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Agricultural machinery — Rotary and flail mowers — Thrown-object test and acceptance criteria

Matériel agricole — Faucheuses rotatives et faucheuses-broyeuses — Essai de projection d'objets et critères d'acceptation

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 17101 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 7, *Equipment for harvesting and conservation*.

Agricultural machinery — Rotary and flail mowers — Thrown-object test and acceptance criteria

1 Scope

This International Standard gives specifications and acceptance criteria for the thrown-object testing of rotary and flail mowers used in agriculture. Examples of machines are shown in Annex A. It is not applicable to

— mowers with an articulated arm,

— mowers with one or more vertical axis designed for mulching,

— pedestrian-controlled motor mowers,

— lawn mowers or machines designed as lawn mowers,

— inter-row mowing units,

— machines designed for highway and road maintenance only.

NOTE If a machine is also designed for use outside agriculture, other thrown-object tests may apply.

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 536, *Paper and board — Determination of grammage*

ISO 789-1, *Agricultural tractors — Test procedures — Part 1: Power tests for power take-off*

ISO 1974, *Paper — Determination of tearing resistance (Elmendorf method)*

ISO 2758, *Paper — Determination of bursting strength*

3 Terms and definitions

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

3.1
rotary mower
mower in which one or more functional components cut or shear by impact without mulching and rotate about a vertical axis

3.2
flail mower
mower with a multiplicity of free-swinging cutting elements that rotate about a horizontal axis, which cuts the grass by impact and mulches it with the same tools

3.3
conditioning device
mechanical device allowing the acceleration of the crop-drying process (e.g. crushing, impact, abrasion, lamination)

3.4
swath board
adjustable device for controlling the swath width

3.5
kraft paper
paper produced from pure unbleached sulfate kraft pulp with machine-finished surface

NOTE 1 It is mainly used for the manufacture of paper sacks and for lining and laminating.

NOTE 2 See 4.2.1 for details of specifications.

3.6
impact
hole in kraft paper caused by a stone passing completely through the kraft paper or tear with a deformation of the paper towards the exterior

4 Thrown-object test

4.1 Testing conditions

4.1.1 General

Tests shall be performed on horizontal hard ground.

EXAMPLE Concrete, asphalt.

Tests shall be performed using the same mower, or mower with conditioning device, and the same protective devices. If the mower can be fitted with a removable conditioning device, the test shall be performed both with and without the conditioning device. If the mower can be operated in different working positions (right side, centre or left side of the tractor, see 4.2.7), the test shall be performed with the mower in the rightmost and leftmost working positions behind the tractor, as given by the manufacturer in the instruction handbook.

Adjustable devices (e.g. swath board) which could influence the efficiency of the protective device in preventing projections shall be located in the least favourable position.

During tests, the mower shall be moved so that the tools run through the test material with a forward speed of from 2 km/h to 4 km/h.

4.1.2 Mounted, semi-mounted or trailed mowers

During tests, the mowers shall be driven at the speed recommended by the manufacturer, e.g. at power take-off (PTO) speed of 540 min^{-1} or 1 000 min^{-1}, by a tractor with minimum power at least equal to the minimum (PTO) needed for the mower measured according to ISO 789-1.

4.2 Target

4.2.1 General

A target is used to record the impact of stones projected from the protected zone of the mower.

The target consists of several panels on which kraft paper is stretched such that it extends below in the lower zone (see 4.4.1) for a minimum of 50 mm. The kraft paper grammage shall be 120 $g/m^2 \pm 10$ g/m^2, determined in accordance with ISO 536. The bursting strength shall be 500 kPa minimum, determined by using the method specified in ISO 2758. The tearing resistance shall be 1 200 mN minimum, in the machine direction, determined in accordance with the test method specified in ISO 1974. There shall be no reinforcing slat within 20 mm of the

kraft paper. There shall be no overlapping of kraft paper, and, in order to have no overlaps, the kraft paper should be stretched from the roll in the horizontal direction on the frames.

Panels 1 to 4 shall be made of a rigid frame, 2 000 mm in height (see Figures 2 to 6).

4.2.2 Panels in the operator's zone for mowers attached at the rear three-point tractor linkage

Panels 5, 7a and 7b act as a target in the operator's zone (see Figure 1); they shall be made of a rigid frame and shall comply with the specifications given in Table 1.

