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Agricultural machinery — Safety —

Part 13: Large rotary mowers

Matériel agricole — Sécurité —

Partie 13: Grandes faucheuses rotatives

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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.

ISO 4254-13 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 7, *Equipment for harvesting and conservation*.

ISO 4254 consists of the following parts, under the general title *Agricultural machinery — Safety*:

— *Part 1: General requirements*[1)]

— *Part 5: Power-driven soil-working machines*

— *Part 6: Sprayers and liquid fertilizer distributors*

— *Part 7: Combine harvesters, forage harvesters and cotton harvesters*

— *Part 8: Solid fertilizer distributors*

— *Part 9: Seed drills*

— *Part 10: Rotary tedders and rakes*

— *Part 11: Pick-up balers*

— *Part 12: Rotary disc and drum mowers and flail mowers*

— *Part 13: Large rotary mowers*

ISO 4254-2, *Tractors and machinery for agriculture and forestry — Technical means for providing safety — Part 2: Anhydrous ammonia applicators*, has been withdrawn; ISO 4254-3, *Tractors and machinery for agriculture and forestry — Technical means for providing safety — Part 3: Tractors*, has been cancelled and is to be replaced by ISO 26322 (all parts), *Tractors for agriculture and forestry — Safety*; and ISO 4254-4, *Tractors and machinery for agriculture and forestry — Technical means for providing safety —Part 4: Forestry winches,* has been cancelled and replaced by ISO 19472*, Machinery for forestry — Winches — Dimensions, performance and safety.*

1) For the purposes of global relevance, the requirements related to the guarding of moving parts for power transmission have been transferred and published as two separate Technical Specifications: ISO/TS 28923, *Agricultural machinery — Guards for moving parts of power transmission — Guard opening with tool,* and ISO/TS 28923, *Agricultural machinery — Guards for moving parts of power transmission — Guard opening without tool*.

Introduction

The structure of safety standards in the field of machinery is as follows:

— type-A standards (basis safety standards) giving basic concepts, principle for design, and general aspects that can be applied to machinery;

— type-B standards (generic safety standards) dealing with one safety aspect or one type of safeguards that can be used across a wide range of machinery;

  — type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

  — type-B2 standards on safeguards (e.g. two-hand control devices, interlocking devices, pressure-sensitive devices, guards);

— type-C standards (machinery safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This document is a type-C standard as stated in ISO 12100:2010.

When provisions of this type-C standard are different from those which are stated in type-A or -B standards, the provisions of this type-C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type-C standard.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this part of ISO 4254. These hazards are specific to large rotary mowers.

Significant hazards that are common to all agricultural machines (self-propelled ride-on, mounted, semi-mounted and trailed) are dealt with in ISO 4254-1.

Agricultural machinery — Safety —

Part 13: Large rotary mowers

1 Scope

This part of ISO 4254, when used together with ISO 4254-1, specifies the safety requirements and their verification for the design and construction of towed, semi-mounted, or mounted large rotary mowers with single or multiple cutting elements which have a cutting diameter of 1 000 mm or greater for any single cutting element assembly, mounted on a propelling tractor or machine, intended for agricultural mowing equipment and designed for shredding crop residue, grass and small brush by impact. It describes methods for the elimination or reduction of hazards arising from the intended use and reasonable foreseeable misuse of these machines by one person (the operator) in the course of normal operation and service. In addition, it specifies the type of information on safe working practices to be provided by the manufacturer.

NOTE 1 These machines can be used for shredding grass. When used outside agriculture, additional requirements not specified in this part of ISO 4254 can be applicable.

This part of ISO 4254 is not applicable to:

— rotary disc mowers, rotary drum mowers, and flail mowers designed for forage crop harvesting as covered by ISO 4254-12;

— arm-type large rotary mowers.

— pedestrian-controlled motor mowers;

— lawn mowers covered by ISO 5395.

When requirements of this part of ISO 4254 are different from those which are stated in ISO 4254-1, the requirements of this part of ISO 4254 take precedence over the provisions of ISO 4254-1 for machines that have been designed and built according to the provisions of this part of ISO 4254.

This part of ISO 4254, taken together with ISO 4254-1, deals with all the significant hazards, hazardous situations and events relevant to large rotary mowers used as intended and under the conditions foreseen by the manufacturer. (A list of significant hazards is provided in Annex A.)

NOTE 2 Example illustrations of two mowers (a rigid-deck large rotary mower and a trail-type multi-section foldable-wing large rotary mower) dealt with in this part of ISO 4254 are shown in C.1.

NOTE 3 Example illustrations of mowers not dealt with in this part of ISO 4254 are shown in C.2.

This part of ISO 4254 is not applicable to environmental hazards, road safety, electromagnetic compatibility, vibration and hazards related to moving parts for power transmission. It is also not applicable to hazards related to maintenance or repairs to be carried out by professional service personnel.

NOTE 4 ISO 14982 specifies test methods and acceptance criteria for evaluating the electromagnetic compatibility of all kinds of mobile agricultural machinery.

This part of ISO 4254 is not applicable to large rotary mowers which are manufactured before the date of publication of this document by ISO.

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 148-1:2009, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 730:2009, *Agricultural wheeled tractors — Rear-mounted three-point linkage — Categories 1N, 1, 2N, 2, 3N, 3 and 4N, 4*

ISO 3600:1996, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Operator's manual — Content and presentation*

ISO 4254-1, *Agricultural machinery — Safety — Part 1: General requirements*

ISO 4254-12:2012, *Agricultural machinery — Safety — Part 12: Rotary disc and drum mowers and flail mowers*

ISO 5673-1:2005, *Agricultural tractors and machinery — Power take-off drive shafts and power-input connection — Part 1: General manufacturing and safety requirements*

ISO 6508-1:2005, *Metallic materials — Rockwell hardness test — Part 1: Test methods (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 11684:1995, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Safety signs and hazard pictorials — General principles*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4254-1, ISO 4254-12, ISO 12100, and the following apply.

3.1 Rotary mowers

3.1.1
large rotary mower
mower, which may include mulching, with single or multiple cutting-element assemblies which have a cutting diameter of 1 000 mm or greater powered by a propelling machine in which one or more functional components rotate(s) about a vertical axis to cut or shear crop residue, grass and small brush by impact

3.1.1.1
rigid-deck large rotary mowers
large rotary mowers with single or multiple cutting-element assemblies on a common rigid deck

3.1.1.2
multi-section, foldable-wing large rotary mowers
large rotary mowers with multiple cutting-element assemblies and with a single wing or multiple wings that are capable of following the terrain

NOTE The wings are foldable for transport and to clear obstacles, but are intended to operate only with all sections in close proximity to the ground surface when mowing.

3.2 Cutting elements

3.2.1
cutting element
mower tool designed to cut or shear crop residue, grass and small brush by impact

NOTE 1 This can include mulching.

NOTE 2 Knives, blades and sickles are common cutting elements.

3.2.2
cutting-element lot
determined by the cutting-element manufacturer, traceable to the mill heat and manufacturing process

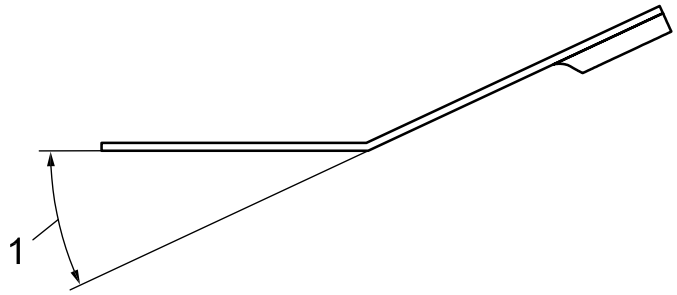
NOTE A new cutting-element lot is established when there is a change in the heat of steel.

3.2.3
heat of steel
metal produced by a single cycle of a batch-melting process

NOTE The heat analysis is obtained from a small sample of molten metal from the ladle or furnace. The sample is allowed to solidify, then, a spectrochemical analysis is performed. If the chemical analysis is within specification, the balance of molten metal can be cast as one heat treat number. Typically, heats are over 50 t with many mills running heats about 300 t.

3.2.4
permanent set angle
angle formed by the back of the cutting element or test coupon in the area of the bend after removal from the cutting-element bend-test fixture

See Figure 1.



Key
1 permanent set angle

Figure 1 — Permanent set angle of cutting element after the bend test

3.2.5
total deflection angle
sum of the permanent set angle and the estimated spring back

NOTE This angle is for ease of fixture design and not acceptance criteria. (See 5.8, Table 1.)

3.2.6
test coupon
flat specimen with the same cross-section and of the same cutting-element lot as the cutting elements it represents

3.3 Thrown-object testing

3.3.1
normal operating position
space within the operator zone occupied by the operator while operating the mower

NOTE 1 The operator is sitting on the seat of the propelling machine with hands on the steering controls and feet on controls or areas provided for foot placement.

NOTE 2 For examples of target configurations, see Figures 7 and 8.

3.3.2
projectile impact
rupture of the front layer but not the back layer of the target material by a test projectile

3.3.3
projectile hit
rupture of all layers of the target material by a test projectile.

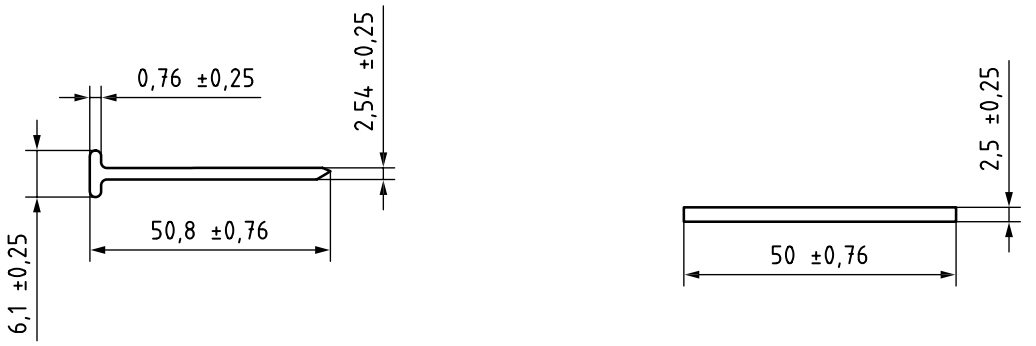
3.3.4
target material
material used for the thrown-object test

NOTE See Annex D.

3.3.5
test projectile
common steel nail or steel wire with the approximate dimensions shown in Figure 2

NOTE The wire projectile should be capable of bending 180° with no cracks or breaks.

Dimensions in millimetres



a) Criteria for nail projectile **b) Criteria for wire projectile**

Figure 2 — Test projectile

3.3.6
operator zone
space within the target area in which operator is seated in the normal operating position on the propelling machine while operating the mower

See Figures 7 and 8.

3.3.7
target walls
arrangement of target material and supports

See the cross-section in Figure 9 with the configuration shown in Figures 7 and 8.

4 Safety requirements and/or protective measures

4.1 General

4.1.1 Machinery shall comply with the safety requirements and/or protective measures of Clauses 4 and 5. Machinery shall meet the test requirements and acceptance criteria as specified in 5.3, 5.4 and 5.5. In addition, the machine shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

4.1.2 Unless otherwise specified in this part of ISO 4254, the machine shall comply with the requirements of ISO 4254-1 and with Tables 1, 3, 4 and 6 of ISO 13857:2008.

