



BSI Standards Publication

# Equipment for crop protection — Method for measurement of potential spray drift from horizontal boom sprayers by the use of a test bench

**National foreword**

This British Standard is the UK implementation of ISO 22401:2015.

The UK participation in its preparation was entrusted to Technical Committee AGE/15, Equipment for crop protection and application of liquid fertilizer.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2015

ISBN 978 0 580 86834 4

ICS 65.060.40

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2015.

**Amendments/corrigenda issued since publication**

Date	Text affected
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**Equipment for crop protection —  
Method for measurement of potential  
spray drift from horizontal boom  
sprayers by the use of a test bench**

*Matériel de protection des cultures — Méthode de mesurage de la  
dérive potentielle des pulvérisateurs à rampe horizontale au moyen  
d'un banc d'essai*





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## Foreword

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The committee responsible for this document is ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

## Introduction

In recent years, spray drift control has become more and more relevant and buffer zones to reduce potential impact of spray drift have been widely introduced.

Normally, the determination of buffer zone widths or other regulations take into account the type of spraying equipment used for pesticide application and its spray drift or potential spray drift.

This International Standard is aimed at defining a test procedure to assess potential spray drift from horizontal boom sprayers, using an ad hoc test bench, in order to get a quick and simple assessment of this spraying equipment.

This test procedure can be used as an alternative method for the spray drift assessment obtained with the field measurement of spray drift (ISO 22866), or to the laboratory measurement of spray drift from nozzles (ISO 22856).

The application of this International Standard may support advisory services for farmers, sprayer manufacturers, product development and certification and classification schemes.





# Equipment for crop protection — Method for measurement of potential spray drift from horizontal boom sprayers by the use of a test bench

## 1 Scope

This International Standard provides a test method to measure spray sedimentation from horizontal boom sprayers using a test bench. The sedimentation measure gives a value for potential spray drift. These measurements can be used to compare different sprayer setups on the same sprayer.

This International Standard is applicable to mounted, trailed and self-propelled horizontal boom sprayers used in arable crops; and horizontal boom sprayers used for weed control in orchards/vineyards and spray application on horticultural crops.

This International Standard is intended for booms using a uniform set of spray generators. If intended for spray drift classification of the sprayer, the comparison is limited to nozzle type, spray pressure and boom height.

NOTE Further investigations and tests are on-going to consider other parameters for classification aims (e.g. air assisted system, forward speed, nozzle spacing and orientation).

## 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 5681, *Equipment for crop protection — Vocabulary*

## 3 Terms and definitions

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

### 3.1

#### **sprayer setup**

combination of nozzle and boom parameters and sprayer adjustment on a given sprayer

Note 1 to entry: Examples of setting parameters to be considered are nozzle type and size, nozzle spacing, orientation, boom height, forward speed, spray pressure, and spray deposition assistance (e.g. air assistance or shielding).

### 3.2

#### **potential spray drift**

percentage of initial spray volume that remains suspended in the air after the sprayer passage and which represents the fraction of spray liquid susceptible to drift out of the treated area by the action of air currents during the application process

### 3.3 reference spray deposit RSD

calculated amount of the expected spray deposit in the treated area based on measured forward speed and nozzle flow rate assuming an even distribution under the spray boom

Note 1 to entry: For example, applying a volume of 100 l/ha the reference spray deposit (RSD) corresponds to 1 µl/cm<sup>2</sup>.

## 4 Principles

The method is aimed at determining the potential spray drift generated by horizontal boom sprayer setups, by collecting the spray droplets sedimenting after the boom has passed over the entire length of the test bench. The total amount of collected sediment is compared to the reference spray deposit (RSD) to obtain the drift potential value (DPV), see [7.2](#).

To allow comparison of results between facilities/laboratories, one measurement shall be done with the sprayer setup specified in [Annex A](#).

## 5 Test materials and equipment

### 5.1 Test liquid

Where possible, all measurements shall use a tracer of low toxicity that can be safely applied to the treated area with no associated risks of environmental contamination (e.g. yellow Tartrazine E102, Brilliant sulpho flavine). Tracer concentration and analytical sensitivity shall be appropriate to guarantee a detection limit of at least 0,1 % of RSD.

