



International Code of Conduct on the Distribution and Use of Pesticides

Guidelines on the Organization of Schemes for Testing and Certification of Agricultural Pesticide Sprayers in Use



FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

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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
2. TESTING POLICY	7
3. RESPONSIBILITIES	8
4. ALTERNATIVE TESTING SCHEMES	8
5. ORGANIZATION OF TESTING SCHEMES	9
5.1 <i>General requirements</i>	9
5.2 <i>Test Locations</i>	9
5.3 <i>Testing staff</i>	10
5.4 <i>Equipment</i>	11
5.5 <i>Approach to testing</i>	11
5.6 <i>Test procedures</i>	12
Figure 1 - Portable (operator-carried) sprayer component modules	13
Figure 2 - Vehicle mounted and trailed sprayer component modules	14
5.7 <i>Test report and records</i>	16
5.8 <i>Certification, labelling and control</i>	16
6. FINANCING	17
7. INTRODUCING AND SUSTAINING SPRAYER-TESTING SCHEMES	17
8. QUALITY ASSURANCE	18

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Background

Since 1995, FAO AGSE has worked to improve the safety and efficiency of pesticides within systems of sustainable agriculture and integrated pest management (IPM). This began with the publication of guidelines to assist member states to control the quality of the most commonly used types of application equipment. 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.

In 2001, FAO AGSE, produced a new, revised and expanded series of pesticide application equipment-related guidelines, which includes this publication. The guidelines in this document cover the testing and certification of the sprayers currently applying pesticides on commercial farms. The series addresses 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 aircraft, large, field crop and orchard sprayers as well as to operator-carried equipment.

The series consists of the following other guidelines:

Guidelines on minimum requirements for agricultural pesticide application equipment;

An important objective of these guidelines 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. Even the cheapest sprayer models should meet minimum standards of safety and durability.

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

Guidelines on standards for agricultural pesticide sprayers and related test procedures;

These guidelines 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 proposed standards. The guidelines cover the major types of portable (operator-carried), vehicle-mounted and trailed agricultural pesticide sprayers manufactured in or supplied to FAO member countries.

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 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.

1. Introduction

Agricultural pesticide application equipment is required to deposit plant protection products as safely and accurately as possible on target. The aim is to deliver only those amounts, which are required to control the pest and to minimise contamination of the operator and off-target losses into the environment. These guidelines refer to spray equipment and do not cover the application of granules or dusts at this stage.

With careful use and regular maintenance, a well-designed and manufactured sprayer should continue to perform satisfactorily. However, the reality is that once spray equipment enters field use it is subject to considerable wear and tear and even amongst advanced farmers, servicing and maintenance are often inadequate.

In parts of Europe, even in highly developed agriculture, it is common for 30% to 50% of field crop sprayers to fail routine testing. While it is true that many of the faults can be rectified with minor repairs and replacements, without the test a sprayer could continue operating in a hazardous and less than optimum manner without anyone being aware of it.

In developing countries and countries with economies in transition, there are few examples of routine testing and certification of sprayers (which is referred to as “testing” throughout this guideline). There are schemes and initiatives to improve the safety and efficiency of pesticide sprayers through formal and informal operator training. These schemes are provided by official bodies and by private sector organisations such as the pesticide and sprayer manufacturing industries.

There is cause for serious concern in the developing world over the condition of agricultural pesticide sprayers in the field. This situation seriously affects the amount of pesticide used, the way it is applied, and the risk to human health and the environment.

Well-structured systems of sprayer testing and certification can make a major contribution towards reducing pesticide use and improving safety and efficiency and schemes of this type are well within the reach of many countries. These guidelines aim to assist countries that do not yet have schemes, to benefit from international experience.

2. Testing policy

Most of the experience of sprayer testing schemes is on field crop, boom sprayers and orchard sprayers and there is little experience of the testing of portable (operator-carried) equipment, most of which is used in warm climate agriculture and in developing countries.

