

Guidelines on  
MINIMUM REQUIREMENTS  
FOR AGRICULTURAL PESTICIDE  
APPLICATION EQUIPMENT

Volume Three  
Portable (operator-carried) foggers



GUIDELINES ON MINIMUM  
REQUIREMENTS FOR AGRICULTURAL  
PESTICIDE APPLICATION EQUIPMENT

Volume Three

PORTABLE (OPERATOR-CARRIED)  
FOGGERS



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# **C O N T E N T S**

## **Volume Three**

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## **BACKGROUND**

Safety and quality standards for agricultural pesticide sprayers do not exist in all FAO member countries and existing international standards for this type of equipment are often inappropriate for many member countries. Since 1995 FAO-AGSE has worked on the formulation of guidelines to improve the safety and efficiency of the most commonly used types of spray equipment.

The FAO guidelines on standards are based on existing international, European and national standards and other published references. They also draw on the in-depth knowledge and experience of international sprayer standards of the experts assigned to the project and on the authors' experience of pesticide application in the developing world.

The first versions of the FAO guidelines on pesticide application equipment were approved for publication in May 1997 by; the FAO Panel of Experts on Pesticide Specifications, Registration Requirements, Application Standards and Prior Informed Consent; and the FAO Panel of Experts on Agricultural Engineering.

This publication is the first revision of these guidelines, which incorporate comments and suggestions received from member states and new international developments since 1997. There are two guidelines; the first covers minimum requirements and the second covers more precise standards and test procedures to determine compliance.

### **Minimum requirements**

An important objective of the guidelines on minimum requirements is to assist FAO and other agencies to ensure that sprayers purchased are safe to users and to the environment as well as being efficient and durable in operation. Price will always play an important part in purchase decisions

on equipment but even the cheapest sprayer models should meet minimum standards of safety and durability.

The FAO minimum requirements take into account sprayers that are already on the market, many of which already meet the requirements. The prime objective therefore is that member countries should adopt them immediately, to begin to eliminate substandard and unsafe sprayers from national markets and ultimately from the international scene.

The guidelines on minimum requirements are presented in separate volumes covering different categories of spray equipment, such as the principal types of portable (operator-carried) sprayers, including rotary atomizers, vehicle-mounted and trailed (tractor) sprayers and others.

## **Guidelines on standards and test procedures**

The guidelines on standards are more demanding than the minimum requirements and provide more precise safety targets for spray equipment. They consist of detailed specifications and requirements, supported by test procedures to measure compliance with the FAO standard, for the major types of agricultural pesticide sprayers manufactured or used in FAO member countries. These standards reflect current manufacturing practice, other national and international standards and the practical reality in the field in member states. Separate volumes of the standards cover different categories of sprayers.

The aim of both the minimum requirements and the standards guidelines is to provide manufacturers and governments with a practical and consistent quality assurance system. Each member country can then decide on the form and speed of introduction of the respective guidelines into national practice and into legislation where appropriate.

The entire series consists of the following other guidelines:

*Guidelines on procedures for the registration, certification and testing of new pesticide application equipment;*

These guidelines outline a further way by which governments can influence pesticide safety by controlling the quality of the pesticide application equipment manufactured in or imported into the country. By incorporating into national legislation, a requirement for manufacturers and importers to declare that application equipment meets standard of safety and durability, it should be possible to gradually reduce and eventually eliminate sub-standard equipment from the market.

*Guidelines on the organization of schemes for testing and certification of agricultural pesticide sprayers in use*

This publication covers the testing and certification of the sprayers currently applying pesticides on commercial farms. They address an urgent need in many countries to ensure that where pesticides are used in crop production, they are applied through equipment, which is safe and fully functional. The issue applies to both large, field crop and orchard sprayers as well as operator-carried equipment.

*Guidelines on the organization and operation of training schemes and certification procedures for operators of pesticide application equipment.*

These guidelines consider the training, testing and certification of those who actually operate pesticide application equipment. Even the most well designed and maintained sprayer can do immeasurable damage in the hands of an unskilled operator and the importance of these guidelines should not be underestimated.