NOTE 1 Depending on the toxicity of the tracer the safety of the test personnel may be affected. Regulations for occupational health and safety apply.

The spray liquid shall have physical properties representative of liquids typically used in the application of plant protection products. This can normally be achieved by the addition of a water-soluble surfactant at typical usage rates (for example 0,1 %).

NOTE 2 The formulation of some tracers can include a surfactant component.

### 5.2 Test bench to assess potential spray drift

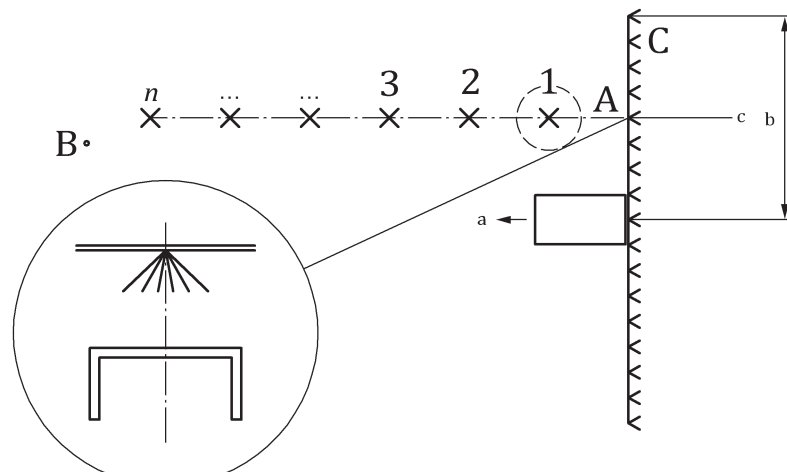
The test bench consists of a frame track provided with aligned slots in which the deposit collectors are situated (e.g. Petri dishes) with sliding covers linked together, preventing any unintended entry of droplets on the artificial collectors slots (see [Figure D.1](#)).

Two slots, one at the beginning and one at the end of the test bench, shall be maintained permanently uncovered in order to collect the whole spray deposit under the boom.

Spacing between slots shall be  $(500 \pm 2)$  mm. The test bench shall be equipped with at least 20 covered slots for deposit collectors, numbered from 1 to  $n$  according to the sprayer travel direction. The area of the deposit collector in each slot shall be a minimum of 100 cm<sup>2</sup>.

The sliding covers shall be linked to a control device enabling simultaneous covering and/or uncovering of the deposit collectors by the boom passing.

The control device that uncovers the deposit collectors shall be activated automatically when the boom passes point B (see [Figure 1](#)). Point B shall be positioned so that the deposit collectors are uncovered when the spray hits the ground at  $(2 \pm 0,1)$  m distance beyond the middle of collector  $n$ . This should prevent the nozzles from spraying directly onto the deposit collectors.



### Key

- 1, 2, 3,  $n$  collectors
- A slot for artificial collector
- B starting point for uncovering collectors positioned so that the collectors are uncovered when the nozzle spray hits the ground at  $(2 \pm 0,1)$  m distance beyond the middle of collector  $n$
- C horizontal boom sprayer
- a Travel direction.
- b Half-boom.
- c Middle of the right half-boom.

NOTE See also [Annex D](#) showing an example of test bench.

**Figure 1 — Scheme of the test bench**

## 6 Test conditions

### 6.1 Environmental conditions

Tests shall be operated, preferably indoors, with an average wind velocity  $< 1,0$  m/s and a maximum wind velocity  $< 1,5$  m/s, with air temperature between  $5$  °C and  $35$  °C and relative humidity between  $40$  % and  $95$  %.

Wind velocity measurements shall be reported and carried out at least at  $1$  Hz frequency and at  $2$  m height. In the test report the environmental average temperature, the average relative humidity, the maximum, minimum and average wind velocity and the average wind direction (with respect to the test bench direction) during the test shall be recorded (see [Annex C](#)).

The test area shall have a track length before the test bench ensuring that the sprayer has reached even intended output flow considering forward speed.

