



Ministry of Health
National Malaria Control Centre

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DDT Guidelines for IRS

Indoor Residual Spraying

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Unloading pesticides for storage in full Personal Protective Equipment

1.0 Introduction

Dichlo Diphenyl Trichloroethane (DDT) has been shown to be an effective, affordable residual insecticide for malaria vector control. It is considered to be a relatively safe insecticide to use in public health vector control activities. However, its long persistence in the environment and its high bioaccumulation in fatty tissues have led to a great reduction in its use in recent years.

Generally, all insecticides are poisons and can be harmful if improperly used. Users should be fully aware of the hazards they pose. They can enter the body by three different routes: the skin (dermal absorption), the mouth (ingestion), and the lungs (inhalation). Poisoning may occur while preparing, spraying, storing, or transporting insecticides.

Taking special safety precautions and using common sense minimizes the risk of poisoning that insecticides not only pose to users, but to other people, non-target organisms, and the environment (including drinking water, food, and soil).

Precaution must be central to a proper insecticide management and monitoring system. People who work with insecticides should receive quality training in procedures for handling insecticides safely.

Zambia is currently exempt from an international ban of DDT and can use it for malaria vector control. The exemption is granted provided that Zambian authorities ensure that DDT is used solely for malaria

control and in accordance with all the regulations and requirements of the Stockholm and Basel conventions and the World Health Organization (WHO). The use of DDT for any other purpose, including agriculture, is strictly banned in Zambia. Locally, DDT use is regulated by the Environmental Council of Zambia (ECZ) and the National Malaria Control Centre (NMCC).

“It is considered to be a relatively safe insecticide to use in public health vector control activities.”

These guidelines provide basic information and direction to health workers working with DDT in Zambia. It also includes fundamental information on Indoor Residual Spraying that should help them use it effectively. It is hoped that workers’ adherence to these guidelines will facilitate the judicious use of insecticides in malaria control and reduce disease burden in Zambia

2.0 General Description

DDT is a white, crystalline, tasteless, almost odourless, solid substance. It does not occur naturally in the environment and is a man-made synthetic. Thus, the presence of DDT in the environment is generally a result of human dispersal of DDT residuals through land, water, and air.

DDT is insoluble in water, but very soluble in ethyl ether, acetone, benzene, and other organic solvents. It is stable in strong acids and can withstand acid permanganate oxidation.

3.0 DDT Formulation

In its raw form, DDT cannot be easily applied. It must be prepared or formulated before it can be easily sprayed or applied onto a target and have lasting effect. The formulation is usually made up of several components:

- (a) Active Ingredient (the chemical component that kills or controls the insect)
- (b) Carrier (an inert component of solid formulations, e.g. powders, granules)
- (c) Solvent (used in liquid formulations)
- (d) Surface Active Agents (used in liquid or solid formulations to enable the product to mix with water. Also used to allow the product to spread or stick to target better)

For example, the formulation DDT 75% WP is a 75% formulation. It contains 750 grams of DDT in every 1000 grams of formulated product. It is a wettable powder and 25% of it is carrier.

DDT, like many insecticides, is not applied in its pure form. It is a mixture of finely ground inert materials with highly concentrated active chemical. DDT is water dispersible. The insecticide remains suspended in water with occasional stirring. Water-dispersible DDT powder is most suited for porous surfaces such as walls made of brick and mud (informal structures). Its insecticide particles are large so absorption is low, thereby allowing the active ingredient to remain on the surface for the target vector to pick up.

Water-dispersible particles are also lighter. Prior to application, the powder is mixed with a large volume of water, resulting in an insecticide suspended in water. However, no suspension is stable. Therefore, with time,

solid particles will separate from liquid and settle. It is important that the spray liquid should be prepared just before application and agitated every 30 minutes.

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4.0 DDT Production and Supply

DDT is not manufactured locally in Zambia but supplied from South Africa. The production of DDT has been allowed but restricted to the sole purpose of malaria vector control in accordance with WHO recommendations, which promote safety and cost-effectiveness.

An identified local supplier should be responsible for transporting DDT into Zambia and to its points of use. When ordering DDT, one should take into account the lag time between order and arrival at its point of use.

