INTERNATIONAL STANDARD

ISO 14131

First edition
2005-02-01

Agricultural sprayers — Boom steadiness — Test methods

Pulvérisateurs agricoles — Stabilité des rampes — Méthodes d'essai

Reference number
ISO 14131:2005(E)

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Published in Switzerland

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Foreword

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ISO 14131 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

Agricultural sprayers — Boom steadiness — Test methods

1 Scope

This International Standard specifies test methods for measuring boom steadiness in agricultural field crop sprayers, with the objective of evaluating the stability of the boom and the quality of its suspension, and determining its movements.

NOTE Safety methods for agricultural sprayers are specified in ISO 4254-6.

2 Normative references

The following referenced documents are indispensable for the application 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.

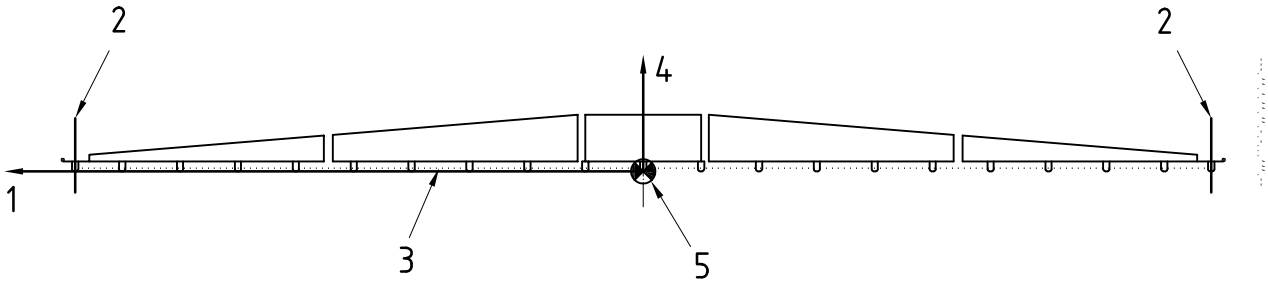
ISO 5008, *Agricultural wheeled tractors and field machinery — Measurement of whole-body vibration of the operator*

3 Terms and definitions

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

3.1
boom centre
point located in the vertical plane of the boom and at the median of the segment joining the output of the nozzles in this plane

See Figure 1.



Key

1 Y-axis
2 axis of end nozzle
3 segment joining output of nozzles
4 Z-axis
5 boom centre

Figure 1 — Defined locations on a boom

3.2
boom section end
distal point of each boom section

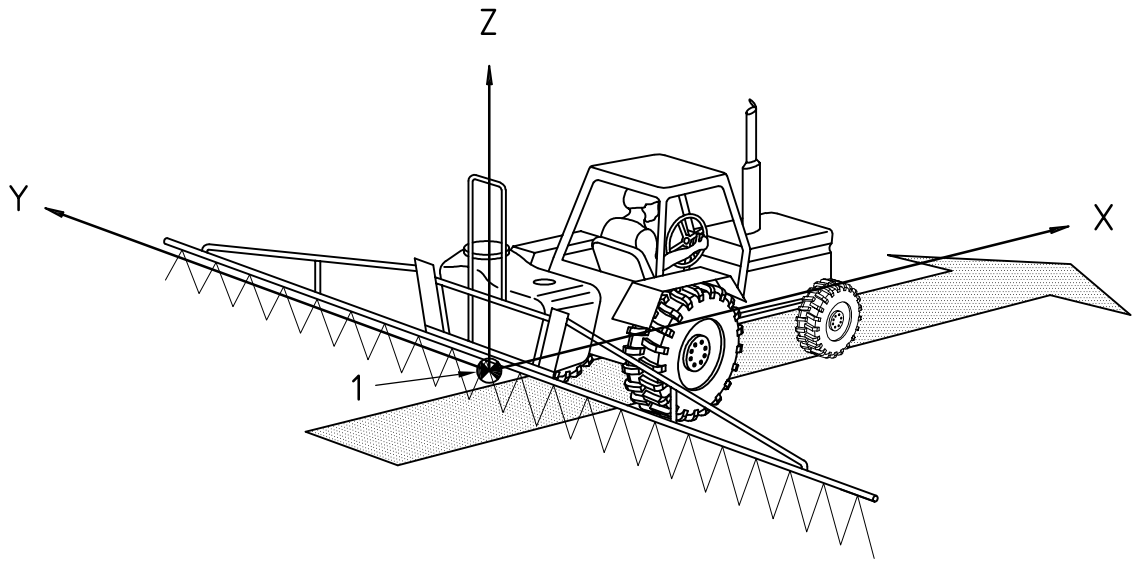
3.3
boom tip
distal point of the boom

3.4
reference axle
axle nearest the boom

NOTE In the case of a trailed sprayer, it is the axle of the sprayer.

