

# EQUIPMENT FOR VECTOR CONTROL

## SPECIFICATION GUIDELINES



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# **EQUIPMENT FOR VECTOR CONTROL SPECIFICATION GUIDELINES**

**Revised edition**



Department of Control of Neglected Tropical Diseases  
WHO Pesticide Evaluation Scheme (WHOPES)

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# 1 INTRODUCTION

The purpose of this document is to standardize the development of specifications for major equipment used to apply pesticides for control of vectors. The specification guidelines provided herein are also intended to assist national authorities in selecting equipment of assured quality used to apply pesticides for vector control activities.

The World Health Organization (WHO) has previously published specifications for pesticide application equipment, the last series being published in *Equipment for vector control*<sup>1</sup> in 1990. The specification guidelines included in this document contain the minimum required standards advocated by WHO, and incorporate technological advances in the field; they therefore supersede the specifications previously published by WHO for such equipment.

The test methods described in this document are intended to assess whether the equipment will function for a minimum of three years with appropriate routine maintenance according to the manufacturer's guidance.

Manufacturers shall be requested to provide warranty on the equipment and any certification required by national authorities regarding materials used in the construction of the equipment, and tests that have been carried out for compliance with national or international specifications.<sup>2</sup> If problems occur with equipment that is alleged to meet the published WHO specification guidelines, feedback to WHO on the performance of the equipment will be

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<sup>1</sup> *Equipment for vector control*, 3rd ed. Geneva, World Health Organization, 1990.

<sup>2</sup> WHO no longer tests equipment used to apply pesticides, for compliance with WHO specifications, at the request of industry. If a national programme wishes for a specific item of equipment to be evaluated, it will be its responsibility to arrange a test with a recognized laboratory equipped to evaluate pesticide application equipment.

welcomed and will be used in future revisions of the guidelines.

Manufacturers are responsible for supplying operating and maintenance manuals in the relevant language and, where necessary, assisting in training local staff in proper use of equipment, its routine maintenance and correct storage practices.

## **2 AIMS, APPLICABILITY, METHODS AND REQUIREMENTS OF SPECIFICATIONS**

A specification is a list of characteristics that, by measurement or examination, unambiguously defines the difference between acceptable and unacceptable equipment. Measurements require clearly defined methods known to be capable of producing reproducible results.

A specification guideline is an outline specification, expected to be applicable to a group of products that share broadly similar characteristics. Limits for characteristics are included in the guideline if they can be expected to apply to the group of products. Where applicable, methods to be used for measurement of characteristics should be defined in the guideline.

A specification may differ from the guideline where: (i) evidence is available to show that a guideline characteristic is not appropriate; or (ii) the guideline lacks an appropriate characteristic to distinguish between acceptable and unacceptable equipment.

Specifications for pesticide application equipment should include clauses to address characteristics that have relevance to operator safety, robustness and operational performance.

Some characteristics will relate only to certain types of equipment. The buyer of equipment should have confidence that equipment meeting a specification will be effective, safe to use and perform according to specifications over a sustained period of operation and through several seasons with proper maintenance, including consumable parts.

Although not part of specifications for quality control, pesticide application equipment must be provided with a manual that details method of operation, including

calibration method, safety precautions and maintenance procedures, as well as essential spare parts required for routine maintenance during the first year.

The following section provides the aim of a characteristic included in the specification guidelines, its applicability to different application equipment, the method for its measurement or examination and the technical requirements. The test procedures recommended in this document are not intended to exclude other accepted equivalent methods that may be in use in different countries. However, in the event of disagreement, the procedures described herein shall govern. All pressure tests must be carried out with a safety screen to protect the operator. Pesticides should not be used in testing unless special arrangements are made for their use and disposal. Where possible, inert materials that have similar physical properties to pesticide formulations and sprays should be used.

## **2.1 Title**

### Aim

To provide a brief unequivocal identification of the equipment.

### Applicability

All specifications.

### Requirements

Where there is no internationally agreed terminology for, and classification of, equipment used to apply pesticides, the terminology should follow the glossary provided in Annex 1 of this document.

## **2.2 Description**

### Aim

To provide a concise description of the equipment and its intended use(s).

### Applicability

All specifications.

### Methods

Not relevant.

### Requirements

The description must cover the key areas of concern, and items that can be checked by simple inspection.

## **2.3 Materials of construction**

### Aim

To have a machine that is constructed with materials that are resistant to corrosion and chemical formulations and will not deteriorate with normal usage and affect normal operation of the equipment.

### Applicability

All types of equipment.

### Methods

Samples of materials used in the manufacture of components that come into direct contact with the pesticides should be immersed in water together with representative samples of the pesticide liquids or suspensions that will be used in the specific equipment being tested, to determine if any adverse effect on the material occurs by checking whether it absorbs water or whether any visible effect (e.g. deformity), change in physical properties (e.g. flexibility) or weight change results from any action of the pesticide liquid on the material. Alternatively, components made of elastomers,

such as gaskets, should be immersed in (i) a mixture of equal parts of diesel and gasoline and (ii) 10% acetone in water, to assess their suitability for use in the equipment. The period of immersion shall be 24 hours at a temperature of 20–30 °C. The weights of each sample of material shall be recorded before and after immersion. The weight after immersion is taken after removing any surplus liquid on the surface of the sample and drying for 24 hours.

Where a pesticide is used, these tests should be done in a well ventilated place, e.g. a fume cupboard. Any individual component removed from the equipment to conduct the test should be dried for a further 24 hours, before being re-assembled in the equipment. Then, the equipment is operated to check that all components function correctly.

Note:

- 1 Where a large component is involved, such as the carrying frame, a small off-cut from the material should be obtained from the manufacturer for the appropriate test.
- 2 Where stainless steel is used in the manufacture of a part of a sprayer, austenitic steel (i.e. non-magnetic) should be used, which can be checked using a simple magnet, except in the construction of springs.

### Requirements

Materials used in the construction of equipment must not show any indication of susceptibility to corrosion or of being otherwise adversely affected (e.g. becoming hard, brittle or less flexible) by exposure to chemical formulations that are used in vector control. This is especially important where it is known that ultra-low volume liquid (UL) formulations may be used. A weight increase of over 5% will indicate a potential problem. All seals and gaskets used in the above tests shall be capable of operating satisfactorily in their original positions in the equipment.

## **2.4 Weight**

### Aim

The weight of the complete sprayer shall allow easy movement of the equipment.

### Applicability

All types of equipment.

### Methods

Weighing with scales certified for accuracy.

### Requirements

The maximum weight shall not exceed the weight specified by national health and safety regulations. In the absence of national regulations, the maximum weight of manually carried equipment should be 25 kg (knapsack) or 20 kg (hand carried) when it is filled to the manufacturer's maximum recommended capacity. Larger equipment used on vehicles may be up to 250 kg when empty, provided it can be held and lifted by not more than four people, if suitable lifting equipment is not available.

## **2.5 Pesticide tank and fittings**

### **2.5.1 Capacity**

#### Aim

To have sufficient capacity to minimize the number of times a sprayer has to be refilled during a spraying operation.

#### Applicability

All types of equipment.

#### Methods

The volume of the pesticide tank shall be measured, in litres, when all fittings and components, e.g. pump, dip-tube, etc., are in position.



### Requirements

Tank size on portable equipment will depend on the maximum weight that can be carried. On mechanized equipment, the size of the tank should be related to the period that the engine can be operated in relation to normal operational requirements. It must be possible to drain the tank without removing it or inverting the equipment on mechanized equipment. In addition to indicating the maximum level of liquid in the tank, the tank should be graduated with markings at 1-litre intervals (tanks up to 10-litre capacity) and 5-litre intervals (for larger tanks).