4.1.3 The maximum tip speed for the cutting elements shall not exceed 96,5 m/s.

4.2 Protection against thrown objects

The mower shall be designed to minimize thrown objects so that tests defined in 5.6 are satisfied.

Protective devices (e.g. protective skirts, chains or rubber strips) may be used.

4.3 Protection against inadvertent contact with the cutting elements

4.3.1 The mower shall be designed or guarded in such a way that any inadvertent contact with the cutting elements at the sides and on the top is prevented when the mower is operated according to the manufacturer's instructions in the operator's manual.

4.3.2 The mower shall be designed or guarded in such a way that any inadvertent contact with the cutting elements at the front (normally the intake) and at the rear (normally the exhaust) is minimized when the mower is operated according to the manufacturer's instructions in the operator's manual.

4.3.3 The top protection shall be achieved by a rigid guard or by the device used to prevent thrown-objects.

4.3.4 At the sides, at the front (intake area) and at the rear (exhaust area), there shall be protection by rigid or flexible guard; the device used to minimize projections; or a combination of these devices so when tested according to 5.2, there will be no contact between the test probe and the cutting element or the cutting-element assembly.

4.4 Rotating power component guarding and shielding

4.4.1 The mower shall be designed or guarded in such a way that any inadvertent contact with the rotating power component is minimized when the mower is operated according to the manufacturer's instructions in the operator's manual.

4.4.2 Drive shafts and their connecting points shall be guarded in accordance with ISO 5673-1:2005. Other moving parts for power transmission shall be guarded against contact to comply with the safety distances of Tables 1, 3, 4 and 6 of ISO 13857:2008.

4.5 Overrunning clutch or freewheel device

4.5.1 Mowers equipped with an overrunning clutch or a free-wheel device shall be guarded as described in 4.4.

4.5.2 Rotating elements that can be inadvertently contacted shall have evidence of rotation and a suitable safety sign to warn of the hazard.

4.5.3 There shall be instructions in the instruction handbook stating to wait until all movement is stopped before servicing.

4.6 Attachment means for trailed mowers

Any trailed unit shall be designed in such a manner that there is a remaining downward load of 3 % of the total weight, or at least 500 N on the hitch point, in order to avoid an uncontrolled upward movement when it is disconnected.

4.7 Attachment means for mounted and semi-mounted mowers

Three-point hitch-mounted and semi-mounted mowers shall be attached to the propelling machine by means of one or a combination of the standardized attachment methods as defined in ISO 730:2009.

4.8 Cutting elements

4.8.1 Cutting-element identification and marking

Every cutting element shall include the following information, stamped or otherwise permanently affixed, in a non-critical-stress area that will be readable on a used cutting element:

— cutting-element manufacturer identification;

— date of manufacture or lot number or production run number.

4.8.2 Hardness

The Rockwell hardness value shall be at least 38 HRC in accordance with ISO 6508-1:2005.

4.8.3 Charpy impact strength

The cutting element shall have an average Charpy value of at least 20,3 J when tested according to 5.7.

4.8.4 Bending

The cutting element shall not have any cracks visible to the naked eye after being submitted to the bend test in 5.8.

4.9 Impact of the cutting means assemblies

4.9.1 The mower shall withstand a sudden impact to the cutting means.

4.9.2 Compliance is checked by conducting the test in 5.3 without loss of any part of the mower or failure of any mower component, excluding portions of the cutting element with a mass of 30 g or less, in a manner that can be hazardous to the operator or bystanders. There shall be no punctures made in the target walls by any part of the mower or cutting elements.

4.10 Unbalance

The mower shall withstand unbalanced cutting means. No part of the mower shall loosen, break up or be ejected, if they are necessary for compliance with the requirements of this part of ISO 4254, nor shall any other component or part of the mower, puncture all the target walls, when tested in accordance with 5.4.

4.11 Structural integrity

4.11.1 The cutting means assemblies shall withstand the impact stresses to which they are subjected when used.

4.11.2 The top or side deck shall be designed with a mild carbon steel material of 3 mm thickness or more.

4.11.3 For other materials, and for materials < 3 mm thick, compliance is checked by conducting the test in 5.5. There shall be no break-through of test rods through the cutting-element housing or cutting-element enclosure and there shall be no failure of other shielding.

5 Verification of safety requirements and/or measures

5.1 Test conditions — General

5.1.1 Assembly

5.1.1.1 The mower shall be completely assembled and mounted on, or attached to, its propelling machine except for tests where mounting on a suitable test fixture is designated; or, where necessary, the mower unit may be tested while separated from the power unit and power be provided by some other means. However, the speeds shall be the same as those attained when on, or attached to, the propelling machine, and the fixed parts of the mower which extend into the trajectory area shall also be duplicated as nearly as practicable.

5.1.1.2 Adjustable guards shall be set in the most open position for the test.

5.1.2 Mower position

The mower shall rest on a horizontal surface that is flat within 2°.

Means to restrain the mower in position during the test should be employed, if necessary. Resilient restraints (e.g. chains) may be used.

5.1.3 Test speed

Except for static tests, the mower shall be operated at the highest operating speed recommended in the operator's manual.

5.1.4 Number of tests

All tests shall be run once for each cutting-element assembly of the mower, except where otherwise herein designated. A new mower can be used for each test, except for the structural integrity test and the thrown-object test.

5.2 Foot-probe test

5.2.1 Foot-probe test equipment

Foot-probe test equipment shall be constructed in accordance with Figure 3.

Dimensions in millimetres

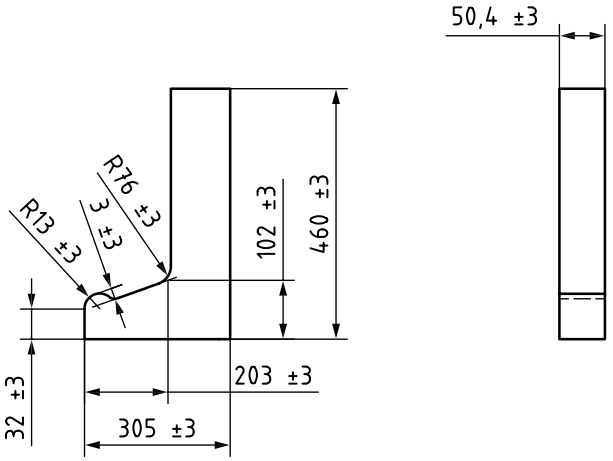
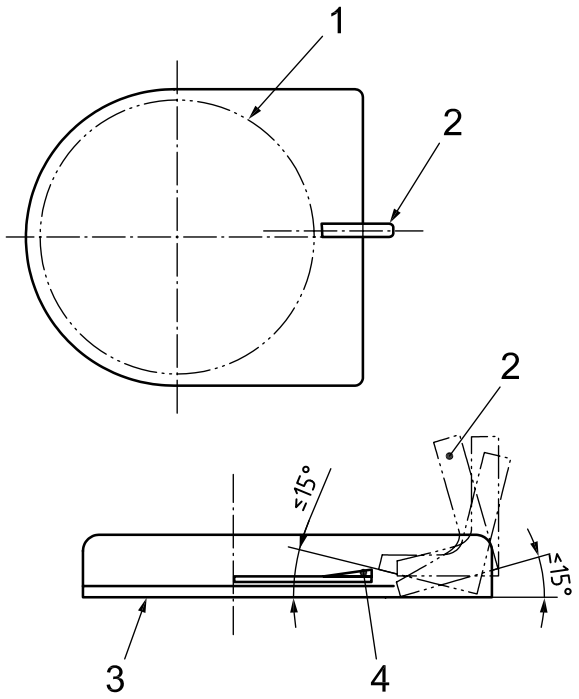


Figure 3 — Foot-probe test equipment

Dimensions in millimetres



Key

1 cutting-element tip circle
2 foot probe
3 ground level
4 mower cutting element

Figure 4 — Foot-probe test

5.2.2 Test conditions

5.2.2.1 The test shall be conducted under static conditions on a flat surface attached to a tractor.

5.2.2.2 The cutting element shall be clamped to the cutting-element holder simulating the maximum cutting-tip diameter in the cutting plane.

5.2.2.3 Components of the mowers or machine, or both, such as frames, etc., can be considered as part of the cutting-element enclosure for the purpose of this test.

5.2.3 Test procedure

5.2.3.1 The foot probe shall be introduced with the lower part horizontally to the mower and be held with the upper part in a vertical plane and rotated horizontally and vertically a maximum of 15° to either side of the centreline while simultaneously being raised and lowered as shown in Figure 4.

5.2.3.2 The probe shall be applied until a horizontal force of 110 N ± 10 is reached, or until any portion of the cutting means enclosure lifts from its original position, or until contact is made with the cutting means path, whichever occurs first. If the cutting-element path height is different for different cutting-element speeds or cutting-element options, the test shall include the two cutting-element-height extremes.

5.2.4 Test acceptance

The requirement that there be no contact between the probe and the cutting element or cutting-element assemblies shall be verified by slow manual rotation of the cutting elements with all power off.

5.3 Impact test for cutting-element assemblies

5.3.1 Test equipment

5.3.1.1 The mower shall be completely encircled at the time of test by a wall of target material, in accordance with 3.3.7 and tested to Annex D, resting on the floor. Testing can be performed on sand, soil or concrete.

5.3.1.2 The target wall shall be positioned in accordance with Figures 7, 8 and 9.

5.3.1.3 A protective barrier shall be provided to protect the operator.

5.3.1.4 The test rod shall be 51 mm ± 1 mm diameter, medium-carbon steel with a tensile strength of 1 050 MPa ± 50 MPa.

5.3.1.5 The test fixture shall be constructed as shown in Figure 5.

5.3.2 Test conditions

5.3.2.1 The mower shall be adjusted for approximately 75 mm static height of cut or the cutting height setting closest to 75 mm.

5.3.2.2 The mower shall be set to run at a speed as specified in 5.1.3.

5.3.3 Test procedure

5.3.3.1 The mower shall be positioned over a fixture that holds the test rod stationary and dropped onto the test rod such that the cutting element makes positive contact with the rod.

NOTE Examples of the construction and configuration of this fixture are shown in Figures 5 and 6.

5.3.3.2 The mower shall be dropped fast enough so that mower speed is not materially reduced by glancing contact before solid contact is made.

NOTE Modifications to the mowers lift mechanism can be made to increase the mowers drop velocity.