3.5
vertical displacement
distance between the position at rest of a boom section end at moment t_0 of the beginning of the test and its position at the moment given, measured along the vertical axis, in a vertical plane perpendicular to the axis of the boom

See Figure 2.



Key
X X-axis (in driving direction)
Y Y-axis (along boom)
Z Z-axis (in vertical plane)
1 origin (boom centre)

Figure 2 — Origin and direction references

3.6
horizontal displacement
distance between the position at rest of a boom section end, at moment t_0 of the beginning of the test, and its position at the moment given, measured along the horizontal axis, in a vertical plane perpendicular to the axis of the boom

See Figure 2.

4 Test conditions

4.1 General

The sprayer should be operated according to good practice, and should be referenced in the manufacturer's manual unless it is the subject of the test.

4.2 Tyres

All characteristics of the tyres shall be recorded in the test report (see 5.5), including their inflation pressure.

4.3 Adjustment of boom

The boom shall be tested opened, with a height relative to the targets adjusted according to the specifications of the nozzle under test: for 110°/120° nozzles it is usually 50 cm and for 80°/90° nozzles, 75 cm. Adjustments specified in the manufacturer's manual shall be used and specified in the test report.

4.4 Distance between wheels

Track width and wheel bases shall be specified in the report.

4.5 Dimensional specifications

The dimensional specifications for the sprayer, its boom and its suspension (see Annex A), at rest, shall be determined and recorded in the test report.

5 Test methods and requirements

5.1 General

Three categories of test are specified, depending on excitation and measurement situation: field (5.2), track (5.3) and simulator (5.4).

5.2 Tests on fields

5.2.1 General conditions

Good agricultural practices for spraying shall be respected.

Record the meteorological conditions, including wind speed and wind direction related to track direction (see 5.2.2), in the test report. The wind speed, measured at a height of 2 m, shall be not more than 5 m/s.

5.2.2 Track

In case of wind speed higher than 4 m/s, the track direction should be in the crosswind direction.

The sprayer under test shall be driven down the track three times.

The minimum length of the track shall be equivalent to at least 30 s of driving.

The minimum starting length to minimize the start-up effect of the boom movements shall be 1 m/ per 0,1 m/s driving speed with a minimum of 20 m.

5.2.3 Driving speed

Unless speed variation is continuously monitored, the driving speed shall be constant during the test.

5.2.4 Motion measurement

5.2.4.1 General

The frequencies measured shall be at least between 0,1 Hz and 5 Hz.

The sample rate shall be a minimum of 10 Hz.

5.2.4.2 Displacement

If directly measured or obtained by proper integration/double integration of velocity/acceleration, then the accuracy shall be minimum 0,1 cm per 1 m of boom length.

Measure both the vertical displacement and the horizontal displacement.

5.2.4.3 Velocity

If directly measured or obtained by integration of accelerations, then the accuracy shall be the same as that obtained by derivation of displacement.

5.2.4.4 Acceleration

If directly measured, then the accuracy shall be the same as that obtained by double derivation of displacement.

5.2.5 Procedure

5.2.5.1 Specific condition

Measure the travel speed.

5.2.5.2 Minimum requirements

Conduct any test at least five times (the usual number of repetitions is 10 times).

a) Global evaluation of general behaviour of boom

Select a reference point in at least the vertical direction. Depending on the purpose of the test, the reference point may be the sprayer frame, ground surface, crop surface or an absolute point or plane. Carry out measurements at a minimum of one measurement point (e.g. at the boom tip).

b) Evaluation of boom motion

Select reference points in both the horizontal and vertical directions. Depending on the purpose of the test, a reference point may be the sprayer frame, ground surface, crop surface or an absolute point or plane. Carry out measurements, which shall be related to the boom centre, at a minimum of two measurement points — boom centre and boom tip — preferably at each boom section end.

