



International Code of Conduct on the Distribution and Use of Pesticides

Guidelines on Minimum Requirements for Agricultural Pesticide Application Equipment

Volume one

Portable (operator-carried) sprayers



FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

ROME 2001

This publication was developed in the IOMC context. The contents do not necessarily reflect the views or stated policies of individual IOMC Participating Organizations.

The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The participating organisations are FAO, ILO, OECD, UNEP, UNIDO, UNITAR and WHO. The World Bank and UNDP are observers. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

Table of contents

BACKGROUND.....	5
1. MODULE 1 - GENERAL REQUIREMENTS.....	11
2. MODULE 2 - TANK	13
4. MODULE 4 - SPRAYER ASSEMBLY FOR RA (SPRAY-HEAD, BOTTLE, HANDLE)	16
5. MODULE 5 - STRAPS AND PADDING	16
6. MODULE 6 - POWER SOURCE.....	17

Acknowledgements

These guidelines were prepared by T. L. Wiles and D. G. Sharp, of T L Wiles and Associates Limited, Chichester, UK with the assistance of Professor G. A. Matthews of IPARC, Imperial College at Silwood Park, University of London. The valuable contributions and comments of the many international experts from both the public and private sectors are also acknowledged.

Guidelines on Minimum Requirements for Agricultural Pesticide Application Equipment

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.

Introduction

Volume One of the FAO guidelines on minimum requirements covers portable sprayers which are carried in the hands or on the back of the operator and covers five principal types of sprayer:

LK - lever-operated knapsack;

MK- motorized hydraulic knapsack;

CS - compression sprayer;

MB - motorized mistblower;

RA - rotary atomizer.

Fogging machines are not yet included within the scope of the FAO guidelines.

Rotary atomizers

For the purposes of these guidelines, a portable rotary atomizer sprayer consists of a spinning atomizer (usually a disc, or cup) onto which flows spray liquid, to produce spray droplets. The atomizer is driven by a small electric motor powered by a series of dry cells (torch batteries) or by rechargeable batteries carried either within the carrying handle, on the operator's belt, or on a strap slung over the operator's shoulder. Spray liquid flows onto the atomizer by gravity from a small bottle mounted on the spray head, and /or from a backpack or shoulder-slung tank.

Sprayer choice

It is important that buying agencies select the type of sprayer that is most appropriate for the intended use. The following notes will assist in the selection process.

Lever-operated knapsack sprayers

These are the most commonly used portable sprayers and are fitted with one of two types of pump. Diaphragm pumps are a durable option where applications are made through a single nozzle. They are also suitable for multi-nozzle booms where low spraying pressures are adequate (1-2 bar) for example, when spraying herbicides.

Piston pumps are suitable for single-nozzle use and are preferable to diaphragm pumps for multi-nozzle use where higher pressures are required (up to 4 bar).

Under-arm levers are preferable to over-arm levers except where crop conditions impede the movement of the lever.

Motorized hydraulic knapsack sprayers

These units are a good option for use with multi-nozzle booms where prolonged pumping, even with a piston machine, is not practical.

Compression sprayers

Compression sprayers are necessary where field conditions make lever-operated machines impractical, for example on steep slopes and in dense crop foliage. They are also used in grain stores to treat wall surfaces. NB: The output from this type of sprayer declines during the pressure cycle unless a flow control valve is fitted to the sprayer.

Motorized mistblowers

Motorized mistblowers are used where the spray cloud needs to be projected vertically to treat trees, but may also be used to spray horizontally for row and bush crop spraying. They can also be adapted for granule application. NB: Mistblowers are not recommended for herbicide application.

Rotary atomizers

Rotary atomizers are particularly useful and cost effective for the application of pesticides when large areas of crop need to be treated quickly by hand, where water for high volume spraying is scarce and where labour is in short supply. They employ small droplets and often rely on controlled drift techniques to achieve their high work output.

Nozzle choice

The provision of the correct nozzle (not applicable for rotary atomizers) enables safer and more efficient spraying. Appropriate nozzles should be supplied with the sprayer to cover the intended uses.

- Flat fan nozzles are used for spraying products onto flat surfaces for example; for applications to foliage, to the soil surface and for the application of insecticides to walls for the control of stored-product pests.
- Deflector nozzles (also called impact, flood or anvil nozzles) are also used for application of herbicides, where only a single nozzle is used.
- Hollow-cone nozzles are used for the general spraying of insecticides and fungicides to foliage and give good coverage on the outer parts of a leaf canopy.