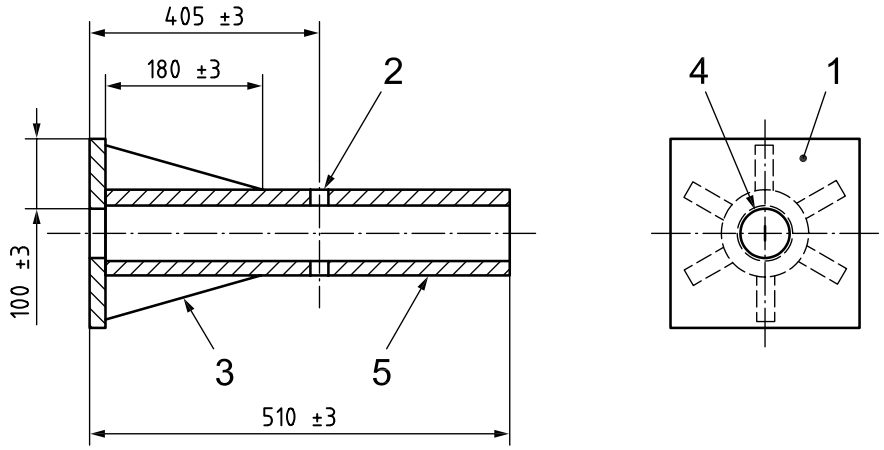
5.3.3.3 The mower shall be dropped onto the rod and allowed to continue for at least 2 s before disengaging the power or lifting the mower.

5.3.3.4 The test shall be conducted once in each of the two following manners.

a) The mower is positioned so that the contact between the cutting element and the rod is at a point as close to the cutting-element holder connection as possible. If the cutting element has a bent configuration such that it is raised close to the cutting-element holder, then the rod shall be elevated to ensure adequate cutting-element contact.

b) The mower is positioned so that the contact between the cutting element and centreline of the rod is approximately 25 mm from the outer tip of the cutting element.

Dimensions in millimetres

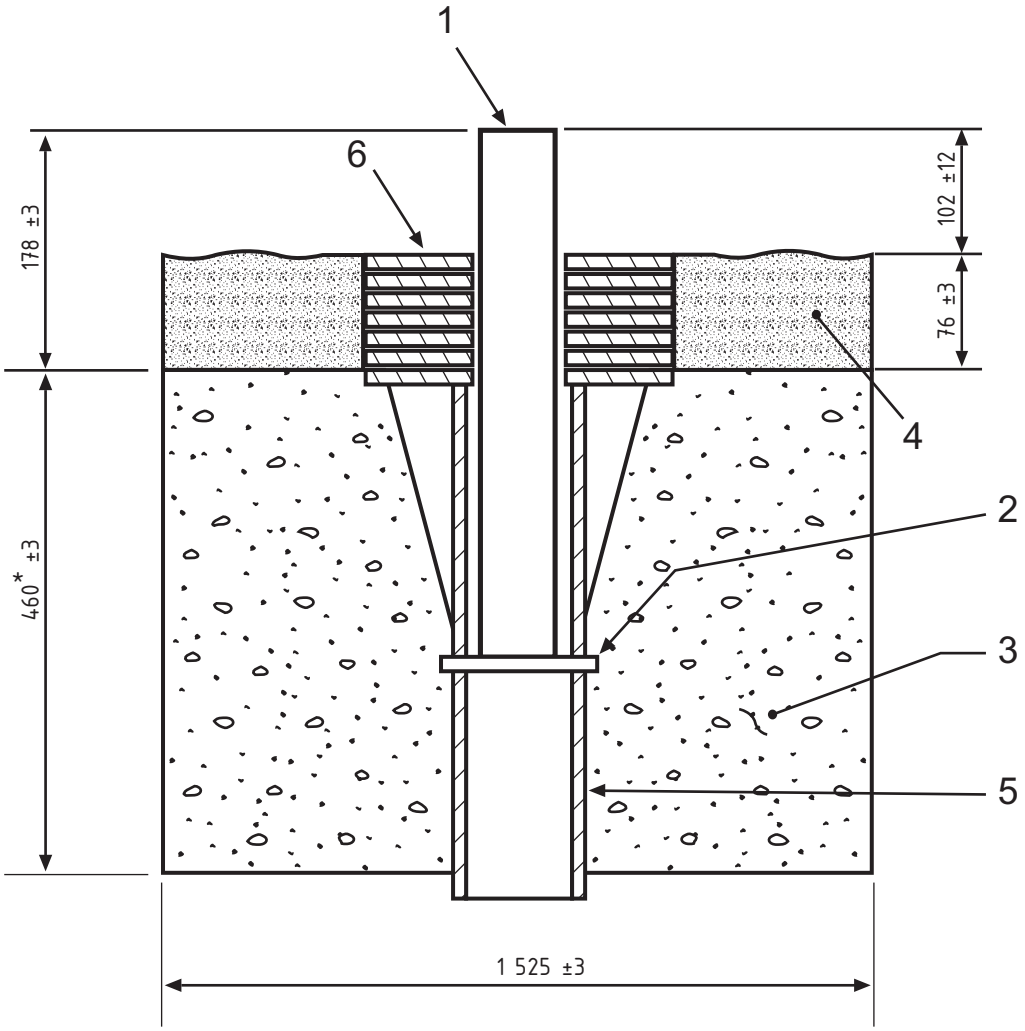


Key

1 300 mm × 300 mm square × 12,7 mm steel plate
2 16 mm diameter through-hole
3 10 mm steel gusset welded to pipe and plate (6 places)
4 54 mm ± 3 mm diameter hole
5 63 mm ASA Schedule 80 steel pipe welded to plate

Figure 5 — Cutting-element test fixture construction

Dimensions in millimetres



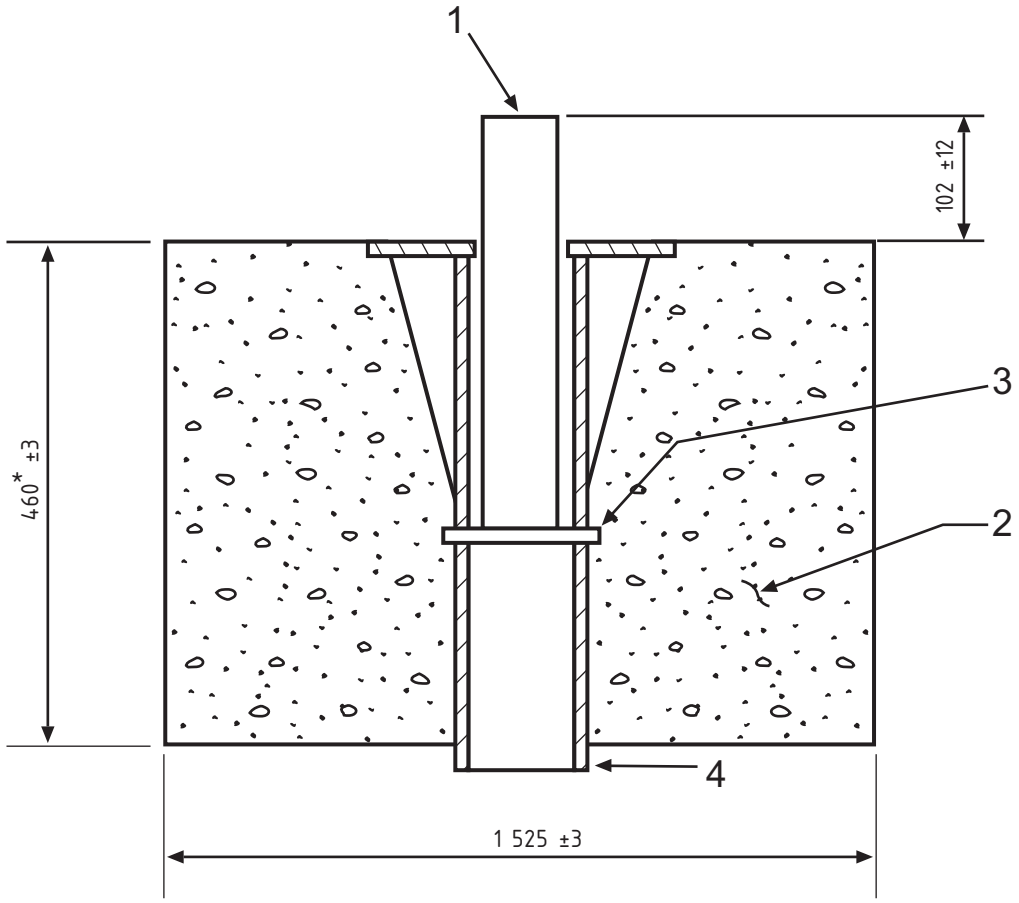
Key

1 test rod
2 16 mm bolt or pin
3 1 525 mm diameter concrete-cured for a minimum of 4 days
4 sand (see 5.6.2.5 and 5.6.2.6 for details)
5 test fixture (see Figure 5)
6 300 mm × 300 mm square × 12,7 mm steel plate with a 54 mm diameter through-hole

* nominal dimension

a) Example of a cutting-element impact test fixture configuration surrounded by sand

Dimensions in millimetres



Key

1 test rod
2 1 525 mm diameter concrete-cured for a minimum of 4 days
3 16 mm bolt or pin
4 test fixture (see Figure 5)

* nominal dimension

b) Example of a cutting-element impact test fixture configuration in concrete

Figure 6 — Examples of cutting-element impact test fixture configurations

5.3.4 Acceptance criteria

The test shall be completed without loss of any part of the mower or failure of any mower component, excluding portions of the cutting element with a mass of 30 g or less, in a manner that could be hazardous to the operator or bystanders. Any target puncture by any part of the mower or any part of the cutting elements weighing 30 g or more shall constitute failure.

5.4 Unbalance test for the cutting element

5.4.1 Test equipment

5.4.1.1 The mower shall be completely encircled at the time of test by a wall of target material, in accordance with 3.3.7 and tested according to the specifications in Annex D, resting on the floor. Testing can be performed on sand, soil or concrete.

5.4.1.2 The target wall shall be positioned in accordance with Figures 7, 8 and 9.

5.4.1.3 A protective barrier shall be provided to protect the operator.

5.4.2 Test conditions — Multi-piece cutting-element construction

For each spindle assembly, remove the cutting elements and fasteners from one end of the cutting-element carrier assembly.

5.4.3 Test conditions — One-piece cutting-element construction

For each spindle assembly, remove the bevelled or sharpened length of the cutting element on one end only.

5.4.4 Test procedure

The mower shall be run for 2 min before shutoff. For multi-spindle mowers, the test can be conducted on all spindles concurrently.

5.4.5 Test acceptance

The requirements in 4.9 are met if there is no loss of any part of the unit or failure of any component in a manner that could be hazardous to the operator or bystanders, or if a puncture penetrates all the layers of the target walls.

5.5 Structural integrity test

5.5.1 Test equipment

5.5.1.1 Target walls shall be positioned around the mower as specified in Figures 7, 8 and 9 and constructed with a material which meets the penetration test specification in Annex D.

5.5.1.2 Use low-carbon hot-finish test rods with the following dimensions.

— For mowers with cutting elements with a tip-circle diameter up to 1 220 mm, use test rods with the following dimensions: 9,5 mm diameter and 50,8 mm long.

— For mowers with one or more cutting elements with a tip-circle diameter over 1 220 mm, use test rods with the following dimensions: 12,7 mm diameter and 50,8 mm long.

5.5.1.3 Rod lengths are to be $\pm$ 3 mm.

5.5.2 Test conditions

5.5.2.1 The mower shall be positioned so the cutting edge of a stationary cutting element is 305 mm $\pm$ 13 mm above the sand base.

5.5.2.2 When supports are necessary to position the mower such that the cutting edge of the cutting element is 305 mm above the sand base, the supports shall consist of round steel bars or tubing no larger than 40 mm in diameter, and no more than six shall be used per frame unit. The supports shall be placed, as necessary, under wheels, side skids, or other structural components which normally rest on the ground if the mower were at the minimum cutting height. If additional supports are needed, they shall be located at least 150 mm outside the cutting-element enclosure.

