INTERNATIONAL STANDARD

ISO 16122-4

First edition
2015-03-15

Agricultural and forestry machines — Inspection of sprayers in use —

Part 4: Fixed and semi-mobile sprayers

Matériel agricole et forestier — Contrôle des pulvérisateurs en service — Partie 4: Pulvérisateurs fixes et semi-mobiles

Reference number
ISO 16122-4:2015(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 16122-4 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 144, *Tractors and machinery for agriculture and forestry*, in collaboration with ISO Technical Committee TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 16122 consists of the following parts, under the general title *Agricultural and forestry machinery — Inspection of sprayers in use*:

— *Part 1: General*

— *Part 2: Horizontal boom sprayers*

— *Part 3: Sprayers for bush and tree crops*

— *Part 4: Fixed and semi-mobile sprayers*

Introduction

There are two main reasons for the inspection:

— less potential risk of environmental contamination by plant protection products;

— good control of the pest with the minimum possible input of plant protection product.

In order to use plant protection products in agricultural production safely, it is necessary to define the requirements and test methods for sprayers in use. This is a relevant step after having standardized minimum requirements for new sprayers, in respect of safety hazards (see ISO 4254-6) and potential risks of environmental contamination (see ISO 16119 series).

Standardising the requirements and methods for inspection of sprayers in use, takes into consideration not only the original performance of the sprayer, but also its use, care and maintenance. This is a logical link to ensure the continued benefit arising from the supply of new sprayers of good quality.

The inspection of sprayers in use can be a mandatory requirement or adopted on a voluntary basis. In both cases further requirements, outside the scope of this standard, are necessary for the management of inspections. These include, for example, requirements for the competence of persons carrying out inspections and the frequency of inspections.

NOTE National or local regulations may also apply concerning the qualifications and competence of inspectors.

Agricultural and forestry machines — Inspection of sprayers in use —

Part 4: Fixed and semi-mobile sprayers

1 Scope

This part of ISO 16122, when used together with ISO 16122-1, specifies the requirements and test methods for the inspection of fixed and semi-mobile sprayers, when in use.

The requirements relate mainly to the condition of the sprayer with respect to its potential risk for the environment and its performance to achieve good application.

It does not apply to application equipment for spatial treatment (e.g. foggers).

NOTE Requirements for the protection of inspectors during an inspection are given in ISO 16122-1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5682-2:1997, *Equipment for crop protection — Spraying equipment — Part 2: Test methods for hydraulic sprayers*

ISO 16122-1:2015, *Agricultural and forestry machinery — Inspection of sprayers in use — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16122-1 and the following apply.

3.1
fixed sprayer
machine primarily for spraying plant protection products in covered structures, and where the *pump/tank unit* (3.3) and/or *application unit* (3.4) do not move

[SOURCE: ISO 16119-4:2014, 3.1]

3.2
semi-mobile sprayer
machine primarily for spraying plant protection products on crops grown in covered structures, and where the *pump/tank unit* (3.3) and *application unit* (3.4) are moveable

[SOURCE: ISO 16119-4:2014, 3.2]

3.3
pump/tank unit
device made at least by the pump and the spray liquid tank

Note 1 to entry: They can be built together as one unit or separate units.

3.4
application unit
device consisting of one or more nozzles/spray generators with or without air-assistance, and used with a separate pump/tank unit to which it is connected by a pipeline

[SOURCE: ISO 16119-4:2014, 3.4]

4 Requirements and method of verification

4.1 Leaks and dripping

4.1.1 Static leaks

The sprayer shall be filled with water to its nominal capacity.

With the pump not running and the sprayer parked on a level horizontal surface (in case of semi-mobile sprayer), a visual inspection for any leakage from the tank, pump and associated pipes shall be carried out.

For high capacity tanks, water filling can be reduced to no less than half of the nominal tank volume, provided an additional inspection of the tank is carried out in order to identify any cracks, holes or other damage that can cause leakage.

Compliance shall be checked by inspection.

4.1.2 Dynamic leaks

4.1.2.1 Leak-test when not spraying

With the sprayer running at a pressure which is equal to the maximum obtainable pressure for the system, with the section valves closed, there shall be no leakage from any part of the sprayer.

Compliance shall be checked by inspection.

4.1.2.2 Leak-test while spraying

While spraying at a pressure that is equal to the maximum working pressure recommended by the sprayer manufacturer, or the nozzle manufacturer for the nozzles mounted on the sprayer if lower, there shall be no leakage from any part of the sprayer.