### **2.5.2 Dimensions of filler opening**

#### Aim

The size of the tank opening shall allow filling without spillage or splashing, irrespective of its total volume.

#### Applicability

All types of equipment.

#### Methods

- a) The tank opening shall be measured.
- b) The time to fill the tank to the recommended maximum level is measured.

#### Requirement

Should not be less than 90 mm in the minor axis. Where the tank opening is less than 90 mm wide, a filter funnel or closed transfer system shall be used. On compression sprayers, the opening shall allow filling of tank without spillage at a rate no slower than 10 litres in 40 seconds.

### **2.5.3 Pressure relief (safety) valves and pressure release devices**

#### Aim

To ensure safe release of internal pressure of the sprayer and also prevent over pressurization.

### Applicability

All types of equipment that have any component operating under pressure of more than 50 kPa.

#### a) Pressure relief (safety) valve

A pressure relief valve shall be fitted to prevent pressurization in the tank above the prescribed limits. If the valve opens to release excess pressure, it should re-seal once the pressure in the tank is lowered to the required maximum value.

#### b) Pressure release devices

Pressure release devices are designed to release pressure from the tank without endangering the operator and without requiring inversion of the tank. It shall be simple and easily operated. It may be incorporated in a pressure relief valve. If the valve opens to release pressure, it should reseat completely to allow normal operation of the sprayer.

c) Threaded fittings to the pressurized tank having a diameter of 1.3 cm or more shall be channelled to provide release of pressure during removal.

### Methods

a) Pressure relief valves. The maximum pressure shall be applied to the component to assess when the valve opens if any further pressure is applied. The valve shall then be operated to check that all the pressure can be released to allow opening of any part of the equipment.

b) Pressure release devices. With pressure in a tank, fitted with a pressure gauge, the device shall be operated and the decrease in pressure noted.

### Requirements

The pressure relief valve shall be able to withstand the maximum working pressure plus safety margin and be easily operated to release all the pressure prior to opening any part of the equipment.

## **2.6 Fuel tank capacity**

### Aim

To minimize the need to refuel before having to refill the pesticide tank.

### Applicability

All engine-driven pesticide application equipment.

### Methods

Tank capacity is determined by direct measurement. To determine fuel consumption, the engine shall be operated with a small quantity of fuel until it stops. A known volume of fuel (e.g. 0.1 litre) is added to the fuel tank. When the engine has been re-started, the time taken before the engine stops due to lack of fuel is measured. The fuel consumption per hour is then calculated. This value is used to determine the time taken to discharge a full fuel tank. The time taken is then compared with the time required to empty the pesticide tank (see test to measure flow rate) at the recommended minimum flow rate.

### Requirements

For portable and vehicle-mounted pulse-jet thermal foggers, the equipment should operate without stopping for the time required to empty a full pesticide tank, with the machine set to deliver at the recommended minimum flow rate.

Ideally, other equipment should operate without refuelling during a typical operational period.

## **2.7 Blower/compressor/fan**

### Aim

To provide acceptable atomization of the liquid or to project spray towards the target being sprayed.

### Applicability

Mistblowers, cold foggers and some thermal foggers.

### Methods

The output of air from mistblowers shall be measured by using an anemometer, e.g. hot-wire anemometer. The mean velocity shall be measured at nine positions at the intersections of three vertical and three horizontal transects, 1 cm outside the end of the discharge tube, and within the central cross-sectional area of the air flow. The position of measurements must avoid the edge of the air flow. Additional measurements may be taken at 3, 6 and 9 m from the nozzle to assess the extent to which the velocity decreases with distance.

A further check on the projection of the spray in open, still conditions may be made by attaching water-sensitive papers to vertical posts which are positioned at 1-metre intervals from 5 m onwards to determine the distance droplets are carried by the air horizontally. A similar method using a rope and pulley to elevate water-sensitive paper targets can be used to measure the vertical projection of droplets.

### Requirements

The requirements for volume of air and velocity will depend on the type of equipment, nozzle used, expected spray liquid volume rate and droplet size spectrum required. For knapsack mistblowers, at least 5 droplets per cm<sup>2</sup> must be detected on surfaces placed at 15 m horizontally, and 8 m vertically from the nozzle when operating the equipment for 10 seconds in still air, to ensure spray can be directed up into the eaves of houses.

## **2.8 Air pump**

### **2.8.1 Pump performance**

#### Aim

The aim is to deliver the air pressure required to provide efficient operation of the sprayer and the starting of some pulse-jet thermal foggers.

#### Applicability

- a) Compression sprayers
- b) Certain types of fogging equipment that have an air pump used in starting the equipment.

#### Methods

- a) Compression sprayers  
The number of full pump strokes of manually operated air pumps to attain the required internal pressure of the sprayer tank shall be measured.
- b) Certain types of pulse-jet thermal foggers  
Count the number of pump strokes needed to start the engine. (Note that the fuel mix may need to be adjusted and the ignition checked.)

#### Requirements

- a) The pump should be capable of delivering the maximum rated operating pressure in no more than 60 strokes.
- b) The equipment shall start with fewer than 20 strokes of a manual air pump or 30 seconds of operation of an electrically operated pump.

### **2.8.2 Check valve**

#### Aim

To prevent back-flow into the pump.

### Applicability

Compression sprayers.

### Methods

The sprayer pump is used to pressurize the tank. Tank pressure is observed to ensure that pressure does not decrease due to a faulty valve in the pump. Check whether any liquid has entered the pump chamber after an hour of pressurization. To facilitate observation, the pump handle-lock can be released and, after an hour, the tank pressure released and the pump chamber disassembled to check whether any liquid is present. This test shall be made after the sprayer has undergone simulated use filled and discharged 20 times with an inert powder suspension (see Annex 2) at 20 g/litre.

Note: The operator may be exposed to expelled liquid in the event of failure; use of a face shield is therefore recommended for safety.

### Requirements

The design of the valve shall allow the full recommended pump output to flow to the nozzle. Valves in air pumps shall prevent seepage of liquid into the air pumps.

## **2.9 Filter system**

### **2.9.1 Air filter**

#### Aim

To protect the blower and engine system.

#### Applicability

All engine-driven equipment using a blower /compressor /air pump.

#### Methods

Check equipment to ensure that a specified filter is present.

#### Requirements

The type of filter at the air intake of the compressor, blower or engine shall be capable of retaining particles of over 100 µm in diameter.

### **2.9.2 Filter in liquid lines**

#### Aim

To remove foreign matter from the spray liquid and avoid stoppages during control operations due to blockage of nozzles and other liquid-carrying hoses or tubing.

#### Applicability

All spray equipment.

#### Methods

Measure the size of the openings of the mesh screen and the overall dimensions of the screen. Measure the nozzle orifice dimensions.

#### Requirement

The filter screen mesh size should be smaller than any down-stream passage.

The overall area of a filter should be sufficient to avoid any need to clean the filter during one day's operation and avoid reducing the flow by more than 5%.

## **2.10 Discharge system**

### **2.10.1 Hose**

#### ***2.10.1.1 Burst resistance***

##### Aim

To ensure that any hose can withstand the maximum operating pressure without failure.

##### Applicability

All sprayers that utilize a pressurized system.

##### Methods

Samples of hose not less than 50 cm in length shall be coupled to a hydraulic pump. The sample of hose filled with water shall be closed with a metal plug and secured with a compression clamp. The hydraulic pump is then used to apply to the hose twice the maximum working pressure recommended for normal sprayer use for a period of not less than one minute.

##### Requirements

The hose shall withstand twice the maximum recommended working pressure of the pesticide liquid or air.

#### ***2.10.1.2 Kink resistance***

##### Aim

To ensure that the hose will not kink or flatten during use.