NOTE The mower can also be supported from above.

5.5.3 Test procedure

5.5.3.1 The test shall consist of vertical downward introduction of test rods inserted into each of eight equally spaced holes for each cutting-element assembly in accordance with Figure 10.

5.5.3.2 The test rods shall be introduced through the tube and funnel arrangement as specified by Figure 11 or through a similar arrangement with air or mechanical assist.

5.5.3.3 A sufficient number of test rods shall be dropped into each of the eight positions so that a cutting-element contacts at least 12 test rods per position.

WARNING — Test rods can puncture the test enclosure as noted in Figures 7, 8 and 9. Additional protection, such as straw bales or steel sheets, around the exterior of the target enclosure from the cutting-element line to the sand should be in place.

5.5.4 Test acceptance

The test rods shall not break through the cutting-element housing or cutting-element enclosure but can escape through deflector-type shields such as chain shielding as long as no failure is caused to shielding.

5.6 Thrown-object test

The thrown-object test shall only be conducted after the structural integrity test, if required, has been completed and has met the requirements of 5.5.4.

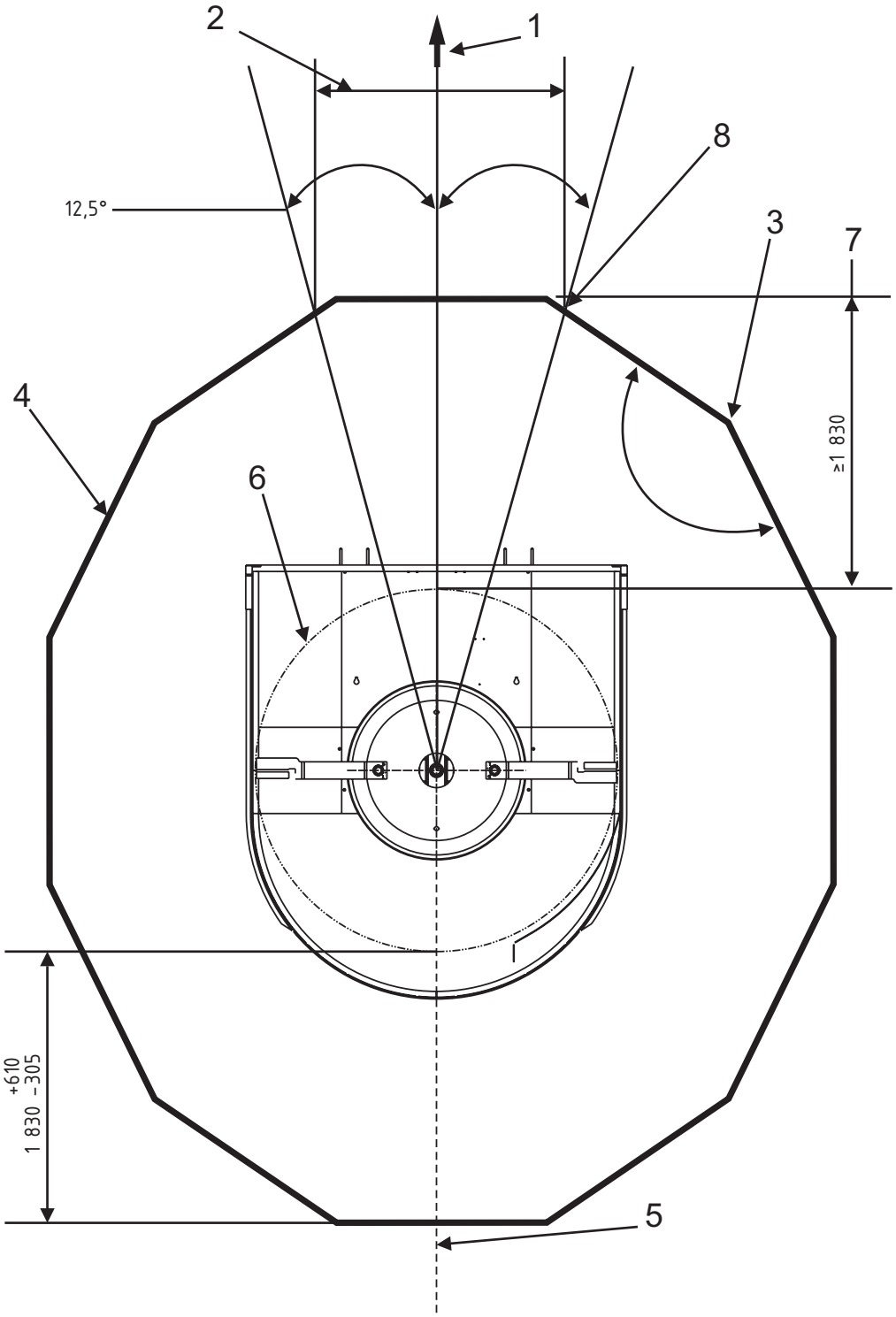
5.6.1 Operator zone

5.6.1.1 The operator-zone height shall be 610 mm above the cutting-element line to the top of the target wall.

5.6.1.2 The operator-zone width shall be defined by 25° included angle projected to the target wall and shall not exceed 2 000 mm.

5.6.1.3 For multiple spindle mowers, the operator-zone focal point shall be on a line, in the forward direction of travel, midway between the hitch pins, or on the centreline of the tongue hole.

Dimensions in millimetres

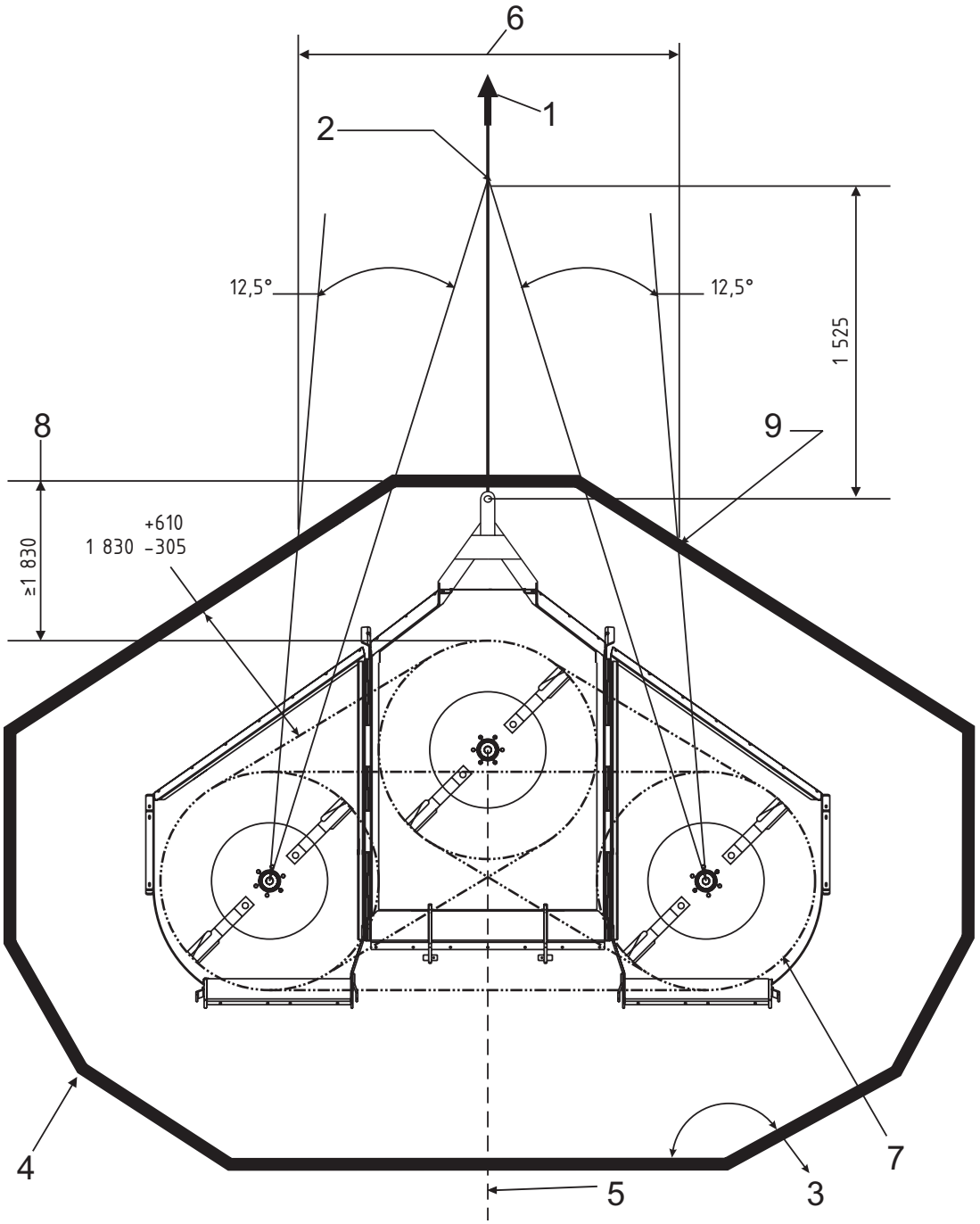


Key

1 direction of forward travel
2 width of the operator zone
3 125° (min.) angle between optional flat panels
4 target wall
5 mower to be as centrally located as possible
6 cutting-element tip circle
7 minimum wall distance from blade tip circle in operator zone
8 intersection points of the projected lines and the wall

Figure 7 — Target wall configuration and operator zone for a single spindle mower