Compliance shall be checked by inspection.

4.1.3 Spraying and dripping on parts

Regardless of the distance between the spray boom to the target to be sprayed, in the range between the nozzles and the target surface, no liquid shall be sprayed directly on to the sprayer itself (e.g. parts of the sprayer, hoses). This does not apply if needed by function (e.g. sensors) and if dripping is minimised.

Compliance shall be checked by inspection and function test.

4.2 Pump(s)

4.2.1 Capacity

4.2.1.1 General

The pump capacity shall be suited to the needs of the sprayer.

4.2.1.2 Sprayers built according to ISO 16119-4

The agitation capacity (liquid backflow in the tank) of the pump shall be at least equal to the value given in the instruction handbook.

Compliance shall be checked by measurement according to 5.2.1.3.

4.2.1.3 Other sprayers

a) The pump capacity shall be at least 90 % of its original nominal flow given by the sprayer manufacturer or another minimum pump capacity given by the sprayer manufacturer.

   Compliance shall be checked by measurement according to 5.2.1.2.3;

   or for sprayers not fitted with a test adapter:

b) The pump(s) shall have sufficient flow rate capacity in order to be able to spray while maintaining a visible agitation as specified in 4.3.1.

   Compliance shall be checked by measurement according to 5.2.1.2.2.

4.2.2 Pulsations

The pulsations shall not exceed ± 10 % of the working pressure.

Compliance shall be checked by inspection, measurement and function test according to 5.2.2.

4.2.3 Air chamber

If an air chamber is present the membrane shall not be damaged, there shall be no appearance of liquid when operated at the maximum pressure recommended by the sprayer manufacturer. The air pressure shall be the pressure recommended by the sprayer manufacturer or between 30 % to 70 % of the working pressure for the nozzles in use.

Compliance shall be checked by function test and measurement.

4.3 Spray mix agitation

4.3.1 Hydraulic

A clearly visible agitation shall be maintained:

— when spraying at the maximum working pressure as recommended by the sprayer or nozzle manufacturer (whichever is the lower);

— with the largest nozzles mounted on the application unit;

— with pump rotation speed as recommended by the sprayer manufacturer;

— with the tank filled to half its nominal capacity.

Compliance shall be checked by inspection.

4.3.2 Mechanical

A clearly visible agitation shall be maintained when the agitation system is working as recommended by the sprayer manufacturer, with the tank filled to half its nominal capacity.

Compliance shall be checked by inspection.

4.4 Spray liquid tank(s)

4.4.1 Lid

The tank(s) shall be provided with a lid that shall be well adapted and in good condition.

This lid shall be tightly sealed to prevent leakage and shall avoid unintended opening. This requirement does not apply to fixed installations.

If a vent is fitted in the lid (according to 4.4.4), it shall prevent spillage.

Compliance shall be checked by inspection.

4.4.2 Filling hole(s)

For semi-mobile sprayers there shall be a strainer in good condition in the filling hole(s).

Compliance shall be checked by inspection.

4.4.3 Induction hopper

If there is an induction hopper, it shall:

— prevent any object greater than 20 mm diameter from entering into the sprayer tank.

Compliance shall be checked by measurement.

— function and not leak.

Compliance shall be checked by function test.

4.4.4 Pressure compensation

There shall be a pressure compensation device to avoid over-pressure and under-pressure in the tank.

Compliance shall be checked by inspection.

4.4.5 Tank content indicator(s)

The volume of liquid in the tank shall be clearly readable from where the tank is filled.

Compliance shall be checked by inspection.

4.4.6 Tank emptying

It shall be possible to:

— empty the tank e.g. using a tap, and

— collect the liquid without contamination of the environment and without potential risk of exposure of the operator.

Compliance shall be checked by inspection.

4.4.7 Tank filling

If there is a water filling device on the sprayer, water from the sprayer shall be prevented from returning to the water source, e.g. by means of a non-return valve.

Compliance shall be checked by inspection and function test.

4.4.8 Cleaning device for plant protection product containers

If provided, the cleaning device for plant protection product containers shall function.

Compliance shall be checked by inspection and function test.

4.4.9 Cleaning equipment

If provided, tank cleaning devices, devices for external cleaning, devices for cleaning of induction hoppers, and devices for the internal cleaning of the complete sprayer, shall function.