##### Applicability

All hoses.



### Methods

A sample of the hose, without any liquid in it, is bent through 180° around a radius of 50 mm at temperatures up to 30 °C.

### Requirements

The hose must not kink (flatten), preventing free flow.

## **2.10.2 Trigger valve**

### Aim

To provide a reliable, manually operated, on/off valve.

### Applicability

Manually-operated sprayers.

### Method

The trigger valve shall be mounted on a test rig that is designed to open and close the valve at 10–15 cycles per minute by means of a cam, applying less than 500 kPa to the valve face. The spray line shall be fitted with a nozzle to deliver 0.75 litres of a suspension of 20 g/L silica (see Annex 2 for specification of the silica used in this test) in water at 300 kPa to test the abrasion resistance of the valve components. The nozzle may discharge directly or through appropriate piping into a reservoir from which the liquid is returned under pressure to the inlet port of the valve. The test suspension shall be changed after every eight hours of use.

The mechanism shall open the valve in not less than 0.1 seconds and not more than 0.2 seconds. After an initial test of 500 cycles at 100 kPa, the test shall continue for 50 000 cycles of operation at 300 kPa. Finally, the test shall be repeated with the input pressure to the valve set at 1000 kPa for 500 cycles. Alternatively, a pneumatically controlled test apparatus can be used using pneumatic timers, valves and counters. The test rig should shut down if the valve under test fails.

The torque needed to operate the valve is determined by measuring the weight to move the lever from the closed to open position, multiplied by the distance from the point of application of the weight to the pivot point of the lever.

#### Requirement

The valve should continue to function at maximum operating pressure without leakage after 51 000 cycles. The torque must be less than 1.5 newton metres.

### **2.10.3 Lance**

#### Aim

To provide a means of manually directing a spray.

#### Applicability

Principally applies to manually-carried equipment.

#### Method

The distance between the trigger valve handle and the nozzle shall be measured.

#### Requirements

The lance shall be straight and of a minimum length of 500 mm so that spray is released away from the operator's body.

### **2.10.4 Flow rate control device**

#### Aim

To maintain the recommended pressure and flow of liquid at the nozzle.

#### Applicability

All types of equipment.

#### Methods

a) Compression sprayer

The sprayer tank is filled with water to the recommended maximum level and operated at the recommended

pressure. Spray is collected for each consecutive minute separately and measured. The valve may cut off liquid before the tank is empty, in which case the tank is re-pressurized before continuing the test.

b) Other equipment, e.g. fogging equipment

Disconnect the hose from the pesticide tank so that one end can be placed in a calibrated measuring container. Operate the machine so that amounts of liquid of the same viscosity as the pesticide being applied and emitted each minute over a five-minute period can be determined with the restrictor upstream of the sampling point.

#### Requirements

The variation in output of the equipment while emptying the tank shall be less than 5% of the stated output of the nozzle at the selected pressure.

### **2.10.5 Nozzle**

#### ***2.10.5.1 Flow rate***

##### Aim

To check that the output of a nozzle is correct.

##### Applicability

All types of hydraulic nozzles.

##### Method

The output of a nozzle shall be measured by collecting the liquid in a container when the nozzle is operated at a specified pressure, e.g. 3 bar.

##### Requirement

The output shall be within  $\pm 5\%$  of the manufacturer's declared output.

### **2.10.5.2 Droplet size**

#### Aim

To produce a cloud of spray droplets with a defined size spectrum. A nozzle shall also control the flow of liquid unless a separate flow control is included in the design. The nozzle may also determine the shape or pattern of the flow of spray droplets emitted from the nozzle.

#### Applicability

All types of equipment.

#### Methods

Use of a laser light diffraction particle size analyser is recommended. The equipment consists of an optical bench with a low-powered laser at one end and a sensor at the other. Laser light is directed by lens to the sensor, connected to a computer with appropriate software. Prior to sampling droplets, the position of the laser beam relative to the sensor is checked. A background reading without spray is taken and then, with the nozzle mounted to direct the spray through the laser beam, a representative sample of droplets is measured across a transect through the spray cloud. The equipment will provide a printout with detailed data of the droplet spectrum. (Note that standardized sampling procedures for this type of equipment are available, such as those published as ASAE and ISO Standards.)

Note: The droplet spectrum of the equipment shall be tested at all flow rates recommended by the manufacturer, or at a range of pressures, when using a hydraulic nozzle. Special care is needed to ensure that the spray does not impact on the lenses. Secondly, sufficient droplets must pass through the laser within one focal length of the lens, but not so many that light is too obscured to give an acceptable result. The latter may be a problem with a dense cloud from a thermal fogger, which usually requires a sub-sampling technique. Water shall normally be the liquid used to measure droplet size. For specific

equipment where different types of formulation are used, the simulant liquid should have a similar viscosity and surface tension to the formulations used in the equipment (e.g. a surfactant (Tween 20) at 0.1% should be added to water). For thermal fogging equipment, odourless kerosene or oil may be used.

### Requirements

Droplet spectrum requirements will depend on the type of spray required. Space treatments require droplets below 30  $\mu\text{m}$  in diameter to remain airborne. Ideally, for most vector species, optimally airborne droplets need to be in the 10–15  $\mu\text{m}$  range. Where water is used to measure droplet size, the volume mean diameter (VMD) will be larger than odourless kerosene.

For residual spraying of surfaces and treating other areas with larvicides, the median droplet size of aqueous sprays, when using hydraulic nozzles, should be larger than 200  $\mu\text{m}$  and specified. The droplet size from mistblowers is ideally in the range 50–100  $\mu\text{m}$  VMD to minimize the rapid fall-out of large droplets from the airflow. The output through a nozzle will depend on sprayer design and shall be specified according to the type of application and equipment to which the nozzle is fitted.

### **2.10.5.3 Erosion resistance**

#### Aim

To ensure that the output of the nozzle will not increase due to rapid erosion of its orifice.

#### Applicability

All types of hydraulic nozzles.

#### Method

The output of the nozzle shall be measured initially. An inert powder suspension e.g. synthetic silica (See Annex 2 for specification of silica used in this test) at 20 g/litre at 300 kPa shall be pumped through the test nozzle and its

output measured at either 200 litre or 5-hour intervals, up to 20 hours.

Requirement

The nozzle will fail if the output increases by more than 5% within 20 hours.

## **2.11 Remote control system**

Aim

To provide a means of operating the equipment from the safety of the cab.

Applicability

All types of vehicle-mounted equipment.

Methods

Verify the operation of the remote control system. Confirm that the connection to the equipment is designed to prevent pesticide reaching the vehicle cab.

Requirements

The operator must be able to turn off and re-start the engine and operate a spray on/off switch from the vehicle cab. The design of the control system must ensure that pesticide does not enter the vehicle cab.

## 2.12 Straps and fastenings

### Aim

To ensure strap durability and enable a machine to be carried comfortably and safely by the operator.

### Applicability

All types of manually-carried equipment. In addition to straps, any material used in a backrest should meet the same criteria as for straps.

### Methods

a) Dimensions to be measured directly.

b) Strap durability. The sprayer tank is filled to the recommended maximum level with water and then the sprayer is suspended by its straps from a rigidly mounted horizontal bar (75 mm diameter) to simulate the operator's shoulders.

The sprayer is lifted 300 mm, then allowed to drop so that it is held by the horizontal bar. This is repeated 25 times, always allowing the sprayer to hang freely by the straps after each drop.

c) Absorbency of straps. Remove the straps, and any padding attached to them, from the sprayer and weigh them dry. Completely immerse the straps in water for two minutes. Remove the straps from the water, shake off surplus liquid and hang freely to drain for 20 minutes at 21 °C, before re-weighing.