A further two guidelines in the series cover application of pesticides using aircraft and field crop sprayers and tree and bush crop sprayers:



*Guidelines on good practice for aerial application of pesticides;  
Guidelines on good practice for ground application of pesticides.*

These guidelines have been prepared to offer practical help and guidance to all those involved in using pesticides for food and fibre production or in public health programmes. They cover the main terrestrial and aerial spray application techniques.

# **PART ONE**

## **GUIDELINES ON MINIMUM REQUIREMENTS: (PORTABLE OPERATOR- CARRIED) HOT-FOGGERS**

### **INTRODUCTION**

For the purpose of this guideline, foggers are portable (operator-carried) pesticide application appliances used to treat large areas and spaces. They generate fine aerosol droplets with a volume median diameter (VMD) of less than 25 µm, with oil-based formulations. Droplet size is usually slightly larger when water-based formulations are used.

Pesticides applied through hand-held portable foggers are used to treat insects in an air space however droplets will slowly sediment and deposit primarily on upper surfaces. Foggers are widely used in closed spaces like greenhouses, warehouses, grain stores and livestock buildings, as well as in some open situations, principally in plantation crops in still air conditions.

### **Hazards**

With all foggers, there are a number of potential hazards and only trained, certified operators should operate this class of equipment. Inhalation can cause problems due to the large number of droplets, below 10µm. There is a risk of fire with hot foggers, so fire extinguishers should always be readily available when this equipment is used. Some fog applications can pose a risk of explosion in confined spaces and can cause phytotoxicity in sensitive crops.

### **HOT FOGGERS**

With hot foggers, often referred to as thermal foggers, pesticide liquid, often dissolved in oil, is vaporised in a combustion chamber then expelled

via an outlet tube to form a dense fog cloud as it condenses on contact with cool ambient air. Hot foggers are usually equipped with a petrol-driven pulse jet engine.

## **HF Module 1 - GENERAL REQUIREMENTS**

Hot foggers should be reliable and capable of working efficiently under practical conditions.

They should be robustly constructed from strong, durable materials, which will not obviously be prone to undue deterioration during use thereby adversely affecting safety and lowering efficiency due to corrosion, rust, distortion or premature wear.

To meet the FAO Minimum Requirements, a hot fogger, (referred to throughout this part of the document as a “fogger”) should comply with the following requirements.

- 1.1 Total mass when both fuel and pesticide tanks are full to nominal (manufacturer’s recommended maximum) capacity should not exceed 20 Kg.
- 1.2 The fogger should not leak.
  - First, check that all hose, pipe and other connections are tight. This is especially important in a new fogger.
  - Fill the spray tank to the manufacturer’s recommended maximum capacity with water. Then carefully dry the complete outside of the sprayer and its attachments and check for leakage with the on /off valve in both the open and closed positions.
  - Do this, operate the fogger for a few minutes at the normally recommended operating pressure and re-check for leakage.

- Pay special attention to the most likely leak points: pump assemblies, pipe connections and on/off valves.
  - With the tank filled to the manufacturer's maximum recommended capacity, tilt the tank 45 degrees from the vertical in all directions to ensure that the liquid does not leak from the lid.
- 1.3 The pesticide liquid circuit in the fogger should be easy to flush thoroughly with cleaning fluid.
- 1.4 Rough exterior surfaces should be avoided and difficult-to-clean and awkward recesses minimised.
- 1.5 There should be no sharp edges, abrasive areas or unnecessary projections, which could injure the operator.
- 1.6 The fogger should incorporate a conveniently located "handle" to enable it to be carried safely when not in use.
- 1.7 The fogger must be fitted with guards to minimise the risk of the operator being burned by heated parts.
- 1.8 The fogger should be stable and stand in its normal upright position on slopes up to 15% (1 in 7), irrespective of the amount of liquid in the tank.
- 1.9 Servicing, maintenance, adjustment and cleaning of all fogger components should be easily accomplished and where required, special tools (i.e. tools specifically designed for the fogger) should be supplied with the fogger.
- 1.10 To facilitate the accurate identification of replacement parts, the fogger should be clearly and durably marked to indicate; the manufacturer's name, address and the fogger name and model.