The routine testing and certification of sprayers have been carried out on voluntary basis for several decades in some countries however, national schemes are increasingly becoming mandatory and bound by plant protection, health and environmental legislation.

There are good reasons why sprayer testing should be voluntary and there are good examples of valuable voluntary schemes. However, it should be the legal responsibility of governments to control pesticides to protect human health and the environment, and this responsibility should include controls over how pesticides are applied.

In many countries, farmers and growers are also accountable to avoid the indiscriminate use of pesticides, however, quite apart from legal obligations, there are sound commercial reasons why farmers should have their sprayers tested regularly. The financial losses incurred from over-application, through worn nozzles or faulty setting and the indirect losses from poor pest, disease and weed control can be considerable. Unfortunately, these losses and potential savings are not readily apparent to the majority of growers and spray operators and many farmers do not offer their sprayers for testing under voluntary schemes.

In order to seek the participation of all farmers, mandatory schemes are increasingly being introduced. However, mandatory schemes require organization and infrastructure and almost inevitably incur extra costs and while they may be highly desirable to maximise control, they are not always possible.

3. Responsibilities

In all countries, testing and certification schemes for sprayers should be included as part of the responsibility of government to minimize the risks to human health and the environment from the exposure to and the release of pesticides.

The authority that controls pesticides should ideally be an inter-ministerial/ interdisciplinary body as it is probable that departments of health, environment, agriculture and economic affairs will be involved. In order to help to meet this obligation, a designated board or agency should control pesticide hazard programmes and schemes. An operational sprayer testing service, which could typically be part of a Ministry of Agriculture, is likely to respond to central government through this type of structure.

A further option is that, as well as ministries being involved, the authority should include representatives from agriculture and other interest groups. This type of inter-institutional arrangement could involve representatives from farmers' unions, associations of chemical and equipment manufacturers and importers, machinery dealers and repair shops and the insurance industry. Such systems have merit because a range of interest groups is represented, therefore forming a good basis for an objective scheme.

Efficient schemes can also be set up and operated by completely independent farmers' associations or more probably by professional bodies such as associations of professional engineers or agronomists. Their prime motive is usually to protect the industries which they serve by ensuring high standards of good practice in relation to reduced pesticide hazard and improved productivity, however, these schemes can be readily recognised under national legislation and can be forerunners of what eventually become full and effective national schemes.

4. Alternative testing schemes

There is no one scheme that is best for all circumstances. The ultimate aims are to limit pesticide hazards and to minimise the losses that can result from poorly maintained agricultural sprayers and several key factors affect the choice of system:

- numbers of the different sprayer types in a country or area and their distribution;
- size of the territory and the infrastructure available, especially the communication and transport systems;
- solutions for spray aircraft or field-crop boom sprayers and orchard sprayers may well be very different from those required for a large population of lever-operated sprayers in a region of small-scale, intensive agriculture.

Nevertheless, whatever the situation, the principles outlined in these guidelines apply to all sprayer types, production systems and social structures.

5. Organization of testing schemes

5.1 General requirements

The body designated to run any scheme is required to perform the following principal functions:

- design and update of the overall scheme and control of the test methodology and compliance standards;
- administration of the scheme (to include publicity, documentation, appeals, certificates, decals (stickers), databases);
- appointment of testing stations;
- inspection of testing stations and their staff;
- training and certification of the testing staff;
- maintenance of uniform quality and objectivity (Quality Assurance);
- monitoring the performance of the scheme;
- collection of fees and financial administration.

5.2 Test Locations

Tests can be conducted using either mobile testing units, which travel round the country or through a network of test centres at fixed locations.

Mobile units with vehicle or trailer-mounted rigs

With this approach, tests are conducted on farms or at locations close to the place where the sprayers are normally used and housed. Mobile units are convenient for the farmers, however, the organisation required is high and this approach is likely to be more costly than other schemes to set up.