### Requirements

a) The width of the strap shall be sufficient to avoid discomfort when positioned on the operator's shoulder and shall be 50 mm  $\pm$  5 mm. The strap shall be of adjustable length.

b) Neither the straps nor the fittings should fail the durability test.

c) In the immersion test, the increase in weight after drying should not exceed 10% of the dry weight.

## **2.13 Sprayer performance**

### **2.13.1 Leakage**

#### Aim

To protect the operator from exposure to pesticide while operating the equipment.

#### Applicability

All types of equipment.

#### Methods

Compression sprayer. The sprayer shall be set up for use with the pesticide tank filled to the recommended maximum level with water to which a suitable non-ionic surfactant at 0.1% and a suitable visible dye have been added. Any liquid on the outside of the tank is removed. The pump is operated to pressurize the tank to twice the maximum operating pressure. The sprayer is stood within a safety cage on a clean plastic sheet for one hour with the tank vertical and then repeated with the tank set at an angle of 45°, horizontal and inverted. The surface of the sheet and sprayer are examined for leaks and pressure drop. The same test should be repeated in all positions with no pressure in the tank; no leakage should be experienced.

Other equipment. The sprayer shall be set up for use with the pesticide tank filled to the recommended maximum level with water to which a suitable non-ionic surfactant at 0.1% and a suitable visible dye have been added, Any liquid on the outside of the tank is removed. The sprayer is stood on a clean plastic sheet for one hour. The surface of the sheet and sprayer are examined for leaks.



### Requirements

No liquid should escape from the sprayer tank and associated delivery system, e.g. valves and hoses to the nozzle, or from the nozzle when the cut-off valve is closed.

## **2.13.2 Noise level**

### Aim

To protect the operator from excessive noise while operating the equipment.

### Applicability

All types of engine-driven equipment.

### Methods

A recognized sound meter is used to measure the sound level at the operator's ear for manually-carried equipment and at the same height at one metre from each side of the vehicle-mounted equipment when the engine is running at its recommended speed.

### Requirements

If the noise level exceeds 85 decibels, ear protectors should be provided and used. The requirement to use ear protection should be marked permanently on the equipment and instructions included in the operating manual.

Where the equipment can be remotely controlled, as in a vehicle cab, it is still essential to measure the noise level outside the cab where a person may be standing alongside the equipment, e.g. a maintenance engineer.

## **2.13.3 Durability**

### Aim

The equipment needs to be sufficiently robust to provide reliable service with minimum maintenance to avoid interruptions during periods of application.

### Applicability

All types of equipment.

### Methods

a) Compression sprayers.

#### *Tank fatigue test*

To measure whether the sprayer tank can withstand repeated pressurizations, the sprayer, completely full of water, is attached to an apparatus, e.g. see Figure 1. The dip tube or tank outlet connection is connected to the manifold, preferably by the sprayer hose. Compressed air is introduced through the manifold via a pressure regulating valve and controls so that a pressure of 500 kPa is applied for 15 seconds and then released for 15 seconds, e.g. two cycles per minute. This cycle is repeated 12 000 times, unless a drop in pressure caused by tank failure shuts down the apparatus. A counter in the apparatus indicates the number of cycles completed.

#### *Tank drop test*

To determine whether the sprayer can still operate effectively after being accidentally dropped from the operator's back, the compression sprayer, pressurized to maximum recommended pressure, with its tank filled with water to the recommended maximum operational volume, will be dropped from a height of 60 cm on to a flat wooden surface (suggested 20–30 mm thick by 800 mm square) placed on a level floor and surrounded by a metal cage to protect the tester from injury. This drop is repeated in total six times upright and six times tilted at 10° in a simulation of how the tank hangs on the shoulder. The sprayer should continue to function normally after the test and meet the leakage test requirements.

b) Other equipment

Test samples should be subject to a test involving a minimum of 50 hours operation over a 10-day period. One period of 8 hours' operation should be included to represent a full day's operation in a vector-borne disease

outbreak area. All stoppages shall be recorded with reasons for the stoppages and details of any repairs carried out. Data on fuel consumption shall be collected.

### Requirements

During the durability tests, no leaks should be detected for compression and other equipment.

#### a) Compression sprayers

##### *Tank fatigue test*

The sprayer must withstand 12 000 cycles of 0–500 kPa pressure.

##### *Tank drop test*

The sprayer should continue to function normally after the test and meet the leakage test requirements.

#### b) Other equipment

The sprayer shall operate as recommended throughout the test period without any major breakdown. Fuel consumption shall meet the requirements specified above.

## **2.14 Markings**

### Aim

The identification of the machine, components and operating position of controls on the equipment.

### Applicability

All types of equipment.

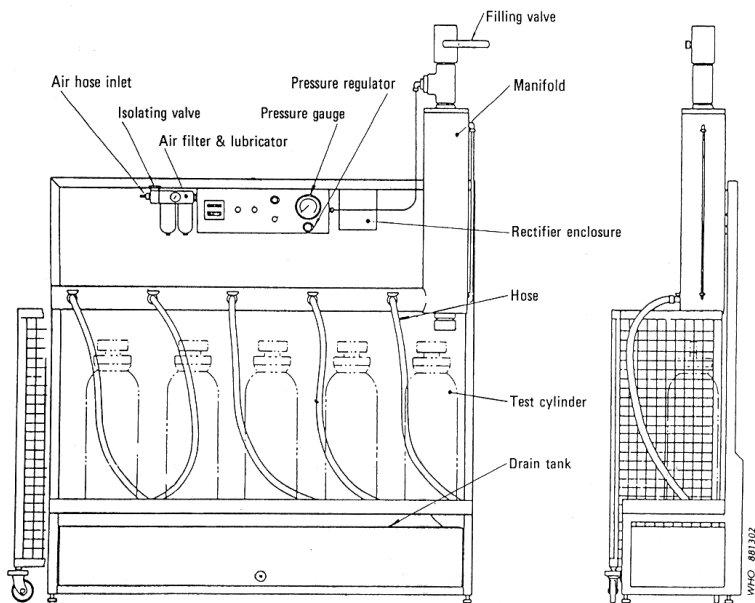
### Methods

The placement of markings by labels, embossing or other technique that remain permanently positioned and easily read while operating the equipment.

### Requirements

The equipment operator must be able to easily locate and see details of the name and contact details of the manufacturers, type of machine, date of manufacture or serial number and position of key components affecting routine use of the equipment. Position of any valves or switches to indicate on/off positions, size of nozzle or flow restrictor and position of any other controls must be clear. The type of liquid to be added to any tank must be clear. The markings shall not be obscured or made illegible by exposure to pesticide formulations and shall be clearly visible to the operator.

**Figure 1. Test apparatus for determination of fatigue failure in compression sprayer tanks**



### **3 SPECIFICATION GUIDELINES FOR HAND-OPERATED COMPRESSION SPRAYERS<sup>1</sup>**

#### **3.1 Description**

The sprayer shall consist of a tank, usually cylindrical, equipped with a hand-operated air pump with a two-handed handle (if required) and locking device, separate from the tank lid, pressure-release safety device, hose attached at the top of the tank to a dip-tube, trigger valve with locking-off device, lance, control flow valve and nozzle, with other accessories as specified by the user agency. The sprayer should have a system for parking the lance when not in use to protect the nozzle. The sprayer with fittings assembled shall have no sharp edges or projections that might injure workers during normal operation.

#### **3.2 Materials of construction**

The materials of construction, including filler cover, shall be declared and shall be corrosion, pressure and UV-resistant. No broken or leaking welds or cracks should result when subjected to the tank fatigue test (see section 2.13.3). No solder containing lead and/or tin as major components shall be used in the construction of sprayers or component parts, except on joints between the lance, the cut-off valve, the nozzle body and the dip-tube, provided that all tests pertaining to this item are satisfactory. No wooden parts shall be used in the construction of any part of the sprayer.

