INTERNATIONAL STANDARD

ISO 11839

Second edition
2021-02

Machinery for forestry — Thrown object guard — Test method and performance criteria

Matériel forestier — Protection contre les projections d'objets — Méthode d'essai et critères de performance

Reference number
ISO 11839:2021(E)

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Published in Switzerland

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

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

This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 15, *Machinery for forestry*.

This second edition cancels and replaces the first edition (ISO 11839:2010), which has been technically revised. It also incorporates the Technical Corrigendum ISO 11839:2010/Cor 1:2012.

The main changes compared to the previous edition are as follows:

— revises the test procedure to a more repeatable and realistic representation of the guarding system.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Mobile and self-propelled machinery used in forestry and related operations that use powered cutting or grinding attachments can expose the operator to a hazard from thrown cutting or grinding elements, and residual matter created during the cutting or grinding procedures. Guarding meeting the requirements of this document can be incorporated into other operator protective structures (e.g. ROPS, FOPS, OPS) or as provided as an independent guard to provide protection from the hazard from these thrown objects.

Machinery for forestry — Thrown object guard — Test method and performance criteria

CAUTION — The test method specified in this document involves the use of dynamic processes which could lead to a hazardous situation. The test creates projectile shots. Under no circumstances shall the test be performed without the containment structure for the test apparatus in place.

1 Scope

This document establishes a laboratory test method and performance requirements for thrown object guards (TOG) that provide operator protection against thrown objects. This applies to mobile and self-propelled machinery used in forestry and related operations including, but not limited to, those defined in ISO 6814. The TOG is intended to provide reasonable protection for the operator on the host machine from powered rotating cutting or grinding elements and residual matter thrown by an attachment on the host machine.

As the tests in the document are dependent upon the mass, velocity, and the cutting or grinding element profile, the TOG meeting the requirements of this document are specific to each cutting or grinding attachment and the host machine model.

This document does not address protection from saw chain shot.

NOTE A separate standard ISO 21876 addresses saw chain shot hazards.

2 Normative references

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

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

ISO 5353, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*

ISO 9248, *Earth-moving machinery — Units for dimensions, performance and capacities, and their measurement accuracies*

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

ASTM A-108, *Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
cutting or grinding element
cutting or grinding component incorporating single or multiple cutting or grinding surfaces

Note 1 to entry: The cutting or grinding element attachment hardware is not considered part of the cutting or grinding element for purposes of calculating the cutting element mass.

3.2
cutting or grinding attachment
mechanism designed to control and propel *cutting or grinding elements* (3.1) that are used in mobile and self-propelled machinery used in forestry and related operations

3.3
deflection-limiting volume
DLV
approximation of a large seated operator as defined in ISO 3411

[SOURCE: ISO 3164:2013, 3.1]

3.4
falling-object protective structure
FOPS
system of structural members arranged in such a way as to provide operators with reasonable protection from falling objects (e.g. trees, rocks)

[SOURCE: ISO 8083:2006, 3.1]

3.5
independent guard
protective guard that is not attached to and does not receive support from an operator cab or canopy

3.6
indicator panel
corrugated cardboard approximately 3,2 mm thick

3.7
operator protective structure
OPS
system of structural members arranged in such a way as to minimize the possibility of operator injury from penetrating objects (e.g. whipping saplings, branches, broken winch lines)

3.8
roll-over protective structure
ROPS
system of structural members whose primary purpose is to reduce the possibility of a seat-belted operator being crushed should the machine roll over

[SOURCE: ISO 8082-1:2009, 3.1, modified — Note 1 to entry is not included here]

3.9
sabot
device or holder used in an *impact object launcher* (3.11) that carries an *impact object* (3.10) as it travels through the launcher

3.10
impact object
representative object used to test the TOG

3.10.1
F1 profile
impact object (3.10) consisting of a representative four-point shankless sawtooth

Note 1 to entry: See Figure 1.

3.10.2
F2 profile
impact object (3.10) consisting of a representative four-point shank sawtooth

Note 1 to entry: See Figure 1.