5.3 Tests on tracks

5.3.1 General

The objective is to use bumps and/or holes to generate impulses, the intent being to approximate working conditions in the field in a reproducible way, and to analyse the movements of the boom under these conditions.

Unless tank filling level is the subject of the test, the tank of the sprayer shall be empty.

5.3.2 Track

The track shall be built using a material that does not lose its shape. Movable obstacles may be added if they are fixed on the track such that the tractor cannot displace them.

The minimum length of the track shall be 50 m or such that at least 25 s of driving can be monitored.

The minimum starting length to minimize the start-up effect of the boom movements shall be 1 m per 0,1 m/s driving speed with a minimum of 20 m.

A suitable track is as specified in ISO 5008:2002, 11.2.1 b) (“smoother track”).

5.3.3 Driving speed

Unless speed variation is continuously monitored, the driving speed shall be constant during the test.

5.3.4 Motion measurement

5.3.4.1 General

Measure and record the vertical and horizontal motion.

The frequencies measured shall be at least between 0,1 Hz and 5 Hz.

The sample rate shall be a minimum of 10 Hz.

5.3.4.2 Displacement

If directly measured or obtained by proper integration/double integration of velocity/acceleration, then the accuracy shall be minimum 0,1 cm per 1 m of boom length.

Measure both the vertical displacement and the horizontal displacement.

5.3.4.3 Velocity

If directly measured or obtained by integration of accelerations, then the accuracy shall be the same as that obtained by derivation of displacement.

5.3.4.4 Acceleration

If directly measured, then the accuracy shall be the same as that obtained by double derivation of displacement.

5.3.5 Procedure

5.3.5.1 Specific conditions

Measure the travel speed.

Track tests should have a flag in the displacement/velocity or acceleration data stream (or temporally close in a parallel data stream) to indicate the location of a bump or dip.

5.3.5.2 Minimum requirements

Conduct any test at least three times.

Select reference points in both the vertical and horizontal directions. Depending on the purpose of the test, a reference point may be the sprayer frame, ground surface, crop surface or an absolute point or plane. Carry out measurements, which shall be related to the boom centre, at a minimum of two measurement points — boom centre and boom tip — preferably at each boom section end.

5.4 Tests on simulators

5.4.1 General

A simulator is a device used to apply mechanical energy with different degrees of freedom to the stationary sprayer in order to force sprayer movements. This gives the opportunity to study spray boom movements under well-defined conditions in a reproducible way. Simulators may be designed to apply excitations to just one wheel, to both wheels of one axle or to the whole sprayer or tractor-sprayer-combination with or without wheels.

Unless tank filling level is the subject of the test, the tank of the sprayer shall be empty.

5.4.2 Signal inputs

Different drive signals may be used, for example, artificial signals as sine vibrations or random signals to simulate practical conditions.

If the sprayer is tested with several successive sinusoidal inputs, the frequencies shall be in a range of 0,1 Hz to 3 Hz with increments of preferably 0,5 Hz. The amplitudes of these signals shall be

— between ± 10 mm and ± 20 mm for the frequencies 0,1 Hz to 0,5 Hz,

— between ± 5 mm and ± 10 mm for the frequencies 1 Hz to 1,5 Hz, and

— between ± 2 mm and ± 5 mm for the frequencies 2 Hz to 3 Hz.

If the sprayer is tested with wheels, these amplitudes shall be doubled in order to compensate the filtering by the tyres. The duration of the signal shall be such that 10 periods can be recorded once the system has stabilized.

A swept sine or a random signal with the above frequency and amplitude range may be used as an input.

5.4.3 Motion measurement

Measure and record the vertical displacement and the horizontal displacement relative to the balance position.

Adapt the sample rate to the maximum frequency of the drive signal so as to obtain 10 points per period. The maximum sample rate is thus 30 s^{-1} for an input at 3 Hz.

5.4.3.1 Accuracy

Minimum measuring accuracy shall be 2 mm.

5.4.4 Procedure/minimum requirements

Conduct any test at least three times.

The reference point in both the vertical and horizontal directions shall be the position of the boom when the sprayer is at rest. Carry out measurements, which shall be related to the boom centre, at a minimum of two points — boom centre and boom tip — preferably at each boom section end.

5.5 Test report

5.5.1 General conditions

The following shall be detailed in the test report.