5.0 Factors Guiding the Choice of DDT

The following should be considered when deciding whether or not to use DDT for IRS in a certain locale:

5.1 Target Mosquito Vector

Vector characteristics are a critical consideration. It is important that the target vector is highly endophilic (indoor resting) and susceptible to the DDT. Target mosquitoes should die within 30 minutes after contact

with DDT, otherwise, resistance should be suspected.

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5.2 Public Compliance

DDT should never be used without express consent of target house owners. Since it is a restricted substance and leaves a white residue on walls, health education is important: reasons for spraying should be explained to house owners and fellow health workers. Local customs and beliefs should also be respected.

5.3 Insecticide Characteristics

- (a) DDT should be cost-effective
- (b) DDT should be highly toxic to target mosquitoes. Insecticides lose their effectiveness when insects develop resistance. Resistance should be tested for from time to time
- (c) DDT should have long-lasting effect on target surfaces.
- (d) DDT should not repel nor irritate target insects. This ensures that target insects will pick up lethal doses of DDT
- (e) DDT should be safe to humans and domestic animals (domestic animals should be kept away from spray sites)
- (f) DDT should not be a danger to spray operators
- (g) DDT should be acceptable to house owners (some insecticides are less acceptable)

because they smell or because they leave unattractive residue on walls)

5.4 Construction Material of Houses

The presence of large numbers of informal structures (structures with mud or unplastered walls and thatched roofs) in malarial peri-urban areas in Zambia calls for the use of DDT. DDT is proven to be more effective than pyrethroids when sprayed on informal structures with absorbent surfaces, and, indeed, it has been successfully used on such surfaces in Zambia. Other insecticides are more effective on non-absorbent surfaces.

use of DDT.

A user who has either been authorized or licensed to buy DDT for public health use should never transport the product across district boundaries except with express permission from the MOH and the ECZ. The DDT should be well labelled.

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6.0 DDT Regulations

6.1 Importation

DDT importers should obtain a license to import DDT from the ECZ and provide them with information on their supplier and the quantity they intend to import. The ECZ should ensure that DDT importers take the responsibility of ensuring its proper disposal.

6.2 Use

Following correct procedures for storage, application, and waste management that ensure safety for people and the environment, users should only use DDT for purposes of public health vector control.

Users should send information to the ECZ on how they monitor the

7.0 DDT Storage



Insecticides should be stored properly on a raised pallet

It is important that DDT is correctly stored to maintain its quality. The following should be especially considered in its storage:

- (a) The store should be lockable, sufficiently far from people's

- homes, and not susceptible to floods and fires
- (b) Unauthorised personnel should not have access to the store
 - (c) Warning signs should be placed at each entrance of the store
 - (d) DDT should be stored in its original containers with labels intact
 - (e) Food should neither be stored nor eaten in the store
 - (f) The store should be kept dry
 - (g) DDT should be stored away from fires and direct sunlight
 - (h) DDT containers should be stacked well to prevent breaks and spills
 - (i) The store should be constructed of fire-resistant materials, have a concrete floor (for easy cleaning of spills), and be well ventilated
 - (j) The store should be guarded 24 hours everyday by dedicated store attendants
 - (k) A checklist card for stored insecticides must be available in the store.

8.0 DDT Packaging and Labelling

DDT should be packaged and labelled according to WHO specifications (refer to “Specifications for Pesticides in Public Health: Insecticides, Molluscides, Repellents, Methods” 6th ed. Geneva, World Health Organization, 1985). Packaging it in water-soluble sachets ensures that it can be added easily and directly into water-filled spray pumps thereby reducing the hazard associated with handling and mixing them in separate containers.

Labels should be in English (Zambia’s official language) and indicate the following:

- (a) Date of manufacture
- (b) Date of expiry
- (c) Trade or brand name

- (d) Generic name
- (e) Contents
- (f) Ingredients
- (g) Net volume or weight
- (h) Registration or licence number
- (i) Type of formulation
- (j) Name and address of manufacturer, distributor, and/or formulator

It should also provide directions for use, safety instructions, warnings (symbolic or textual), and measures to take in case of accident (e.g. ingestion, contamination). It also provides physicians with instructions on what antidote to use in case of poisoning.