With a rate control in manual mode a minimum track length before the bench of  $10$  m is suggested for travel speed up to  $2$  m/s and of  $20$  m for travel speeds up to  $4$  m/s. With the rate control in an automatic mode the track length before the bench has to be adapted considering the system reaction time.

When operating indoors, the length of the testing hall shall be at least equal to the test bench length plus  $20$  m before and after the test bench, the height shall be a minimum of  $7$  m and the width shall be at least equal to the boom width plus  $4$  m.

The temperature difference between ground surface and ambient air shall not be large enough to create turbulence. Both ground surface and air temperatures shall be recorded (see [Annex C](#)).

NOTE Differences of temperature between air and soil higher than 10°C may result in air turbulence.

If comparison tests between sprayer setups are undertaken then the same test shall be carried out in similar conditions and always under the following limits: differences between average wind velocities shall not exceed 0,2 m/s, differences between air temperature shall not exceed 10°C and differences between air relative humidity shall not exceed 20 % as recorded during the measuring period. Maximum and minimum wind velocity shall also be recorded in all tests.

## 6.2 Test bench positioning

When operating indoors the test bench shall be positioned on artificial grass or on a bare soil flat surface. When operating outdoors the test bench shall be positioned in an open field on a flat surface with grass, with the height of vegetation between 50 mm and 100 mm in order to stabilize test conditions. Do not operate tests on concrete or hard surfaces. Always verify the horizontality of the test bench and preferably position it so that the deposit collectors are placed at a maximum height of 300 mm from the ground parallel to the sprayer travel direction. The centre of the test bench should be positioned underneath the nozzle closest to the middle of the right or left half-boom (see Figure 1).

In identifying the place of the outdoor test area take notice of the effect of vegetation on wind. The test area should be at least 10 times the height of the vegetation or constructions away from the surrounding vegetation or constructions.

When comparing different sprayer setups take care to operate with the test bench collectors positioned at the same height from the ground and report this height in the test report.

NOTE Additional information regarding assessment of transverse distribution under the boom can be included in the test report.

## 6.3 Forward speed

Measure the forward speed of the tested sprayer with a maximum error of 0,1 km/h, measuring the time needed to cover a distance of at least 50 m along the travel track.

When comparison of different sprayer setups is undertaken the forward speed of the sprayers shall be the same ( $\pm 0,2$  km/h) and at least one comparison test shall be made at a forward speed of ( $7 \pm 0,2$ ) km/h.

## 6.4 Vehicle travel track

The sprayer/tractor travel track shall be a level surface to minimize sprayer boom movement. Other surface types can be used to assess the effect of boom movements on potential spray drift.

# 7 Test procedure

## 7.1 Method

**7.1.1** Adjust sprayer parameters (forward speed, operating pressure, boom height), select the nozzle parameters (e.g. type, spacing, size and orientation) to be used in the test and calculate the RSD under the boom. Boom height shall be measured from the nozzle tip to the deposit collectors.

**7.1.2** Insert the deposit collectors in the test bench slots and activate the control device in order to cover them.

**7.1.3** Take a representative sample of the sprayed liquid from one spraying nozzle at spray boom and analyse it through a spectrophotometer, fluorometer or equivalent means.

**7.1.4** Operate the boom over the test bench with covered collectors and activate all boom nozzles: start spraying at least 20 m before and stop spraying at least 20 m after the test bench.

**7.1.5** After the boom passes the last covered slot of the test bench, the control device shall be activated in order to uncover the deposit collectors when the spray hits the ground at  $(2 \pm 0,1)$  m distance beyond the middle of the last covered collector.

**7.1.6** Wait for at least 60 s before starting to collect the exposed collectors in order to allow all droplets suspended in the air to sediment. Waiting time shall be the same for all test comparisons.

**7.1.7** Wait until the deposit collectors are dry/dried before performing analysis. Wash each collector using a measured ( $\pm 0,1$  ml) amount of deionised water or appropriate solvent and measure the tracer concentration in the washing liquid from each deposit collector by spectrophotometric analysis, fluorometric analysis or equivalent means.

**7.1.8** After each test replicate take care to clean and dry the test bench in order to prevent risks of cross contamination due to subsequent passes of the boom over the test bench.