- 1.11 All controls should be easy to operate and adjust with gloved hands (gloves for test purposes should be a minimum thickness of 0.5 mm).
- 1.12 Fuel tanks should have sufficient capacity to enable the fogger to be used for periods of at least one hour without refilling and should be durably marked with a clear warning not to refill the fuel tank when it is hot.
- 1.13 The manufacturer should provide with the fogger a clear, simple, illustrated manual in English, French or Spanish and in an accepted commercial language in the specific country for which the fogger is being evaluated.
- 1.14 The manual should contain procedures for:
- initial assembly;
  - identification of all the replacement parts including an “exploded” diagram;
  - setting and calibration;
  - minimising the need to dispose of dilute pesticide;
  - cleaning and safe disposal of any washings;
  - routine maintenance and storage;
  - safe, accurate field use;
  - setting and starting the engine including carburettor adjustments.

It should also provide information on:

- safeguards to prevent explosion and fire;
- precautions to minimise the risk of operator injury and contamination;
- precautions to minimize the risk of environmental contamination;

- safe-handling of undiluted pesticides, particularly when mixing chemicals and filling the tank;
- disposal of leftover spray liquid and empty pesticide containers;
- maximum restrictor size to be used in the fogger;
- recommended uses for the fogger to ensure that the correct model of fogger is used for water-based, heat sensitive and oil-based pesticide formulations.

1.15 The manufacturer should also provide written assurance in the manual that:

- parts of the fogger that come into constant direct contact with the spray liquid are made from non-absorbent materials, which are suitable for use with approved pesticide formulations;
- parts of the fogger that are exposed routinely to direct sunlight are made from materials which do not unduly deteriorate;
- a practical system is in place to assist in the provision of replacement parts for a minimum of five years after the date of manufacture;
- the pesticide tank will withstand a pressure of 2 times the working pressure of the fogger.

## **HF Module 2 - PESTICIDE TANK, STRAINER AND LID**

2.1 Where a funnel with an integral strainer is supplied with the sprayer (to facilitate filling without splashing and/or overflowing) the mesh aperture size should not exceed the minimum recommended restrictor orifice size.

- 2.2 A system or mechanism should be incorporated into the design of the fogger to avoid the risk of overfilling and spilling pesticide solution from the fill opening of the tank during filling.
- 2.3 The fill opening should be sealed with an airtight lid or cap, which can be opened and securely closed without tools and with gloved-hands (see Section 1.11).
- 2.4 The design of the fogger should enable the pesticide tank to be easily and thoroughly drained and cleaned.

### **HF Module 3 - PESTICIDE DELIVERY PIPES AND HOSES**

- 3.1 Pesticide delivery pipe and hose connections should not leak when released and then reconnected.
- 3.2 An on/off valve, which can be fixed in the “off” position, should be located in the pesticide delivery line.
- 3.3 To open the on/off valve should require no more than 1.5 N/m torque.
- 3.4 A removable filter, which is readily fitted and removed with gloved hands (see Section 1.11) and with a mesh aperture size not exceeding the size of the smallest recommended restrictor, should be fitted in the pesticide delivery line, upstream of the on/off valve.

- 3.5 Interchangeable restrictors or an alternative positive metering system should be supplied with the fogger.
- 3.6 The fogger should be fitted with a mechanism, which automatically and immediately shuts off the supply of pesticide solution to the exhaust tube when the engine stops.
- 3.7 The flow rate should not exceed  $\pm 10\%$  through the largest restrictor at normal working pressure at any specified temperature within the normal working range.

#### **HF Module 4 - STRAPS AND PADDING**

- 4.1 The fogger should be equipped with a shoulder strap.
- 4.2 The strap and fixings should be strong and durable.
- 4.3 The design should ensure that the strap cannot be damaged from contact with hot parts of the fogger.
- 4.4 The load-bearing part of the shoulder strap should be a minimum of 50 mm wide.
- 4.5 When adjustable shoulder pads are included, they should remain firmly in place in their adjusted positions when the fogger is in use.