— Description of tractor, sprayer (with dimensional specifications of the boom and the suspension, see Annex A), specific equipment and set-up, test conditions (tyres, tractor and sprayer weights, wheelbase and axle, filling of tank, attachment of sprayer, etc.).

— Measurement device and procedure (type of sensors, position of measurement points, etc.). Provide a chart of the position of the measurement points.

— Conditions during the measurements.

— For tests on field and track, the references required.

5.5.2 Results

Results shall be presented for the average values for all the repetitions (except for the curves for horizontal displacement and vertical displacement).

Depending on the purpose of the tests, results may be, for example,

— curves of the horizontal displacement and vertical displacement of the boom tip related to the balance position or to the centre of the boom (see Annex B),

— the percentage of time with movement within a given bandwidth,

— vertical amplitudes (maximum and standard deviation, peak-to-peak amplitudes of the main oscillations, see Annexes C and D),

— horizontal amplitudes (maximum and standard deviation, peak-to-peak amplitudes of the main oscillations, see Annexes C and D),

— the horizontal velocity of the boom tip (maximum, minimum and standard deviation, see Annex D), or

— for simulator tests, the frequency response function for drive signals as input and the boom tip displacement in the horizontal and vertical planes as output.

Annex A
(normative)

Dimensional specifications of boom and suspension

The dimensional specifications shall be

— the height between the lower base of the lower trapeze or the lower pivot point and the line joining the output points of the nozzles,

— the distance between outer nozzles, and

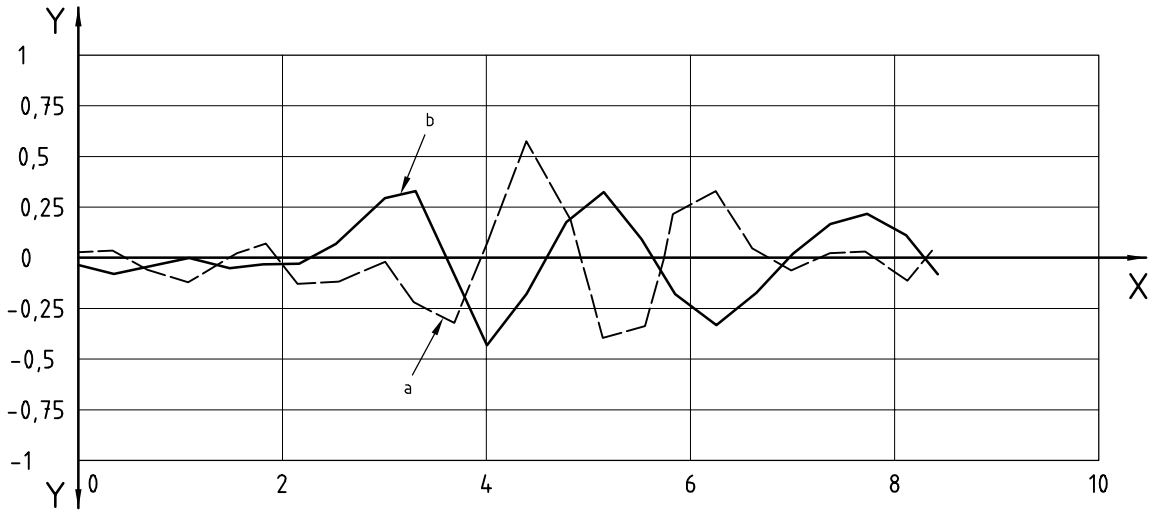
— the geometric parameters of the suspension, such as

1) the distance between the lower basis of the lower trapeze or the lower point of the skids, and

2) the height between the upper basis of the upper trapeze or the upper pivot point and the fictitious soil at moment t_0.

Annex B
(informative)

Example results for field or track tests — Curves of displacements related to balance position