9.0 Safe Application of DDT

9.1 Principles

Though considered a relatively safe insecticide, DDT, like any other insecticide, is a toxic chemical that can harm and even kill people, animals, and plants if improperly used. However, DDT can be used with minimum or no risk to either people or the environment if the principles below are observed. Note that the use of DDT for any purpose other than malaria vector control (e.g. as an agricultural pesticide) has been banned in Zambia:

- (a) Following guidelines that ensure safety to the environment and spray operators, apply insecticides carefully and correctly only on to target surfaces
- (b) Before any application, evaluate the likelihood of effectiveness to justify the application and have adequate knowledge of the method of application, equipment, and protective clothing
- (c) Observe all directions, restrictions,



Trainees pressurizing pumps

and precautions as stated on insecticide labels

- (d) Store DDT in a locked room in its original containers with labels intact away from food, feed, and clothing, and out of the reach of animals and unauthorized people
- (e) Experience in dealing with DDT or insecticides in general is useful to ensure safety. Engage services of experienced persons as often as possible
- (f) Use DDT at correct dosages with correct nozzle sizes to avoid excessive residue and injury to non-target people, plants, and animals

9.2 Precautions to Take Before and During Spraying

- (a) Remove all jewellery (e.g. watches), foodstuffs, drinking water, and utensils used in the preparation of foods from the vicinity during spraying
- (b) Remove all bedding
- (c) Wear protective clothing and use equipment as specified on labels
- (d) Clear the area around houses being sprayed of people, pets, and livestock
- (e) Move the elderly and the sick from rooms which are being sprayed. If this is not possible, those rooms should not be sprayed
- (f) Check your application equipment for leaks and faulty nozzles
- (g) Be sure that your equipment is

“Note that the use of DDT for any purpose other than malaria vector control (e.g. as an agricultural pesticide) has been banned in Zambia”

putting out the proper amount of water. Calibrate spray equipment before adding DDT

- (h) Use the correct spraying pressure and nozzle orifices
- (i) Check the label to determine the precautions that must be taken after DDT application
- (j) Reserve a pair of spare gloves and ensure they are in good condition before using them
- (k) Do not eat or smoke after handling or spraying DDT until hands are washed
- (l) Take sufficient breaks during spraying (20 minutes for every hour of spraying)
- (m) Never employ spray operators for more than 6 hours a day and check them for toxicity every 60 days

9.3 Mixing and Loading DDT into Tanks

Read the directions carefully on DDT labels before you open the containers. Prepare it accordingly and keep the following basic principles in mind:

- (a) Keep people, pets, and livestock away from the area where mixing and loading of DDT is taking place
- (b) Work in a well lit and ventilated area, preferably outdoors. Do not work alone
- (c) Wear tightly woven pants and shirts with long legs and sleeves that extend over liquid proof boots and gloves
- (d) Wear a liquid proof apron or raincoat, a wide-brimmed liquid proof hat, goggles, and any other protective clothing or equipment that is specified on the label
- (e) Consider the toxicity of the pesticide and the working conditions when deciding on the protection you need
- (f) Measure carefully and mix only

the amounts you intend to use. Keep containers below eye level to avoid splashes and spills entering your eyes. Close them immediately after you finish with them

- (g) Stand with your back to the wind when loading or mixing DDT so that it does not blow onto you. If you spill any DDT on yourself, immediately remove the contaminated clothing, wash the affected area with detergent and water, and clean up the spill

9.4 Procedures to Follow at the End of Each Spraying Day

- (a) Leave all clothing in the storeroom before going home
- (b) Take a complete shower, shampoo your hair, and clean your fingernails
- (c) Launder the clothing you wore before wearing it again with hot water and a strong detergent
- (d) Thoroughly flush application equipment with water, both inside and out, to prevent daily accumulation of chemicals
- (e) Choose your cleaning area with great care
- (f) Never pour remaining DDT into rivers, pools, or sources of drinking water
- (g) Pour remaining DDT into a drum to save for reuse the following day

9.5 Clean Up of Equipment

At the end of each spraying season, clean the sprayer thoroughly, both inside and out, by following the steps below:

- (a) Fill sprayers half way with clean water and flush it out through the nozzles by operating them. Do this twice.
- (b) Remove nozzle tips and screens



