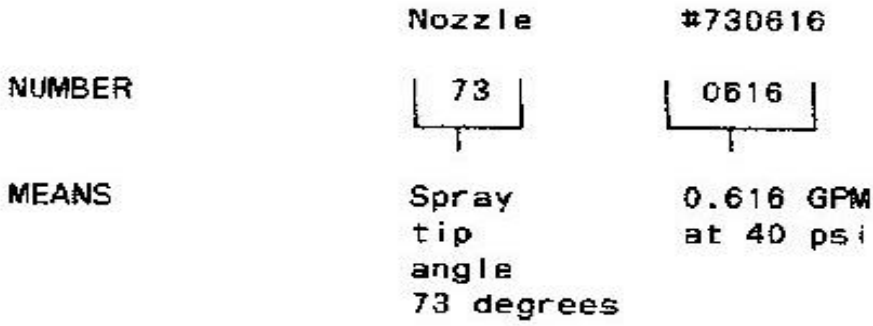

Figure 3-7. Flat fan nozzle numbers.

(2) Preventive maintenance.

(a) Clean sprayer daily after spraying. DO NOT allow formulations to stand in the tank after use. Empty the sprayer and triple rinse the sprayer assembly with clean water (one-tenth the volume of the sprayer per rinse is adequate). Remove the pump cylinder assembly, nozzle, and screen, and depress the shutoff assembly using a rubber band. Hang the tank upside down to dry and lubricate pump cylinder assembly with lightweight oil. Be careful when using wrenches on fittings and when reassembling the sprayer. Most threaded connections have tapered threads; others have gaskets between fittings. Tighten the connection only enough to prevent leaks. Extra tightening will only weaken brass threads and shorten the sprayer's service life.

(b) If the nozzle tip clogs during sprayer, do not attempt to force it open with pressure. Release pressure from tank. Remove and clean shutoff strainer and nozzle strainer, and clean nozzle tip. Do not use wire or blow with your mouth when removing and reassembling shutoff strainer. Do not use pliers on the housing for this strainer; it is removable by hand.

(c) To maintain pumping efficiency and ease of operation, add a few drops of clean, light lubricating oil through the small hole in the pump cap. Also, add a few drops through the plunger tube hole in the pumping cap to lubricate the plunger tube. Should the leather cup dry-out, the pumping stroke will be ineffective. Remove the plunger from the pump cylinder and work oil into the leather with the fingers until it is supple. DO NOT use grease for this purpose.

(d) If the discharge rate from the nozzle tip is irregular, excessive air is probably entering the discharge line. Check the tightness of the hose connector where it is attached to the tank. If this fitting is properly assembled, check the supply tube gasket and replace if necessary.

(e) If the air pressure head within the tank seems to decrease rapidly, check the tightness of the pump cap on the collar of the tank top. If this fitting is properly assembled, check the pump cylinder gasket for defects and replace if necessary.

(f) Occasionally the pump cylinder button valve may become worn or misformed to the point of allowing liquid to enter the pump cylinder. Carefully remove the valve from the cylinder for inspection and, if necessary, replace it by snapping a new valve into place.

c. **Duster, Manually Operated, Tubular Pump, NSN 3740-00-132-5936.** This hand duster (see figure 3-8) is made of galvanized tin or plastic and holds about one pound of dust. It is suitable for spot treatment of fleas, ants, and insects in ornamental shrubbery. It may also be used for delousing troops or civilian populations. The

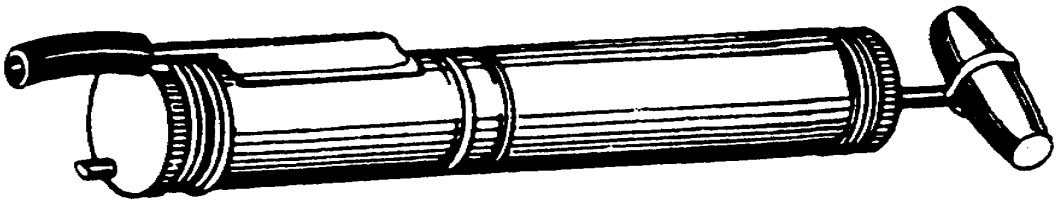

Figure 3-8. Plunger duster.

plunger duster should be used with the wand atop the tank; otherwise, the dust particles will come out in large, coarse clumps. Maintenance of this piece of equipment consists of keeping the duster dry by simply pumping out the contents into a storage container. Water (or any other liquid) should never be put into the duster since the duster will rust and any dust which remains inside it will clump.