Dimensions in millimetres

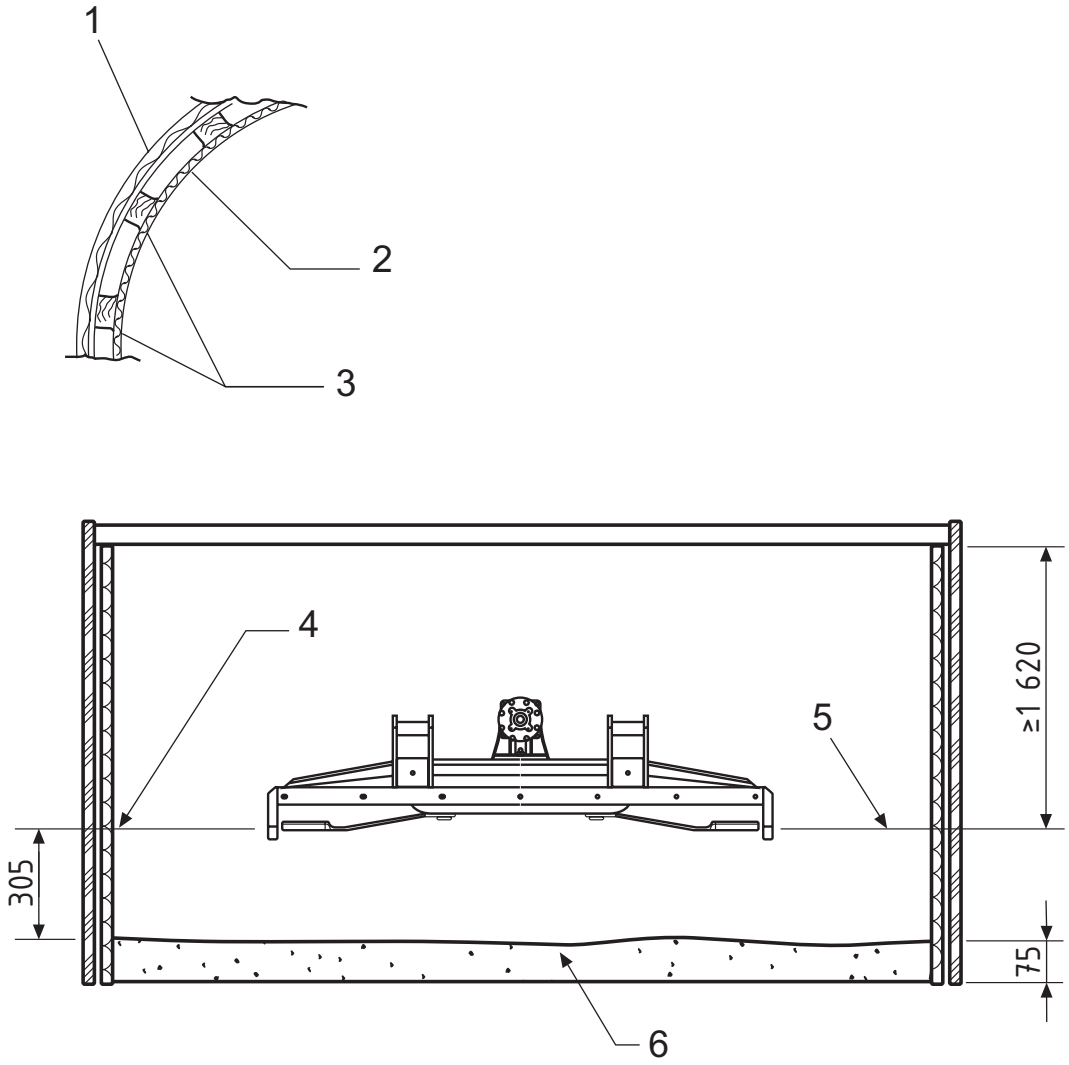


Key

1 direction of forward travel
2 operator-zone focal point
3 125° (min.) angle between optional flat panels
4 target wall
5 mower to be as centrally located as possible
6 width of the operator zone
7 cutting-element tip circle
8 minimum wall distance from the blade tip circle in the operator zone
9 intersection points of the projected lines and the wall

Figure 8 — Target wall configuration and operator zone for a multiple spindle mower

Dimensions in millimetres



Key

1 secondary wall
2 target material
3 target material supports
4 cutting-element line drawn on target wall
5 horizontal plane of static cutting element(s)
6 sand base (see 5.6.2.5 and 5.6.2.6 for details)

Figure 9 — Target wall construction detail and cross-section of target wall configuration

5.6.2 Test equipment

5.6.2.1 Test shall be performed using test projectiles as described in 3.3.5 and shown in Figure 2.

5.6.2.2 Target walls shall be constructed as shown in Figure 9 and configured as shown in Figure 7 or Figure 8, as applicable.

If more than one panel is used in a corner, the panels should be approximately the same width.

5.6.2.3 For under-mounted units, a 915 mm diameter vertical cylinder of target material shall be placed in the operator zone such that the back of the cylinder is 76 mm behind the back of the operator's seat, or 76 mm behind the rear position of an actual operator if there is no back support on the seat.

5.6.2.4 The target cylinder shall extend from the operator's normal foot position to a height of 1 m above the operator's seat.

5.6.2.5 The sand base shall be a minimum of 75 mm in depth.

5.6.2.6 Sand particle size shall be in a range from 0,074 mm to 0,476 mm.

5.6.3 Test conditions

5.6.3.1 In the situation where introduction tube locations can be varied as necessary to clear structural components, these tube locations shall be positioned to direct the vector of impacted test projectiles toward the target enclosure rather than toward adjacent cutting elements or the sides of the unit.

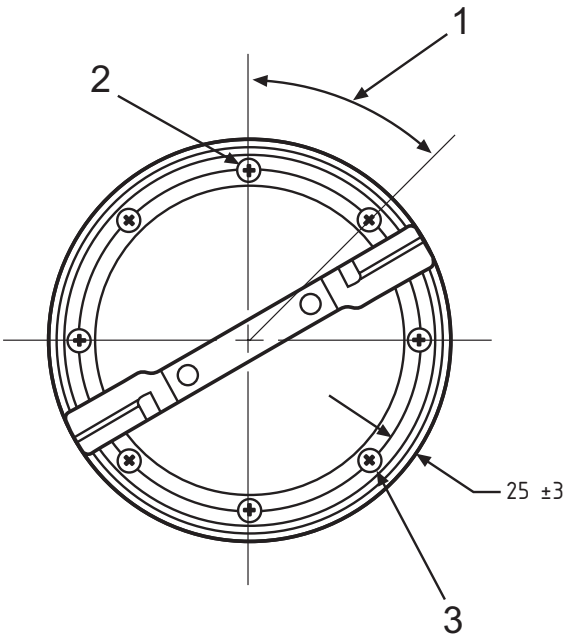
5.6.3.2 During tests, all holes shall be plugged with the introduction tube or by other means.

5.6.3.3 Provisions shall be made to protect the operator during the test.

5.6.3.4 If the mower is equipped with multiple-level cutting elements, the upper blade(s) shall be removed for the test.

5.6.3.5 Sand for the base as described in 5.6.2.6 shall be moistened to prevent blowing.

Dimensions in millimetres



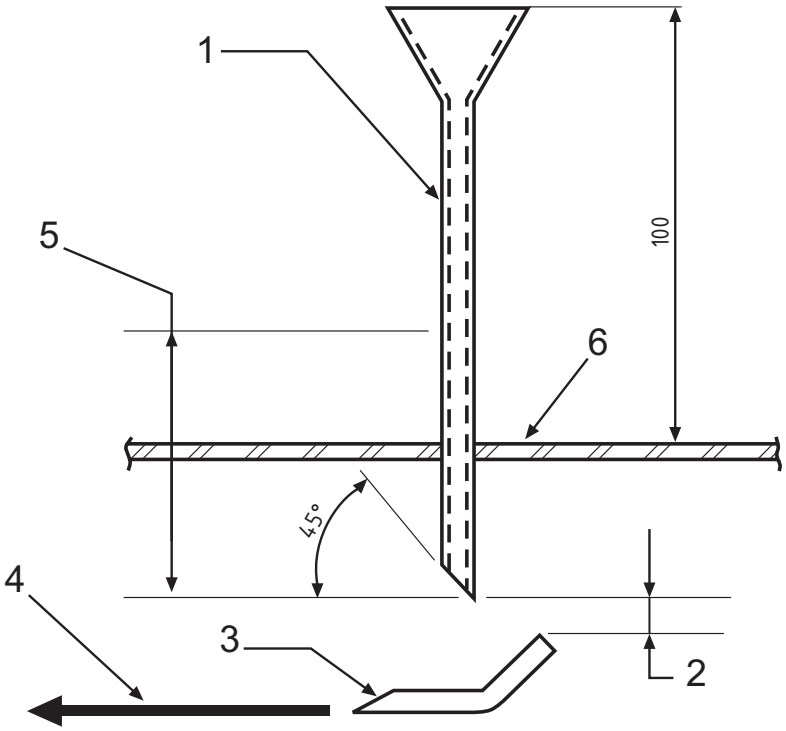
Key

1 45° basic between holes (see note)
2 primary hole located on line of travel
3 hole diameter to fit introduction tube

NOTE Each hole can be varied as necessary to clear structural components.

Figure 10 — Typical introduction tube location

Dimensions in millimetres



Key

1 introduction tube (32 mm maximum OD × 25 mm ± 3 mm ID)
2 57 mm ± 6 mm cutting element at normal operating position (see note)
3 mower cutting element
4 direction of cutting-element travel
5 vertical within 5° over a 100 mm length
6 mower top protection

NOTE Measurement is taken with mower off and blade clamped to blade carrier in the running position.

Figure 11 — Introduction tube configuration

5.6.4 Test procedure

5.6.4.1 The test shall consist of vertical downward introduction of 150 test projectiles inserted into each of eight equally spaced holes for each cutting-element assembly in accordance with Figure 10.

5.6.4.2 The test projectiles shall be introduced through the tube and funnel arrangement as specified by Figure 11 or through a similar arrangement with air or mechanical assist.

5.6.4.3 The introduction shall be repeated three times for each hole (450 per hole) for a total of 3 600 per cutting-element assembly.

5.6.4.4 The drop velocity should remain relatively constant and be adjusted to ensure that between 5 % and 15 % of the test objects drop through the cutting element without making cutting-element contact (in order to ensure that the entire length of the test object is exposed to the cutting element). Where a common hole is used between two cutting elements, the 5 % requirement of test projectiles dropping through the cutting element is waived, due to the impossibility of test projectiles passing through the cutting elements.

5.6.4.5 After each 150 test projectiles are introduced, the projectiles in a 610 mm diameter circle under the introduction hole shall be counted to verify that not more than 15 % of the test projectiles pass through the

cutting element without making cutting-element contact. On some mowers, it might not be possible to prevent more than 15 % of the test projectiles from passing through the cutting-element path without contact. In this case, the 150 quantity shall be increased to ensure that at least 128 projectiles do make cutting-element contact in each test; however, the number of additional nails introduced shall remain consistent through the entire mower. This can be determined either by sound or by counting the pass-throughs.

5.6.5 Scoring

5.6.5.1 After every 150 projectiles have been introduced, record the number of test projectiles contacted by the cutting element and record the marks on the wall above the cutting-element line in the following groups:

a) projectile hits in the operator zone;

b) projectile impacts in the operator zone;

c) projectile impacts outside the operator zone;

d) projectile hits outside the operator zone.

5.6.5.2 Total the number of marks in each of these four categories to obtain their totals for the particular cutting-element spindle.

5.6.5.3 Divide each sum by the total number of cutting-element projectile contacts for that spindle and multiply by 100 to achieve a percentage.

NOTE Sample test reporting forms are shown in Annex B.

5.6.6 Test acceptance

5.6.6.1 For each cutting-element spindle, none of the composite individual spindle scores shall exceed the following acceptance criteria:

a) 0 % projectile hits in the operator zone;

b) 0,20 % projectile impacts in the operator zone;

c) 10,00 %, calculated as the sum of projectile impacts and projectile hits outside the operator zone;

d) 3,50 % projectile hits outside the operator zone.

5.6.6.2 Failure of test criteria a) shall constitute a test hole failure.

— In the event of a failure of one test hole, the test can be repeated for that test hole.

— Two consecutive tests of that test hole with 0 % projectile hits in the operator zone shall be accomplished to meet the requirements of this test criterion.

— The number of impacts of the final successfully passed test shall be recorded for this hole.

— Failure to comply with the test acceptance of a) indicates the machine has failed the test.