Dimensions in millimetres

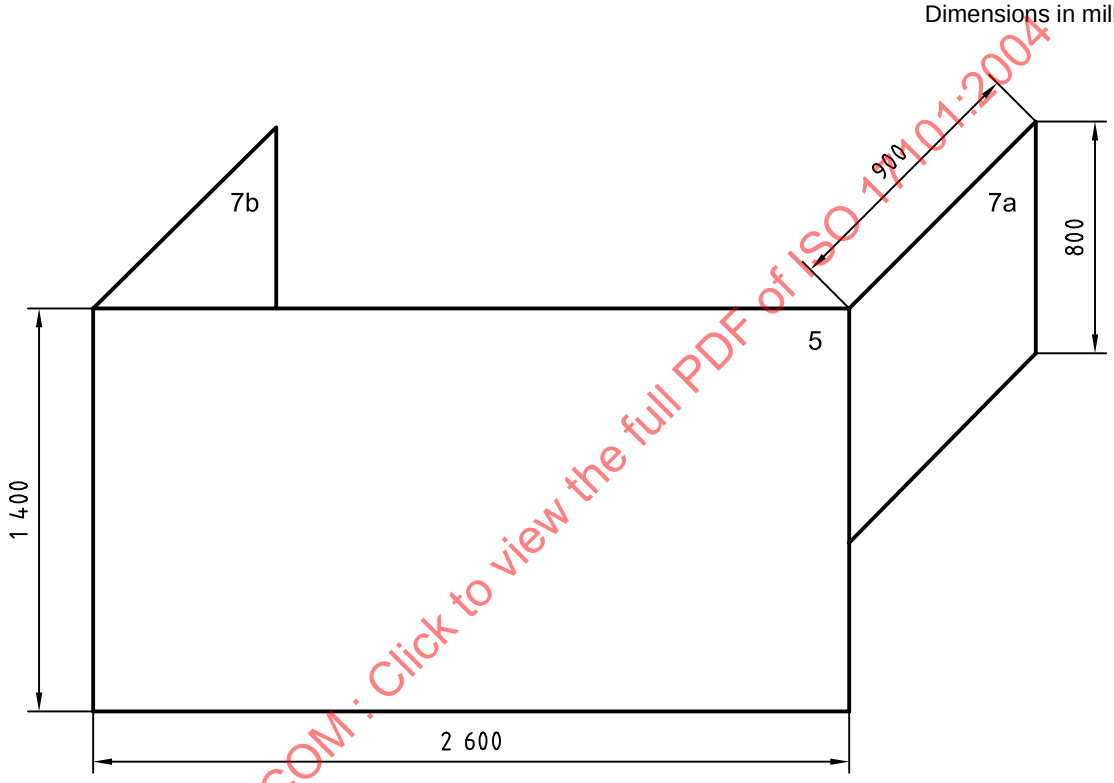


Figure 1

Table 1 — Panels 5, 7a and 7b

Dimensions in millimetres

Panel	Dimensions	Height above ground of lower edge
5	height: 1 400 width: 2 600	900
7a and 7b	height: 800 width: 900	1 500

At the rear angle of Panels 7a and 7b, there may be a slat, in contact with paper and with a maximum thickness of 3 mm.

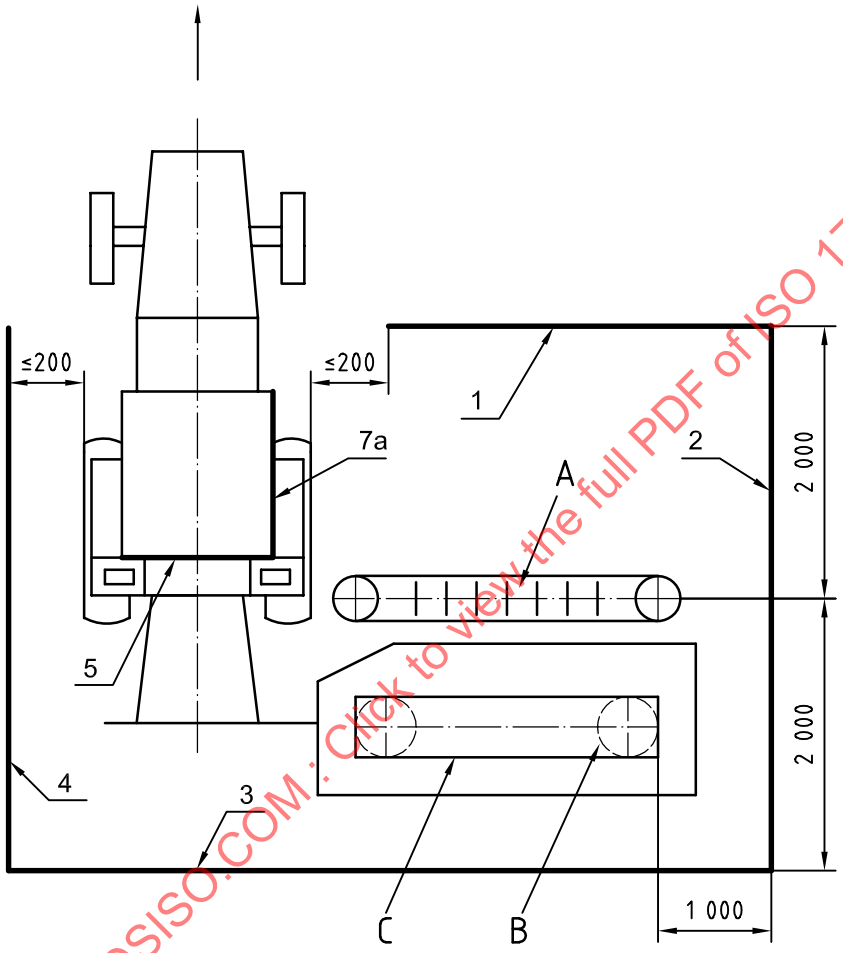
Panel 5 connects Panels 7a and 7b and shall be perpendicular to them. Panels 7a and 7b shall be parallel to the longitudinal axis of the tractor.

Panel 5 shall be located at a horizontal distance of 800 mm in front of the axis of the lower hitch points of the mower. In order to comply with the required dimensions, it may be necessary to use an intermediate frame on

which Panel 5 can be mounted and which is itself mounted between the hitch points of the tractor and the hitch points of the mower.

4.2.3 Target for offset mowers with one or several vertical axes or horizontal axis attached at rear three-point tractor linkage (see Figure 2)

Dimensions in millimetres



Key

A	test material
B	tool path (mower with vertical axle)
C	tool path (mower with horizontal axle)
———	panel (1, 2, 3, 4, 5, 7a)

Figure 2

The target is made up of six panels (Panels 1, 2, 3, 4, 5 and 7a), which shall comply with the specifications of 4.2.1 and 4.2.2.

Panels 2 and 4 shall be 4 000 mm long. If, due to mower dimensions, it is not possible to achieve this length, it may be increased. In this case, Panel 3 shall be located at a maximum horizontal distance of 200 mm from the rear of the mower in the test starting position.

Panel 2 shall be parallel to the longitudinal tractor axis and located at a distance of 1 000 mm from the nearest tool path.