Compliance shall be checked by inspection and function test.

4.5 Measuring systems, controls and regulation systems

4.5.1 General

All devices for measuring, indicating and/or adjusting the pressure and/or flow rate shall function.

The valves for switching on or off the spray shall function.

Switching on and off of all nozzles shall be possible simultaneously.

The controls to be operated during spraying shall be operable from the operator`s position and the instrument displays shall be readable from this position.

If using a spray boom, switching on and off individual boom sections shall be possible.

Compliance shall be checked by inspection and function test.

4.5.2 Pressure indicator

4.5.2.1 General

A pressure indicator shall be present on the tank/pump unit.

An additional pressure indicator shall be present on the application unit, except for spray guns and lances manufactured before publication of ISO 16119-4.

The pressure indicators shall be fitted at a position where they are clearly readable. Pressure indicators shall be suitable for the working pressure range used.

Compliance shall be checked by inspection.

4.5.2.2 Diameter of analogue pressure indicator

For analogue pressure indicators the minimum diameter shall be 63 mm, except for those mounted on spray guns and lances which shall have a minimum diameter of 40 mm.

Compliance shall be checked by measurement.

4.5.2.3 Scale of analogue pressure indicator

The scale of analogue pressure indicators shall provide graduations:

— at least every 0,2 bar[1)] for working pressures less than 5 bar;

— at least every 1,0 bar for working pressures between 5 bar and 20 bar;

1) 1 bar = 0,1 MPa = 0,1 N/mm^2 = $10^5 N/m^2$.

— at least every 2,0 bar for working pressures more than 20 bar.

Compliance shall be checked by inspection.

4.5.2.4 Accuracy of pressure indicator

The accuracy of the pressure indicator shall be:

— ± 0,2 bar for working pressures at 2 bar and below;

— ± 10 % of the real value for pressures at 2 bar and above.

This requirement shall be achieved within the working pressure range suitable for the nozzles mounted on the sprayer under test.

Compliance shall be checked by measurement according to 5.3.

4.5.3 Other measuring devices

Measuring devices other than pressure indicators, especially flow meters and forward speed sensors used for controlling the volume/hectare rate shall measure within a maximum error of ± 5 % of the value read on the reference instrument within the range of the measuring device.

Compliance shall be checked by measurement according to 5.4 and 5.5.

4.5.4 Pressure adjusting devices

All devices for adjusting pressure shall maintain a constant pressure with a tolerance of ± 10 % at constant setting and shall return within 10 s to the original working pressure ± 10 % after the sprayer has been switched off and on again.

Compliance shall be checked by function test and measurement according to 5.10.

4.5.5 Direct injection systems

Direct injection systems shall:

— not leak;

— have no backflow leakage though the chemical pathway or water inlet of the dosing unit;

— have a mixing chamber on the outlet side.

The injection rate of the chemical shall not deviate from what is set on the dosing device by more than ± 10 %.

Compliance shall be checked by inspection, function test and measurement according to 5.11.

4.6 Lines (pipes and hoses)

Lines shall not show excessive bending, corrosion and abrasion through contact with surrounding surfaces. Lines shall be free from defects such as excessive surface wear, cuts or cracks.

Compliance shall be checked by inspection.

4.7 Filters

4.7.1 Filter presence

There shall be at least one filter to be placed either:

— on the pressure side of the pump, as close as possible to the application unit;

or

— on the tank unit, when the application unit is a spray gun or lance.

In the case of sprayers with positive displacement pumps and fixed sprayers, there shall also be a filter on the suction side.

NOTE Nozzle filters are not considered as pressure side filters.

The filter(s) shall be in good condition and the mesh size shall correspond to the nozzles fitted according to the instructions of the nozzle manufacturer.

Compliance shall be checked by examination of specification and inspection.

4.7.2 Isolating device

It shall be possible, with the tank filled to its nominal volume, to clean filters without any spray liquid leaking out, except for that which may be present in the filter casing and the suction lines.

Compliance shall be checked by function test.

4.7.3 Filter insert changeability

Filter inserts shall be changeable in accordance with the sprayer manufacturers' instructions.

Compliance shall be checked by inspection and function test.

4.8 Application unit

4.8.1 Dripping

After being switched off there shall be no continuous dripping from nozzles 5 s after the spray jet has collapsed.

Compliance shall be checked by inspection.