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<sup>1</sup> The compression sprayer is mainly used for residual spraying of wall surfaces and for larviciding.

### **3.3 Weight**

The weight of the complete sprayer, when filled to the manufacturer's maximum recommended capacity for operation, shall be declared and shall not exceed 25 kg.

### **3.4 Pesticide tank and fittings**

#### **3.4.1 Capacity**

The operational liquid capacity shall be declared.

#### **3.4.2 Dimensions of filler opening**

The filler opening shall be declared and shall be not less than 90 mm in minor axis.

#### **3.4.3 Pressure-release devices and pressure relief (safety) valves**

##### ***3.4.3.1 Pressure release device***

A pressure release device shall be declared, fitted on the top of the sprayer and shall be capable of completely depressurizing the tank before it is opened. If the valve operates, it should reseal to allow normal operation of the sprayer without leakage.

##### ***3.4.3.2 Pressure relief (safety) valve device***

A pressure relief device shall be declared that prevents pressurization in the tank beyond the limits prescribed by the manufacturers  $\pm 10\%$  for safety. If the valve operates, it should reseal to allow normal operation of the sprayer without leakage.

#### **3.4.4 Straps and fastenings**

The number and width of straps shall be declared, and shall be at least 50 mm wide at the shoulder and adjustable to at least 100 cm in length. The width of strap shall be declared and shall be at least  $50 \pm 5$  mm wide. The straps, fastenings and strap clips shall not show

structural failure when subjected to the strap drop test (see section 2.12). The strap when subjected to absorbency test method (see section 2.12) shall not increase in weight by more than 10%.

### **3.4.5 Markings**

The sprayer shall be clearly and permanently marked with a horizontal permanent line to indicate the maximum liquid volume in litres. Other markings should indicate 1-litre graduations.

## **3.5 Air pump**

### **3.5.1 Performance**

The tank, with all its fittings attached and filled with liquid to the maximum liquid charge mark, shall reach the maximum operational pressure on completion of no more than 60 full strokes of the pump.

### **3.5.2 Check valve**

The pump check valve shall prevent any leakage of the liquid into the pump cylinder when the tank is pressurized to the maximum recommended working pressure and the check valve is fully submerged.

## **3.6 Discharge system**

### **3.6.1 Filter size**

The filter in the trigger valve must be smaller than the size of the nozzle aperture and not larger than 50 mesh size (with an aperture not larger than 0.5 mm or 0.3 mm if there is no filter in the nozzle body). The equipment must be supplied with one or more filters, with a mesh size that prevents passage of particles that would cause nozzle blockage. At least one filter should be fitted close to the nozzle.



### **3.6.2 Hose**

The length of the hose shall be declared and shall be not less than 1.5 m and of a material suitable for the pesticide product(s) specified by the purchasing agency. The hose should meet the requirements stated in section 2.10.1.

### **3.6.3 Trigger valve**

The type of trigger valve shall be declared and shall not drip or leak when subjected to the test method described in section 2.10.2. The trigger valve must have a positive lock-off position. The length of the valve lever shall not be less than 100 mm measured from the pivot point. The maximum torque on the lever shall be 1.5 newton metres.

### **3.6.4 Lance**

The length of the straight lance shall be declared and shall not be less than 500 mm.

### **3.6.5 Flow rate control device**

A flow rate control device shall be fitted and its type declared. The device shall maintain a uniform output at the nozzle  $\pm 5\%$  of the specified discharge rate, when subjected to the method outlined in section 2.10.4.

### **3.6.6 Nozzle tip**

The type of the nozzle tip and the flow rate shall be declared and comply with international standards. Tolerance limits of the discharge rate shall not exceed  $\pm 5\%$  when tested in accordance with the procedure described in section 2.10.5.1.

**3.6.6.1. Erosion resistance.** The output of the nozzle shall not increase more than 10% when subjected to the test described in section 2.10.5.3. The pattern should remain consistent and unchanged.

## **3.7 Sprayer performance**

### **3.7.1 Leakage and durability**

The maximum working pressure (kPa) shall be declared. The tank, with all its fittings attached, shall withstand an internal hydrostatic pressure of twice the maximum recommended working pressure when subjected to the tank leakage test and have no leakage after subjecting the tank to the impact (drop) test (see section 2.13.3). The sprayer shall be tested with the recommended working pressure and without pressure in the tank when positioned vertically, horizontally and at 45°. The lid should be leak-proof without pressure in the vertical and horizontal positions and at 45°.

## **4 SPECIFICATION GUIDELINES FOR KNAPSACK-MOTORIZED MISTBLOWERS<sup>1</sup>**

### **4.1 Description**

The sprayer shall have an engine-driven fan to produce a high-velocity air-stream into which the pesticide liquid is metered. The engine shall be provided with an easy starting mechanism and the fuel tank mounted below the engine. All moving parts and the exhaust shall be guarded to prevent injury. Engine controls, including a stop switch and speed control, shall be mounted so that they are visible in front of the operator, when in use. The engine/fan unit shall be mounted on a knapsack frame designed to be carried comfortably on the operator's back. A non-absorbent padded backrest shall be fitted to the frame. The mounting of the engine must dampen vibrations. The sprayer with fittings assembled shall have no sharp edges or projections that might injure workers during normal operation. All parts that are regulated while operating the equipment shall be permanently and identifiably marked.

### **4.2 Materials of construction**

All materials of construction shall be declared and the components that come in direct contact with the insecticide must be chemical-resistant non-absorbent and be subjected to the test methods described in section 2.3.

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<sup>1</sup> The knapsack-motorized mistblower is used for projecting sprays up into the eaves of houses and into other areas that are less accessible to hydraulic sprayers and where some residual effect of insecticide is needed.

### **4.3 Weight**

The weight of the equipment, when both fuel and pesticide tanks are filled to the recommended level, shall be declared and shall not exceed 25 kg.

### **4.4 Pesticide tank and fittings**

#### **4.4.1 Capacity**

The operational liquid capacity shall be declared.

#### **4.4.2 Dimensions of filler opening**

The dimensions of the filler opening shall be declared and shall not be less than 90 mm diameter. The opening shall be fitted with an air-tight lid.

#### **4.4.3 Filter**

Provision of a filter set deep enough inside the tank opening to allow filling within 60 seconds without splashing or spillage, shall be declared.

#### **4.4.4 Pressure release device**

Equipment that requires tank pressurization should have a device that shall be declared and shall be capable of completely depressurizing the tank before it is opened (see section 2.5.3).

### **4.5 Fuel tank capacity**

The capacity of the fuel tank shall be declared and allow field operation for at least one hour, without the engine stopping. The type of fuel and fuel mix shall be permanently indicated on the fuel tank, filler cap and on the machine.

## **4.6 Discharge system**

### **4.6.1 Air duct**

Air from the blower shall be ducted in a tube to the nozzle. The type of nozzle shall be declared. The air duct shall be flexible to facilitate direction of the spray by the operator. Liquid from the pesticide tank or a pump is delivered to the nozzle via the flow control restrictors.

### **4.6.2 Liquid flow control**

#### ***4.6.2.1 Cut-off valve***

Control of the flow of pesticide liquid with an on/off valve, attached to the air duct in front of the operator, shall be declared.

#### ***4.6.2.2 Flow rate control***

A system using preset or inter-changeable restrictors shall be declared. These shall be mounted in the spray delivery tube to control the volume application rate.