N.B. Adjustable multi-purpose nozzles are not recommended for use in crop protection. Consistent spray quality is difficult to reproduce and operators tend to adjust and touch these types of nozzle with bare hands when they are contaminated with pesticides.

High pressure and drift

One of the primary sources of operator hazard from hand-carried portable sprayers relates to high pressure (over 4 bar) with hydraulic nozzles, which can produce fine droplets that are prone to uncontrolled drift and inhalation. High pressures can also increase hazard through failure of sprayer components, resulting in major leakage of spray liquid. Therefore, a key criterion in appropriate sprayer design is the provision of systems of pressure control.

The minimum requirements specify the pressure limits recommended to minimize potential hazard without compromising spraying efficiency.

N.B. High-pressure spray guns and lances, which are commonly used in protected crops and in small-scale horticulture, produce an unacceptably high proportion of small droplets of a respirable size. The spray cloud produced by this type of equipment represents an unacceptable human hazard and drift potential and should not be used either for protected or for outdoor horticultural or agricultural crops.

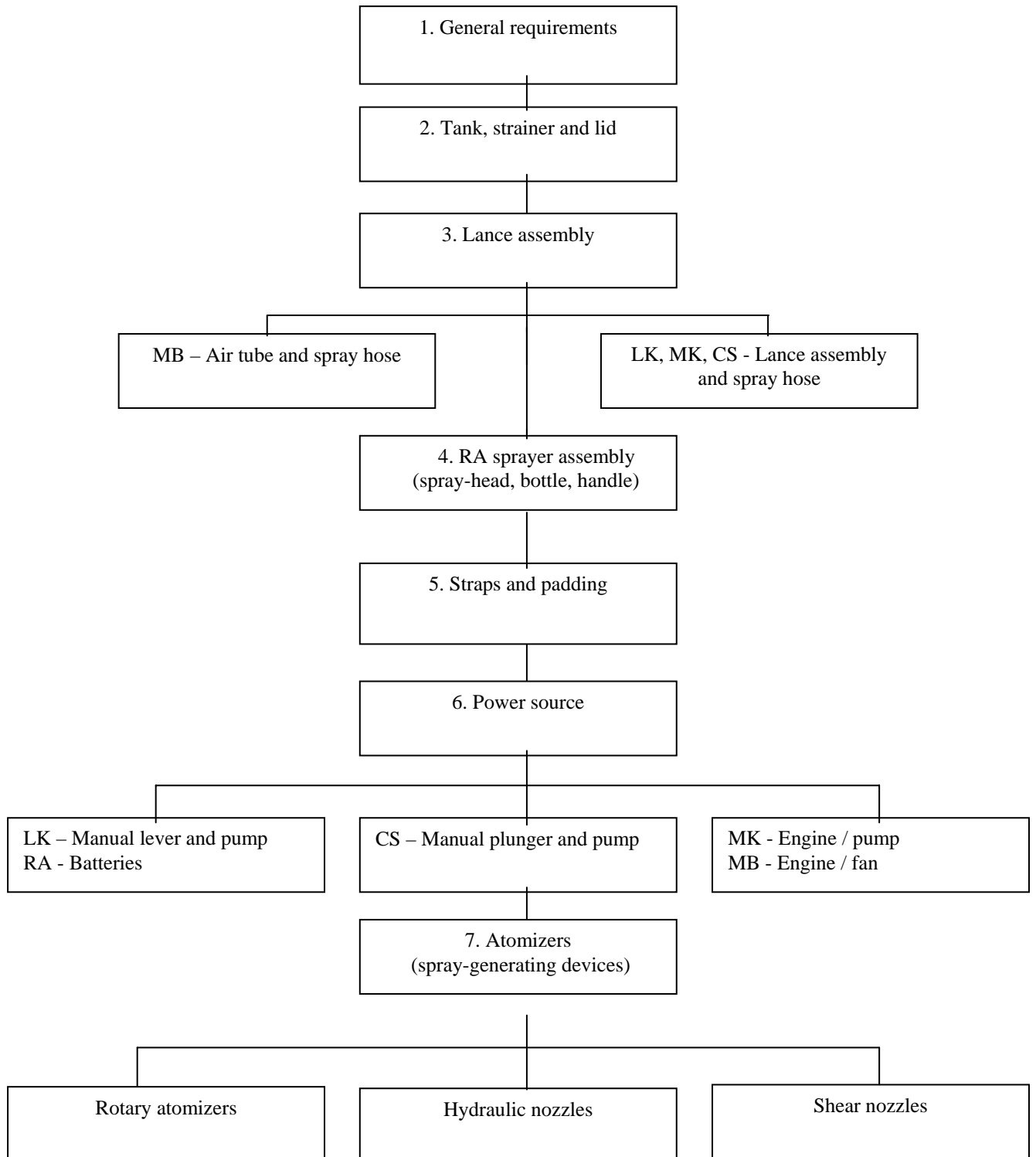
Using the guidelines on minimum requirements