4.8.2 Horizontal spray boom

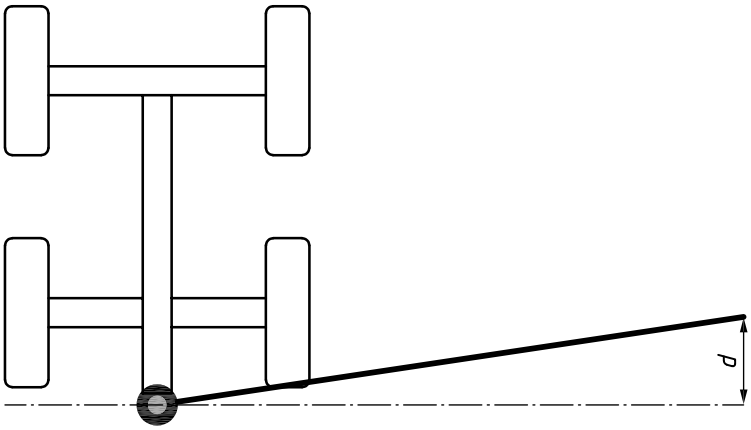
4.8.2.1 Stability / Alignment (not for hand-held or carried booms)

The boom shall be stable in all directions, i.e. no excessive movement caused by wear and/or permanent deformation.

When measured with the horizontal spray boom stationary, the vertical distance between the lower edges of each nozzle and a horizontal reference line (e.g. on level horizontal surface) shall not vary more than ± 10 cm or ± 0,5 % of the working width, whichever is the highest.

The boom shall not be bent in the horizontal plane: the maximum deformation d from the centre-frame to the boom end nozzle shall not exceed ± 2,5 % of the boom width. See Figure 1.

Compliance shall be checked by inspection and measurement.



Key

1 boom centre

d maximum deformation distance from the centre-frame to boom end nozzle

Figure 1 — Horizontal deviation of the boom

4.8.2.2 Nozzles

4.8.2.2.1 Similarity

All nozzles fitted to the booms shall be of the same type, size, material and produced by the same manufacturer, except where they are intended for a special function (e.g. the end nozzles for border spraying, bed spraying or band spraying).

Other components (e.g. nozzle filters, anti-drip devices) shall be equivalent over the length of the boom.

Compliance shall be checked by inspection.

4.8.2.2.2 Spacing/orientation

The nozzle spacing and their orientation shall be uniform along the boom.

The nozzle spacing (adjacent nozzle centre to centre distance) shall be within ± 5 % of their nominal distance.

The verticality of the nozzle body shall be achieved with a maximum deviation of 10°.

In case of special design or applications (e.g. border spraying), nozzle body spacing, orientation and configuration shall correspond to the manufacturer's design specification.

It shall not be possible to modify unintentionally the position of the nozzles in working conditions, for example by folding/unfolding the boom.

Compliance shall be checked by inspection and measurement.

4.8.2.3 Height adjustment

If provided, height adjustment devices shall function.

Compliance shall be checked by inspection and function test.

4.8.2.4 Damping

When provided, devices for damping unintended boom movements shall function (e.g. well-functioning and not damaged springs, gas dampers or rubber buffers).

Compliance shall be checked by inspection and function test.

4.8.2.5 Compensative returns

When measured at the inlet of each boom sections or read on the spray pressure indicator, 10 s after a section has been closed, the pressure shall not vary more than 10 %, when the sections are closed one by one.

This requirement is only applicable for sprayer equipped with boom valves which can be set to return the same liquid volume to the tank when closed that would otherwise go through the nozzles on that boom section when the valve is open.

Compliance shall be checked by measurement according to 5.9.

4.8.2.6 Pressure drop

The pressure drop between the point on the sprayer where the indicated spray pressure is measured during working and the outermost end of each boom section shall not exceed 10 %.

In case of using measurement on a patternator (4.10.3), only one measuring point at one outer end of the boom is required.

Compliance shall be checked by measurement according to 5.8.

4.8.3 Vertical spray boom

4.8.3.1 Symmetry

The nozzle arrangement (e.g. nozzle types, sizes, material and production by the same manufacturer) shall be symmetrical on the left and right hand sides, except where they are intended for a special function (e.g. spraying on one side, fitting of nozzles to compensate the air distribution asymmetry, etc.).

Compliance shall be checked by inspection.

4.8.3.2 Switching off

If provided, the system to switch off each nozzle separately shall function.