3-3. POWER-OPERATED EQUIPMENT FOR DISPERSING LIQUIDS AND DUSTS

a. **Insecticide Hydraulic Sprayer Frame Mounted, NSN 3740-00-772-0090.** This sprayer is used for outdoor spraying, misting, or solid stream application (see figure 3-10). It is often used for disperse fairly large volumes of wettable powder suspensions, emulsions, or solutions. It is frequently used in spraying mosquito larval breeding sites or in residual treatment beneath and around buildings. Recirculating agitation is provided to keep wettable powders in suspension. This sprayer is very useful in treating sanitary landfills and areas of turf. The hydraulic piston-pump sprayer has a maximum output of 180 gallons per hour or 3 gallons per minute at 300 pounds per square inch (psi). Insecticide is discharged at the spray gun nozzle and the spray pattern is controlled by manual adjustment of the spray gun control handle. Maintenance of the sprayer consists of the following steps.

(1) Place suction and recirculating line into first rinse of 3-gallons flush (water).

(2) Start engine and adjust pressure to 300 psi.

(3) Open main discharge valve.

(4) Open spray gun adjustment handle and rinse out spray lines. Continue to rinse with two more containers of 3 gallons each. If liquid is of a type that will harden or crystallize, flush the sprayer with ammonia and water and then with clear water.

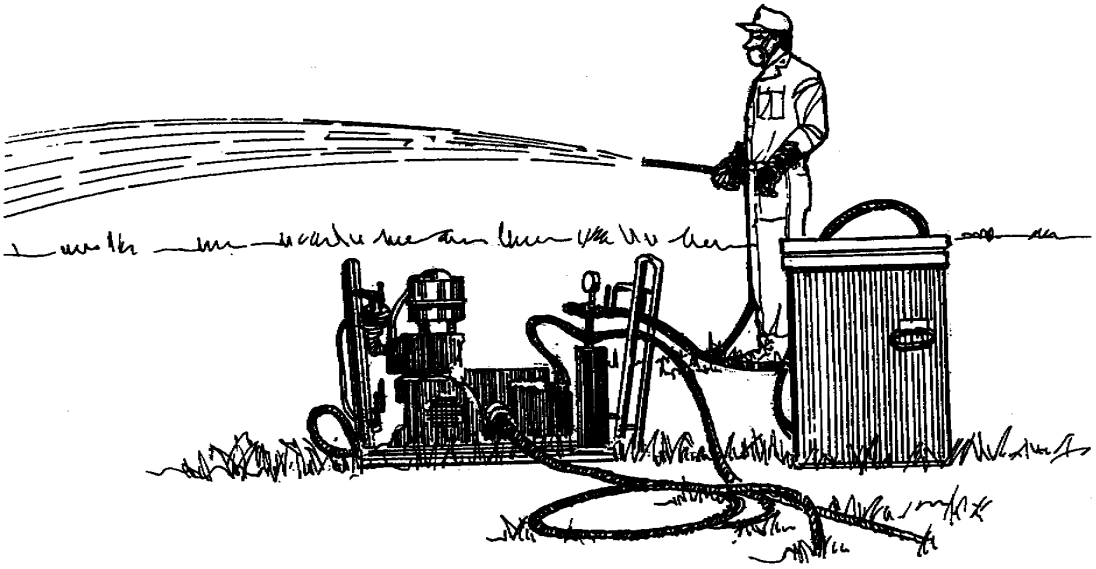

Figure 3-9. Hydraulic sprayer.

(5) Turn off spray gun; stop engine.

(6) Open the main discharge valve, the pressure relief valve, and the petcock; drain the surge tank before storing.

(7) Open the spray gun adjustment handle to drain the main discharge spray hose.

(8) Check the oil level and change the oil occasionally in the crankcase and the bath bowl.

(9) Check all belts and hoses for cracks and loose fittings.