For the purposes of defining these guidelines, portable sprayers can be divided into several "component modules" (see Figure 1). Within each module, especially in relation to safety, with relatively few exceptions the functional requirements are the same for all sprayer types.

The guidelines on minimum requirements do not aim to provide precise quality requirements and test procedures. These are addressed in the companion guideline in this series. *Guidelines on standards for agricultural pesticide sprayers and related test procedures*. The guidelines on minimum requirements provide a practical aid to assist purchasing and other agencies to avoid buying or approving sprayers with quality and design limitations, which could compromise operator and environmental safety.

FIGURE 1

PORTABLE SPRAYER COMPONENT MODULES



1. Module 1 - General requirements

For LK, MK, CS, MB, RA

Portable (operator-carried) pesticide sprayers for agriculture 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 undue deterioration during field use, thereby adversely affecting safety and lowering efficiency due to corrosion, rust, distortion or premature wear.

To meet the FAO minimum standard, a portable sprayer (the sprayer) should comply with the following requirements.

- 1.1. Total mass when filled to the manufacturer's recommended maximum capacity should not exceed 25 Kg.

For RA, the following are acceptable guidelines for the division of the total mass.

- 20 kg maximum for a backpack (or shoulder-slung) tank and battery power source carried on a waist belt, or on a shoulder strap.
 - 7 kg for a lance / battery case, spray head, spray bottle and a hand-carried tank, where present.
- 1.2. The sprayer should not leak.
 - First check that all hose and other connections are tight. This is especially important in a new sprayer;
 - 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 with the on /off valve in both the open and closed positions, check for leakage;
 - Do this for all sprayers without pressurising (i.e. operating) the sprayer, then, for LK, MK, CS, operate the sprayer 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, hose 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 or through the ventilation valve.
 - 1.3. The sprayer should be easy to clean thoroughly both inside and out. Rough surfaces and awkward recesses should be avoided.
 - 1.4. The outer surfaces of the sprayer should not trap nor retain spray liquid.
 - 1.5. There should be no sharp edges, abrasive areas or unnecessary projections, which could injure the operator.

- 1.6. The sprayer should incorporate a conveniently located handle to enable it to be safely carried when not in use. (LK, MK, CS,).
- 1.7. The sprayer should be stable and stand upright on slopes up to 15% (1 in 7), irrespective of the amount of liquid in the tank. (LK, MK, CS, MB.)
- 1.8. Servicing, maintenance, adjustment and cleaning of all sprayer components should be easily accomplished without needing special tools (i.e. tools specifically designed for the sprayer).
- 1.9. To facilitate the accurate identification of replacement parts, the sprayer should be clearly and durably marked to indicate the manufacturer's name and address and the sprayer name and model.
- 1.10. All pressure and flow control devices should be adjustable from outside the spray tank.
- 1.11. A safety device should be incorporated into the sprayer to prevent the maximum pressure exceeding 5 bar (LK, MK,) and 6 bar (CS) in any part of the sprayer and vented liquid should be discharged inside the tank.
- 1.12. The manufacturer should provide with the sprayer a clear, simple, illustrated manual in English, French or Spanish and an accepted commercial language in a specific market for which the sprayer is being evaluated.
- 1.13. The manual should contain procedures for:
 - initial assembly;
 - identification of all replacement parts including an “exploded “ diagram;
 - setting and calibration;
 - minimising the need to dispose of dilute pesticide;
 - cleaning and safe disposal of washings;
 - routine maintenance and storage;
 - safe, accurate field use;
 - safe release of residual pressure in the lance when a spray management valve is used; (LK, MK, CS)
 - safe release of pressure in the spray tank. (CS)