3.10.3
F3 profile
spherical *impact object* (3.10) with a mass representative of cutting or grinding element mass

Note 1 to entry: See Table 1

3.11
impact object launcher
device that can consistently accelerate and release an *impact object* (3.10) to a defined, consistent velocity

3.12
impact target
area where the *impact object* (3.10) is intended to strike the TOG

3.13
test sample
representative specimen of the TOG including mounting system

3.14
thrown object guard
TOG
system of structural members, screens and panels arranged in such a way as to minimize the possibility of operator injury from thrown *cutting or grinding elements* (3.1) and subsequently thrown residual matter

4 General

4.1 A risk assessment shall be conducted in accordance with ISO 12100 to determine if the operator is in the direct path of a thrown cutting or grinding element.

Only panels in the path of a potential thrown object as identified in the risk assessment need to be tested.

4.2 Fasteners used to mount the structure of the TOG and fasteners used to mount the panel materials shall be

— property class 8.8, 9.8 or 10.9 in accordance with ISO 898-1, or equivalent, for bolts, and

— property class 8, 9 or 10 in accordance with ISO 898-2, or equivalent, for nuts.

5 Laboratory tests

5.1 Safety

The test facility should complete a risk assessment to determine the containment structure surrounding the test projectile trajectory, target assembly and thrown object guard provides suitable protection for test personnel and bystanders. The risk assessment should determine the access and energy control systems (e.g. ISO 14118) will assure the safety of laboratory and observer personnel.

5.2 Instrumentation

5.2.1 Instrumentation accuracies not mentioned below shall meet the requirements of ISO 9248.

5.2.2 Scale to weigh cutting or grinding elements and impact objects shall have an accuracy of ±1 % of the impact object mass.

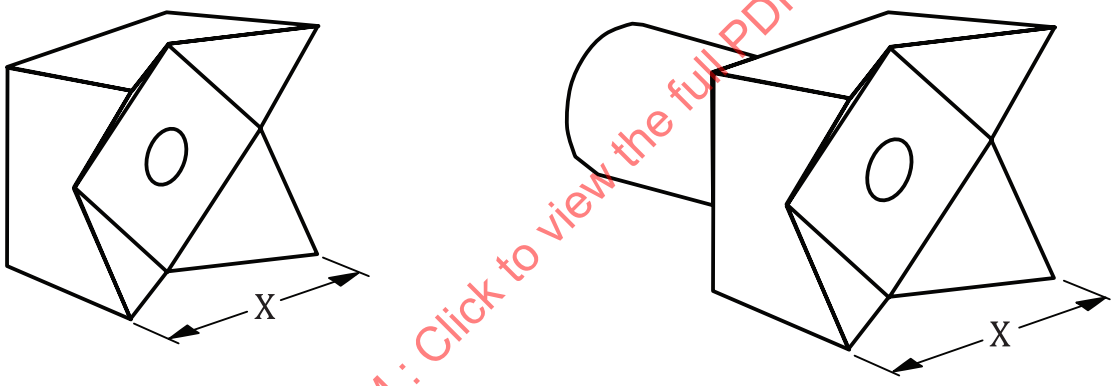
5.2.3 Means of measuring the impact object velocity shall have an accuracy of ±2 m/s.

NOTE The tolerances above are only related to the accuracy of the instrumentation.

5.3 Impact object

5.3.1 The impact object shall be selected from the respective F1, F2, or F3 profiles detailed in 5.3.2 and 5.3.3.

5.3.2 For circular disc saws, the F1 profile or the F2 profile that is most representative of the cutting element shall be selected. See Figure 1. The impact object shall be made of steel in accordance with ASTM A-108 or equivalent.



F1 Profile **F2 Profile**

Key

X kerf

Figure 1 — Illustrative arrangement of F1 and F2 profile specification

5.3.3 The impact object for cutting or grinding elements not represented by F1 or F2 profiles (see Figure 1) shall be an F3 profile of a mass that is selected from the respective mass range from Table 1, using the corresponding range that represents the heaviest cutting and grinding element that can be fitted to the cutting or grinding attachment. The mass of the impact object shall be within ±2 % of the stated mass. The impact object shall be made of steel in accordance with ASTM A-108 or equivalent. The circularity tolerance of the F3 profile impact object shall be ±0,125 mm.