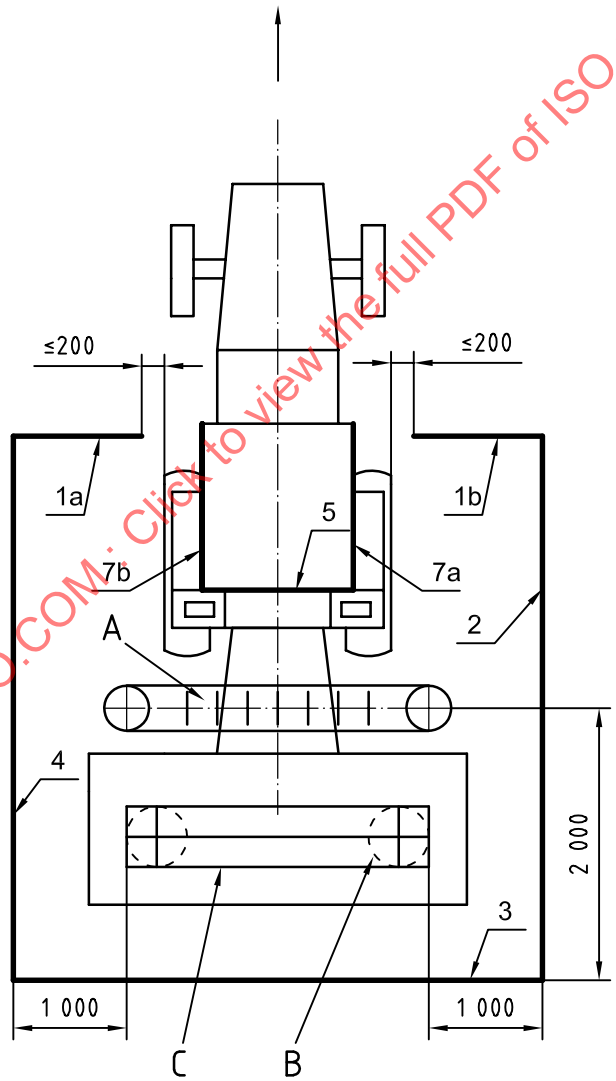
Panel 4 shall be parallel to Panel 2 and located at a distance of 2 000 mm from the nearest tool path. When, owing to the dimensions of the tractor, this distance cannot be achieved, it may be increased. In this case, Panel 4 shall be located at a maximum horizontal distance of 200 mm from the rear wheel of the tractor.

Panel 3 connects Panels 2 and 4 and shall be perpendicular to them.

Panel 1 shall be perpendicular, and immediately adjacent, to Panel 2 with the unattached end located at a maximum horizontal distance of 200 mm from a horizontal line projected forward across the outside face of the rear wheel of the tractor nearest to the mower in the test starting position.

4.2.4 Target for in-line mowers with one or several vertical axes or horizontal axis attached at rear three-point tractor linkage (see Figure 3)

Dimensions in millimetres



Key

A	test material
B	tool path (mower with vertical axle)
C	tool path (mower with horizontal axle)
———	panel (1a, 1b, 2, 3, 4, 5, 7a, 7b)

Figure 3

The target is made up of six (or eight) panels (Panels 1a, 1b, 2, 3, 4, 5 and, in some cases, 7a and 7b) which shall comply with the specifications of 4.2.1. and 4.2.2.

Panels 7a and 7b shall be used when the cutting width of the mower is more than 2 m or the mower can be operated at different working positions (right side, centre or left side of the tractor).

Panels 2 and 4 shall be 4 000 mm long. If, owing to mower dimensions, it is not possible to achieve this length, it may be increased. In this case, Panel 3 shall be located at a maximum horizontal distance of 200 mm from the rear of the mower in the test starting position.

Panel 1a shall be perpendicular, and immediately adjacent, to Panel 4, with the unattached end located at a maximum horizontal distance of 200 mm from a horizontal line projected forward across the outside face of the rear wheel of the tractor nearest to Panel 4 in the test starting position.

Panel 1b shall be perpendicular, and immediately adjacent, to Panel 2, with the unattached end located at a maximum horizontal distance of 200 mm from a horizontal line projected forward across the outside face of the rear wheel of the tractor nearest to Panel 2 in the test starting position.

Panels 2 and 4 shall be parallel to the longitudinal tractor axis and located at a distance of 1 000 mm from the nearest tool path.

Panel 3 connects Panels 2 and 4, and shall be perpendicular to them.

4.2.5 Target for front mowers or self-propelled mowers with one or several vertical axes or horizontal axis (see Figure 4)

The target is made up of six panels (Panels 1, 2, 3a, 3b, 4 and 6).

Panels 1 to 4 shall comply with the specifications of 4.2.1.

Panel 6 acts as a target at the rear side of the mower.

For mounted mowers, Panel 6 shall be located in front, on an intermediate frame located between the mower and the tractor, at a distance of 500 mm behind the lower link hitch point of the mower. The width of Panel 6 shall be equal to the working width of the mower and its height shall be 1 000 mm. An adequate opening inside Panel 6 for the passage of the PTO drive shaft is acceptable. Panel 6 shall be placed vertically, with its lower edge at a height of 200 mm from the ground.

For a self-propelled mower, Panel 3a and Panel 3b are not required.

For a self-propelled mower, Panel 6 acts as a target in the operator's zone. It shall consist of a rigid frame, on which is stretched kraft paper covering the exposed faces of the cab. This panel shall be fixed on the cab.

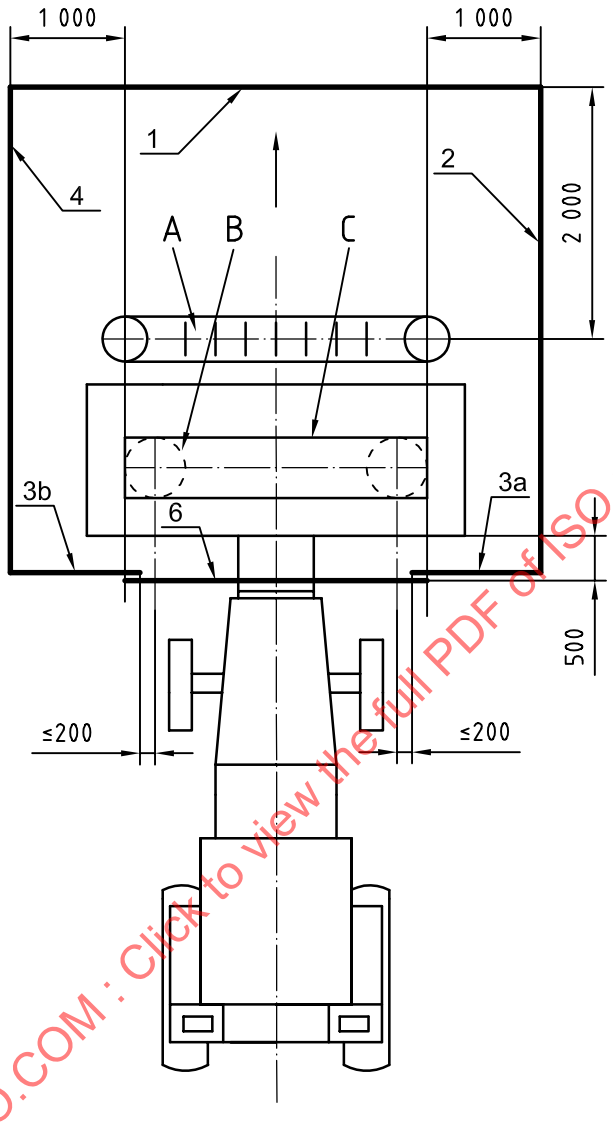
Panels 2 and 4 shall be 4 000 mm long. If, owing to mower dimensions, it is not possible to achieve this length, it may be increased. In this case, Panels 3a and 3b shall be located at a maximum horizontal distance of 200 mm from the rear of the mower in the test starting position.