- 4.6 The manufacturer should provide written assurance in the fogger manual that straps and padding are of non-absorbent material and resist undue deterioration from contact with approved pesticide formulations.
- 4.7 The strap should be equipped with a quick release catch that function efficiently when the tanks are full and in the working position on the operator.

## **HF module 5 - POWER SOURCE**

### **Engine**

- 5.1 The throttle lever must remain firmly fixed in any pre-set position during use.
- 5.2 The engine should be equipped with an instant “cut- out” mechanism, which is readily accessible to the operator when the fogger is in the working position.
- 5.3 The engine should have a robust starting mechanism.
- 5.4 The exhaust should be:
- robustly shielded to avoid burning the operator, a third party or the strap
  - positioned as far as practical from the controls.
- 5.5 The engine should be robustly protected against accidental physical damage.

- 5.6 The fuel tank and the fuel on/off valve should be positioned to minimise the risk of fuel spilling onto the engine or exhaust tube.
- 5.7 The fuel on/off valve should be easily accessible to the operator and close to the fuel tank outlet.
- 5.8 An easily serviceable fuel filter should be located in the line between the tank and the carburettor.
- 5.9 Carburettor settings should remain firmly in any pre-set position at all times.
- 5.10 When two-stroke and four-stroke engines are used in the fogger, an easily replaceable dry-type air filter should be installed directly on the carburettor intake.
- 5.11 The fuel on/off valves and air intake filter should be easily removable for cleaning.
- 5.12 The noise level at the ears of the operator (without ear defenders) should not exceed 110 dB.
- 5.13 Ear defenders should be supplied with the fogger to limit the noise level at the ears of the operator to 85 dB.
- 5.14 When a two-stroke engine is used, the fuel tank should be durably marked with the recommended fuel/oil ratio.

## **HF module 6 - PERFORMANCE**

- 6.1 For oil-based formulations, the fogger must produce droplets with a VMD of  $<25\mu\text{m}$ . For other formulations, the VMD should not exceed  $50\mu\text{m}$ .
- 6.2 At any specific temperature within the recommended working range and at normal working pressure and maximum flow-rate, variation in pressure at the restrictor should not exceed  $\pm 10\%$ .
- 6.3 Spray droplets emitted from the air outlet in still air conditions should be projected horizontally not less than 2m horizontally.

## **PART TWO**

### **GUIDELINES ON MINIMUM REQUIREMENTS (PORTABLE OPERATOR-CARRIED) COLD FOGGERS**

#### **COLD FOGGERS (CF)**

Cold foggers use an air shear or vortical (swirl) nozzle to shatter an ultra-low volume (ULV) spray formulation so that the VMD of the droplets is  $<50\mu\text{m}$ . Portable hand-held cold foggers are usually powered, either by an electric motor or by a petrol or propane-fuelled engine.

In agriculture, cold foggers are used in glasshouses and produce stores.

#### **Hazards**

Cold foggers present a risk of small droplets being inhaled. All safety instructions supplied by the manufacturer should be carefully followed.

#### **CF Module 1 - GENERAL REQUIREMENTS**

Cold foggers should be safe, reliable and capable of working efficiently under practical “field” conditions.

They should be robustly constructed from strong, durable materials which will not obviously be prone to deterioration during use thereby adversely affecting safety and lowering efficiency due to corrosion, rust, distortion or premature wear.

To meet the FAO Minimum Requirements, a cold fogger (referred to as a “fogger” throughout this part of the document) should comply with the following requirements:

- 1.1 Total mass when filled to nominal (manufacturer's recommended maximum) capacity should not exceed 25 Kg for a back-carried model and 20 Kg for a hand-carried model.
- 1.2 The fogger should not leak.
  - First check that all hose pipes and other connections are tight. This is especially important in a new fogger.
  - Fill the spray tank to the manufacturer's recommended maximum capacity with water. Carefully dry the complete outside of the sprayer and its attachments and check for leakage with the on/off valve in both the open and closed positions.
  - Operate the fogger for a few minutes at the normally recommended operating pressure and re-check for leakage paying special attention to the most likely leak points: pump assemblies, pipe connections and on/off valves.
  - With the tank filled to the manufacturer's maximum recommended capacity, tilt the tank 45 degrees from the vertical in all directions to ensure that the liquid does not leak from the lid.
- 1.3 The pesticide liquid circuit in the fogger should be easy to flush thoroughly with cleaning fluid.
- 1.4 Rough exterior surfaces and awkward recesses, which could retain liquid should be minimised.
- 1.5 There should be no sharp edges, abrasive areas or unnecessary projections, which could injure the operator.
- 1.6 The fogger should incorporate a conveniently located "handle" to allow it to be carried safely when not in use.