#### ***4.6.2.3 Filter***

A 50-mesh or finer filter shall be positioned in the liquid flow line so that the restrictor or nozzle will not be blocked.

### **4.6.3 Droplet size**

The droplet spectrum shall be declared at different flow rates and test liquid. The VMD of the droplets shall be 50–100  $\mu\text{m}$  as determined by the test method provided in section 2.10.5.2.

### **4.6.4 Droplet projection**

The distance that droplets are projected by the sprayer shall be declared at the recommended operating engine speed and be at least 15 m horizontally and 8 m vertically in still air. The number of droplets should be at least 5  $\text{cm}^2$  at these distances.

## **4.7 Straps**

The number and width of straps shall be declared and shall be at least 50 mm wide at the shoulder and padded; each strap shall be adjustable to at least 75 cm in length. The width of strap shall be declared and shall be at least  $50 \pm 5$  mm wide. The strap when subjected to the absorbency test method (see section 2.12) shall not increase in weight by more than 10%. Any material in the backrest should also meet the same criteria as for the straps.

## **4.8 Sprayer performance**

### **4.8.1 Leakage**

The sprayer must operate without any pesticide liquid leaking from the tank or other components during normal operation and when subjected to the test method provided in section 2.13.1.

### **4.8.2 Durability**

The sprayer shall be subject to a minimum of 50 hours' operation over a 10-day period, with one period of 8 hours' operation included to represent a full day's operation in a vector-borne disease outbreak area. All stoppages shall be recorded, with reasons for the stoppages and details of any repairs carried out. Data on fuel consumption shall be collected.

### **4.8.3 Noise level**

The level of noise during operations shall be declared as determined by the method provided in section 2.13.2. The equipment shall be permanently labelled to indicate the need to use ear protection if the noise level exceeds 85 decibels.

## **4.9 Markings**

The operational positions of engine and other controls, e.g. flow control, must be clearly and permanently marked. The sprayer shall be clearly and permanently marked with a horizontal permanent line to indicate the maximum liquid volume in litres. Other markings should indicate 1 litre graduations.

## **5 SPECIFICATION GUIDELINES FOR PORTABLE COLD FOGGERS (AEROSOL GENERATORS)<sup>1</sup>**

### **5.1 Description**

The cold fogger shall be a hand-carried or knapsack-mounted aerosol generator with a system for producing an aerosol for space treatment. The engine shall be provided with an easy starting mechanism and the fuel tank mounted below the engine. All moving parts and the exhaust shall be guarded to prevent injury. Engine controls that are needed for application as well as an engine stop switch shall be mounted so that they are visible in front of the operator. Machines that run on a fixed speed setting do not need a speed control in front of the operator. The engine/blower unit shall be mounted on a knapsack frame designed to be carried comfortably on the operator's back. A non-absorbent padded backrest shall be fitted to the frame. The mounting of the engine must dampen vibrations. The sprayer with fittings assembled shall have no sharp edges or projections that might injure workers during normal operation. All parts that are regulated while operating the equipment shall be permanently and identifiably marked.

### **5.2 Materials of construction**

All materials of construction shall be declared and the components that come in direct contact with the insecticide must be chemical-resistant and non-absorbent and be subjected to the test methods described in section 2.3.

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<sup>1</sup> Portable cold foggers are used for space treatment within buildings and outdoors for treating areas inaccessible to vehicles.



## **5.3 Weight**

The weight of the equipment, when filled with pesticide and fuel for normal operation, shall be declared and shall not exceed 20 kg when hand carried, and 25 kg if mounted on a knapsack frame.

## **5.4 Pesticide tank and fittings**

### **5.4.1 Capacity**

The capacity of the interchangeable or fixed pesticide tank shall be declared and shall be 1 L capacity or greater. There should be a means to measure or indicate the volume of liquid in the tank, and the means shall be declared.

### **5.4.2 Dimensions of filler opening**

A built-in filter or filter funnel shall be supplied with the equipment except when a ready-to-use container is used and the provisions of 2.5.2 apply.

### **5.4.3 Pressure release devices**

If the tank is pressurized at more than 50 kPa, a device capable of completely depressurizing the tank before the tank is opened shall be provided (see section 2.5.3).

## **5.5 Fuel tank capacity**

The capacity of the fuel tank shall be declared and allow field operation for at least one hour, without the engine stopping. The equipment should operate continuously for at least one hour. The type of fuel and fuel mix shall be permanently indicated on the fuel tank, filler cap and on the machine.

## **5.6 Discharge system**

### **5.6.1 Nozzle**

The type of nozzle shall be declared.

### **5.6.2 Cut-off valve**

The unit shall be supplied with a cut-off valve at the nozzle unless the flow of liquid is stopped immediately when the engine stops.

### **5.6.3 Flow rate control**

The method of liquid transfer to the nozzle shall be declared. Control of flow of liquid to the nozzle shall be by fixed but interchangeable restrictor(s) and shall be declared.

### **5.6.4 Droplet size**

The droplet spectrum shall be declared at different flow rates and test liquids. The volume median diameter (VMD) of the droplets shall be less than 30  $\mu\text{m}$  at the specified flow rate, as determined in section 2.10.5.2.

## **5.7 Straps and fastenings**

The number and width of straps shall be declared and shall be at least 50 mm wide at the shoulder and adjustable to at least 75 cm in length and conform to the requirements of section 2.12. The width of strap shall be declared and shall be at least 50  $\pm$  5 mm wide. Any material in the backrest should also meet the same criteria as the straps.

## **5.8 Sprayer performance**

### **5.8.1 Leakage**

The sprayer must operate without any pesticide liquid leaking from the tank or other components during normal operation and while in transport, as specified in section 2.13.1.

### **5.8.2 Durability**

The machine must be able to withstand repeated use for a minimum of three hours per day throughout a five-day operation without problems of restarting the engine (see section 2.13.3). In testing for 50 hours, it is recommended that the maximum is 3 hours per day and not 8 hours.

### **5.8.3 Noise level**

The level of noise during operation shall be declared as determined by the methods given in section 2.13.2. The equipment shall be permanently labelled to indicate the need to use ear protection if the noise level exceeds 85 decibels.

## **6 SPECIFICATION GUIDELINES FOR VEHICLE-MOUNTED COLD FOGGERS (AEROSOL GENERATORS)<sup>1</sup>**

### **6.1 Description**

The cold fogger shall be an aerosol generating machine, mountable on a flat-bed truck or trailer and designed so that it may be operated from the vehicle cab. The sprayer shall have a pesticide flushing system. The equipment shall be fitted with an appropriate control system. A separate pesticide tank can be removable for cleaning or, if not removable, must have a facility for drainage. The frame shall be corrosion-resistant. All individual tanks shall be permanently and identifiably marked. The engine exhaust and moving parts shall be guarded to prevent injury. There shall be no sharp edges that might injure workers during normal operation and maintenance.

### **6.2 Materials of construction**

All materials of construction shall be declared and the components that come in direct contact with the insecticide must be chemical-resistant, non-absorbent and be subjected to the test methods described in section 2.3.

### **6.3 Weight**

The net weight of the equipment, without pesticide, fuel or detachable equipment, shall be declared and shall not exceed 250 kg.

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<sup>1</sup> Vehicle-mounted cold foggers are used for outdoor space treatments with no residual spray deposit.

## **6.4 Pesticide tank**

### **6.4.1 Capacity**

The capacity of the pesticide tank shall be declared and shall be not less than 50 litres. If the tank is not translucent and graduated, there shall be a metering measuring device to measure indicate the volume of liquid in the tank.

### **6.4.2 Dimensions of filler opening**

The filler opening shall be on the top of the tank and the size of the filler opening shall be declared and shall not be less than 40 mm in diameter. When less than 90 mm, a filter funnel shall be supplied to facilitate filling without spillage.

