
**Equipment for crop protection —
Spraying equipment —**

**Part 3:
Test method to assess the
performance of volume/area
adjustment systems**

*Matériel de protection des cultures — Équipement de pulvérisation —
Partie 3: Méthode d'essai pour évaluer les performances des systèmes
de régulation du volume/surface*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

This second edition cancels and replaces the first edition (ISO 5682-3:1996), which has been technically revised as follows:

- clarification of the test method;
- alignment with state-of-the-art sprayer systems.

A list of all the parts in the ISO 5682 series can be found on the ISO website.

Equipment for crop protection — Spraying equipment —

Part 3:

Test method to assess the performance of volume/area adjustment systems

1 Scope

This document specifies the test method to assess the performance of volume/area adjustment systems for spray systems.

This document is not applicable for manually-operated knapsack sprayers or for aircraft sprayers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5681, *Equipment for crop protection — Vocabulary*

ISO 5682-1:2017, *Equipment for crop protection — Spraying equipment — Part 1: Test methods for sprayer nozzles*

ISO 5682-2:2017, *Equipment for crop protection — Spraying equipment — Part 2: Test methods to assess the horizontal transverse distribution for hydraulic sprayers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Test conditions and apparatus

4.1 General test conditions

The general test conditions shall be those specified in ISO 5682-2:2017, Clause 5, and the specific conditions given in [4.2](#).

4.2 Specific test conditions

4.2.1 All measurements of the volume/area are carried out at the spray boom using water as the test liquid. Measuring and recording shall continue after adjustments until a steady-state of the system is achieved.

Stationary tests are allowed for sprayers or laboratories where the driving speed can be simulated (e.g. sprayers with flow check modes, laboratories with a method of providing simulated speed to the wheels or control system).

4.2.2 At the start of the measurements defined in [5.2](#) and [5.3](#), the following sprayer settings shall apply:

- a) nominal driving speed v_N : 4 km·h⁻¹, 6 km·h⁻¹, 8 km·h⁻¹, 16 km·h⁻¹ or 24 km·h⁻¹, according to the relevant local practice and regulations;
- b) nominal rotational frequency n_N of the pumps:
 - 1) for pumps driven by power take-off (PTO) according to:
 - i) a PTO rotational frequency of 400 min⁻¹, if nominal rotational PTO frequency is 540 min⁻¹;
 - ii) a PTO rotational frequency of 800 min⁻¹, if nominal rotational PTO frequency is 1 000 min⁻¹;
 - iii) a PTO rotational frequency of 75 % of the nominal rotational PTO frequency, if this deviates from 540 min⁻¹ or 1 000 min⁻¹.
 - 2) for pumps not driven by a PTO of the tractor or carrier vehicle (e.g. hydraulic driven) according to an engine rotational frequency of 75 % of rated engine speed.
- c) a nominal volume/area r_N according to the relevant Good Agricultural Practice and local regulations.

4.2.3 If the pump drive is independent of engine rotational frequency (e.g. pumps driven by the hydraulic system of the tractor) or if the driving speed is not controlled by engine rotational frequency (e.g. hydrostatic transmission or variable transmission), variation of the speed ([5.3.2.](#)) is not necessary.

4.3 Measuring equipment

See ISO 5682-1.

5 Test procedure

5.1 General

The tests shall be made on a stationary sprayer. If the volume/area adjustment system does not provide a driving speed simulation mode, the driving speed shall be simulated with the help of a function generator. Its frequency shall be adjustable in conjunction with the pump rotational frequency or separately.

Preferably, a flow meter according to [4.3](#) shall be used for the measurements. If the measurements are performed using a pressure indicator, the relation between volumetric flow rate and spray pressure shall be determined prior to the measurements using the method provided in ISO 5682-2:2017, 6.5. The pressure shall be measured downstream of any central pressure filter. If other parameters are used to control the flow rate, they shall be substituted in place of the term “pressure”.

For all measurements, the volumetric flow rate shall be recorded with a minimum sample rate of 10 measurements per second.

The measurements shall be made under the conditions specified in 4.1 and 4.2 together with the conditions specified in 5.2 and 5.3.

The measurements in 5.2 and 5.3 shall be performed three times.

5.2 Switching on and off spray boom sections

5.2.1 Measure continuously the duration(s) for which the mean volume/area deviates more than 10 % from the mean volume/area in the steady-state.

5.2.2 Operate the sprayer at the conditions specified in 4.2.2 and switch off the main spray control. Switch on the main spray control and make the measurements simultaneously.