Suitable buildings in which to carry out the tests on or near farms are not always available and the majority of the on-farm testing is done outdoors. This can limit the capability to carry out certain tests, for example spray droplet distribution tests involving patternation or computerised spray scanning.

An alternative approach using mobile units is to carry out the tests in selected buildings throughout the test area, which are independent of the sprayer owners. In this case, sprayer owners are required to take their sprayer to a location that is reasonably close to them.

Fixed location “official” or officially approved test centres.

Where the scheme is based on fixed locations, test centres are usually “official” or “officially recognised” workshops. These “officially recognised.” centres can be either independent workshops or parts of agricultural equipment dealership networks. All workshops must meet the following criteria:

- officially approved by the regulatory body;
- adequate premises for the purpose:
 - protected from weather where necessary;
 - clean and ordered;
 - meet local environmental requirements.
- equipped to carry out the tests;
- staffed by mechanics who hold current testing service certificates to show that they are competent sprayer inspectors within the scheme;
- adequate administrative and management ability to participate in the scheme, to forward records to the regulatory authority and to issue certificates;
- regularly inspected by the regulatory authority.

Schemes, with “official”, in-house mobile units facilitate good control as all the testing staff belong to the testing authority itself. This type of scheme can be expensive to initiate but is used very effectively in some countries and can be self-financing once the number of tests carried out routinely is high enough.

Schemes with a network of “officially recognised” testing centres, operating along similar lines to a motor vehicle testing and certification scheme, can be efficient provided there are close controls and an independent quality assurance system is in place, which is run by the testing service. These schemes are usually less expensive to initiate but can require more resources to control.

A further advantage of an, “officially recognised” network is that the workshops are likely to carry replacement parts and are capable of immediately carrying out any required repairs. The value of this capability should be considered against the need for objective, independent testing.

5.3 Testing staff

Each testing station should have at least two staff that meet the following requirements:

- reliable people with appropriate vocational training (e.g. agricultural mechanic);
- technical knowledge, skills and experience;
- specific and detailed knowledge of the different types of sprayer being tested at the centre, their operation and calibration;

- hold a certificate of competence in sprayer testing (specifying the types of sprayer) issued by the testing authority.

5.4 Equipment

The following range of equipment is normally required for routine testing of agricultural pesticide sprayers:

- facility to measure the uniformity of spray distribution of field boom sprayers and spray aircraft (should the regulatory authority require this test);
- flow meters, officially calibrated. N.B. where fitted to field crop, orchard or portable compression sprayers, flow meters should be damped and fitted with pressure relief device;
- manometers, officially calibrated
- facility for validating manometers
- measuring cylinders to measure the output from nozzles
- equipment to measure nozzle spacing and spray angles.
- stopwatch
- stroboscope to check rotary atomizers
- non-profiled bucket (i.e. without a lip)

Test equipment should be appropriate in its operational range and adequate in number for the type(s) of sprayer to be tested. Ideally, it should be checked annually by the regulatory authority.

5.5 Approach to testing

Schemes vary; however, there are several central issues, which are common to all:

- tests should be realistic, practical, reproducible and indisputable;
- the methodology should be technically acceptable, uniform and professionally implemented;
- tests conducted by different teams or at different test centres, should consistently produce the same results;
- tests should be objective and open and the user/owner should be informed of the faults and remedial action required;
- the scheme should be affordable to the owners and financially viable for the responsible authority.

Schemes should seek to strike a balance between the importance of the parameter, the complexity of the test and the cost implications. A scheme, which employs excessive testing or which severely restricts the number of sprayers evaluated in a year, runs the risk of rendering the scheme unpopular and financially non-viable. On the other hand, a test series that is too simple or lacks precision is unlikely to be of value.