(10) During freezing weather, pump a pint of antifreeze mixed with 1 gallon of water through the machine and then leave to drain.

b. **Aerosol Generated, Ultra-Low Volume, Electric (AGULVE) Sprayer.** This vehicle-mounted unit (see figure 3-10) is the military version of the Beecomist, Promist 15 Ultra Low Volume (ULV) Sprayer, NSN 3740-01-445-8380. The costs of operating an electric cold aerosol ULV sprayer is less than that of thermal foggers and gasoline powered cold aerosol ULV sprayers. This model is an electrical powered system (12 volts) that can use its own battery power or be wired to use vehicle power. It is easy to maintain, calibrate, use, and clean. Moving from storage to vehicle is simple since it weighs only 95 pounds when empty as compared to 446 pounds for gasoline powered models. Eighty percent of all insecticide droplets are within the flying arthropod control

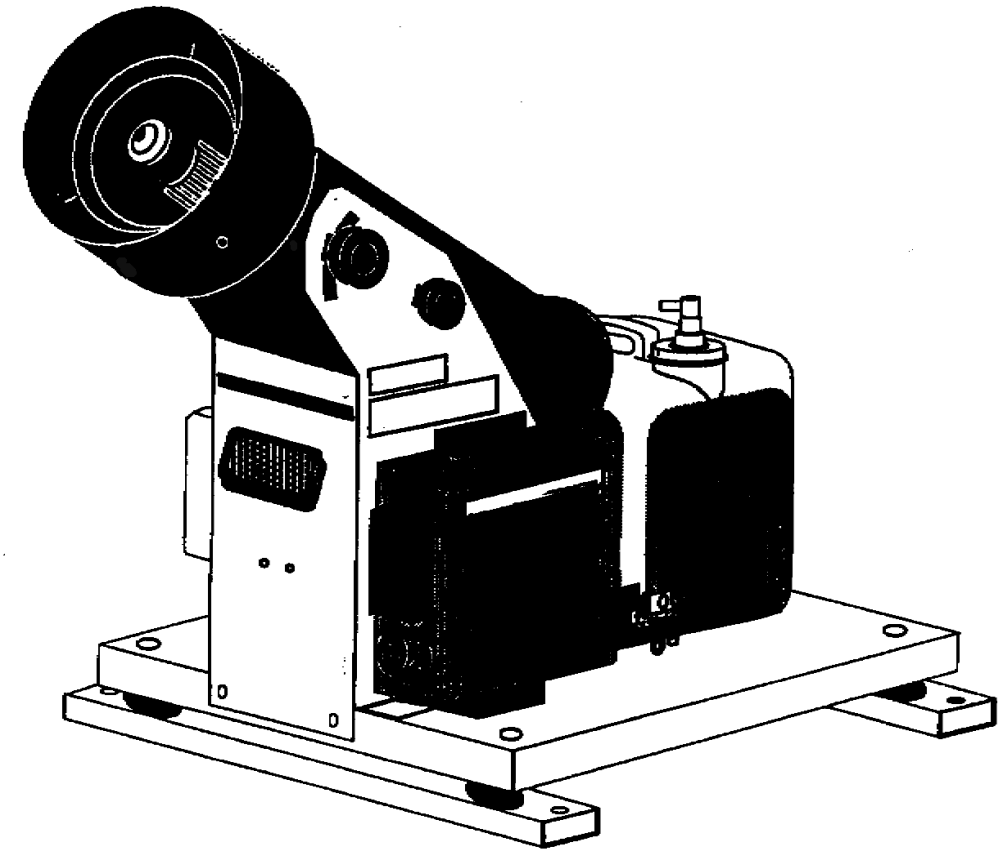

Figure 3-10. Aerosol generated ultra-low volume electric sprayer (AGULVE).

range (5-30 microns), giving superior control over previous models that only delivered 50-60 percent. This is accomplished by forcing the pesticide through a porous sleeve that rotates at 30,000 RPM. The AGULVE is equipped with a remote control assembly, wiring harness for vehicle power supply, a five-gallon insecticide holding tank, a one-gallon flushing agent tank, and a protective frame for field use. This equipment is principally designed for outdoor treatment of adult mosquitoes and sandflies. Certain environmental conditions must exist prior to the use of this equipment -- wind speed must be less than 10 mph; air temperature must be between 40-85°F; and air temperature must be higher than ground temperature. This equipment can only be calibrated with the actual insecticide; flow rate is dependent on the pesticide temperature.