Panel 6 shall be perpendicular to, and at a maximum distance of 200 mm from, Panel 3a and Panel 3b.

Panels 2 and 4 shall be parallel to the longitudinal tractor or self-propelled mower axis, and located at a distance of 1 000 mm from the nearest tool path.

Panel 1 connects Panels 2 and 4 and shall be perpendicular to them.

Dimensions in millimetres



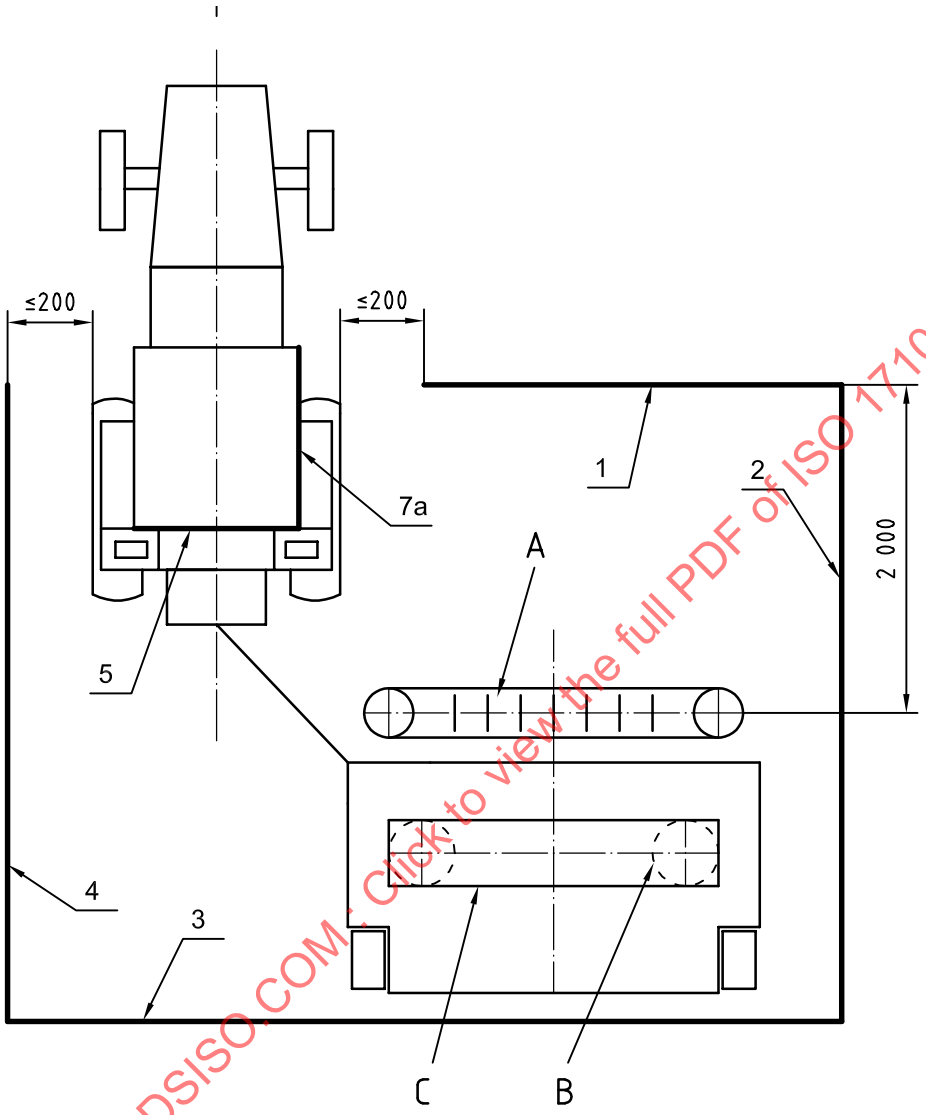
Key

A	test material
B	tool path (mower with vertical axle)
C	tool path (mower with horizontal axle)
———	panel (1, 2, 3a, 3b, 4, 6)

Figure 4

4.2.6 Target for mowers with one or several vertical axes or horizontal axis, trailed and semi-mounted
(see Figure 5)

Dimensions in millimetres



Key

A	test material
B	tool path (mower with vertical axle)
C	tool path (mower with horizontal axle)
———	panel (1, 2, 3, 4, 5, 7a)

Figure 5

The target is made up of six panels (Panels 1, 2, 3, 4, 5 and 7a), which shall comply with the specifications of 4.2.1 and 4.2.2.

Panels 2 and 4 shall be 4 000 mm long. If, due to mower dimensions, it is not possible to respect this length, it may be increased. In this case, Panel 3 shall be located at a maximum horizontal distance of 200 mm from the rear of the mower in the test starting position.

Panel 2 shall be parallel to the longitudinal tractor axis and located a distance of 1 000 mm from the nearest tool path.

Panel 4 shall be parallel to Panel 2 and shall be located at a distance of 2 000 mm from the nearest tool path. If, due to tractor dimensions, this distance cannot be achieved, it may be increased. In this case, Panel 4 shall be located at a maximum horizontal distance of 200 mm from the rear wheel of the tractor.

Panel 3 connects Panels 2 and 4 and shall be perpendicular to them.

Panel 1 shall be perpendicular to and immediately adjacent to Panel 2, with the unattached end located at a maximum horizontal distance of 200 mm from a horizontal line projected forward across the outside face of the rear wheel of the tractor nearest to Panel 2 in the starting position.

4.2.7 Target for mowers with one or several vertical axes or horizontal axis, trailed and functional either to the right side, centre or left side of tractor (see Figure 6)

The target is made up of seven panels (Panels 1, 2, 3, 4, 5, 7a and 7b), which shall comply with the specifications of 4.2.1 and 4.2.2. Figure 6 a) shows the target for the mower operated at the rightmost position and Figure 6 b) shows the target for the mower operated in the leftmost position.