5.6 Test procedures

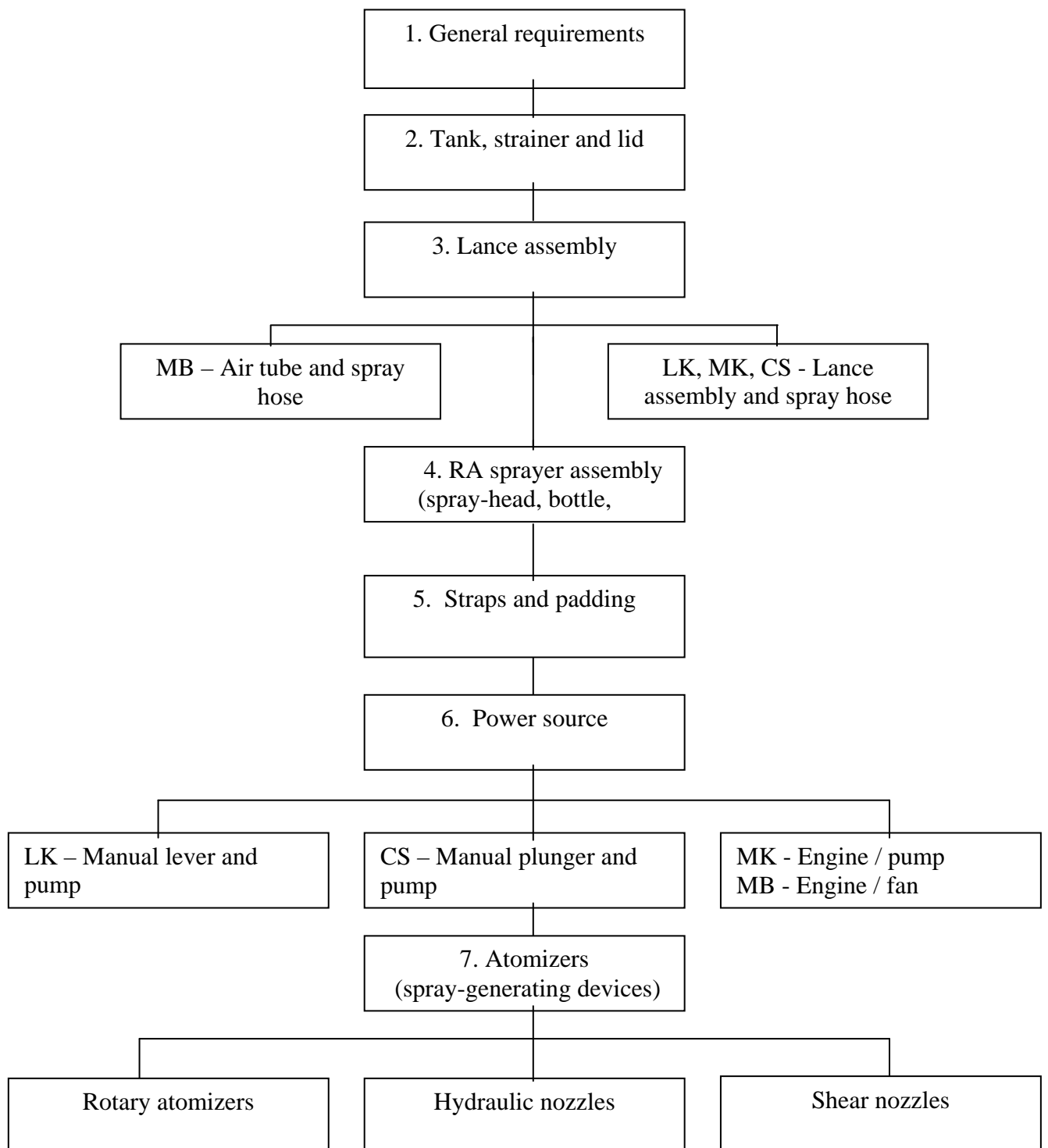
Most testing protocols have been developed for large-scale field crop and orchard sprayers and approaches to testing vary between schemes and protocols. Testing schemes approach the essential elements under the following or similar groupings, broadly as follows.