5.6.6.3 Failure of any of the acceptance criteria b), c) or d) shall constitute failure of the test.

5.6.6.4 If the machine fails the test, it can be retested.

5.6.6.5 The scores of b), c) and d) criteria are then computed on the sum of the two tests.

5.6.6.6 If the scores from b), c) or d) still exceed the acceptance criteria, the machine has failed the test.

5.7 Charpy impact strength test

5.7.1 The Charpy impact strength shall be determined from finished sampled cutting elements. The Charpy impact testing shall be conducted in accordance with ISO 148-1:2009 and shall be performed at a temperature between 21 °C and 24 °C. Three specimens from one cutting element or test coupon for each heat of steel shall be tested. Specimens shall be of the longitudinal (LT) orientation. This test can be performed on a sample cutting element or test coupon after the bend test.

5.7.2 The test cutting element or test coupon from a heat of steel shall have an average Charpy value of 20,3 J or greater.

5.8 Cutting-element bend test

5.8.1 Sampling

Samples shall be pulled from each cutting-element lot at the minimum rate of one for each 200 cutting elements, but not less than two samples from any one lot.

5.8.2 Test fixture

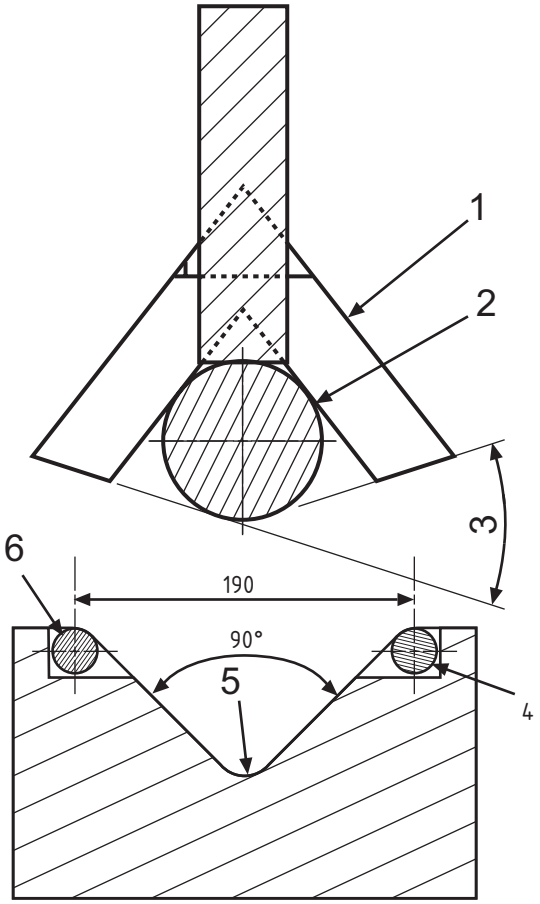
5.8.2.1 Cutting elements selected for bend testing shall be tested on the fixture as specified in Figure 12 using the ram diameter selected from Table 1 based on the material thickness of the cutting element in the area to be bent.

5.8.2.2 Stops may be used on the ram which will stop against the roller area of the bottom die, but they shall not make contact in the area of the bend in the cutting element. The stops shall be positioned to provide the minimum permanent set angle in accordance with Table 1. Suggested stop angles (total deflection angles) are specified in Table 1.

Table 1 — Cutting-element bend angles

Cutting-element material thickness mm	**Ram diameter** ± 1 mm	**Minimum permanent set angle** degrees	**Approximate total deflection angle** degrees
5,73 and under	38	25	36
5,74 to 8,52	50	25	36
8,53 to 10,68	70	25	36
10,69 to 14,49	89	25	36
14,50 and over	108	15	23

Dimensions in millimetres



Key

1 optional stop
2 ram
3 total deflection angle
4 hardened rollers
5 19 mm ± 3 mm radius
6 13 mm ± 0,5 mm radius

Figure 12 — Cutting-element bend-test fixture

WARNING — Brittle cutting-element fracturing can cause cutting-element parts to be ejected with considerable force. Use adequate guarding around the fixture.

5.8.3 Cutting-element bend-test procedure

5.8.3.1 All parts shall be placed flat on the bend-test die and bent at least enough to give the permanent set, total included angle over a period of time not to exceed 15 s and at the maximum temperature of 49 °C (120 °F).

5.8.3.2 The cutting-element area placed between the support points in the die shall not be in a fin area, near a mounting hole or in an area of other bends or distortions. If this is not possible due to cutting-element geometry, use a test coupon.

5.8.3.3 When the beginning of a crack or break is indicated, stop the test and remove the cutting element.

5.8.4 Alternative method

The objective of this test fixture and procedure is to produce 14,5 % permanent elongation in the surface of the metal all the way across the cutting element. This is based on the assumption that the neutral axis of the cutting element is located in from the inside bend surface a distance equal to 40 % of the thickness. Any other form of cutting-element test fixture and procedure can be substituted as long as this objective is achieved.

5.8.5 Acceptance criteria

If any cutting element or test coupon from a lot breaks or incurs a crack visible to the naked eye before reaching the permanent set angle specified in Table 1, that entire lot shall be totally rejected, and cutting elements from that lot cannot be used without corrective measures.

5.8.6 Corrective measures

If a corrective measure such as annealing or reheat treating is performed on the cutting-element lot, the lot shall be retested, but the sample size shall be doubled. If all sample cutting elements pass the retest, then the lot can be accepted.

6 Information for use

6.1 Operator's manual

6.1.1 An operator's manual and a durable weather-resistant storage location for the instructions shall be provided on the equipment. Comprehensive instructions and information on all aspects of maintenance and the safe use of the machine, including suitable clothing and personal protective equipment (PPE) requirements and the need for training, shall be provided by the manufacturer in the operator's manual. Useful information for the drafting of the operator's manual is given in ISO 3600:1996 and 6.4.5 of ISO 12100:2010.

6.1.2 The operator's manual and the technical documentation describing the machine prepared by the manufacturer for the information of potential users shall emphasize:

a) that all persons not involved with the mower operation shall be kept away;

b) the use of a PTO drive shaft assembly equipped with a guard in good condition;

c) the potential hazards involved when bringing a part of the mower into working or transport position;

d) that the mower shall not be operated without guard(s) in place.

e) that the engine and all movement shall be stopped before any blockage removal, servicing or adjusting;

f) that variation in field conditions (such as the type and the density of the material being cut) can result in blockages and the action of the operator can take to remove blockages;

g) that the working elements (provided with the mower) be used and the instructions be followed for clearing blockages (including a reminder of the need to stop the engine);

h) the need to apply locking devices for the raised parts before carrying out maintenance or transporting the mower;

i) the need for support or blocking when working under a raised mower;

j) the hazards associated with PTO overspeeding;

k) the hazard caused by the working elements continuing to rotate for some time after the power source has been disconnected;

l) the need to check for damage of the protective structures, canvases, chains and/or rubber strips and to replace damaged parts as necessary;

m) that there is a hazard that worn or damaged cutting elements can be ejected, so detailed information on when and how to replace the cutting elements shall be given;

n) that no person be allowed to climb on or ride on the mower;

o) the correct way of storing the mower to ensure stability;

p) that worn and damaged means of cutting-element attachment are a hazard, so detailed information on when and how to replace the means of attachment;

q) to take care of the link between tractor and the machine and, if necessary, put an overrunning clutch or a freewheel device according to 4.5;

r) the need to use replacement blades, blade attachment means, protective skirts and wear parts, as recommended by the manufacturer;

s) that the driveline is securely locked on to the PTO.

7 Marking and safety signs

7.1 Marking

All mowers shall be marked in accordance with ISO 4254-1.

In addition, safety signs or symbols shall be affixed, drawing attention to

— hazards caused by cutting elements during working and due to their inertia after the power source has been disconnected,

— hazards caused by objects ejected from the protected zone of the mower,

— hazards caused by operation of the mower without guard(s) in place.

— hazards caused by bringing a part of the mower into the transport or working position,

— prohibiting persons from climbing on or riding on the mower.

7.2 Safety signs

7.2.1 Safety signs shall be appropriately displayed when necessary to alert the operator and others of the risk of personal injury during normal operations and servicing.

7.2.2 Safety signs shall conform to the requirements as specified in ISO 4254-1.

Annex A
(informative)

List of significant hazards

For the purposes of this part of ISO 4254, Table A.1 gives the significant hazard(s), the significant hazardous situation(s) and event(s) covered by this part of ISO 4254, that have been identified by risk assessment as being significant for this type of machine, and which require specific action to eliminate or to reduce the risk.

Table A.1 — List of significant hazards

N°	Hazard	Hazardous situation and event	Subclause of ISO 4254-1:2008[a]	Subclause of this part of ISO 4254
1.1	Crushing hazard			4.1, 6.1, 7.1
1.2	Shearing hazard			4.1, 4.3, 6.1, 6.2, 7.1
1.3	Cutting or severing hazard			4.1, 4.3, 6.1, 6.2, 7.1
1.4	Entanglement hazard			4.1, 4.3, 4.4, 4.5, 6.1, 6.2, 7.1
1.5	Drawing-in or trapping hazard			4.3, 4.4, 4.5, 6.1, 6.2, 7.1
1.6	Impact hazard			4.2, 4.3, 5.5.3, 6.6
1.7	High pressure fluid injection hazard		4.10	
1.8	Ejection of parts			4.2, 4.3, 5.5.3, 6.6
2.1	Electrical hazards, caused by electrical contact (direct or indirect)		4.9	
2.2	Hazards due to batteries, fire, emissions of dust and gas, etc.		5.1.8.2, 5.3, 5.6	
3	Thermal hazards resulting in burns and scalds, by a possible contact of persons, by flames or explosions and also by the radiation of heat sources		5.5	
4.1	Hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	Noise	4.2	
5.1	Unhealthy postures or excessive efforts		4.4.5	
5.2	Human error			6.1, 7.1
6.1	Failure of energy supply (of energy and/or control circuits)	a) failure, malfunction of control system (unexpected start up, unexpected overrun); b) starting and stopping devices	 5.1.8	6.1, 7.1
6.2	Errors of fitting			6.1
6.3	Overturn, unexpected loss of machine stability			6.1
7.1	All kinds of guards			4.1, 4.3, 4.4, 4.5, 6.1, 6.6, 7.1
7.2	All kinds of safety related (protection) devices			4.1, 4.3, 4.4, 4.5, 6.1, 6.6

Table A.1 *(continued)*

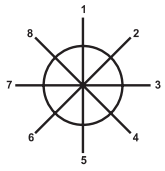
N°	Hazard	Hazardous situation and event	Subclause of ISO 4254-1:2008[a]	Subclause of this part of ISO 4254
7.3	Safety signs			6.1
7.4	Essential equipment and accessories for safe adjusting and/or maintaining			6.1
8	Hazards due to sudden movement, instability, etc.			4.1, 4.6, 4.7
9.1	Hazards to exposed persons due to uncontrolled movement			4.6, 4.7
9.2	Hazards due to break-up and/or ejection of parts			4.2, 4.3, 4.4, 5, 5.4, 5.5, 6.1, 6.4, 6.5, 6.6
9.3	Loss of stability			6.1

[a] Under revision.