c. **ULD Hand-Held Aerosol Fog Generator.** The hand-held unit most frequently used is the Micro-Gen Model HCSI-2AA, NSN 3740-00-434-6555 (see figure 3-11). The portability of this unit allows the applicator the flexibility to apply the pesticide when needed. This unit can be used in and around buildings and tents and is used to control flying insects, to flush cockroaches, and to control stored products pests. The unit weighs approximately 20 lbs., is powered by a 2 HP 2 cycle engine, and has a chemical bottle capacity of 1 quart. This unit is being phased out of the system. It will be used until no longer functional.

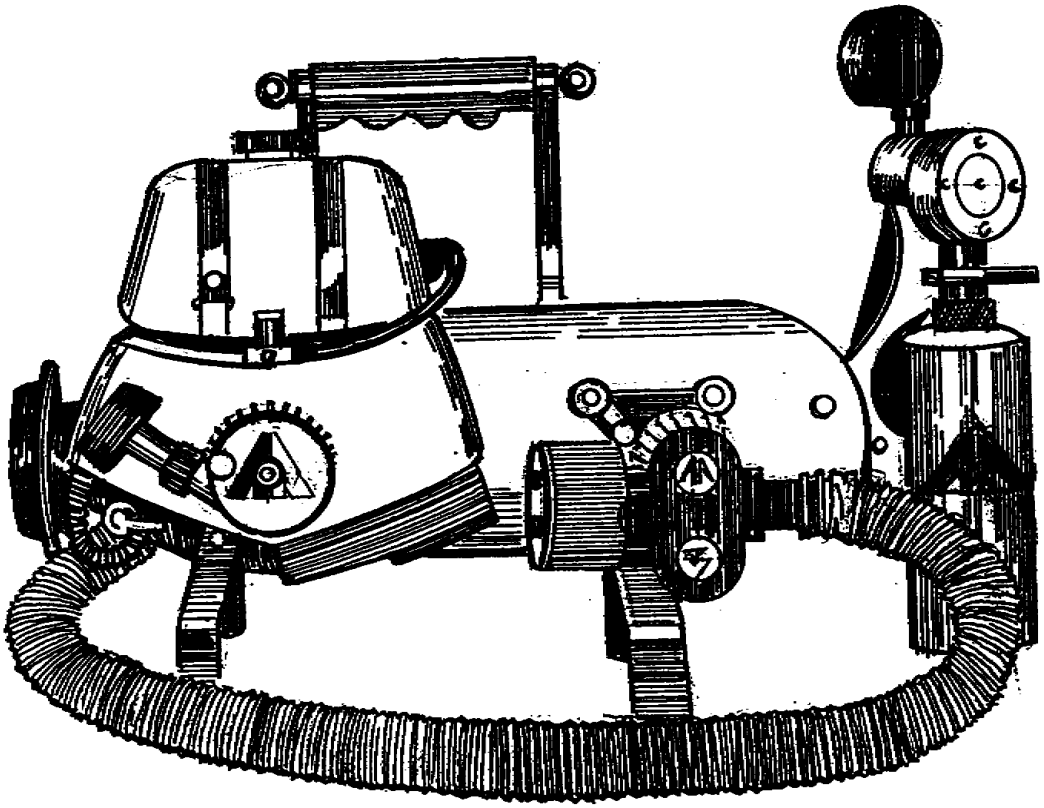

Figure 3-11. Micro-Gen Model, HCSI-2AA hand-held ULD cold aerosol fog generator.

d. **Backpack Sprayer and Duster, NSN 3740-01-157-4000 Model DM-9.** This unit (see figure 3-12) dispenses dusts, granules, solutions, or emulsions. Accessories are available to switch the unit between various modes (granule-spreading nozzle, NSN 3740-01-158-1728; ULV misting nozzle, NSN 3740-01-156-9999). The empty unit weighs 26.45 pounds. The pesticide tank holds 5.3 gallons of liquid or 13.2 to 19.8 pounds of dust/granules. It has a pesticide output of 2 gal/min. This unit is used where areas must be treated with power-operated equipment, but are inaccessible to ground equipment.