Table 1 — F3 profile mass

Cutting or grinding element mass (g)	**Impact object mass** (g)
< 250	Actual mass
250 to 399	325
400 to 599	500
600 to 999	800

Table 1 *(continued)*

Cutting or grinding element mass (g)	**Impact object mass** (g)
1 000 to 1 599	1 300
1 600 to 2 600	2 100
>2 600	Actual mass

5.3.4 For cutting and grinding attachments other than circular disc saws that use cutting and grinding elements similar to those described in Figure 1, the test may use either impact objects described in 5.3.2 or 5.3.3.

5.4 Impact object launcher

The launcher shall have a means to control the orientation, direction and velocity of the impact object. The impact object may be supported in the launcher by a sabot provided any impact of the sabot on the TOG is inconsequential to the result. The sabot shall not be included in the mass of the impact object.

5.5 Calculations

The maximum kinetic energy (KE) shall be determined by risk assessment using the combination of mass (m_0) and rotational tip velocity (v_0) of the cutting and grinding elements approved for the machine.

The maximum kinetic energy (KE) shall be used to determine the calculated velocity (v_t) based on the mass of the impact object (m_t).

The value of the perpendicular test velocity (v_p) shall be calculated based on impact angle of the thrown object (θ) from the risk assessment. See Figure 2.

Formulae (1) to (3) shall be calculated by the manufacturer or testing facility prior to testing to determine the necessary requirements:

$$KE = \frac{1}{2} m_0 v_0^2 \tag{1}$$

$$v_t = \sqrt{\frac{2 \cdot KE}{m_t}} \tag{2}$$

$$v_p = (\cos \theta) v_t \tag{3}$$

where

m_0 is the mass (kg) of the cutting or grinding element as determined by the risk assessment;

v_0 is the velocity (m/s) determined by the rotational tip speed of the cutting or grinding element as determined by the risk assessment;

KE is the kinetic energy (J) calculated using Formula (1);

m_t is the mass (kg) of the impact object;

v_t is the velocity (m/s) determined by Formula (2), calculated velocity to produce an equivalent kinetic energy of the impact object;

v_p is the velocity (m/s) determined by Formula (3), used as the minimum impact velocity for testing purpose.

θ is the impact angle of the thrown object in relation to a line perpendicular to the test sample.

NOTE m_0 and v_0 are the combination determined by the risk assessment.

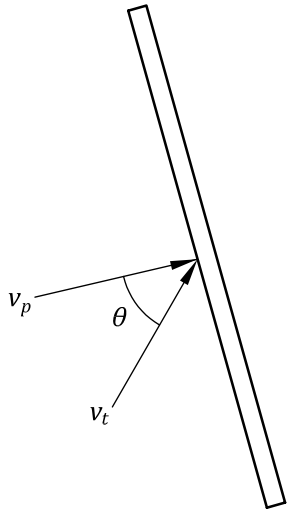


Figure 2 — Perpendicular test velocity

5.6 Test sample preparation

5.6.1 Test samples shall be representative of the commercial specification of the given product material.

5.6.2 The test sample shall be mounted so that the majority of the impact energy is absorbed by the TOG and not by the attachment hardware or the fixture to which the test sample is mounted. A complete machine, cutting or grinding attachment is not required.

5.6.3 Non-structural elements that are not part of the TOG may be removed.

5.6.4 Where the same structure is used for multiple impacts, complete replacement or repair of the TOG and its supporting structure is allowed between impacts.

5.6.5 The impact locations shall consist of visibly marked impact targets. The impact target shall be a circle with a radius of 75 mm ± 5 mm and be located on the TOG. The outer circumference of the impact target shall be 50 mm ± 2 mm from the closest edge of the TOG opening (see Figure 3), except for the centre impact target. If the same TOG is used for more than one impact, all of the impact targets shall be marked on the TOG prior to the first impact.

5.6.6 Multiple TOG's can be required per the risk assessment. Each TOG shall be tested at the impact velocity calculated in 5.5. Impact velocity can be different for each individual TOG.

5.7 Test setup

5.7.1 The deflection-limiting volume (DLV) shall be located based on the ISO 5353 SIP methodology and rigidly attached. The test shall be conducted with the seat in the position that brings the DLV closest to the TOG for each surface tested. If the operator's seat can be rotated, the DLV shall be rotated to represent the most vulnerable orientation. The DLV shall be oriented in its upright neutral position with no fore/aft or lateral tilt applied. The DLV feet shall be in their most forward position. A TOG to provide protection to a trainer seat vulnerable to thrown object hazards shall also be tested by placing a DLV in the location of the trainer seat using the same orientation/placement guidelines as used for the operator's seat.