Annex B
(informative)

Examples of test recording forms

B.1 Large rotary mower thrown-object testing recording form



Machine Model: _____ Shielding Type (if used): _____

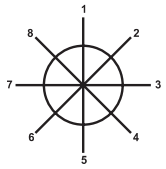
Serial No.: _____ Shielding Part No.: _____

Cutting Element Spindle (if multiple): _____ Conducted By: _____

Cutting Element Part No.: _____ Date: _____

NOTE % - Based on ratio of test object impacts or hits to number of objects struck by the cutting element.

Hole Position	Run No.	No. of Test Objects Dropped	No. of Test Objects Struck by Cutting Element	OUTSIDE OPERATOR ZONE				IN OPERATOR ZONE			
				Object Target Impacts		Object Target Hits		Object Target Impacts		Object Target Hits	
					% of Projectile Impacts		% of Projectile Hits		% of Projectile Impacts		% of Projectile Hits
		150 (min)	127 (min)	No.		No.		No.		No.	
1.	1.										
	2.										
	3.										
TOTAL #1											
2.	1.										
	2.										
	3.										
TOTAL #2											
3.	1.										
	2.										
	3.										
TOTAL #3											
4.	1.										
	2.										
	3.										
TOTAL #4	4.										
TOTAL OF ALL 8 HOLES											



Machine Model: _____ Shielding Type)if used): _____

Serial No.: _____ Shielding Part No.: _____

Cutting Element Spindle (if multiple): _____ Conducted By: _____

Cutting element Part No.: _____ Date: _____

NOTE % - Based on ratio of test object impacts or hits to number of objects struck by the cutting element.

Hole Position	Run No.	No. of Test Objects Dropped	No. of Test Objects Struck by Cutting Element	OUTSIDE OPERATOR ZONE				IN OPERATOR ZONE			
				Object Target Impacts		Object Target Hits		Object Target Impacts		Object Target Hits	
		150 (min)	127 (min)	No.	% of Projectile Impacts	No.	% of Projectile Hits	No.	% of Projectile Impacts	No.	% of Projectile Hits
5.	1.										
	2.										
	3.										
TOTAL #5											
6.	1.										
	2.										
	3.										
TOTAL #6											
7.	1.										
	2.										
	3.										
TOTAL #7											
8.	1.										
	2.										
	3.										
TOTAL #8	4.										
TOTAL OF ALL 8 HOLES											

B.2 Structural integrity test recording form

Hole position	No. rods dropped	No. rods struck by cutting element	TEST RESULTS
1			
2			Passed - No failures in cutting-element housing
3			
4			Failed - Why?
5			
6			
7			
8			

Annex C
(informative)

Example illustrations of mowers

C.1 Examples of mowers dealt with in this part of ISO 4254

These examples are functional representations of the mowers and do not give an illustration of the safety measures required by this part of ISO 4254.