Mechanical safety and general condition

- Delivery systems (tank, lid, pump, hoses etc.)
- Application systems (spray lines nozzles, anti-drip valves etc.)
- Accessories /support systems: (electrics, warning labels;
- flushing tanks, induction hoppers, clothing compartments)

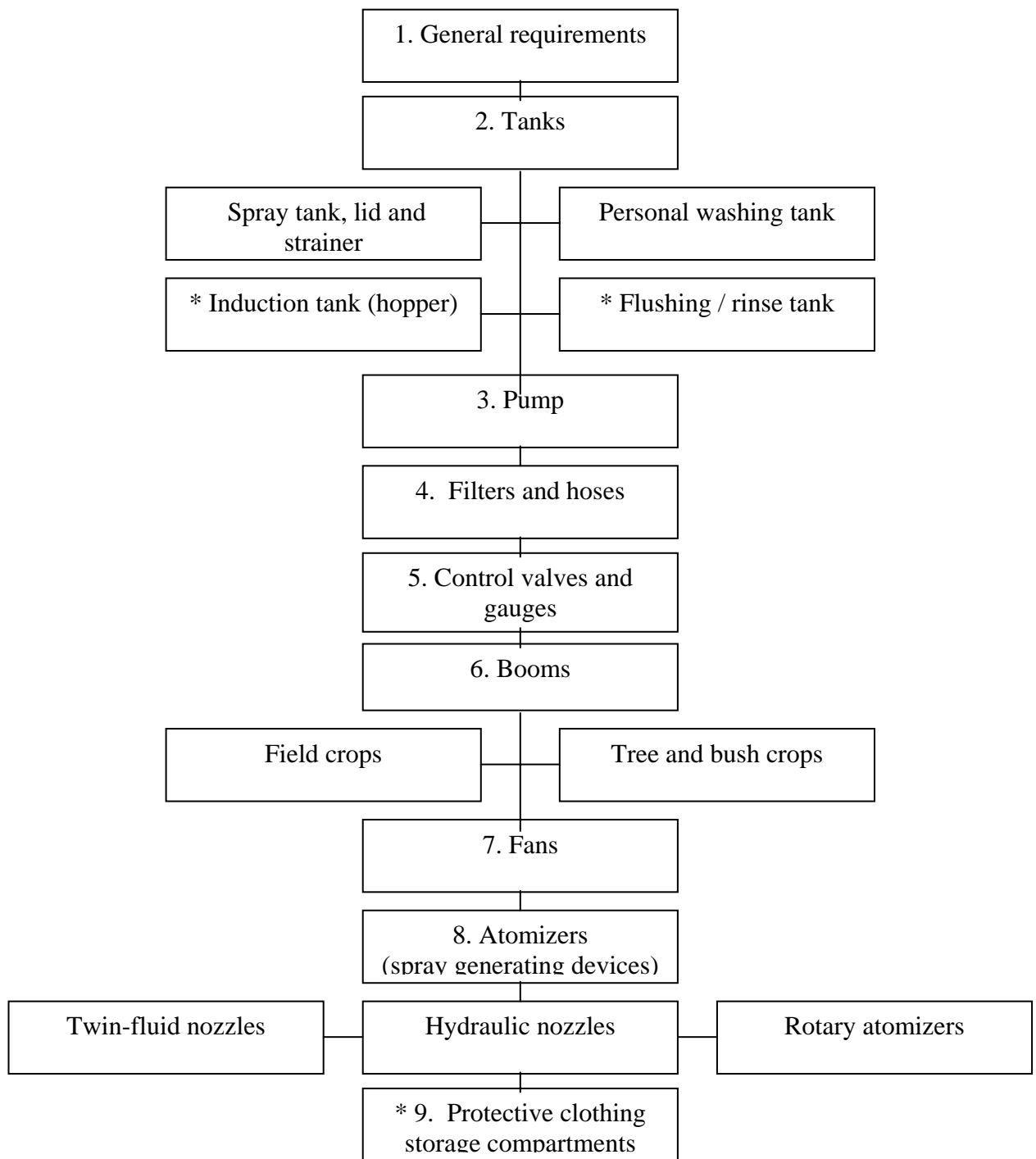
The FAO AGSE guidelines series present sprayers in a comprehensive modular format. Figure 1 shows the system for portable (operator-carried sprayers) and Figure 2 shows the system for vehicle-mounted and trailed sprayers (field crop and orchard sprayers). The system provides a convenient basis from which to develop test protocols for sprayers in use. The *Guidelines on minimum requirements for agricultural pesticide application equipment*, provide the required information.