Key

X sprayer displacement, m

Y relative boom movement, m

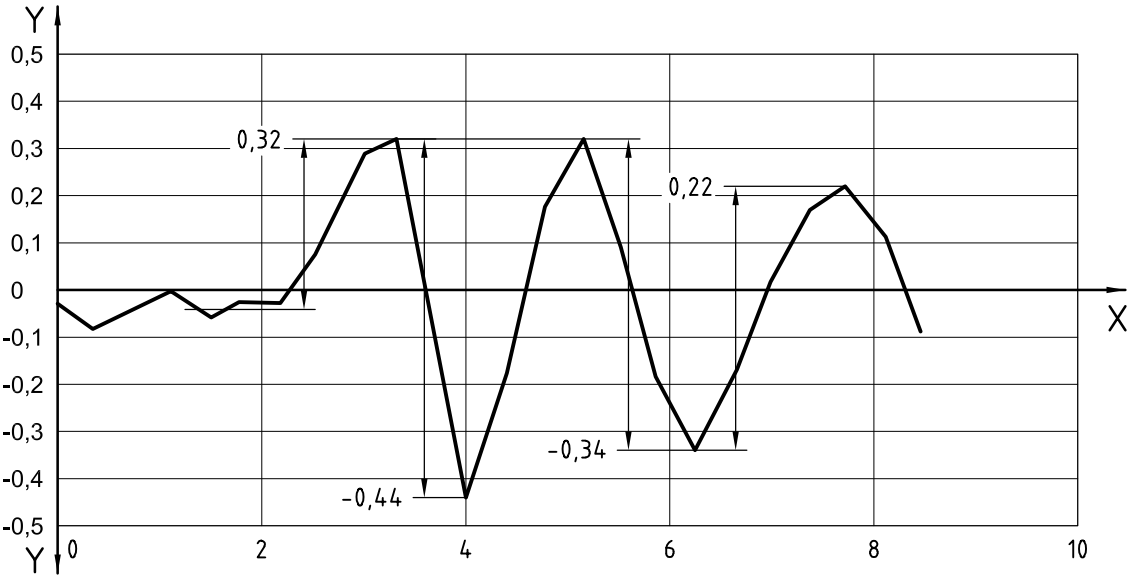
a Horizontal displacements.

b Vertical displacements.

Figure B.1 — Curves of displacements related to balance position

Annex C
(informative)

Example results for track tests — Peak-to-peak amplitudes for oscillations



Peak	Increasing displacement m	Decreasing displacement m
1	0,35	0,76
2	0,76	0,66
3	0,56	—
Number of peaks: 3. Maximum peak-to-peak amplitude: 0,76 m.		