## **6.5 Fuel tank capacity**

The capacity and the fuel consumption/running time of the engine shall be declared and shall be sufficient for not less than two hours of continuous operation at the minimum recommended flow rate without refilling. The type of fuel shall be clearly indicated on the filler cap.

## **6.6 Air compressor or blower (if fitted)**

A filter shall be fitted to the air compressor or blower. It shall be corrosion-resistant and shall retain particles of over 100 µm in diameter.

## **6.7 Discharge system**

### **6.7.1 Control of pesticide flow**

#### ***6.7.1.1 Flow control***

The type of flow control shall be declared. All equipment should have a manual flow control (that can be on a fixed

setting), but there can be the option of a regulated flow control device to adjust output in relation to the vehicle-speed. When there is no flow to the nozzle, i.e. because the solution tank is empty, a warning device in the cab shall indicate to the operator that no droplets are being emitted from the nozzle. Note: Some systems using instrumentation that detects the RPM of a positive displacement pump display the results as ml/min or l/per hour whether there is flow to the nozzle or not.

#### **6.7.1.2 Cut-off valve**

The type of cut-off valve shall be declared and shall automatically close when any part of the equipment is turned off or ceases to function.

#### **6.7.1.3 Pressure release system**

If a pressure system above 50 kPa is used, an automatic pressure release device must be fitted and the type declared (see section 2.5.3).

#### **6.7.2 Droplet size**

The type of nozzle shall be declared. It shall deliver a droplet size of no larger than 30 µm VMD (see section 2.10.5.2).

### **6.8 Control panel system**

#### **6.8.1 Remote control**

The control panel shall be provided with permanently labelled switches for turning off the machine and for turning on and off the pesticide flow and be designed for installation in the vehicle cab. The design of the remote control system must ensure that pesticide does not enter the vehicle cab.

### **6.8.2 Other instrumentation not required on the remote control panel**

The equipment shall be fitted with the following: (i) an engine hour meter; (ii) an air pressure gauge for blower type equipment or supplied with a tachometer for rotary nozzle equipment (to monitor the RPM of a rotary nozzle); and (iii) an air pressure valve or sensor for blower-type equipment as a safety device if the pressure drops (this can substitute the need for an air pressure gauge in (ii) above).

## **6.9 Sprayer performance**

### **6.9.1 Leakage**

The sprayer must operate without any pesticide liquid leaking from the tank or other components during normal operation and while in transport (see section 2.13.1).

### **6.9.2 Durability**

The total number of hours without operational failure and without problems of restarting the engine, when operated at the maximum airflow, shall be declared and shall be not less than a total of 50 hours within a period of no more than two weeks (see section 2.13.3).

### **6.9.3 Noise level**

The level of noise during operation shall be declared as determined by the method described in section 2.13.2. The equipment shall be labelled to indicate the need to use ear protection if the noise level exceeds 85 decibels. Noise level during operation shall be declared and shall not exceed 100 decibels one metre from the machine at any time.

## **7 SPECIFICATION GUIDELINES FOR PORTABLE THERMAL FOGGERS<sup>1</sup>**

### **7.1 Description**

A portable thermal fogger shall have a thermal energy nozzle into which the insecticide liquid (both oil and water miscible formulations) is metered. The main components shall be mounted on a robust frame. If required, the machine shall be provided with a battery starting mechanism consisting of batteries, ignition coil, a spark system and a small manually- or battery-operated air pump to pressurize the fuel line when starting the machine. All hot surfaces must be adequately guarded to avoid burn injury of the operator. There shall be no sharp edges that might injure workers during normal operation. All parts that are regulated while operating the equipment shall be permanently and identifiably marked. The sprayer shall have clearly visible safety instructions on the machine to warn operators not to leave a fogger unattended while in operation.

### **7.2 Materials of construction**

All materials of construction shall be declared and the components that come in direct contact with the insecticide must be chemical-resistant, non-absorbent and be subjected to the test methods described in section 2.3. Pulse-jet type equipment must have a resonator of steel resistant to 1050 °C, e.g. austenitic steel No. 1.4845.<sup>2</sup>

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<sup>1</sup> Portable thermal foggers are used for space treatment within buildings and outdoors for treating areas inaccessible to vehicles.

<sup>2</sup> Manufacturers must supply a certificate that their equipment meets this requirement.



### **7.3 Weight**

The weight of the equipment, when filled to the manufacturer's maximum recommended capacity for operation, shall be declared and shall not exceed 20 kg.

### **7.4 Pesticide tank and fittings**

The capacity of the interchangeable or fixed tank shall be declared. Means for measuring the volume of liquid in the tank shall be declared. If the tank is not translucent and graduated, a measuring device, e.g. a dip-stick, shall be provided to measure the volume of liquid in the tank.

#### **7.4.1 Capacity**

The capacity of the pesticide tank shall be declared.

#### **7.4.2 Dimensions of filler opening**

The filler opening shall be on the top of the tank and the size of the filler opening shall be declared. A filter funnel shall be provided to facilitate filling when the opening is less than 90 mm. If the opening is in a different position, an angled filter funnel must be supplied to facilitate loading.

#### **7.4.3 Filter**

Provision of a pesticide tank filter or filter funnel shall be declared.

#### **7.4.4 Pressure release devices**

A device shall be declared and shall be capable of completely depressurizing the tank before the tank is opened.

## **7.5 Fuel tank capacity**

The capacity of the fuel tank and fuel consumption shall be declared. The engine shall operate to discharge a full pesticide tank continuously at the minimum recommended flow rate without refilling. This is to avoid the risk of flaming and also to avoid refilling a pesticide tank while the equipment is hot. The type of fuel shall be indicated.

## **7.6 Air pump**

The engine must start with less than 15 strokes, if fitted with a manual pump, and within 30 seconds of an automatic electrically operated pump.

## **7.7 Discharge system**

### **7.7.1 Flow control**

#### ***7.7.1.1 Cut-off valve***

Provision of an automatic cut-off to prevent further flow of pesticide to the nozzle if the engine stops, in addition to a manually operated on/off valve, shall be declared and should be mandatory.

#### ***7.7.1.2 Flow rate control***

Control of flow of liquid to the nozzle by a fixed, but interchangeable, restrictor shall be declared.

### **7.7.2 Droplet size**

The droplet spectrum shall be declared at the standard and other flow rates. The volume median diameter of the droplets shall be less than 30  $\mu\text{m}$  (see section 2.10.5.2).

## **7.8 Straps and fastenings**

The width of strap shall be declared and shall be at least 50 mm wide at the shoulder and adjustable to at least 75 cm in length. The width of strap shall be declared and shall be at least  $50 \pm 5$  mm wide. The strap when subjected to absorbency test (see section 2.12) shall not increase in weight by more than 10%.

## **7.9 Sprayer performance**

### **7.9.1 Leakage**

The sprayer must operate without any pesticide liquid leaking from the tank or other components, when subjected to the test methods described in section 2.13.1.

### **7.9.2 Durability**

The total number of hours without operational failure and without problems of restarting the engine shall be declared. The durability test (see section 2.12.3) shall be conducted with water using the largest restrictor, with the flow of water interrupted by opening and closing the fogging tap at intervals of 15 minutes.

### **7.9.3 Noise level**

The level of noise during operation shall be declared as determined by the method described in section 2.12.2. The equipment shall be permanently labelled to indicate the need to use ear protection if the noise level exceeds 85 decibels.