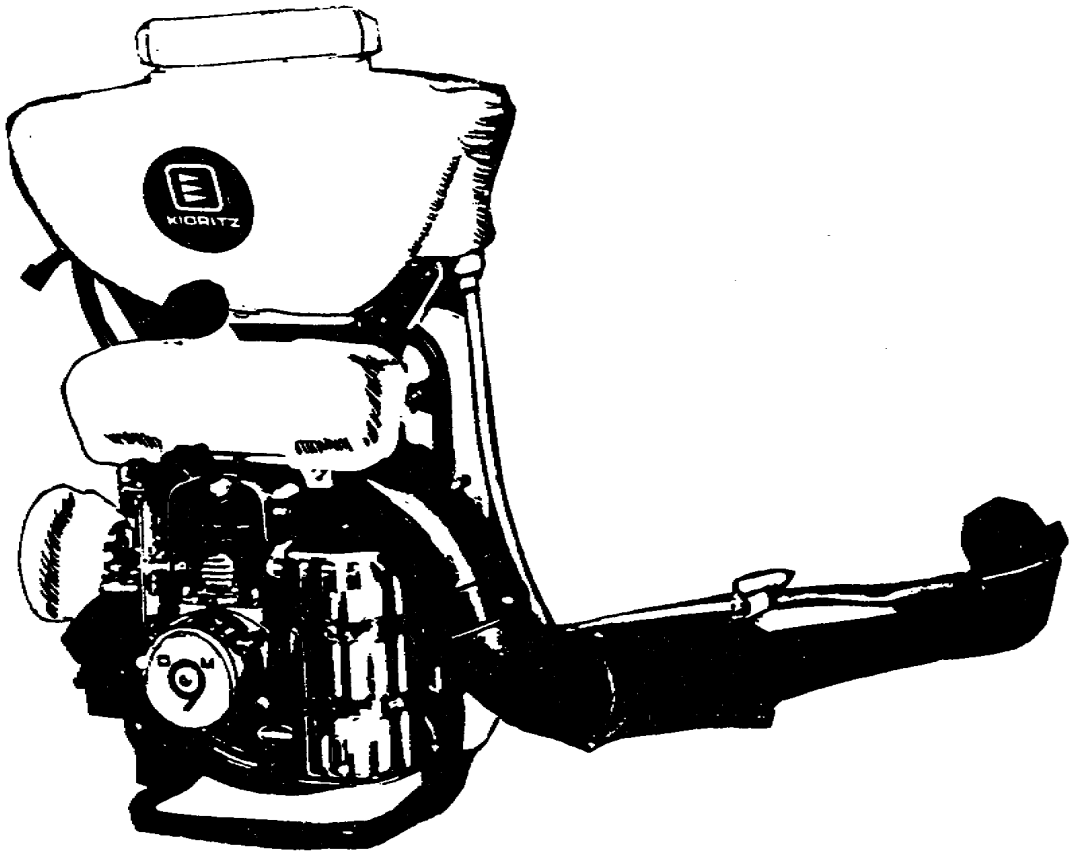

Figure 3-12. Backpack sprayer and duster.

Section II. AERIAL DISPERSAL OF INSECTICIDES

3-4. GENERAL

Aerial dispersal has its advantages and limitations. Aerial dispersal can cover a large area quickly, reaching breeding sources that are otherwise inaccessible. The Army, however, refrains from using aerial dispersal except under dire circumstances because of the hazards involved in the possible poisoning of nontarget organisms. The following factors should be considered when deciding whether or not to conduct aerial control operations.

a. **Wind.** Aerial dispersal is most accurately controlled when there is little (less than 3 mph) or no wind. For practical considerations, any wind greater than 10 miles per hour should be considered excessive.

b. **Temperature.** The most favorable condition of temperature for aerial dispersal is what is commonly referred to as a lapse condition. This is a normal

condition in which the air is at ground level is warmer than the air at higher altitudes. Under a lapse condition, particles in the atmosphere tend to fall vertically with a minimum amount of dispersion. The reverse of this condition is known as a temperature inversion. In an inversion condition, the air at the earth's surface is colder than the air above it. The result is that the cool air is trapped under the warmer air and air movement is lateral rather than vertical. Aerial distribution should be avoided under an inversion condition since the pesticide particles will not penetrate the inversion layer and may fall laterally far from the point of dispersal.

c. **Formulation.** Both liquids and granules can be dispersed from fixed and rotary wing aircraft.

d. **Droplet/Particle Size.** The size of the spray droplet will affect the distance that a pesticide will travel before reaching the ground.

e. **Dust in the Atmosphere.** Liquid chemical droplets adhere to dust particles in the atmosphere and may be carried for great distances. Therefore, aerial dispersal should be avoided under dusty conditions.