**7.1.9** When comparing sprayer setups always randomize all the measurements.

## 7.2 Results

The deposit on each collector ( $D_i$ ), expressed in  $\mu\text{l}/\text{cm}^2$ , shall be calculated according to Formula (1):

$$D_i = \left[ (\rho_{\text{smp1}} - \rho_{\text{blk}}) \times V_{\text{dil}} \right] / (\rho_{\text{spray}} \times A_{\text{col}}) \quad (1)$$

where

$D_i$  is the spray deposit on the single deposit collector, expressed in  $\mu\text{l}/\text{cm}^2$ ;

$\rho_{\text{smp1}}$  is the measurement value of tracer concentration (e.g. absorbance, fluorescence);

$\rho_{\text{blk}}$  is the measurement value of tracer concentration of the blank samples (e.g. absorbance, fluorescence);

$V_{\text{dil}}$  is the volume of dilution liquid (e.g. deionised water) used to dissolve tracer deposit from collector, expressed in microlitres ( $\mu\text{l}$ );

$\rho_{\text{spray}}$  is the measurement value (e.g. absorbance, fluorescence) of the spray mix concentration applied during the tests and sampled at the nozzle;

$A_{\text{col}}$  is the projected area of the collector for catching the spray droplets, expressed in square centimetres ( $\text{cm}^2$ ).

Calculate the DPV according to Formula (2):

$$\text{DPV} = \sum_{i=1}^n D_i / \text{RSD} \times 100 \quad (2)$$

where

DPV is the drift potential value (adimensional);

$D_i$  is the spray deposit on the single deposit collector positioned in the covered slots, expressed in  $\mu\text{l}/\text{cm}^2$ ;

RSD is the reference spray deposit under the boom, expressed in  $\mu\text{l}/\text{cm}^2$ , calculated from the measured forward speed and nozzle flow rate (for example, when applying 100 l/ha, RSD = 1  $\mu\text{l}/\text{cm}^2$ ).

Register in the test report the spray deposit values measured in the permanently uncovered collectors at the beginning and at the end of the test bench.

### 7.3 Test validation

The test is valid when spray deposit on collectors in slots 1 and 2 is < 1 % of RSD. This means that the length of the test bench is enough to ensure capturing sedimenting spray at the beginning of test bench. If this is not achieved, the length of the test bench shall be increased appropriately.

To give an indication of the appropriate test procedure it is recommended that uncovered collectors collect at least 70 % of RSD. This value should be recorded in the test report (see [Annex C](#)).

For each sprayer setup tested at least three test replicates shall be made.

The mean value of the replicates shall be reported as index value of potential spray drift for the horizontal boom sprayer setup tested.

The coefficient of variation (CV) of DPV measurements shall be recorded in the test report ([Annex C](#)).

## 8 Comparison

When this methodology is applied to compare different sprayer setups the comparison shall be made with a reference sprayer setup according to [Annex B](#).

The comparison is made between the DPV of the tested sprayer setup and the DPV of the reference sprayer setup.

If this methodology is used to compare the effect of different spray mixes (e.g. with or without different types of adjuvants) in terms of DPV the test shall be made using the same sprayer setup.

## 9 Test report

The results of the measurements shall be presented in a test report (see an example in [Annex C](#)).

## Annex A (normative)

### Characteristics of the reference sprayer setup for comparison of results between different laboratories/facilities

To allow comparison of results between facilities/laboratories, one measurement shall be done with the sprayer setup indicated in Table A.1.

**Table A.1 — Reference sprayer setup**

<b>Nozzle type and size</b>	Flat fan TeeJet XR 11003 VS <sup>a</sup>
<b>Nozzle spacing along the boom</b>	50 cm
<b>Spray pressure</b>	0,30 MPa
<b>Nozzle orientation</b>	vertical
<b>Nozzle height above deposit collectors</b>	50 cm
<b>Spray deposition assistance</b>	-
<b>Travel speed</b>	7,0 km/h

<sup>a</sup> TeeJet XR 11003 VS is the trade name of a product supplied by Spraying Systems Company/TeeJet. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

## Annex B (normative)

### Characteristics of the reference sprayer setup

To allow comparison of results between different sprayer setups, one measurement shall be done with the sprayer setup indicated in Table B.1.