Panel 2 shall be 6 000 mm long, located at a distance of 1 000 mm from the nearest tool path and parallel to the longitudinal axis of the tractor. If, due to mower dimensions, it is not possible to achieve the 6 000 mm length, it may be increased. In this case, Panel 3 shall be located at a maximum horizontal distance of 200 mm from the rear of the mower in the test starting position.

Panel 4 shall be parallel to Panel 2 and shall be located at a distance of 2 000 mm from the nearest tool path. The length of Panel 4 shall be greater than or equal to the length of Panel 2. If the required length of Panel 4 cannot be achieved with the distance 2 000 mm, then that distance may be increased. In this case, Panel 4 shall be extended towards the tractor, parallel to the longitudinal axis of the tractor, and terminate at a maximum distance of 200 mm from the drawbar of the mower or Panel 5 in the test starting position.

Panel 3 connects Panels 2 and 4 and shall be perpendicular to them.

Panel 1 shall be perpendicular to Panels 2 and 4 and connect at the end of Panel 2. The length of Panel 1 shall be adjusted so that the whole working width of the mower is covered. If, owing to the dimensions of the mower and the drawbar, it is not possible to achieve this, then Panel 1 shall be adjusted so that the drawbar stops within 200 mm (but not in contact with Panel 1) at the conclusion of the test run. If Panel 1 does not intersect the path of the drawbar, then it shall terminate at a maximum horizontal distance of 200 mm from Panel 7a.

The opening between the ends of Panels 1 and 4 is acceptable for the passage of the drawbar.

4.3 Test material

The mixture used as projectile material shall be made up by volume of

— 50 % sand,

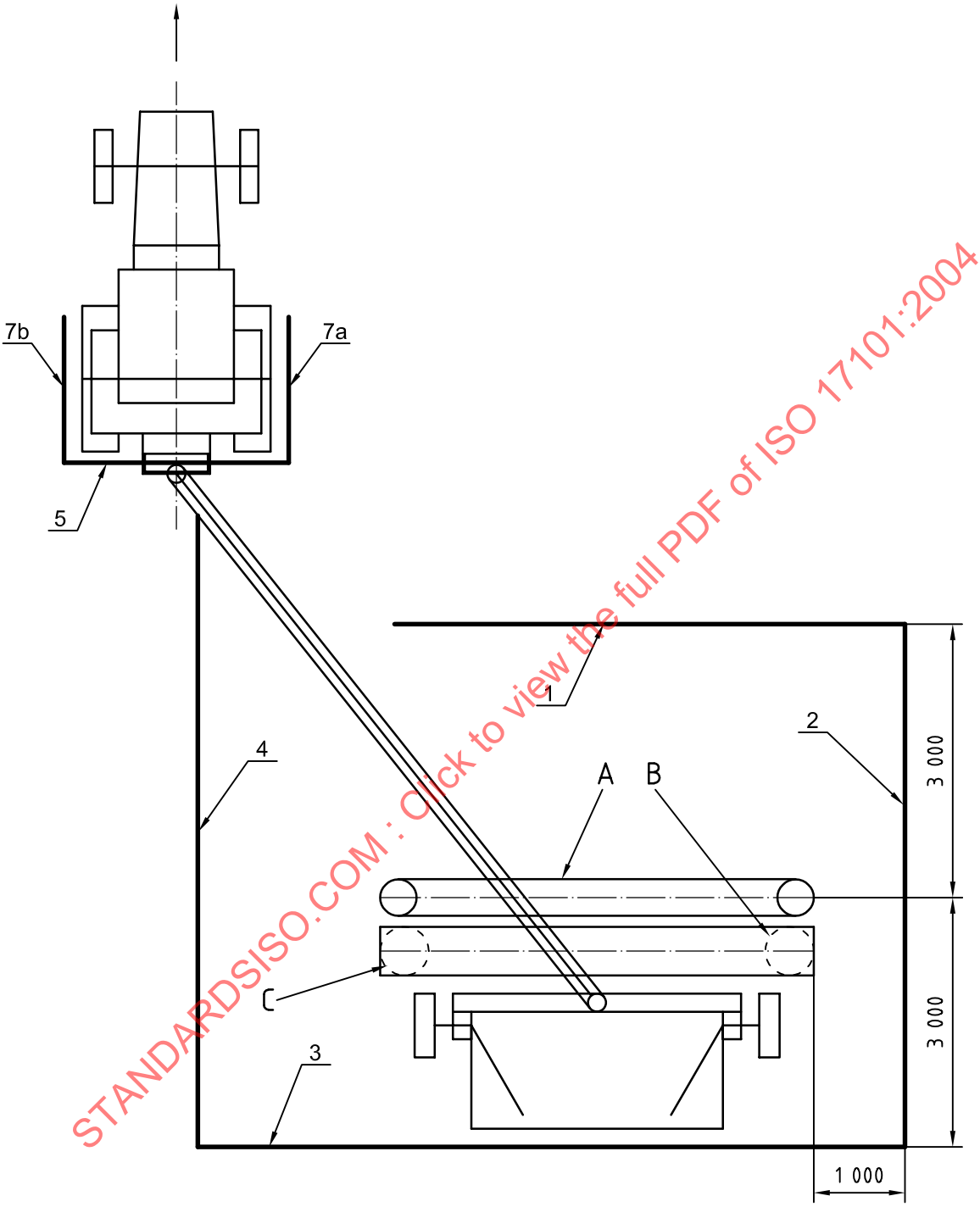
— 25 % gravel of mixture of grain size 8 mm to 16 mm (excluded), and

— 25 % gravel of mixture of grain size 16 mm to 31,5 mm (excluded).

Sand shall be humidified to reach saturation point and be kept damp during the test. The mixture shall be homogeneous.

The test report shall specify the type of test material that has been used (natural, crushed, uncrushed).