It should provide information on:

- durability of the materials used to make the sprayer;
 - safe handling of undiluted agrochemicals, mixing chemicals and filling the tank;
 - disposal of leftover spray liquid and empty pesticide containers;
 - atomizer flow rates and spray quality (see Module 7);
 - nozzle sizes and operating pressures to be used in the sprayer (see Module 7);
 - precautions to minimise the risk of operator and environmental contamination.
- 1.14. The manufacturer should also provide written assurance in the sprayer manual that:

- parts of the sprayer 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 sprayer that are exposed routinely to direct sunlight are made from materials which do not unduly deteriorate;
- that 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.

2. Module 2 - Tank

For LK, MK, MB, RA

- 2.1. For RA in this module, the tank refers to any container that is hand-held, carried on straps on the operator's back or slung on a strap over a shoulder, which is used to contain the spray liquid to be applied through a rotary atomizer.
- 2.2. The tank should be clearly and durably marked with:
 - the manufacturer's recommended maximum filling level, which should be equivalent to no more than 95% of the total volume of the tank;
 - appropriate intermediate filling levels.
- 2.3. During filling, with the strainer fitted (see Section 2.4) the level of liquid in the tank should be clearly visible as it approaches the nominal maximum filling level.
- 2.4. The tank should include a strainer, located in the fill opening to filter the water or spray solution as it enters the tank.
- 2.5. The strainer should be easy to remove and fit with gloved hands. For this and for other checks, where gloves are recommended they should have a minimum thickness of 0.5 mm.
- 2.6. The strainer should have a mesh aperture size no greater than 1.0 mm.
- 2.7. The strainer mesh should be securely fitted to, or form part of, the strainer body.
- 2.8. The strainer should be close fitting and permit safe, easy filling from a non-profiled container (i.e. one without a lip or spout) at a rate of 25 litres per minute without overflowing, splashing or lifting from its seat.

As a guide: it is suggested that the strainer should be recessed into the fill opening, which should be no less than 100 mm across the smallest dimension.
NB: this section refers to tanks on LK, MK, MB, and RA when present.
- 2.9. The tank fill opening should be sealed with a lid that can be opened and securely closed with gloved hands and without tools.
- 2.10. When closed, the lid should not collect spray liquid.

- 2.11. Either the lid or the tank should have a ventilation valve.
- 2.12. When a sprayer includes an agitator device; it should move freely, should not catch on other parts of the sprayer and should be easily removed and refitted with gloved hands.

For Compression sprayers (CS)

- 2.13. The tank should have a minimum capacity of 5 litres.
- 2.14. The tank should be clearly and durably marked to show the nominal (manufacturer's recommended) maximum filling level, which should be equivalent to no more than 75% of the total volume of the tank.
- 2.15. When during filling the spray liquid level in the tank is not clearly visible, the manufacturer's recommended maximum volume in litres should be clearly marked on the tank and included in the sprayer manual.
- 2.16. A funnel with an integral strainer should be supplied with the sprayer, to filter the water or spray solution as it enters the tank.
- 2.17. The funnel strainer should have a mesh aperture size no greater than 1.0 mm.
- 2.18. The funnel strainer mesh should be securely fitted to, or form part of, the funnel body.
- 2.19. The funnel should permit safe, easy filling from a non-profiled container (i.e. one 1.1 without a lip or spout) at a rate of 10 litres per minute, without overflowing or splashing
- 2.20. The tank fill opening should be sealed with a tank lid, which can be opened and securely closed with gloved hands without tools.
- 2.21. The tank should be fitted with a pressure-indicating device.
- 2.22. The tank should be fitted with a pressure relief /safety valve to prevent the pressure in the tank from exceeding 6 bar.
- 2.23. The tank should be fitted with a pressure release valve that operates easily with gloved hands.
- 2.24. After spraying, it should not be possible to remove the lid (or pump) before the residual pressure in the tank has been released.
- 2.25. Threaded fittings to the pressurised parts of the tank with a diameter greater than 13 mm should include a channel to ensure that the pressure in the tank is released before the lid (or pump) can be removed.