Sprayer pumps should be thoroughly cleaned both inside and out

- (c) and check for wear and tear
- (c) Clean the tips and screens in either kerosene or detergent solution using a soft brush
- (d) Do not use knives, wire, or any other hard material to clean nozzle tips (the fine surface of sprayer tips can be easily damaged, causing spray pattern distortion and an increase in the rate of application)
- (e) Fill the tank about half way with clean water and add about 1 pound of detergent for every 50 gallons of water
- (f) Operate the pump to circulate the detergent solution through the sprayer, and then flush it out through the lance
- (g) Fill the tank about half way with
- (h) clean water while hosing down both the inside and the outside, and then flush the water out through the lance
- (h) Remove and store the nozzle tips, strainers, and screens in light oil. Store the sprayer in a clean, dry shed. Order replacement parts if necessary to prepare for the next season

“Do not use knives, wire, or any other hard material to clean nozzle tips ”



10.0 Safe Disposal of DDT

- (a) All empty DDT containers should be returned to the supervisor for safe disposal
- (b) Recommended safe disposal is by a high temperature incineration at 1000 degrees by an authorized person
- (c) Promptly dispose of empty containers while avoiding environmental contamination and possible injury to non-target organisms
- (d) Never reuse empty DDT containers
- (e) Ordering DDT in carton boxes instead of drums eases disposal
- (f) To avoid wasteful disposal, estimate the amounts needed for spraying accurately and apply according to specified directions with common sense and economy

11.0 Preventing the Development of Mosquito Resistance to DDT

- (a) Never apply DDT below the recommended dosage
- (b) Apply insecticides intelligently. Where possible, use different insecticides in rotation if applying and reapplying over a long period of time
- (c) Mix the insecticide properly when diluting

- (d) Monitor the susceptibility of vectors to DDT by bioassays
- (e) Study the indoor resting habits of the vectors (the killing action of DDT is through contact). Vectors should be highly endophilic

12.0 Partnerships in Spraying Campaigns with DDT

A good spraying operation requires an inter-sectarian approach with participation from local authorities such as DHMTs, municipal councils, private entities, NGOs, and any other interested parties.

Information on spraying operations should be well communicated and public acceptance

of and cooperation with spraying operations should be obtained in advance.

13.0 Training Spray Operators on Using DDT

The success of a spraying programme depends to a large extent on training spray operators and supervisors well. This training should be 21 days long, 18 days for practical (85%) and 3 days for theory (15%). Supervisors should receive extra in-depth training on environmental hazards, protection, toxicity, first aid, safe handling, and safe disposal of DDT and other, alternative, insecticides.

To ensure the proper, complete, standard training, follow the guidelines in the Indoor Residual Spraying Spray Operator Training Manual.

I. An Explanation of Selected Terms

Insecticide

An insecticide is a toxic chemical that is used to kill insects, but can also injure and even kill people, animals, and plants if improperly used. Properly used, lethal doses of insecticide can be given to insects without doing collateral harm.

Formulation

Insecticides are seldom used at full strength but, rather, formulated with other substances. Thus, an insecticide as it appears on the market is composed not only of a toxic part (either called the toxicant or the active ingredient), but of a toxic part and one or more non-toxic parts (often referred to as inert materials). The typical ingredients of a formulation include an active ingredient, solvents, carriers, surface active agents, and special additives. The inert materials may serve to dissolve the active ingredient, act as carriers, disperse the active ingredient, improve effectiveness, reduce toxicity, or break the active ingredient down into smaller parts making the resulting formulation diluted, extended, and easier to apply. Formulation has great influence on the effectiveness of an insecticide.

Common formulations include dusts, granules, and wettable powders. Dusts are used dry. Wettable powders have the appearance of dusts but are meant to be diluted or suspended in water and used as sprays. To make a dust act as wettable powder, a dispersing and wetting agent can be added (as is done with DDT). Wettable powders are more concentrated than dusts and are composed of as much as 75% toxicant. In general for all formulations, as the size of an insecticide particle decreases, so does its toxicity.

Active Ingredient

The active ingredient is the toxic or poisonous part of the insecticide. It is the most important part of a formulation as it determines the other ingredients. Relevant properties of active ingredients include its melting or boiling point, water solubility, and stability.

Toxicity

Toxicity measures the degree to which a substance may cause harm to human, animal, or insect. It is usually expressed in terms of Lethal Dosage (LD). To compare the toxicity of various insecticides, the value of Lethal Dose 50 (LD50—see below) is used. Acute oral and acute dermal toxicity is measured by observing test animals' responses to single doses of toxin.