In the case of multi-head nozzles, this requirement applies to each multi-head nozzle.

Compliance shall be checked by inspection and function test.

4.8.3.3 Adjustment

It shall be possible to adjust the position of the nozzles in a symmetric and reproducible manner.

Compliance shall be checked by inspection.

4.8.3.4 Pressure drop

The pressure drop between the measuring point for pressure on the sprayer and pressure measured at the nozzle which is the furthest from the feeding point of the spray line, shall not exceed 15 % of the pressure shown on the pressure indicator.

Compliance shall be checked by measurement according to 5.8.

4.8.3.5 Compensative returns

When measured at the inlet of each boom sections or read on the spray pressure indicator, 10 s after a section has been closed, the pressure shall not vary more than 10 %, when the sections are closed one by one.

This requirement is only applicable for sprayer equipped with boom valves which can be set to return the same liquid volume to the tank when closed that would otherwise go through the nozzles on that boom section when the valve is open.

Compliance shall be checked by measurement according to 5.9.

4.8.4 Spray guns and lances

4.8.4.1 Trigger

The trigger shall function. It shall be lockable in the closed position and not lockable in the open position.

The opening and closing system installed on the gun shall have a quick stop and opening. There shall be no continuous dripping when the trigger is « off » (closed position).

Compliance shall be checked by inspection and function test.

4.8.4.2 Adjustment of flow rate and angle

If the flow rate and/or spray angle of the spray gun is adjustable, the adjustment device shall function.

Compliance shall be checked by inspection and function test.

4.9 Blower

4.9.1 Switching off

If the blower can be switched off separately from other driven parts of the sprayer, the switching off system shall function.

Compliance shall be checked by function test.

4.9.2 Adjustability

Adjustable air guide plates on the blower and on an additional blower casing shall function.

Compliance shall be checked by inspection and function test.

4.10 Distribution

4.10.1 Uniformity of spray jet

With the blower switched off in the case of hydraulic nozzles and switched on in the case of other nozzles (for example pneumatic nozzles), each nozzle shall form a uniform spray jet (e.g. uniform shape, homogeneous spray).

Compliance shall be checked by inspection and function test.

4.10.2 Nozzle output

4.10.2.1 Nominal nozzle flow rate known

The deviation of the flow rate of each nozzle of the same type and size shall not exceed ± 15 % of the nominal flow rate indicated by the nozzle manufacturer for the maximum working pressure given by the nozzle manufacturer.

Compliance shall be checked by measurement according to 5.7.

4.10.2.2 Nominal nozzle flow rate unknown

The flow rate of a single nozzle shall not exceed ± 5 % of the average flow rate of the nozzles of the same type and size mounted on the sprayer.

In case of only two nozzles of a same type and size, the average value is not considered but the deviation between the two nozzles.

For sprayers with only one spray liquid output, or with adjustable flow rate nozzles, the flow rate has to be measured but no indication of wear can be provided.

Compliance shall be checked by measurement according to 5.7.

4.10.3 Spray distribution measurement on a patternator (optional)

4.10.3.1 General

a) The transverse distribution, within the total overlapped range, shall be uniform. The transverse distribution is evaluated on the basis of the coefficient of variation which shall not exceed 10 %;

and

b) the amount of liquid collected by each patternator groove within the overlapped range shall not deviate more than ± 20 % of the total average value.

Compliance shall be checked by measurement according to 5.6.

4.10.3.2 Pressure distribution

When the nozzle flow rate is measured according to 5.7.2 or 5.7.3:

— the pressure at each boom section inlet shall not exceed ± 10 % of the average pressure measured on all boom section inlets;

— the pressure at the inlet and outer end of each boom section shall not drop more than 10 %, when spraying with the largest nozzle set mounted on the sprayer.

Compliance shall be checked by measurement according to 5.12.

4.10.4 Optional vertical distribution information

In case of vertical boom sprayers and similar, in order to provide the owner/operator with further information, the vertical spray distribution information may be provided for example by measurement, using a vertical patternator; or by other visualization means.

NOTE Test method and vertical patternator specifications are still under development

4.11 Autonomous application units

4.11.1 Drive system

The drive system (drive wheels/rolls, motor, battery, etc.) shall be in good condition and function.

Compliance shall be checked by inspection and function test.

4.11.2 Travel speed spray robots

Travel speed shall not deviate more than ± 10 % from those declared by the manufacturer.

Compliance shall be checked by measurement according to 5.5.