3. Module 3 - Lance assembly and spray hose (for LK, MK, CS)

Air tube and spray hose (for mb)

- 3.1. Spray hoses, when bent through 180 degrees at temperatures up to 30°C, should not kink (flatten).
- 3.2. Hose connections should be easily adjustable and removable with gloved hands and should not leak when reconnected.
- 3.3. Spray hoses should be of sufficient length to allow free movement and appropriate positioning of the lance for spraying.
- 3.4. The minimum length of the lance from the front of the hand trigger grip to the nozzle should be 500 mm. For MB the length of the air tube from the on/off lever to the air outlet should be no less than 400 mm.
- 3.5. The sprayer should incorporate a robust "parking system" to secure the lance or air tube when it is not in use.
- 3.6. The lance should be fitted with a trigger-type on/off valve, which can be locked in the "off" position. For MB the liquid supply line to the nozzle should incorporate an on/off valve.
- 3.7. The length of a trigger valve lever measured from the pivot point should be no less than 100 mm.
- 3.8. The lance assembly (LK, MK, CS) should include a removable filter with a mesh aperture size not exceeding 0.3 mm that is easy to install and remove with gloved hands.
- 3.9. The removable filter in the lance assembly (see Section 3.8) should be located upstream of the trigger valve.
- 3.10. Interchangeable but not adjustable nozzles (LK, MK, CS) or restrictors (MB) should be supplied with the sprayer.
- 3.11. The maximum operating pressure at the nozzle should not exceed 4 bar (LK, MK, CS).
- 3.12. When a pressure indicator is included, it should be downstream of the on/off valve (LK, MK, CS).

4. Module 4 - Sprayer assembly for RA (spray-head, bottle, handle)

- 4.1. In all recommended working positions, the spray head should be a minimum of 500 mm from all parts of the operator's body to ensure that there is no direct contamination of the operator from the spray droplets.
- 4.2. To control the rate of flow of the spray liquid, the sprayer should be supplied with colour-coded, interchangeable restrictors that can be changed without special tools (i.e. without tools developed specifically for the sprayer).
- 4.3. A shield should be supplied with the sprayer to protect the atomizer from physical damage when it is not in use.
- 4.4. When the spray liquid to the atomizer is supplied solely from the bottle on the spray head (i.e. not re-filled from a spray tank) a funnel should be provided with the sprayer.
- 4.5. The funnel should enable the bottle to be filled easily from a non-profiled container (i.e. one without a lip or spout, which will normally be a pesticide container) without spilling or splashing, at a rate of 5 litres per minute.

5. Module 5 - Straps and padding

For LK, MK, CS, MB, RA

- 5.1. Straps and fixings should be strong and durable.
- 5.2. The manufacturer should provide written assurance in the sprayer manual that: straps and padding are of non-absorbent material straps and padding resist undue deterioration from contact with approved pesticide formulations.
- 5.3. An LK sprayer should be equipped with a load-bearing waist strap.
- 5.4. The load-bearing part of shoulder straps should be a minimum of 50 mm wide.
- 5.5. When adjustable shoulder pads are included, they should remain firmly in place in their adjusted positions when the sprayer is in use.
- 5.6. Straps when fitted to a back-carried tank (LK, MK, MB, RA) should be easily adjustable when the sprayer is full and in the working position on the operator's back.
- 5.7. Straps should be equipped with quick release catches that function efficiently when the tank (LK, MK, MB, RA) is full and in the working position on the operator's back.
- 5.8. Back-carried tanks when in the working position should be comfortable for the operator, either through the profile of the tank or through the provision of a back-frame.

6. Module 6 - Power source

Manual lever and pump – LK

- 6.1. The lever to operate the pump should be a minimum of 400 mm long and should have an arc of movement not exceeding 400 mm.
- 6.2. The lever should function for both left and right-handed use.
- 6.3. The end of the lever should be firmly and durably equipped with a handgrip with a minimum sectional dimension of 25 mm and a minimum length of 100 mm.
- 6.4. To achieve the maximum recommended flow rates and operating pressures, the pump should operate within the range of 20-30 lever strokes per minute.
- 6.5. At the maximum recommended flow rate, the pressure, measured immediately upstream of the nozzle, should not deviate by more than $\pm 10\%$.