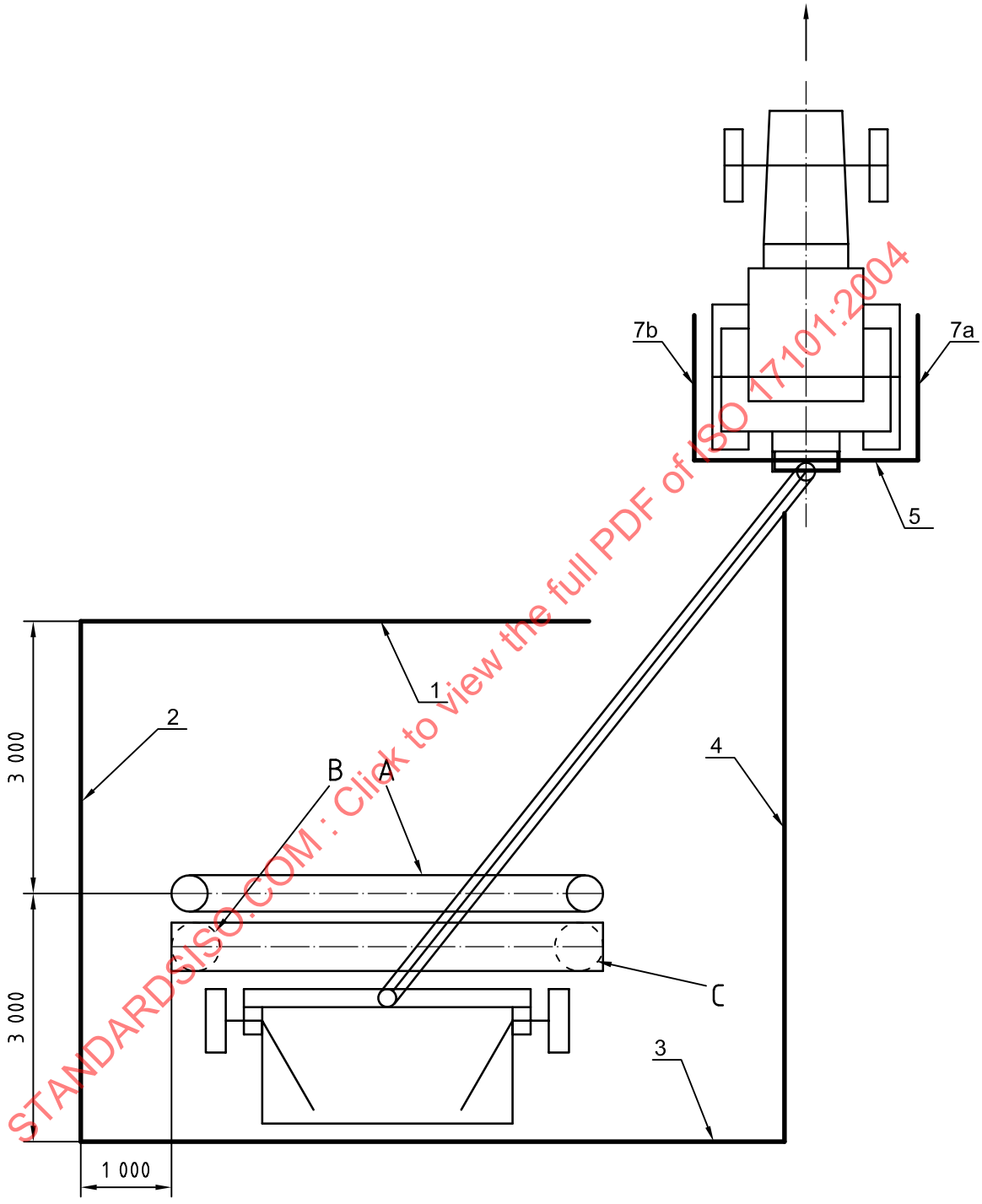
Dimensions in millimetres



a)

Figure 6

Dimensions in millimetres



b)

Key

A	test material
B	tool path (mower with vertical axle)
C	tool path (mower with horizontal axle)
━━	panel (1, 2, 3, 4, 5, 7a, 7b)

Figure 6 (*continued*)