4.12 Cleaning equipment

If provided cleaning devices shall function.

Compliance shall be checked by inspection and function test.

5 Test methods

5.1 Test facilities

In complement to the test benches described below, the following test apparatus are needed for the inspection:

— tachometer (P.T.0) with maximum error of ± 10 rpm;

— measuring tape (nozzle spacing and height);

— stop watch (flow rate; distribution);

— measuring cylinder (with measuring range 2 l; scale graduation 20 ml; error ± 20 ml);

— air pressure indicator (pressure pulsation damper).

Different test equipment and methods can be used, if at least the same measuring results and accuracy is achieved.

5.2 Spray and agitation pump(s)

5.2.1 Pump capacity test

5.2.1.1 Test equipment

The error of the flow meter shall not exceed ± 2 % of the measured value when the capacity of the pump is > 100 l/min and 2 l/min when the capacity of the pump is < 100 l/min.

The flow measuring device shall have a transparent part to identify air leakages on the pump's suction side.

The test equipment shall have a provision that the pressure can be increased up to 10 bar.

5.2.1.2 Test method

5.2.1.2.1 General

The pump capacity shall be measured using one of the following procedures:

5.2.1.2.2 Sprayers not fitted with a test adapter

On sprayers not fitted with a test adapter, when the pump capacity is not given by the sprayer manufacturer for the pump mounted on the sprayer or for pumps for which the maximum working pressure is not known (see 4.2.1), a calibrated pressure indicator shall be placed at an end nozzle and the maximum working pressure recommended by the sprayer manufacturer or the nozzle manufacturer shall be established and used.

5.2.1.2.3 Other sprayers

The spray tank shall be filled with clean water to half its nominal volume. A correct and clean filter shall be placed on the suction side of the pump in accordance with the sprayer manufacturer's instructions.

The measurement shall be carried out with the nominal pump rotation speed recommended by the sprayer manufacturer.

— There shall be neither leakage nor air ingress from any connection.

— Connect the measuring device as close as possible to the pump outlet or at a position provided by the sprayer manufacturer.

— In case of multiple pump outlets, the measuring device shall be connected, either on each outlet separately or all outlets connected together.

— Calculate the total capacity of the pump(s).

— Water discharged from the measuring device should be fed back into the spray tank.

— The flow shall be measured without any forced counter-pressure from the measuring device and at a pressure between 8 (± 0,2) bar and 10 (± 0,2) bar, or if lower at the highest permitted working pressure for the pump.

5.2.1.3 Backflow for agitation

5.2.1.3.1 General

The spray tank shall be filled with clean water to half its nominal volume. A correct and clean filter shall be placed on suction side of the pump in accordance with the sprayer manufacturer's instructions.

The measurement shall be carried out:

— when spraying at maximum working pressure as recommended by the sprayer or nozzle manufacturer (whatever is the highest);

— with the largest nozzles recommended;

— with the nominal pump rotation speed as recommended by the sprayer manufacturer;

— with the maximum number of application units connected;

— following one of the methods given in 5.2.1.3.2 or 5.2.1.3.3.

There shall be neither leakage nor air inlet from any connection.

5.2.1.3.2 Measuring the backflow for agitation

The measuring device shall be connected on all return / agitation line(s) separately or together in order to determine the total backflow.

The measured value(s) shall be recorded.

Water discharged from the measuring device should be fed back into the spray tank.

The recorded values shall be added to determine the total backflow.

5.2.1.3.3 Calculating the backflow for agitation

Connect the measuring device as close as possible to the pump outlet or at a position provided by the sprayer manufacturer.

In case of multiple pump outlets, the measuring device shall be connected, either on each outlet separately or all outlets connected together.

Calculate the total capacity of the pump(s).

Water discharged from the measuring device should be fed back into the spray tank.

Measure or calculate the total discharge from the application unit(s) (TD).

Calculate the back flow (i.e. agitation capacity) in the tank using the following formula:

$$B_F = P_C - T_D$$

where

B_F is the back flow (l/min);

P_C is the measured pump capacity (l/min);

T_D is the total discharge from application units(s) (l/min).

5.2.2 Pump pulsations

Pulsations shall be checked:

— with the nominal rotation speed of the pump;

— at the location of the sprayer's pressure indicator (with the calibrated test pressure indicator or the pressure indicator of the sprayer if the requirement of 4.5.2 is met);

— with the intended working pressure.