**Table B.1 — Characteristics of the reference sprayer setup**

<b>Nozzle type and size</b>	Flat fan TeeJet XR 11003 VS <sup>a</sup>
<b>Nozzle spacing along the boom</b>	50 cm
<b>Spray pressure</b>	0,30 MPa
<b>Nozzle orientation</b>	vertical
<b>Nozzle height above deposit collectors</b>	50 cm
<b>Spray deposition assistance</b>	-
<b>Travel speed</b>	7,0 km/h

<sup>a</sup> TeeJet XR 11003 VS is the trade name of a product supplied by Spraying Systems Company/TeeJet. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.



## Annex C (informative)

### Test report

#### C.1 Meteorological conditions at the test site

- Average air temperature: .....°C
- Average ground surface temperature: .....°C
- Maximum air temperature: .....°C
- Minimum air temperature: .....°C
- Average relative humidity: .....%
- Maximum relative humidity: .....%
- Minimum relative humidity: .....%
- Average wind velocity: .....m/s
- Maximum wind velocity: .....m/s
- Minimum wind velocity: .....m/s
- Average wind direction (with respect to test bench direction): .....°

#### C.2 Characteristics of the tested sprayer

<b>Sprayer type</b>	.....
<b>Nozzle type</b>	.....
<b>Size</b>	
<b>Orientation (direction and angle)</b>	
<b>Offset angle (specify nozzle cap)</b>	
<b>Nozzle spacing (cm)</b>	
<b>Boom width (m)</b>	.....
<b>Spray pressure (MPa)</b>	.....
<b>Nozzle height above target (cm)</b>	.....
<b>Travel speed (km/h)</b>	.....
<b>Volume application rate (l/ha)</b>	.....
<b>Other characteristics (e.g. presence and setting of air assistance)</b>	

### C.3 Drift potential value (DPV)

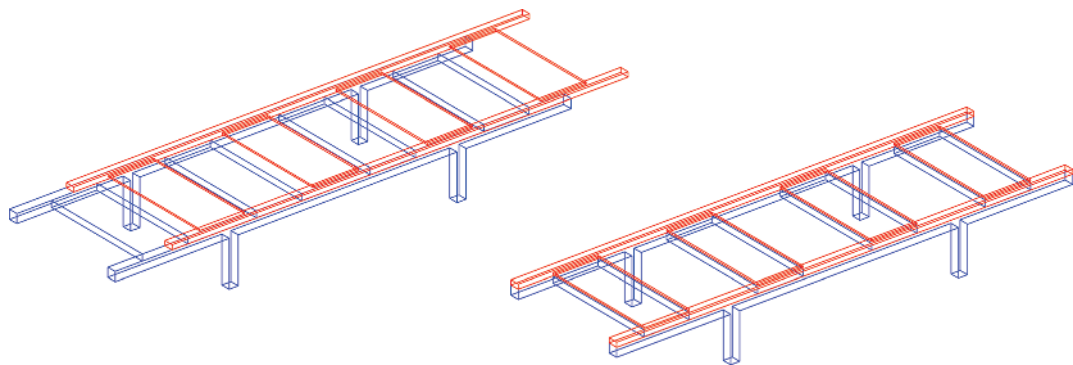
	Tested sprayer setup	Reference sprayer setup
Replicate 1		
Replicate 2		
Replicate 3		
.....		
Replicate $n$		
CV values between $n$ replicates		
Average DPV		
RSD		
Average of uncovered collector deposit as a % of RSD		

## Annex D (informative)

### Example of a test bench

This annex gives an example of a test bench to assess potential spray drift generated by horizontal boom sprayers according to the technical characteristics described in [5.2](#).

The test bench should be constructed in order to allow its horizontality and height adjustment.



**Figure D.1 — Example of test bench structure**

## Bibliography

- [1] ISO 22856:2008, *Equipment for crop protection — Methods for the laboratory measurement of spray drift — Wind tunnels*
- [2] ISO 22866:2005, *Equipment for crop protection — Methods for field measurement of spray drift*







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