Manual plunger and pump – CS

- 6.6. When the pump is manual, it should produce a pressure of 4 bar in the spray tank on completion of not more than 60 complete plunger strokes with the tank filled to nominal capacity.
- 6.7. Where the pump is located inside the spray tank, it should meet the following requirements.
 - the pump handle should be comfortable and convenient to use;
 - the internal length of the handle grip should be no less than 100 mm with a minimum section dimension of 25 mm.;
 - the sprayer should be fitted with a device that locks the plunger assembly in the lowest operating position so that the sprayer can be safely carried using the pump handle.
- 6.8. The sprayer manufacturer should provide written assurance in the sprayer manual that:
 - when the pump is solely hand operated and there is no possibility of pressurising from an outside source, the tank will withstand twice the maximum working pressure (8 bar) without deforming or leaking;
 - when the sprayer is fitted with a connection to allow it to be pressurised from an outside source, the tank will withstand five times the maximum working pressure (20 bar) without deforming or leaking.

Engine – MK and MB

The throttle lever must remain firmly fixed in any pre-set position during operation.

- 6.9. The engine should have an instant “cut out” mechanism that is readily accessible to the operator when the sprayer is in the working position on his/her back.
- 6.10. The engine should have a safe, robust starting mechanism.
- 6.11. The exhaust should be:

- directed away from the operator's body;
 - positioned on the opposite side of the sprayer to the controls;
 - robustly shielded to prevent burning the operator or a third party.
- 6.12. The engine should be isolated from the carrying frame by anti-vibration mountings.
- 6.13. The engine should be robustly protected against accidental physical damage.
- 6.14. The fuel tank and the fuel on/off valve should be positioned to minimise the risk of fuel spilling onto the engine.
- 6.15. The fuel on/off valve should be close to the fuel tank outlet and easily accessible to the operator when the sprayer is in the working position.
- 6.16. An easily serviceable fuel filter should be located in the line between the tank and the carburettor.
- 6.17. An easily replaceable air filter should be located directly on the carburettor intake.
- 6.18. Carburettor adjusting screws should be readily accessible without needing to remove parts or use special tools (i.e. tools specifically designed for the sprayer).
- 6.19. The noise level at the ear of the operator should not exceed 85 dB.
- 6.20. The fuel tank should have sufficient capacity for a minimum of one hour of continuous operation.
- 6.21. When a two-stroke engine is present, the fuel tank should be durably marked with the required fuel/oil ratio.
- 6.22. All moving parts should be well shielded to prevent injury.

Engine-driven pump – MK, (or MB)

- 6.23. Where the engine drives a pump by a pulley or gearing system, special care should be taken to fit adequate guards so that no moving parts are exposed.

Engine-driven fan – MB

- 6.24. Casing measuring no more than 45 cm diameter should protect the fan.
- 6.25. The inlet to the fan should be equipped with a guard with a minimum mesh- aperture size of 5 mm and a maximum size of 10 mm.

7. Module 7 - Atomizers (Spray generating devices)

It is the responsibility of the sprayer manufacturer to comply with the following requirements for atomizers supplied with or recommended for the sprayer even though the information may originate from another manufacturer, who specialises in nozzles or rotary atomizers.

Hydraulic nozzles – LK, MK, CS

- 1.15. Nozzles supplied with or recommended for a sprayer should be manufactured to international standards (ISO).
- 1.16. The sprayer manufacturer should include in the sprayer manual, information on:
 - nozzle flow rates, characteristic spray patterns and spray angles at 2, 3 and 4 bar;
 - nozzle heights and spacing to give uniform spray volume distribution at target level, when a horizontal boom with standard flat fan nozzles is recommended.
 - a procedure for determining when nozzles are worn to 125% of their original flow rate at their recommended operating pressure (s), and should be replaced.
- 1.17. For flat fan nozzles, the nozzle support system should include a method of ensuring correct orientation of the nozzle within the holder.

Rotary atomizers - RA

- 1.18. The sprayer manufacturer should include in the sprayer manual information on:
 - flow rates (measured with water);
 - characteristic drop sizes produced at the manufacturer's recommended restrictor flow rates and atomizer speeds;
 - a method to check the atomizer to determine when it should be replaced.
- 1.19. Output from any restrictor or between restrictors with the same identity code i.e. which claim to have the same characteristics, should not differ by more than $\pm 10\%$ from the nominal output.

Shear nozzles – MB

- 1.20. Where mistblowers are fitted with shear nozzles, the sprayer manufacturer should include in the sprayer manual, information on the recommended range of flow rates for different crop targets.