5.3 Sprayer pressure indicators

5.3.1 Specifications of pressure indicators used for verification

Analogue pressure indicators used for verification shall have a minimum diameter of 100 mm. Other minimum requirements on pressure indicators used for verification are given in Table 1.

Table 1 — Characteristics of pressure indicators used for verification (in accordance with EN 837–1)

Pressure to measure Δp bar	Scale unit max. bar	Accuracy bar	Class required	Scale end value bar
$0 < \Delta P \leq 6$	0,1	0,1	1,6 1,0 0,6	6 10 16
$6 < \Delta P \leq 16$	0,2	0,25	1,6 1,0	16 25
$\Delta P > 16$	1,0	1,0	2,5 1,6 1,0	40 60 100
1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.				

5.3.2 Verification method of the sprayer pressure indicator

The pressure indicator(s) of the sprayer shall be tested mounted on the sprayer or on a test bench by comparison with a calibrated test pressure indicator.

Measurements shall be carried out with both increasing and decreasing pressure. In each case the accuracy of the pressure indicator of the sprayer shall be checked at a minimum of 4 equally spaced points within the relevant working pressure range.

The pressure shall be stable during measurement, e.g. no influence from pump rotation or pulsations.

5.4 Flow meters for controlling the volume/hectare rate

5.4.1 General

The error of the measuring instruments in the test equipment shall not exceed ± 2 % of the measured value with a minimum of 2 l/min.

During the test, the flow rate shall be steady, as indicated by the output of the flow rate sensor or the pressure indicator.

5.4.2 Operating procedure No.1: Verification by nozzle flow rate measurement

The average flow rate of at least 5 nozzles shall be measured with a measuring cylinder, or the single flow rate values for each nozzle obtained from the test in 4.10 shall be used in order to calculate the average value of a single nozzle.

This value shall be compared with the value read on the display of the monitor. The deviation between both values shall be expressed as a percentage (to the reference value).

5.4.3 Operating procedure No.2: Verification by installing a standard flow meter on the circuit of the sprayer

On the pump outlet side of the sprayer and as close as possible to the flow meter to be checked, a calibrated flow meter shall be installed.

This value shall be compared with the value read on the display of the monitor. The deviation between both values shall be expressed as a percentage (to the reference value).

NOTE Other test methods to determine real flow rate can be used provided they give similar results

5.5 System for controlling forward speed

The actual travel speed shall be measured with an error not exceeding ± 2,5 %.

The measurement shall be carried out on the available distance. The beginning and the end of the test distance shall be clearly marked. A reference point shall be marked on the sprayer to assist in the identification of the start and finish of the test.

5.6 Uniformity of the transverse volume distribution with a horizontal patternator

5.6.1 Specification of horizontal patternators used for verification

A patternator with grooves 100 mm wide and at least 80 mm deep, measured as a distance between the top and the bottom of the groove shall be used to measure the uniformity of the transverse volume distribution of the spray.

The groove patternator shall be at least 1,5 m long. The groove width shall be 100 mm ± 2,5 mm. The groove width of a patternator working in steps with electronic data sampling (e.g. scanners) shall be 100 mm ± 1 mm.

Prior to the start of the test, the grooves to be used shall be checked by suitable means such as a pattern to see whether the above tolerance limits are met. The graduated spray liquid measuring cylinders shall be of the same type and size and have a capacity of at least of 500 ml. Scale graduation shall be a maximum of 10 ml.

The error of measurement shall be not more than 10 ml or ± 2 % of the measured value whichever is greater.

When passing the measuring track, positioning in single steps shall be completed with an accuracy of ± 20 mm. The measuring error of the volume of the single grooves at a flow volume of 300 ml/min shall be less than ± 4 %. The adjustment and calibration of the patternator shall be in accordance with the patternator manufacturer's instruction handbook.

The size of the patternator shall be suited to the size of the boom to be tested and to the type of the sprayer. The patternator shall also ensure that the overlapping range of the spray is measured completely.

5.6.2 Calculation of the coefficient of variation (CV)

The following formula shall be applied:

$$\mathrm{CV} = 100 \times \frac{S}{\overline{X}}$$

where

$$S = \sqrt{\frac{\sum \left(X_i - \overline{X} \right)^2}{n-1}}$$

$$\overline{X} = \frac{\sum X_i}{n}$$

X_i is the volume of liquid in the ith tube;

n is the number of grooves;

S is the standard deviation of the volumes collected in the grooves;

$\overline{X}$ is the average/mean volume collected per groove.