5.2.3 Operate the sprayer at the conditions specified in 4.2.2 and switch off the main spray control, then lower the driving speed to 75 % of v_N and reduce the rotational frequency to 75 % of n_N . For compensated pump systems, the rotational frequency n will be set by the control system according to speed and rate. Switch on the main spray control and make the measurements simultaneously.

5.2.4 Operate the sprayer at the conditions specified in 4.2.2 and switch off the main spray control, then raise the driving speed to 125 % of v_N and raise the rotational frequency to 125 % of n_N . For compensated pump systems the rotational frequency n will be set by the control system according to speed and rate. Switch on the main spray control and make the measurements simultaneously.

5.2.5 Operate the sprayer at the conditions specified in 4.2.2 and switch off the main spray control. Switch on the main spray control. Successively switch off each spray boom section, then switch each spray boom section on again. Make the measurements simultaneously.

5.3 Speed variations

5.3.1 General

Measure continuously the duration(s) for which the mean volume/area deviates more than 10 % from the mean volume/area in the steady-state.

5.3.2 Pump rotational frequency

Change the pump rotational frequency from at least 0,75 n_N to n_N and then to 1,25 n_N and then from 1,25 n_N to n_N and to 0,75 n_N in stages of 5 s each. At the same time set the driving speed to the same percentage of v_N . For compensated pump systems the rotational frequency n will be set by the control system according to speed and rate. Make the measurements simultaneously.

5.3.3 Driving speed

Set the driving speed to 0,75 v_N , v_N , 1,25 v_N , v_N and then to 0,75 v_N while keeping the pump rotational frequency constantly at n_N , and make the measurement simultaneously.

5.4 Resetting the volume/area

Measure the volume rate as described below and calculate the coefficient of variation in accordance with Clause 6. Begin the measurement after the system has stabilized to within at least 10 % of the target volume/area. Continue collecting the measurement data for at least 10 s after starting to obtain valid data.

The sprayer is operated at a pump rotational frequency of n_N and a driving speed of v_N . Make the following two series of measurements 7 times.

Set and operate the sprayer at a volume/area of $0,7 r_N$ then successively set it to r_N and $1,3 r_N$. Reduce the rate from $1,3 r_N$ successively to r_N and $0,7 r_N$. Make measurements at each of the successive rates.

When setting the volume/area, be careful not to exceed the required value and to have to adjust the volume/area in the opposite direction.

6 Calculation

For each setting, the coefficient of variation (C_V), expressed as a percentage, is calculated as follows:

$$C_V = \frac{s}{\bar{x}} \times 100 \%$$

where

s is the standard deviation:

$$s = \sqrt{\frac{\sum_{i=1}^n \Sigma (x_{ai} - \bar{x})^2}{n-1}}$$

\bar{x} is the mean volume/area:

$$\bar{x} = \frac{\sum_{i=1}^n \Sigma x_{ai}}{n}$$

x_{ai} is the i^{th} average value of the volume/area:

$i = 1, 2, \dots, n$ is the measurement index ($n = 7$).

The largest positive deviation δ_{max} and largest negative deviation δ_{min} , respectively, from the average x_a (calculated from the data obtained from 10 s of each of the 7 measurements according to 5.4), expressed as percentages, are calculated as follows:

$$\delta_{max} = \frac{x_{max} - x_a}{x_a} 100 \%$$

$$\delta_{min} = \frac{x_{min} - x_a}{x_a} 100 \%$$

The deviation Δ between average volume/area x_a , and nominal volume/area x_{nom} , expressed as a percentage, is calculated as follows:

$$\Delta = \frac{x_a - x_{nom}}{x_{nom}} 100 \%$$

7 Test report

The results shall be presented in a test report. An example of a report is given in [Annex A](#).

Annex A (informative)

Example of a test report

A.1 Duration(s) for which the mean volume/area deviates by more than 10 % from the mean volume/area in the steady-state

A.1.1 Switching on and off the nozzle lines

Values in s

According to sub-clause	1		2		3		Average	
	Off	On	Off	On	Off	On	Off	On
5.2.2 (v_N, r_N)								
5.2.3 $0,75(v_N, r_N)$								
5.2.4 $1,25(v_N, r_N)$								

A.1.2 Switching on and off the boom sections according to [5.2.5](#)

Values in s

Boom section	1		2		3		Average	
	Off	On	Off	On	Off	On	Off	On
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

A.1.3 Speed variations

A.1.3.1 Pump rotational frequency according to [5.3.2](#)

Values in s

Measurement	Sequential settings				
	$0,75 v_N / 0,75 r_N$	v_N / r_N	$1,25 v_N / 1,25 r_N$	v_N / r_N	$0,75 v_N / 0,75 r_N$
1					
2					
3					
Average					