3-5. ROTARY WING AIRCRAFT AND INSECTICIDE DISPERSAL

The Army's helicopter slung, pesticide dispersal unit (PDU) can disperse liquid and granular formulations from rotary wing aircraft. The aircraft themselves must be provided by the requesting unit. Helicopter-mounted spray equipment is used for areas up to 1,500 acres. If areas exceeding this size must be sprayed, the requesting unit should submit a request for Air Force support through normal request channels. The Air Force has C-130 aircraft that are equipped for aerial spraying missions over large areas using liquid formulation only.

3-6 HELICOPTER SLUNG PESTICIDE DISPERSAL UNIT (PDU), NSN 3740-01-262-8707

a. **General.** The helicopter using PDU (see figure 3-13) is designed to be used in three configurations -- low volume (LV) liquid spray, ultra low volume (ULV) liquid spray, and dry system. During operation, the PDU is suspended from the helicopter by a nylon strap. All configurations consist of a hopper containing the pesticide, a self-contained gasoline-powered engine, and a hydraulic pump. In the LV configuration, liquid pesticide is pumped by a hydraulic motor-driven centrifugal pump from the hopper to 34 boom spray nozzles. In the ULV spray configuration, liquid pesticide is pumped by the centrifugal pump from the hopper to boom rotary atomizers; the rotary atomizers are hydraulically driven. In the dry system configuration, granular pesticide (only) drops from the hopper to the slinger where it is dispersed by hydraulic motor-driven vanes.