4.4 Test method

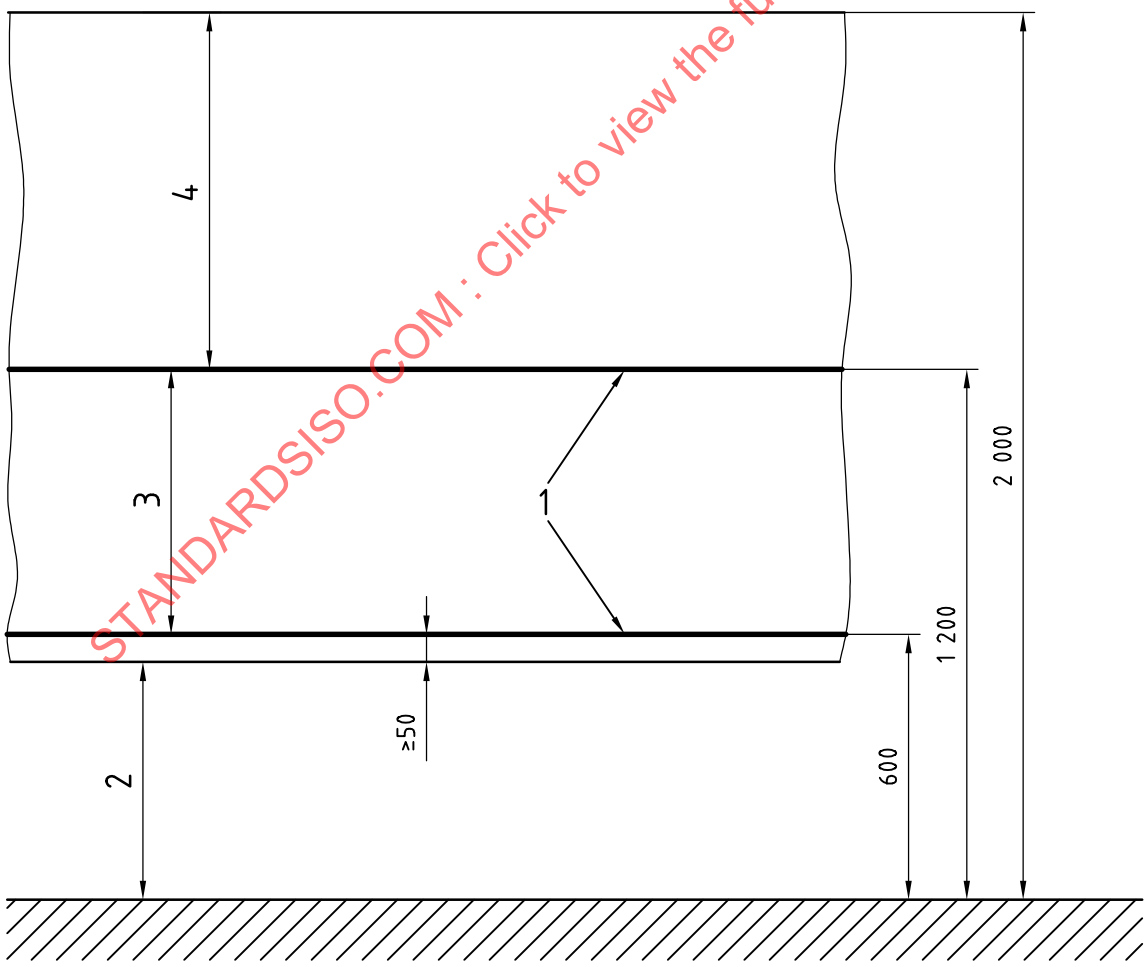
4.4.1 Reference lines

Two reference lines, traced along the target at 600 mm and 1 200 mm from ground level, shall show three zones: lower zone (between 0 mm and 600 mm), middle zone (between 600 mm and 1 200 mm) and upper zone (between 1 200 mm and 2 000 mm) [see Figure 7 a)].

If the mower dimensions require an extension of Panels 1, 2, 3 and 4, reference lines shall be moved proportionally upwards [see Figure 7 b)].

The reference lines of Panel 6 (see 4.2.5) shall be located at 500 mm and 1 000 mm from ground level and show three zones: lower zone (between 0 mm and 500 mm), middle zone (between 500 mm and 1 000 mm) and upper zone (between 1 000 mm and 1 200 mm) [see Figure 7 c)]. If Panel 6 needs to be moved towards the rear due to mower dimensions, the reference lines shall be moved proportionally upwards.

Dimensions in millimetres



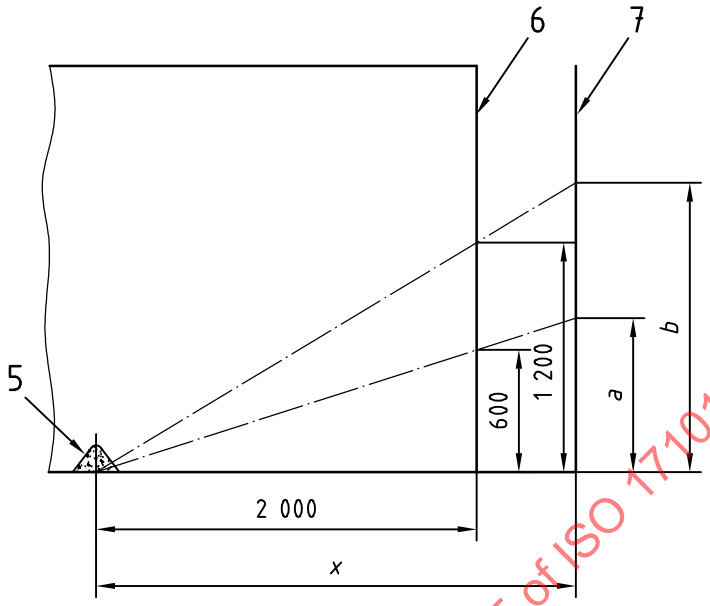
a)

Figure 7

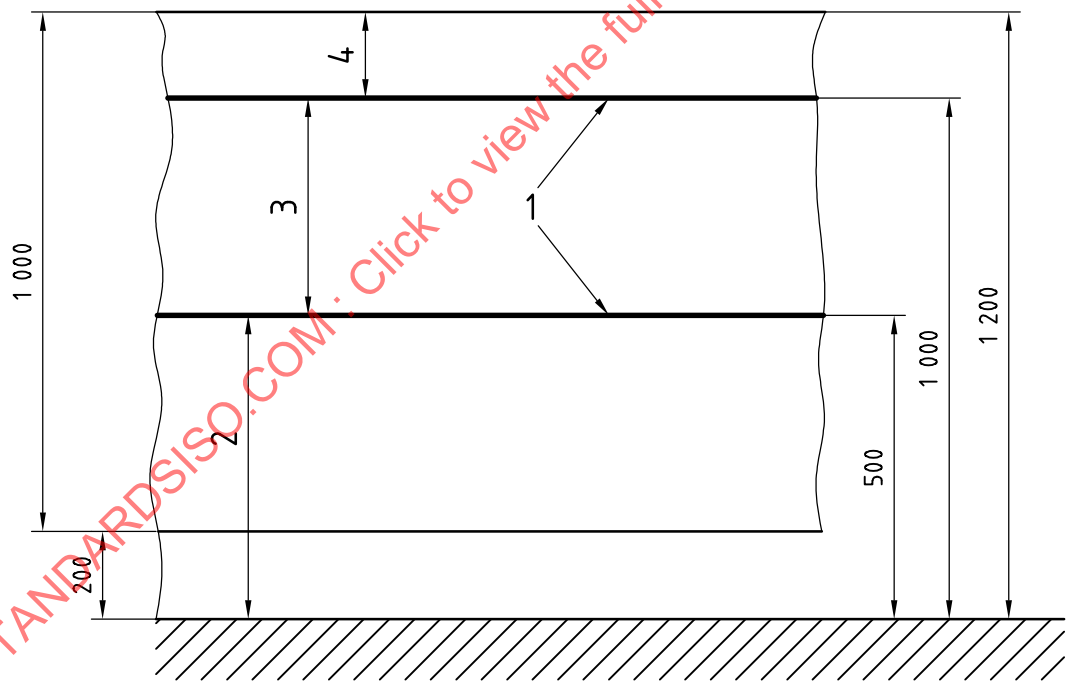
Dimensions in millimetres

$$a = \frac{600x}{2\,000}$$

$$b = \frac{1\,200x}{2\,000}$$



b)



c)

Key

1 reference lines
2 lower zone
3 middle zone
4 upper zone
5 test material
6 Panel 2
7 Panel 3

Figure 7 (*continued*)

4.4.2 **Procedure** (see Figure 8)

At the beginning of each test, the target shall not show any impact other than in the lower zone.