Figure 1 - Portable (operator-carried) sprayer component modules



Key: LK –Lever-operated knapsack MK – Motorized hydraulic knapsack CS-
 Compression sprayer
 MB – Motorized mistblower RA – Rotary atomizer

Figure 2 - Vehicle mounted and trailed sprayer component modules



* required for sprayers with tank volumes over 1000 litres

Spray Aircraft

The airworthiness of an aircraft is normally the responsibility of civil aviation authorities however, checking the condition of the spray equipment is usually carried out by agricultural authorities. The general physical state of the spray unit, condition of controls, gauges and hoses are checked. The spray circuit is also examined visually for general leakage and dripping nozzles or atomizers.

The prime concern is to verify the calibration of the flow rate settings and the uniformity of the spray distribution across the aircraft. Uniformity is usually determined by measuring the output of each individual nozzle/atomizer. In addition, water sensitive papers can be used to measure droplets deposited by flying a test run.

In addition to the above, a special feature of a spray aircraft check is the need to carry out a visual check to ensure that there is not a vortex formed at the wing tips.

Vehicle-mounted and trailed sprayers

In most schemes, the general physical state of the sprayer, functionality of the pressure gauge and the condition of supporting hoses, electrics etc. are checked. The sprayer is also checked visually for leakage and dripping nozzles. Then the prime concern is to check the pressure stability and the uniformity of spray distribution along the boom during spraying.

Ideally, both spray distribution and output from the individual nozzles should be measured, however, in order to measure droplet distribution, suitable patternator equipment or computerised spray scanning devices are required. This involves extra expense and will not always be practical in some countries, especially when mobile units or independent workshops are used.

In schemes where distribution patterns are not required, compliance is determined by measuring the flow rate from the individual nozzles and by a visual assessment of the spray angles.

In developing countries, there is often a strong case for testing teams and centres to carry at least replacement nozzles, washers and filters. Schemes based on “officially recognised” dealer workshops, which encourage routine servicing of a sprayer before it is tested, may not be totally objective, however, they can provide a practical way of ensuring that these sprayers are routinely kept in good working order.

Portable (operator-carried) sprayers

For these types of sprayer, where single nozzles predominate, there is no requirement for droplet distribution measurements. The principal concerns to be addressed by a routine test are:

- the general condition of the sprayer;
- leakage from the sprayer
- the condition of filters and nozzles

Many sprayers leak unacceptably even when they are new, however, with wear and tear and poor maintenance, the problem is further exacerbated. The condition of nozzles and filters on sprayers in the field is notoriously problematic. Portable sprayers with hydraulic nozzles are

often used for several seasons either with partially blocked filters or with deliberately enlarged nozzle orifices and with no filters at all.

5.7 Test report and records

Full details of the test in a standard format, including a copy of the test protocol containing the results of the inspections and measurements, should be sent by the test centre to the regulatory authority, who should archive the information and wherever possible, store it electronically in a database. The owner of the sprayer should also receive a copy of the report directly from the test centre immediately following the test.

The aim of the regulatory authority should be to establish a record of the entire sprayer population and eventually seek to test and certify compliance at regular intervals. This will be extremely difficult in many circumstances however, in some countries, there are already complete records of the entire population of spray aircraft, vehicle-mounted and trailed field crop and orchard sprayers, which is tested at regular intervals.