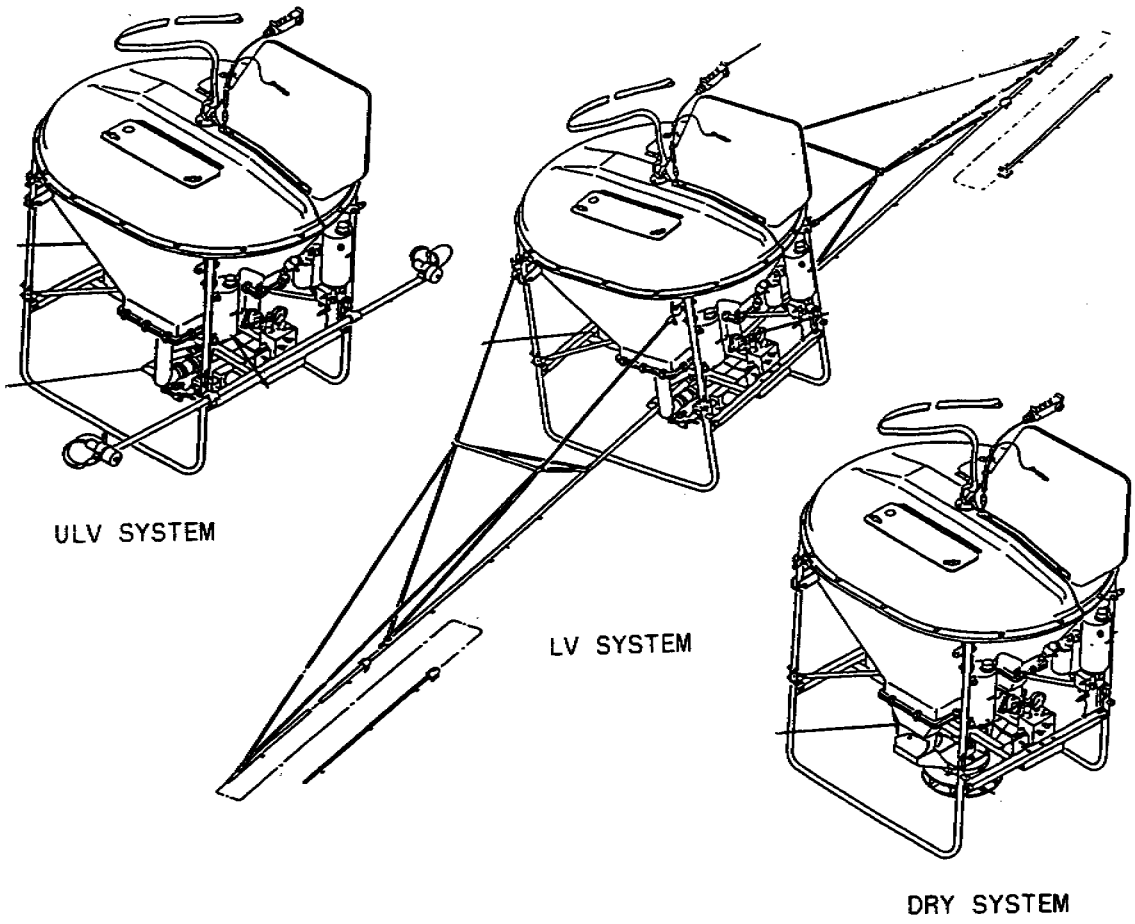

Figure 3-13. Pesticide dispersal unit.

b. **Capabilities and Features.** The remote control operates the PDU from inside the helicopter. When the system switch is in the on position, battery power is applied to the engine. With the system switch on and the engine start switch in the start position, the engine will begin to drive the hydraulic pump and pressurize the system. Pressing the dispersal push-button will release the pesticide. The PDU has a tail fin for stability during flight and is attached to the helicopter with a six- foot nylon strap. A quick-disconnect connection for the remote control protects the operator if the PDU must be released from the helicopter in an emergency. The PDU can be used without modification on any helicopter with a cargo hook.

c. **Major Components.** The PDU consists of the following major components.

(1) Hopper assembly -- fiberglass hopper that holds granular or liquid pesticides. Support frame provides for mounting for engine, gas tank assembly, pump, and hydraulic reservoir.

(2) Remote control assembly -- allows operator to operate PDU from inside the helicopter or on the ground during calibration.

(3) Hydraulic reservoir -- provides supply of hydraulic fluid for system.

(4) Gas tank -- provides fuel for the engine.

(5) Engine -- provides power to drive main hydraulic pump.

(6) Pump and crosstube assembly -- provides hydraulic pressure for operation of LV and ULV systems.

(7) LV boom assembly -- provides LV dispersal of liquid pesticides where minimum penetration is acceptable (sparse foliage). Transports liquid pesticide from hopper to nozzles and provides attachment sites for up to 34 nozzles.

(8) ULV boom assembly -- provides ULV dispersal liquid pesticides where maximum penetration is needed (dense foliage). Provides attachment of two hydraulically actuated rotary atomizers.

(9) Slinger assembly -- provides for dispersal of granular pesticides by rotary action.

(10) Left and right hopper assemblies -- control solid pesticide dispersal through flow metering plates and hydraulically actuated gates.

(11) Battery -- provides electrical power to starter.

3-7. ARMY POLICY ON AERIAL DISPERSAL

The Department of the Army requires the filing of an Environmental Impact Statement (EIS) whenever there is to be an aerial dispersal of pesticides. Considering the hazards involved in such an operation (i.e., the inadvertent poisoning of nontarget organisms and low-level flying), aerial dispersal is used only when other methods are impractical. Military agencies must justify aerial dispersal of pesticides in terms of necessity on an epidemiological basis, having also shown its economy over other measures.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Which one of the following is most effective outdoors against adult mosquitoes and flies?

   a. Rotary duster.

   b. Aerosol generated, ultra-low volume electric sprayer.

   c. Hand sprayer.

   d. Hydraulic sprayer.

2. A dry formulation (i.e., dust or granules) would best be dispersed by a(an):

   a. Backpack sprayer.

   b. Aerosol dispenser.

   c. Two-gallon compressed air sprayer.

   d. Hydraulic sprayer.

3. When spraying mosquito larvae with the 2-gallon sprayer, which of following nozzles should be used?

   a. The hollow cone nozzle.

   b. The flat spray nozzle.

   c. The solid spray nozzle.

   d. The full cone nozzle.