- 1.7 The fogger must be fitted with guards to minimise the risk of heated parts burning the operator.
- 1.8 The fogger should be stable and stand in its normal upright position on slopes up to 15% (1 in 7), irrespective of the amount of liquid in the tank.
- 1.9 Servicing, maintenance, adjustment and cleaning of all fogger components should be easily accomplished and where required, special tools (i.e. tools specifically designed for the fogger) should be supplied with the fogger.
- 1.10 To facilitate the accurate identification of replacement parts, the fogger should be clearly and durably marked to indicate; the manufacturer's name, address, and the sprayer name and model.
- 1.11 All controls should be easy to operate and adjust with gloved hands (gloves for test purposes should be a minimum thickness of 0.5 mm).
- 1.12 The manufacturer should provide with the fogger a clear, simple, illustrated manual in English, French or Spanish and in an accepted commercial language in a specific market for which the fogger is being evaluated.
- 1.13 The manual should contain procedures for:
- initial assembly;
  - identification of all the replacement parts including an “exploded” diagram;
  - setting and calibration
  - minimising the need to dispose of dilute pesticide;

- cleaning and safe disposal of any washings;
- routine maintenance and storage;
- safe, accurate field use;
- setting and starting the engine including carburettor adjustments.

It should also provide information on:

- safeguards to prevent explosion;
- precautions to minimise the risk of operator injury and contamination;
- precautions to minimize the risk of environmental contamination;
- safe-handling of undiluted pesticides, particularly when mixing chemicals and filling the tank;
- disposal of leftover spray liquid and empty pesticide containers;
- maximum restrictor size to be used in the fogger;
- drop size data for the range of recommended uses;
- the cable specification and length to ensure that adequate power is transmitted to the electric motor.

1.14 The manufacturer should provide written assurance in the manual that:

- parts of the fogger that come into constant direct contact with the pesticide liquid are made from non absorbent materials, which are suitable for use with approved pesticide formulations;
- parts of the fogger that are exposed routinely to direct sunlight are made from materials which do not unduly deteriorate;
- a practical system is in place to assist in the provision of replacement parts for a minimum of five years after the date of manufacture;

## **CF Module 2 - PESTICIDE TANK, STRAINER AND LID**

- 2.1 Where a funnel with an integral strainer is supplied with the sprayer (to facilitate filling without splashing and/or overflowing) the mesh aperture size should not exceed the minimum recommended restrictor orifice size.
- 2.2 A system or mechanism should be incorporated into the design of the fogger to avoiding the risk of overfilling and spilling pesticide solution from the fill opening of the tank during filling.
- 2.4 The fill opening should be sealed with an airtight lid (except where a ventilation valve is fitted) or a cap, which can be opened and securely closed without tools and with gloved-hands (see Section 1.11).
- 2.4 The fogger should be designed so that pesticide tank can be easily and thoroughly drained and cleaned.

## **CF Module 3 - PESTICIDE DELIVERY HOSES AND PIPES**

- 3.1 Connections on pesticide delivery hoses or pipes should not leak when released then reconnected.
- 3.2 Where a pesticide delivery hose is made of plastic, it must not kink (flatten) when bent through 180 degrees with an unsupported bend radius of 50 mm at temperatures up to 25° C.