The test material according to 4.3 shall be placed in front of the mower, perpendicular to the forward direction, in the form of conical piles (150 ± 5) mm high. Each pile shall consist of 10 l of the material. This may be achieved, for example, by using a device as shown in Figure 9.

The test shall be carried out twice.

One test includes two runs:

— for the first run, Piles 1-3-5, etc. are put in place,

— for the second run, Piles 2-4-6, etc. are put in place.

The number of piles depends on the mower cutting width. The centre of Pile 1 shall be placed on the external limit of the tools path. The centre of Pile 2 shall be placed at a distance of 300 mm from the external limit of the tool path. The centre of the last pile shall be placed outside the tools path.

The cutting height shall be adjusted to 50 mm. If this is not possible due to the design of the mower, the cutting height shall be adjusted as near as possible to 50 mm.

All other adjustments shall be set as given in the instruction handbook for normal operation.

When the mower reaches the nominal rotational speed recommended by the manufacturer, a run is made through the test material.

For rotary mowers, the test material shall be changed after each test. For flail mowers, the test material shall be changed after each run.

After each run, impacts on the panels shall be marked in order to differentiate them.

After each run, all traces of the test material shall be removed from the ground.

4.5 Test results

The results of one test are considered to be positive when the following three conditions are satisfied:

— in the middle zone, on average, there shall be no more than two impacts per square metre;

— in the upper zone, there shall be no impact;

— in the operator's zone, there shall be no impact.

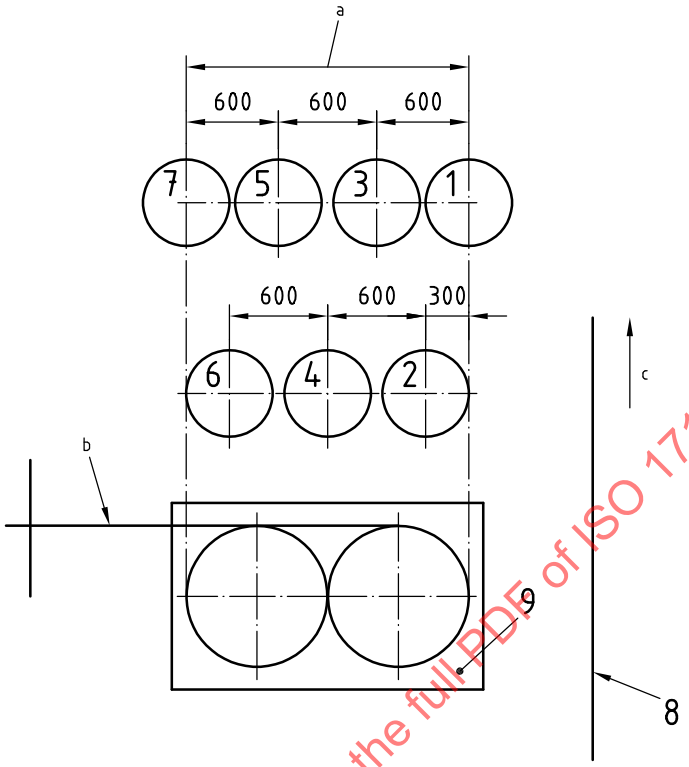
A stone which does not pass completely through the kraft paper, i.e. becomes lodged, shall not be counted as an impact. Impacts located on a reference line shall be counted in the zone beneath the reference line.

4.6 Acceptance criteria

When the results of the two tests are positive, the mower is considered to have fulfilled the thrown-object test requirement.

If the results of the two tests are different, two additional tests shall be carried out. If the results of these tests are positive, the mower is considered to have fulfilled the thrown-object test requirement.

Dimensions in millimetres



Key

1-7 conical piles
8 panel
9 upper guard

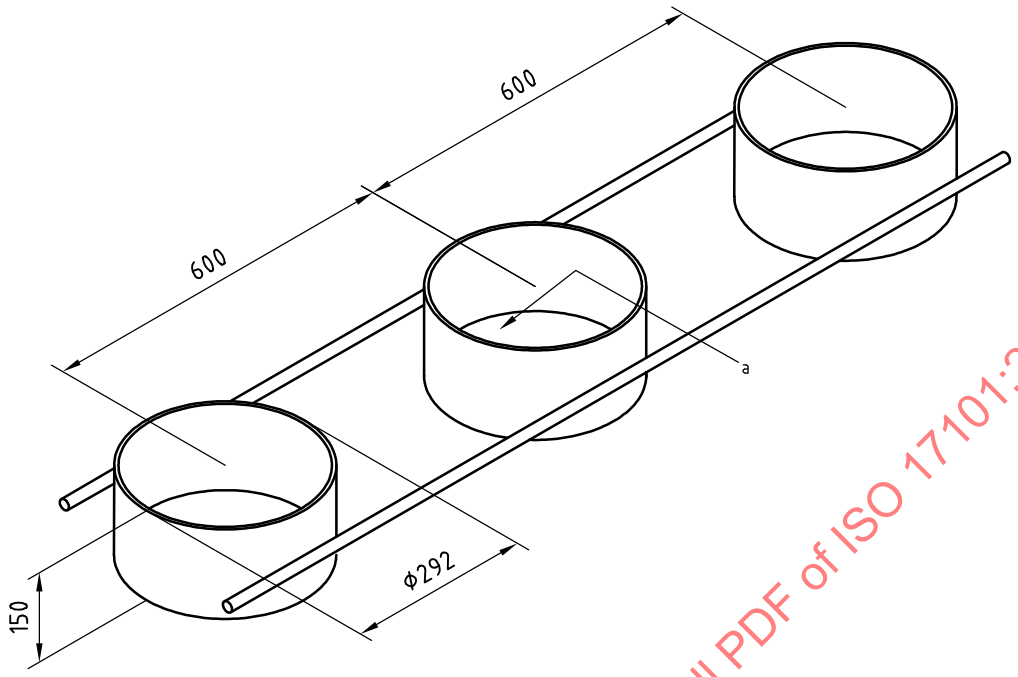
[a] Cutting width.

[b] Attachment axis.

[c] Forward direction.

Figure 8

Dimensions in millimetres



[a] Volume of 10 l.

Figure 9