Toxin doses are measured in milligrams of active ingredient per kilogram weight of test animal (e.g. rat, rabbit). A milligram is one millionth of a kilogram so these units are called parts-per-million (PPM).

LD50

LD50 refers to the dose, measured in PPM, of a chemical that kills 50% of a population of test animals. Insecticides are divided into various hazard classes according to their LD50 values. The toxicity of an insecticide is determined by the concentration of its active ingredient and its formulation. For any insecticide, a granule formulation is safer to use than a spray, and a coarse spray is safer to use than an aerosol.

The most highly toxic chemicals are applied as granules since fine powders are too easily inhaled.

A chemical's LD50 value is not absolute: it varies between different species of animals and even different individuals within a single species of animal. Each species, and each individual (to a lesser extent), reacts differently to different chemicals. This often causes toxicity to be misinterpreted but also allows for species targeting. Toxicity also varies depending on the route of absorption into the body. An LD50 value of a chemical may vary depending on whether it enters the body through the mouth (ingestion), the skin (dermal absorption), or the lungs (inhalation).

Modes of Action

Insecticides generally kill insects by interfering with their normal life processes. Different insecticides have different modes of action in killing insects. For example, some insecticides kill insects on contact by interfering with their nervous systems. Insecticides that kill on contact are called knockdown insecticides, while others, which kill in time, are called systemic insecticides.

II. First Aid Procedures

The following precautions and procedures should be followed to ensure maximum safety and minimum harm:

- (a) If insecticide accidentally comes in contact with skin or clothing, remove the clothing and wash the skin with plenty of water
- (b) Keep extra sets of PPE
- (c) Maintain effective communication with supervisors (with mobile phones, etc.)
- (d) If insecticide is accidentally inhaled, immediately get to a location where there is fresh air
- (e) If insecticide is accidentally ingested, rinse the mouth with plenty of water and see a healthcare provider at once (do not induce vomiting unless specifically instructed to do so on the insecticide label)
- (f) When consulting a healthcare provider in case of accident, take the insecticide label
- (g) Ensure familiarity with first aid procedures on insecticide labels

Symptoms of Poisoning

In order to protect one another, workers must know the signs and symptoms of insecticide poisoning. If someone has been poisoned, co-workers should get that person medical help immediately. They should not leave the person alone. When taking the person to a healthcare provider, they should take with them the insecticide label or, if necessary, the entire insecticide container. If they take the entire container, they should not carry it in the passenger space of the vehicle. Symptoms for different insecticides are detailed below:

Chlorinated Hydrocarbons (e.g. DDT, Chlordane, Lindane)

Not many chlorinated hydrocarbons have poisoned insecticide users. Early indications of poisoning include headache, nausea, vomiting, general discomfort, and dizziness. The victim may also be unusually excited or irritable. With severe poisoning, convulsions occur with or without earlier symptoms. Coma may follow the convulsions (refer to hospital).

Synthetic Pyrethroids (e.g. Deltamethrin, Icon)

Toxicity to warm-blooded animals is generally low, but pyrethrins, the active ingredient in pyrethroids, may elicit inhalant allergic responses: stuffy or runny nose, scratchy throat, asthma and, rarely, anaphylactic shock in extremely sensitive persons. Symptoms can be managed with antihistamines for less severe reactions and adrenalin or hydrocortisone for severe asthma or anaphylaxis.

Organophosphates (e.g. Parathion, Malathion)

Symptoms almost always begin within 12 hours after exposure. They usually occur in approximately the order in which they are listed below:

- (a) Mild poisoning causes fatigue, headache, dizziness, blurred or dark vision, excess

- sweat and saliva, nausea and vomiting, stomach cramps and diarrhoea
- (b) Moderate poisoning causes difficulty in walking, weakness, chest discomfort, muscle twitches, pinpoint pupils, and increased severity of earlier symptoms
 - (c) Severe poisoning causes unconsciousness, severely pinpointed pupils, muscle twitches, secretions from mouth and nose, breathing difficulty, and death if not treated

Carbamates (e.g. Propoxur)

Carbamates cause about the same symptoms as organophosphates, but a physician can treat the poisoning more easily.