5.8 Certification, labelling and control

For all schemes, it is essential that once a sprayer that has passed the official test, an official certificate of compliance is issued.

The aim of the regulatory authority should be to establish and maintain the integrity of the scheme by ensuring appropriate, consistent and uniform test procedures across the test centres so that the owners consider the resulting certificate to be valuable because it provides:

- authorization of the user/owner to operate the sprayer in crop production;
- potential benefit to the activity for which the equipment is used;
- potential added resale value to the sprayer;
- increased public confidence.

In addition to details of the owner, a certificate of compliance should contain certain essential information:

- a unique certificate number
- sprayer make
- sprayer serial number
- test report number
- renewal date

As well as the certificate, the test centre should also issue a weatherproof, durable certification label displaying the above information, which should be firmly fixed on to the sprayer immediately it has passed the official test.

The frequency of testing varies between countries and much will depend upon the general standard of maintenance, the amount of work performed by the type of sprayer in a year and the number of tests that the service is capable of carrying out. For field crop and orchard sprayers there is a tendency in temperate climates, to reduce the interval from every two years to annual testing. For operator-carried sprayers, annual testing is normally required.

6. Financing

Sprayer testing schemes aim to be as close to self-financing as possible and the most obvious route to achieve this is through charging a fee to the owner to have a sprayer tested. However, most successful schemes are initiated with official funding or start-up finance to provide:

- the scheme design
- the infrastructure and core staff
- publicity and promotion to explain the need for and operation of the scheme
- testing equipment, where the scheme has in-house testing
- incentives to sprayer owners to present their sprayers for test

Co-funding with partners from the private sector: farmers' organisations, agrochemical and equipment industries and professional bodies provides an alternative approach.

To ensure the continued existence of the scheme it is important that, in the planning stages, the likely cash flows are accurately predicted, based on a clear understanding that test numbers will take time to build up. It is also important to ensure that the fees charged for the different classes of sprayer are realistic for the participating farm communities and agricultural economies.

7. Introducing and sustaining sprayer-testing schemes

These guidelines outline the principal considerations and options available to countries that do not yet have controls in place to regulate the condition of sprayers working on farms, and the principles presented need to be adapted to suit individual circumstances.

The following sequence, although not exhaustive, serves to provide a summary guide on the way forward for governments who may be considering the introduction of a testing scheme in their country.

Incorporate "the testing of sprayers in use" into the appropriate legislation.

1. Constitute the regulatory authority, which should be multi-institutional and multi-disciplinary and with appropriate statutory powers.
2. Decide and set up the operational sprayer testing body, which will be responsible for the execution of the scheme.
3. Design the scheme.
4. Define sprayer targets and priorities (aircraft, vehicle-mounted, trailed and portable).
5. Consider the control options (voluntary or mandatory, official in-house or officially recognised centres, mobile or fixed centres).

6. Determine the financial viability of options.
7. Procure adequate funding.
8. Decide on and publicise the details of the scheme.
9. Equip the testing authority.
10. Train and organise the core staff who will administer the service and who will train and certify the testers and monitor the scheme.
11. Accredite both “official” and “officially recognised” centres and train and certify the testing staff.
12. Initiate, operate and monitor the scheme.

8. Quality assurance

To ensure the success of any scheme, there is an overriding requirement to establish from the outset, that integrity and value will be maintained. In schemes, which are financially viable and efficiently administered, achieving this goal can be greatly assisted by incorporating a system of strict quality control. This will help to ensure that:

- testing standards remain high but realistic for the country or region;
- methods and procedures remain uniform across all test centres;
- international developments are followed and schemes adjusted when necessary.

Quality assured testing schemes for sprayers in use are well within the reach of many countries. These schemes can provide powerful tools to contribute significantly to the safety of operators and the environment and to assist in the overall control of pesticides in sustainable agricultural production systems.