4. Use _____ to lubricate the leather cup of the 2-gallon sprayer.

   a. Graphite.

   b. Grease.

   c. Oil.

   d. None of the above.

5. During freezing weather, _____ should be pumped through the hydraulic piston-pump sprayer.

   a. Alcohol.

   b. Antifreeze.

   c. Salt water.

   d. None of the above.

6. Helicopter slung insecticide equipment can be used for areas up to:

   a. 1,500 acres.

   b. 4,500 acres.

   c. 8,000 acres.

   d. 12,500 acres.

7. The three configurations of the PDU are:

   a. LV liquid, ULV liquid, and granular.

   b. LV liquid, ULV liquid, and dust.

   c. Liquid, dust, and granular.

   d. None of the above.

8. Aerial dispersal should be avoided under a(an) _____ condition, as the pesticide particles may fall laterally far from the point of dispersal.

   a. Windy.

   b. Inversion.

   c. a and b above.

   d. None of the above.

9. The PDU in ULV configuration is used to apply pesticides where maximum penetration is desired.

   a. True.

   b. False.

10. Only when all other methods of arthropod control have been proven to be impractical will the Army approve:

    a. ULV dispersal.

    b. LV dispersal.

    c. Aerial dispersal.

    d. None of the above.

11. If you were to spot-treat a latrine, which one of the following pieces of equipment would be most appropriate to use?

    a. The plunger duster.

    b. The 2-gallon compressed air sprayer.

    c. The nonthermal fogger.

    d. The rotary duster.

12. Which piece of equipment is capable of dispensing either dry or liquid formulation?

    a. Plunger duster.

    b. 2-gallon sprayer.

    c. Backpack sprayer/duster.

    d. Hydraulic sprayer.

13. Water wettable powders cannot be used with the hydraulic insecticide sprayer because it has no method of agitation.

    a. True.

    b. False.

14. The solid stream nozzle on the 2-gallon sprayer is used for:

    a. Spot treatment.

    b. Crack and crevice treatment.

    c. Broadcast treatment.

    d. Mosquito larvaciding.

15. Pesticide leaking into the pump cylinder of the 2-gallon sprayer usually indicates:

    a. The O-ring is bad.

    b. The nozzle tip is clogged.

    c. The button valve is bad.

    d. The leather cup is dry.

16. If a nozzle plugs up, your best action is to:

    a. Release tank pressure and replace button valve.

    b. Release tank pressure and clean tip.

    c. Release tank pressure and replace the O-ring.

    d. None of the above.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. b (para 3-3b)
2. a (para 3-3d)
3. a (figure 3-2b(1)(b))
4. c (para 3-2b(2)(c))

5 b (para 3-3a(10))

6. a (para 3-5)
7. a (para 3-6a)
8. c (paras 3-4a, b)
9. a (para 3-6c(8))
10. c (paras 3-4, 3-7)
11. b (para 3-2b)
12. c (para 3-3d)
13. b (para 3-3a)
14. b (para 3-2b(1)(a))
15. c (para 3-2b(2)(f))
16. b (para 3-2b(2)(b))

End of Lesson 3

COMMENT SHEET

SUBCOURSE MD0171 Arthropod Control EDITION 100

Your comments about this subcourse are valuable and aid the writers in refining the subcourse and making it more usable. Please enter your comments in the space provided. ENCLOSE THIS FORM (OR A COPY) WITH YOUR ANSWER SHEET **ONLY** IF YOU HAVE COMMENTS ABOUT THIS SUBCOURSE..

FOR A WRITTEN REPLY, WRITE A SEPARATE LETTER AND INCLUDE SOCIAL SECURITY NUMBER, RETURN ADDRESS (and e-mail address, if possible), SUBCOURSE NUMBER AND EDITION, AND PARAGRAPH/EXERCISE/EXAMINATION ITEM NUMBER.

PLEASE COMPLETE THE FOLLOWING ITEMS:

(Use the reverse side of this sheet, if necessary.)

1. List any terms that were not defined properly.

2. List any errors.

paragraph	error	correction

3. List any suggestions you have to improve this subcourse.

4. Student Information (optional)

Name/Rank _____
SSN _____
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MOS/AOC _____

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