## **8 SPECIFICATION GUIDELINES FOR VEHICLE-MOUNTED THERMAL FOGGERS<sup>1</sup>**

### **8.1 Description**

The thermal fogger, mountable on a flat-bed truck or trailer, shall be fitted with a thermal nozzle system into which the insecticide liquid (either oil or water miscible formulation) is metered. The fogger should be designed so that it may be operated from the vehicle cab. A pesticide tank may be provided or provision made for attachment to an independent container. The tank shall be removable for cleaning and must have a facility for drainage. The components that are normally mounted within a frame shall be corrosion-resistant. All parts shall be accessible. All individual tanks shall be permanently and identifiably marked. The engine exhaust shall be guarded to prevent injury. There shall be no sharp edges that might injure workers during normal operation and maintenance. The equipment shall have clear safety instructions permanently marked on the machine to warn operators not to leave a fogger unattended while in operation. No flaming from the machine should occur during operation and shut down.

### **8.2 Materials of construction**

All materials of construction shall be declared and the components that come in direct contact with the insecticide must be chemical-resistant, non-absorbent and be subjected to the test methods described in section 2.3.

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<sup>1</sup> Vehicle-mounted thermal foggers are used for outdoor space treatments with no residual spray deposit. There are two main types of vehicle-mounted thermal foggers: (i) thermal foggers based upon the pulse-jet principle; (ii) thermal foggers driven by a conventional piston type two or four-stroke engine, with a separate air blower, heat exchanger or rotating disk.

Pulse-jet type equipment must have a resonator of steel resistant to 1050 °C, e.g. austenitic steel No. 1.4845.<sup>1</sup>

### **8.3 Weight**

The weight of the equipment, without pesticide, fuel or detachable equipment, shall be declared and shall not exceed 250 kg.

### **8.4 Pesticide tank (if supplied) and fittings**

#### **8.4.1 Capacity**

The capacity of the interchangeable or fixed pesticide tank shall be declared and shall be not less than 50 litres. If the tank is not translucent and graduated, there shall be a metering device to measure the volume of liquid in the tank.

#### **8.4.2 Dimensions of filler opening**

The filler opening shall be on the top of the tank and the size of the filler opening shall be declared. A filter funnel shall be provided to facilitate filling when the opening is less than 90 mm.

#### **8.4.3 Filter**

When the opening is greater than 90 mm, provision of a pesticide tank filter in the opening shall be declared.

#### **8.4.4 Pressure release device**

A device shall be declared and shall be capable of completely depressurizing the tank before it is opened.

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<sup>1</sup> Manufacturers must supply a certificate that their equipment meets this requirement.

## **8.5 Fuel tank capacity**

The capacity of the fuel tank and fuel consumption shall be declared. The engine shall operate to discharge a full pesticide tank continuously at the minimum recommended flow rate without refilling. This is to avoid the risk of flaming and also to avoid refilling a pesticide tank while the equipment is hot. The type of fuel shall be indicated.

## **8.6 Discharge system**

### **8.6.1 Flow control**

#### ***8.6.1.1 Cut-off device***

The type of flow control shall be declared and shall automatically close when any part of the equipment is turned off or ceases to function.

#### ***8.6.1.2 Flow rate control***

Control of flow of liquid to the nozzle by a fixed, but interchangeable, restrictor shall be declared.

### **8.6.2 Droplet size**

The droplet spectrum shall be declared at the standard and other flow rates. The VMD of the droplets shall be less than 30  $\mu\text{m}$  (see section 2.10.5.2).

## **8.7 Control panel**

The control panel shall be provided with permanently labelled switches for turning off the machine and turning on and off the pesticide flow and be designed for installation in the vehicle cab.

## **8.8 Sprayer performance**

### **8.8.1 Leakage**

The sprayer must operate without any pesticide liquid leaking from the tank or other components, when subjected to the test methods described in section 2.13.1.

### **8.8.2 Durability**

The total number of hours without operational failure and without problems of restarting the engine, shall be declared (see section 2.12.3).

### **8.8.3 Noise level**

The level of noise during operation shall be declared as determined by the test methods described in section 2.12.2. The equipment shall be permanently labelled to indicate the need to use ear protection if the noise level exceeds 85 decibels.

## ANNEX 1 GLOSSARY

### **Cold fog**

A fog created by atomization of a liquid without heat.

### **Compression sprayer**

Equipment that consists of a container that can be pressurized by a pump and a means of delivering spray liquid through a hydraulic nozzle.

### **Fog**

*Synonym: Aerosol.* A term used to indicate a space spray with droplets  $<50\ \mu\text{m}$  diameter (VMD), i.e. with a low terminal velocity so that they remain airborne as long as possible.

### **Fog equipment**

Equipment designed to produce either a cold or thermal fog. This equipment may have a blower to project droplets over a short distance but due to the droplet size in a fog, dispersal is dominated by natural air movement in the atmosphere. Water droplets are usually twice the size of oil droplets at the same setting.

### **Fogger**

see Fog equipment

### **Knapsack**

Equipment that is mounted so that it is carried on the user's back and held in place by shoulder straps.

### **Mist**

A spray in which the droplets have a VMD between  $50\ \mu\text{m}$  and  $100\ \mu\text{m}$ . Less than 10% of the volume of a mist should contain droplets  $<30\ \mu\text{m}$  in diameter.

### **Mistblower**

Equipment that uses a high-velocity air-stream to project mist-sized droplets over at least 5 m from the nozzle.



**Nozzle**

Equipment that breaks liquid into spray droplets.

**Portable equipment**

Equipment that can be carried by hand, although a shoulder strap may be provided to carry the weight.

**Thermal fog**

A fog created using a high temperature to vaporize the spray liquid, which then condenses to form a spray with droplets having a VMD  $< 50 \mu\text{m}$ . A thermal fog using an oil-based liquid forms a dense white opaque cloud of droplets that reduces visibility. An adjuvant is added to water-miscible formulations to increase the visibility of the fog.

**UL**

A pesticide formulation specially for use undiluted in ultra-low volume applications.

**ULV**

Ultra-low volume is the application of the minimum volume that achieves economic control, i.e. usually less than five litres per hectare.

**ULV equipment**

Equipment designed to apply ULV sprays.

**VMD**

Volume median diameter. Half the volume of the spray contains droplets with a diameter less than the VMD; droplets in the other half by volume have a diameter larger than the VMD.

## **ANNEX 2 MATERIALS USED IN NOZZLE EROSION TESTING**

The abrading powder shall be a synthetic silica powder with the following chemical and physical properties.

<b>BULK DENSITY</b>	<b>160 KG/M<sup>3</sup></b>
<b>SPECIFIC GRAVITY</b>	<b>1.95</b>
<b>AVERAGE PARTICLE SIZE</b>	<b>0.022 μM</b>
<b>COLOUR</b>	<b>WHITE</b>
<b>REFRACTIVE INDEX</b>	<b>135–165</b>
	<b>GARDNER-SWARD TEST UNITS</b>
<b>SURFACE AREA</b>	<b>140–160 M<sup>2</sup>/G</b>
<b>PH (5% WATER SUSPENSION)</b>	<b>7.3</b>
<b>LOSS AT 105 °C</b>	<b>5%</b>
<b>LOSS AT 1200 °C</b>	<b>10%</b>
<b>SIO<sub>2</sub> CONTENT</b>	<b>87%</b>
<b>CAO CONTENT</b>	<b>0.5%</b>
<b>FE<sub>2</sub>O<sub>3</sub> CONTENT</b>	<b>0.2%</b>
<b>AL<sub>2</sub>O<sub>3</sub> CONTENT</b>	<b>0.6%</b>
<b>NACL CONTENT</b>	<b>1.0%</b>

HIV/AIDS, TB, Malaria and Neglected Tropical Diseases (HTM)  
Department of Control of Neglected Tropical Diseases  
WHO Pesticide Evaluation Scheme (WHOPES)