- 3.3 An on/off valve, which can be locked in the off position, should be located in the pesticide liquid delivery line.
- 3.4 To open the on/off valve in the pesticide liquid delivery line should require no more than 1.5 N/m torque.
- 3.5 A removable filter, which is readily fitted and removed with gloved hands (see Section 1.11) and with a mesh aperture size no larger than the smallest recommended restrictor, should be located in the pesticide delivery line upstream of the on/off valve.
- 3.6 Interchangeable restrictors should be supplied with the fogger.
- 3.7 The flow rate should not exceed  $\pm 10\%$  through the largest restrictor at normal working pressure and at any specified temperature within the normal working range.

#### **CF Module 4 - STRAPS AND PADDING**

- 4.1 The fogger should be equipped with a shoulder strap(s).
- 4.2 Straps and fixings should be strong and durable.
- 4.3 The load-bearing part of shoulder straps should be a minimum of 50 mm wide.
- 4.4 When adjustable shoulder pads are included, they should remain firmly in place in their adjusted positions when the fogger is in use.

- 4.5 The manufacturer should provide written assurance in the fogger manual that straps and padding are of non-absorbent material and resist undue deterioration from contact with approved pesticide formulations.
- 4.6 Straps should be equipped with quick release catches that function efficiently when the tanks are full and in the working position on the operator.

## **CF Module 5 - POWER SOURCE**

### **Engine - petrol and propane**

- 5.1 The throttle lever must remain firmly fixed in any pre-set position during use.
- 5.2 The engine should be equipped with an instant “cut-out” mechanism, which is readily accessible to the operator when the fogger is in the working position.
- 5.3 The engine should have a robust starting mechanism.
- 5.4 The exhaust should be:
- directed away from the operator’s body when the fogger is in the operating position;
  - robustly shielded to avoid burning the operator or a third party;
  - positioned as far as practical from the controls.

- 5.5 The engine should be robustly protected against accidental physical damage.
- 5.6 The fuel on/off valve should be easily accessible to the operator and close to the fuel tank outlet.

**For petrol engines:**

- 5.7 The fuel tank and on/off valve should be positioned to minimise the risk of fuel spilling onto the engine.
- 5.8 An easily serviceable fuel filter should be located in the line between the tank and the carburettor.
- 5.9 An easily replaceable dry-type air filter should be installed directly on the carburettor intake.
- 5.10 Carburettor settings should remain firmly in any pre-set position while the fogger is being used.
- 5.11 Carburettor adjusting screws should be readily accessible without requiring parts to be removed or the use of special tools.
- 5.12 When a two-stroke engine is used, the fuel tank should be durably marked with the required fuel/oil ratio.
- 5.13 The noise level at the ears of the operator (without ear defenders) should not exceed 110 dB.

- 5.14 Ear defenders should be supplied with the fogger to limit the noise level at the ears of the operator to 85 dB.

### **For propane engines**

- 5.15 The connection between the propane cylinder and the engine, including the pressure-reducing valve, must be secure and gas-tight.
- 5.16 The fuel cylinder and all accessories must comply with national safety regulations in the country for which the fogger is being evaluated.

### **For electric motors:**

- 5.17 National electrical safety standards must be met for the country for which the fogger is being evaluated.
- 5.18 The electrical components of the fogger must be designed and constructed for the power supply in the country for which it is being evaluated.
- 5.19 Cables supplied with the fogger should be oil and chemical-resistant.
- 5.20 Cables supplied with the fogger should avoid excessive voltage drop to ensure the supply of the required voltage to the motor.
- 5.21 The noise level at the ear of the operator should not exceed 85 dB.

- 5.22 The motor should have sufficient power to provide the maximum throughput claimed by the manufacturer.
- 5.23 The motor should have an on/off switch mounted on the fogger.

## **CF Module 6 - AIR-DISPLACEMENT SYSTEM**

- 6.1 The cold fogger should be equipped with an air-displacement system (e.g. compressor or blower) capable of producing droplets with a VMD  $<50\mu\text{m}$  at the manufacturer's maximum recommended flow rate and dispersing them away from the operator.
- 6.2 The flow of air from the fogger outlet should be capable of projecting the spray droplets horizontally for a minimum of 2 meters in still air away from the body of the operator.
- 6.3 An easily replaceable dry type air filter should be installed directly on the air intake of the compressor.
- 6.4 The drive to the compressor should be protected by a durable casing.