Key

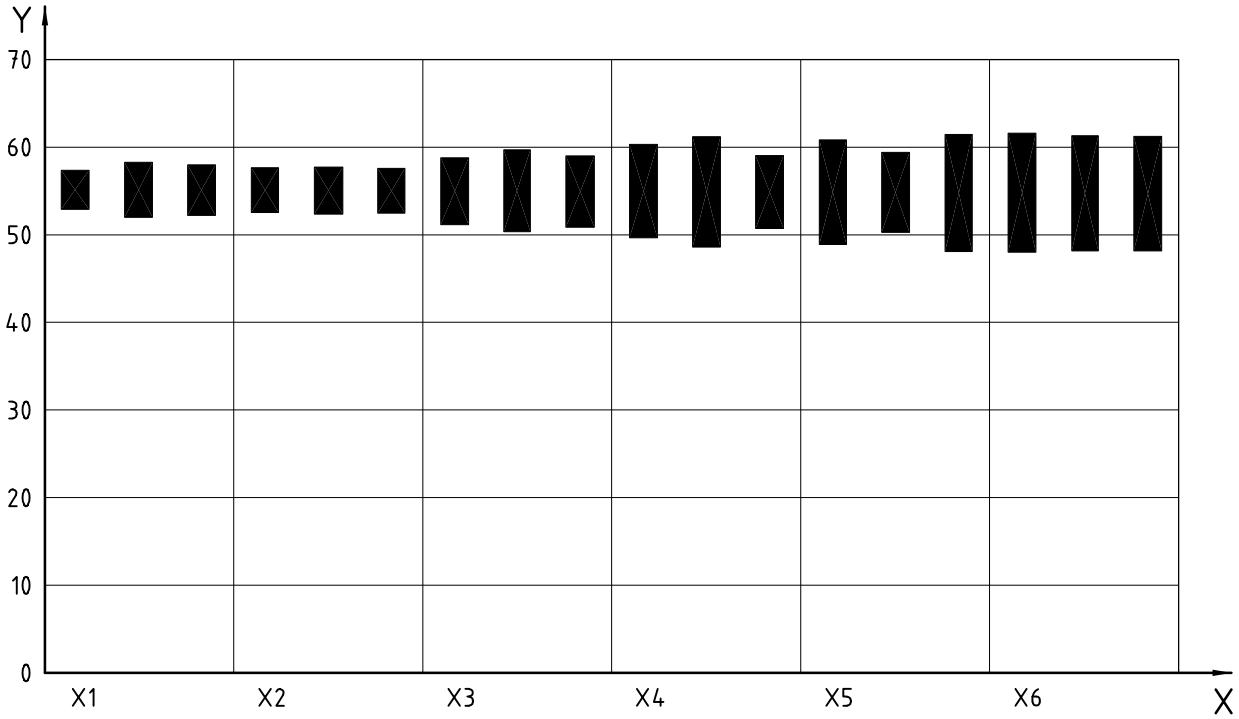
X sprayer displacement, m

Y relative boom movement, m

Figure C.1 — Peak-to-peak amplitudes for vertical displacements

Annex D
(informative)

Example results for field or track tests — Curves of displacements related to balance position

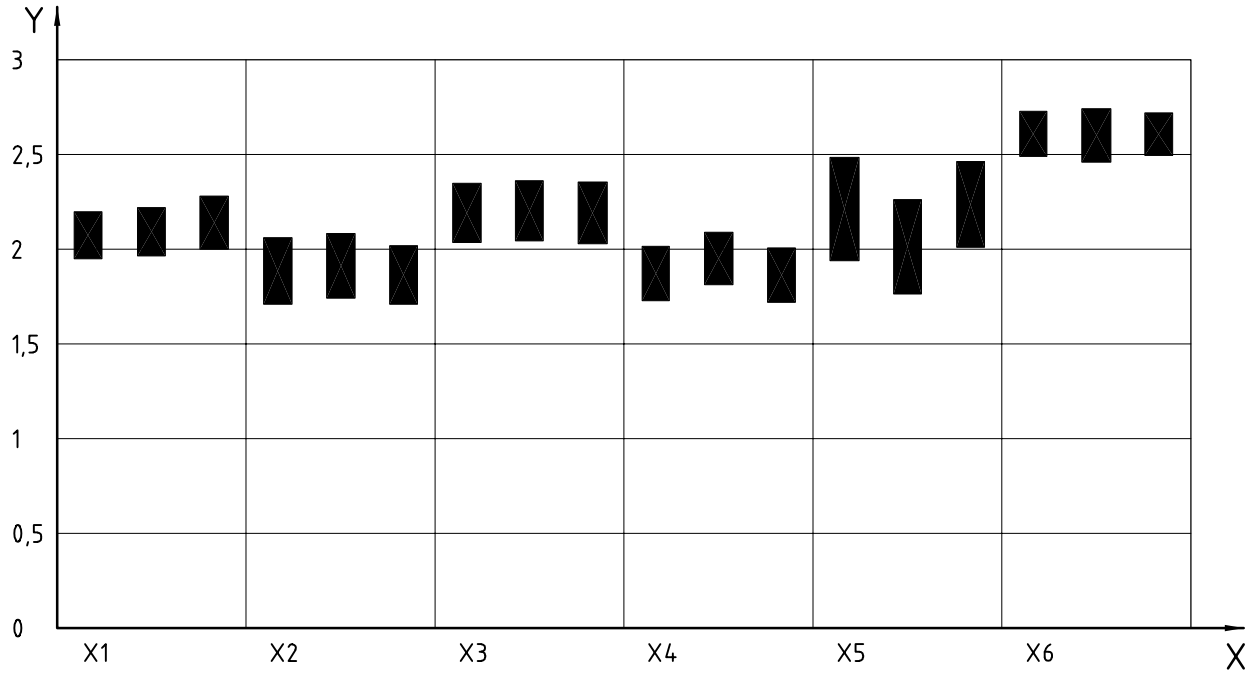


Key

X type of sprayer

Y spray boom height, cm

Figure D.1 — Standard deviation of vertical spray boom movements around 55 cm height at 12 m of centre of spray boom — Three repetitions



Key

X type of sprayer

Y velocity, m/s

Figure D.2 — Standard deviation of spray boom movements in horizontal plane (deviation against average velocity of spray boom) — Three repetitions

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[1] ISO 4254-6, *Agricultural machinery — Safety — Part 6: Sprayers and liquid fertilizer distributors*[1)]

[2] ISO 5681, *Equipment for crop protection — Vocabulary*

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

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

1) To be published. (Revision of ISO 4254-6:1995)

ICS 65.060.40

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