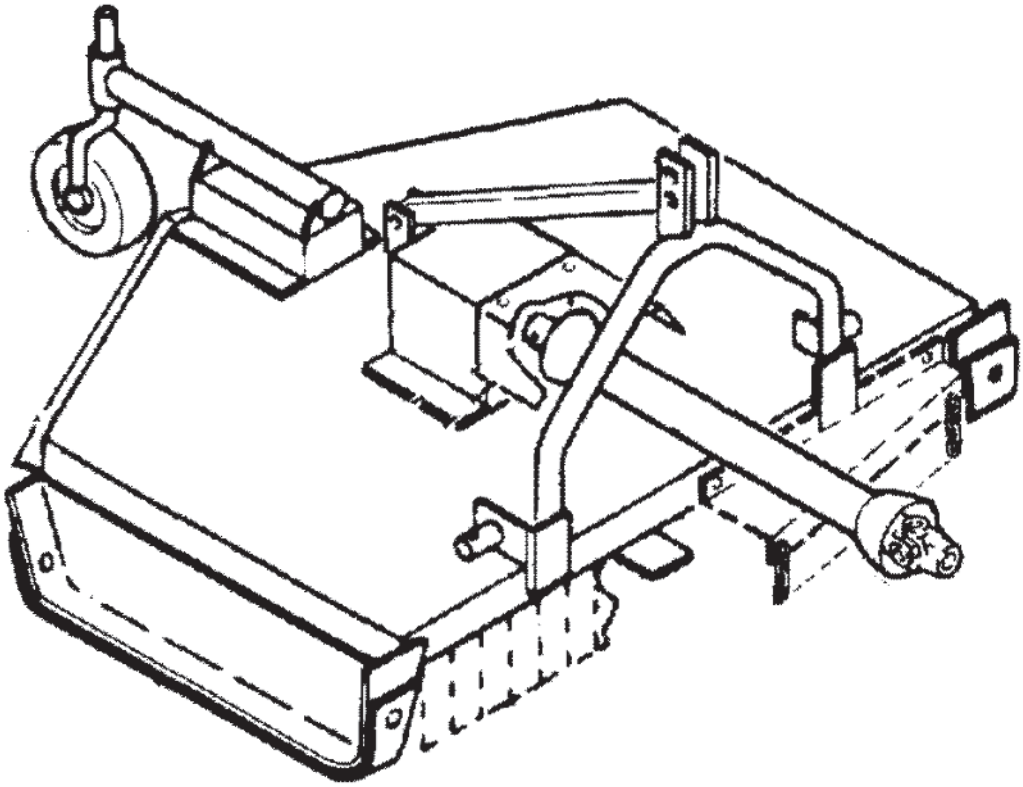


Figure C.1 — Rigid-deck large rotary mower

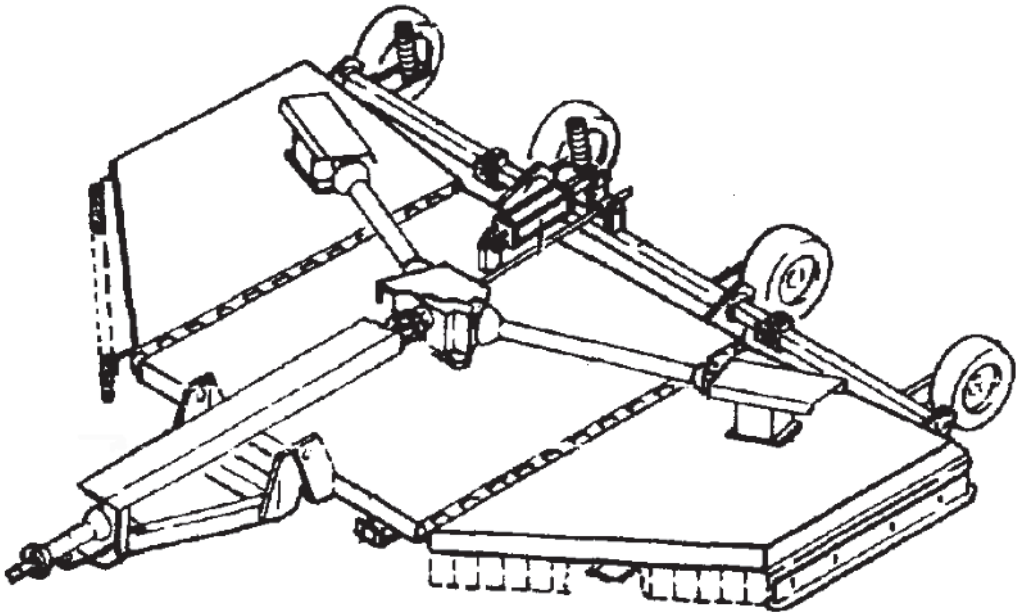


Figure C.2 — Trail-type multi-section foldable-wing large rotary mower

C.2 Examples of mowers not dealt with in this part of ISO 4254

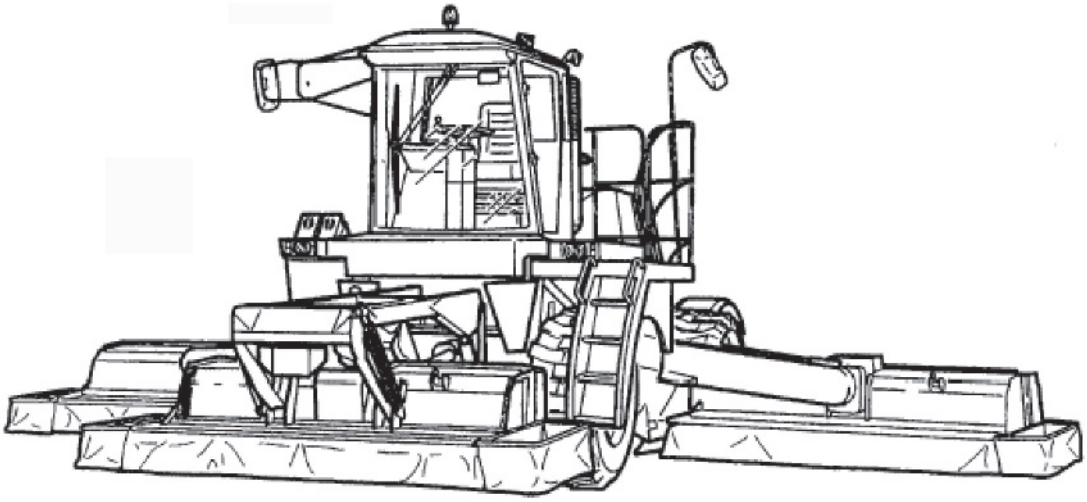


Figure C.3 —Self-propelled rotary disc mower

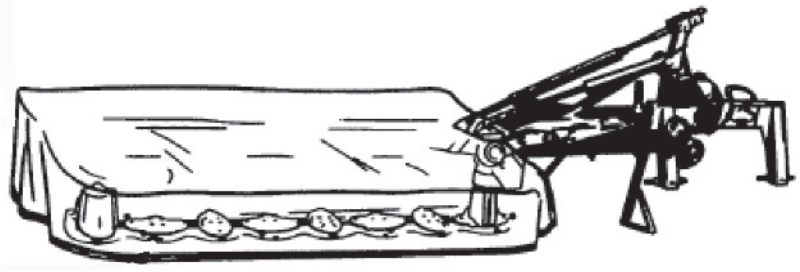


Figure C.4 — Basic rotary disc mower

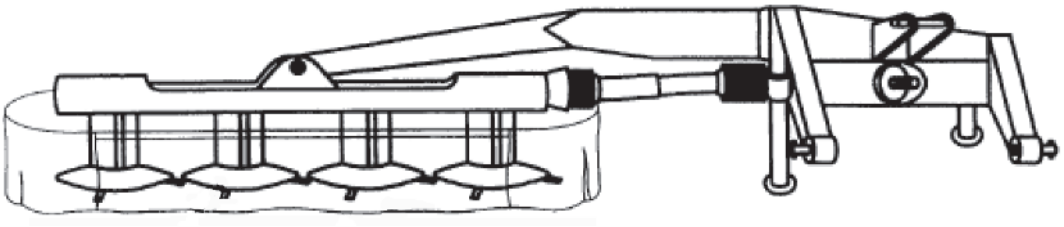


Figure C.5 — Basic rotary drum mower

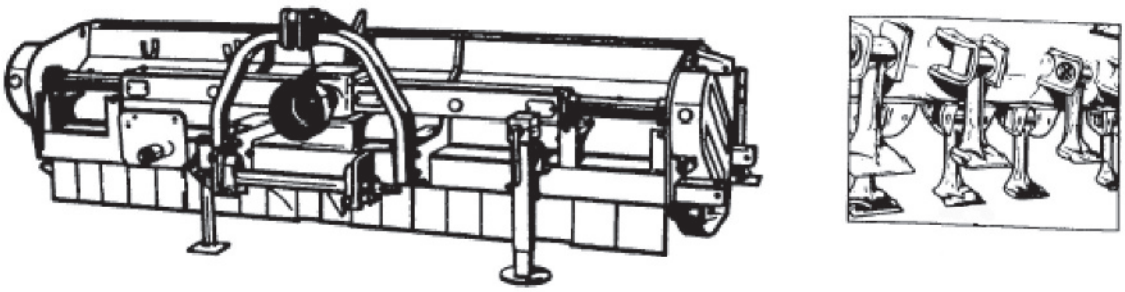


Figure C.6 — Flail-mower

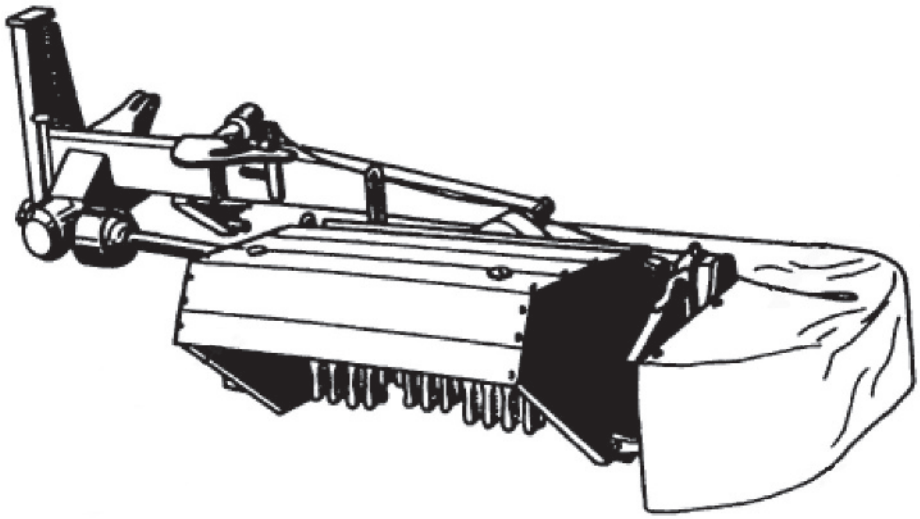


Figure C.7 — Mower with a conditioning device

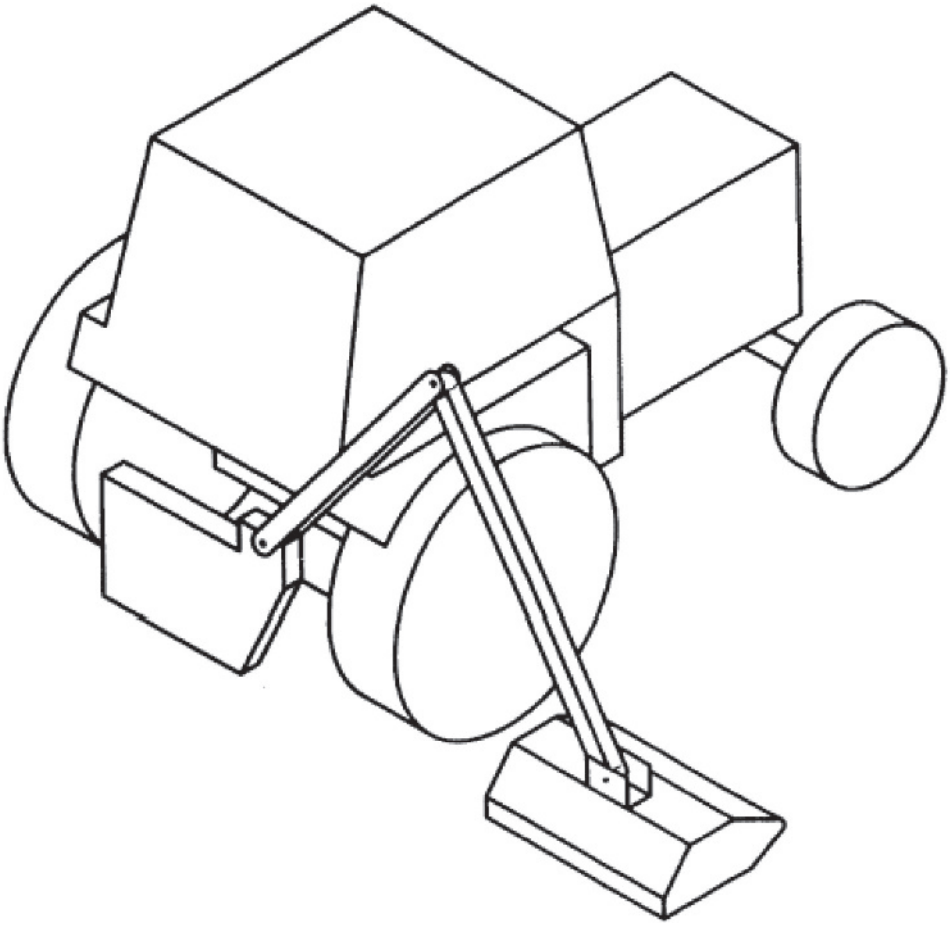


Figure C.8 — Arm-type rotary mower

Annex D
(normative)

Corrugated fibreboard penetration tests

D.1 Purpose

The purpose of these tests is to provide a means of selecting a uniform target wall fibreboard material for thrown-object tests performed on large rotary mowers.

D.2 Test fixture

D.2.1 The test fixture, which includes the test support stand, penetrator rod and plates, shall be constructed in accordance with Figure D.1. The guide tube 2) shall be vertical ± 2°.

D.2.2 The penetrator 3) shall be made of a 6,35 mm ± 0,2 mm diameter steel rod or equivalent, a 0,4 mm ± 0,1 mm diameter connecting rod and a 6,35 mm ± 0,2 mm diameter steel ball assembled as shown in Figure D.1.

D.2.3 The penetrator shall be approximately 1 030 mm in length and have a mass of 25 kg ± 0,005 kg.

D.3 Fibreboard samples

Fibreboard material samples shall be cut into 150 mm × 150 mm squares.

D.4 Procedure

D.4.1 Immediately before and after the mower tests, five samples of the fibreboard material shall be tested and the requirements of D.5 shall be met.

D.4.2 Place a fibreboard square centrally on the bottom plate. The square may be secured at the edges by tape or adhesive. Cover with the steel top plate and make sure that the centre holes of the top and bottom plates are aligned and that the fibreboard is flattened by the top plate.

D.4.3 Raise the penetrator to the heights specified in D.5 and as shown in Figure D.1 and allow it to fall onto the fibreboard material samples.

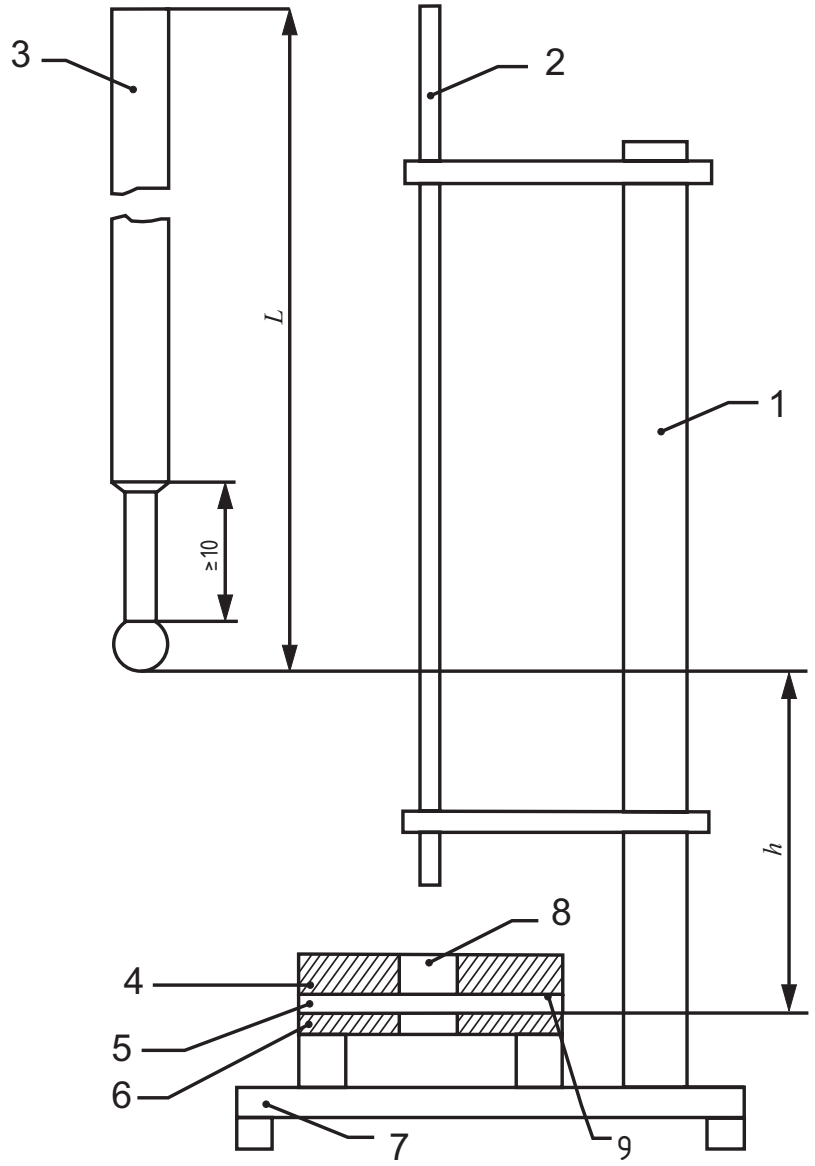
D.5 Acceptance criteria

The spherical end of the penetrator shall not penetrate completely through the test fibreboard material sample more than 2 out of 5 drops when dropped 300 mm.

The spherical end of the penetrator shall penetrate completely through the test fibreboard material sample in at least 4 out of 5 drops when dropped 400 mm.

If the penetrator penetrates the fibreboard more than the allowed number of times permitted by the acceptance criteria when dropped 300 mm, add sufficient sheets of Kraft paper to the target face of the fibreboard in order to meet penetration requirements.

Dimensions in millimetres



Key

1 test stand support
2 guide tube for penetrator (vertical ± 2°)
3 penetrator (see D.2.2 for details)
4 150 mm × 150 mm square × 20 mm steel top plate
5 fibreboard sample
6 150 mm × 150 mm square × 6,35 mm steel bottom plate
7 base
8 50 mm ± 0,3 mm diameter hole
9 add additional Kraft paper above fibreboard sample here, if necessary (see D.5, note)
h drop height as specified in D.5
L length of penetrator (see D.2.2 for details)

Figure D.1 — Test fixture for corrugated fibreboard penetration test

Bibliography

[1] ISO 5395, *Power lawn-mowers, lawn tractors, lawn and garden tractors, professional mowers, and lawn and garden tractors with mowing attachments — Definitions, safety requirements and test procedures*

[2] ISO 14982, *Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria*

[3] ASTM E18:2008, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

[4] ASTM E23:2007, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

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