5.6.3 Verification method of the uniformity of the transverse distribution

For all of the nozzle sets present on the sprayer, the transverse distribution shall be verified for the complete working width of the sprayer.

The test shall be carried out at a standard testing height (measured from the tip of the nozzle to the top of the grooves of the patternator) following the recommendations of the nozzle manufacturer and a standard test pressure, within the pressure range given by the nozzle manufacturer.

The verification shall be carried out from the midpoint between the centre of the outermost nozzle and the centre of the penultimate nozzle on one side of the boom to the midpoint between the centre of the outermost nozzle and the centre of the penultimate nozzle on the other side of the boom.

5.7 Flow rate of the spray nozzles

5.7.1 General

This test shall be performed either with nozzles mounted on the sprayer (5.7.2) or removed from the boom (5.7.3). It shall be ensured that the spray jets are correctly formed when nozzles are mounted on the boom and before dismounting.

The error in the measured flow shall not exceed ± 2,5 % of the measured value or $2{,}5 \times 10^{-2}$ l/min, whichever is greater.

The test shall be carried out for a pressure within the pressure range given by the nozzle manufacturer.

5.7.2 Measurement with nozzles fitted on the sprayer

The flow rate of each nozzle shall be measured according to ISO 5682-2:1997, 8.1, except 8.1.1.

NOTE Specific methods for testing pneumatic nozzles are to be developed.

5.7.3 Measurement with nozzles removed from the sprayer

The measurement of the flow rate of each nozzle shall be carried out on a test bench.

The test bench consists of a pump which pumps water with a certain pressure through the nozzle, a pressure regulator, a pressure indicator (analogue or digital) by which the actual pressure can be monitored and a flow meter by which the actual flow rate can be measured.

The pressure indicator shall meet the requirements of 5.3.1.

The liquid system, adapters, etc. shall not influence the flow rate.

5.8 Pressure drop

The test shall be carried out with the highest flow rate nozzle provided on the sprayer and at a pressure within the working pressure range given by the nozzle manufacturer.

A calibrated test pressure indicator (see 5.3.1) shall be fitted at the same position as the nozzle furthest from the pump.

The values indicated by the pressure indicator of the sprayer shall be compared with values measured by the calibrated test pressure indicator.

5.9 Pressure variation when the sections are closed

Pressure variation shall be checked with a calibrated test pressure indicator (see 5.3.1) at the location of the sprayer's pressure indicator.

Variations in the value indicated by the calibrated test pressure indicator shall be observed and recorded as the sections are closed one by one, with all sections that have been closed kept closed until all measurements have been made.

The pressure shall be observed before and 10 s after each section is closed.

5.10 Pressure variation when the spray is switched off

Pressure variation shall be checked with a calibrated test pressure indicator (see 5.3.1) at the location of the sprayer's pressure indicator.

Variations in the value indicated by the calibrated test pressure indicator shall be observed and recorded when the spray is switched off. The pressure shall be observed before and 10 s after the spray is shut off.

5.11 Accuracy of direct injection systems

Operate the direct injection system at the most used setting indicated by the owner/farmer.

Use clean water in the direct injection system during measurement of the flow rate. Calculate the dosing rate as a percentage from using the following formula;

$$\text{Dosing rate} = \frac{B}{A-B} \times 100$$

where

A is the measured flow rate of total discharge of the complete system (pump flow rate + direct injection system flow rate) after the mixing device, expressed in l/min;

B is the direct injection system flow rate.

5.12 Pressure distribution

The test shall be carried out with the highest flow rate nozzle provided on the sprayer and at a pressure within the working pressure range given by the nozzle manufacturer.

A calibrated test pressure indicator (see 5.3.1) shall be fitted at the same position as a nozzle at the inlet of each boom section.

The average inlet pressure from all sections shall be calculated and compared to individual inlet pressures.

A calibrated test pressure indicator shall be fitted at the same position as a nozzle at the outermost end of each boom section.

For each section, the pressure drop between the inlet and the outermost end shall be calculated using the following formula:

$$\text{Pressure drop} = 100 \times \frac{(P_0 - P_1)}{P_0}$$

where

P_0 is the inlet pressure of the section;

P_1 is the outermost end pressure of the same section.

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ICS 65.060.40

Price based on 19 pages