5.7.2 The DLV shall have indicator panels applied to all surfaces that are exposed to thrown objects (not applicable to independent guards directly mounted to cutting or grinding attachments). TOGs that are directly mounted to cutting or grinding attachments shall have the indicator panels attached to a mount that is located 200 mm behind the TOG, so that it is located between the DLV and the TOG.

5.7.3 Prior to launching the impact object, the impact object launcher shall be measured to be perpendicular to the TOG impact surface, ±3°.

5.7.4 Measurement of the velocity of the impact object shall be performed within of 1 m of the TOG impact target.

5.8 Test temperatures

Test samples shall be tested at -18 °C or below. Test samples shall be conditioned to allow the full thickness of the material to reach the test temperature.

5.9 Test method

5.9.1 Apply impacts to the TOG at the following locations, in no particular order (refer to Figure 3):

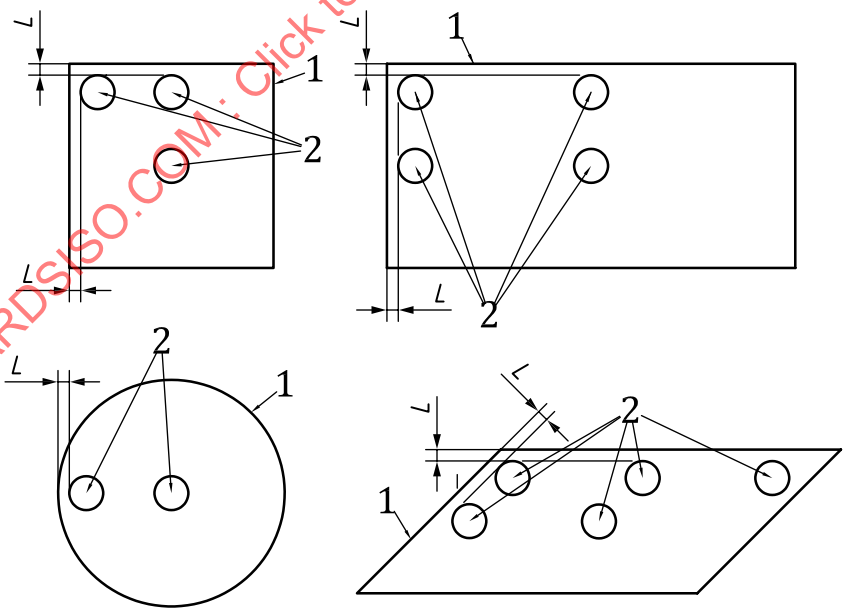
— the centre;

— mid-way along the longest side;

— mid-way along the shortest side;

— at the sharpest corner;

— at the dullest corner.



Key

1 opening of the window

2 impact target

L = 50 mm

Figure 3 — Locations of impact targets

5.9.2 The initial impact of the impact object shall be within the impact target. If more than one point of the F1 or F2 profile impact object contacts the test sample simultaneously, the centroid of the simultaneous impact locations shall be within the impact target.

6 Performance requirements

The TOG and indicator panel shall be visually examined after each impact object launch.

Following an impact object launch, the TOG is deemed to have failed if the impact object or any part of the TOG deforms, tears or imbeds in the indicator panel.

7 Labelling

7.1 A label of permanent type shall be applied visible to the operator, located on the machine so that it can be easily read and protected from defacing by the weather.

A single label may be used where multiple type of guards are used (i.e. ROPS, FOPS, and OPS).

7.2 The label shall provide the following minimum information:

a) name and address of the manufacturer or constructor of the TOG;

b) TOG identification number;

c) machine make, model(s), or product identification number(s) the TOG is designed to fit;

d) International Standard(s) for which the TOG meets and the performance levels (i.e. impact test object type, mass, and impact test velocity);

EXAMPLE F1/300/105

e) the manufacturer may include such other information as deemed appropriate, e.g. installation, repair or replacement information.

7.3 Operators and maintenance manuals for TOG should provide appropriate cleaning instructions, guidance on when to replace damaged TOG components and replacement instructions.

8 Reporting results

The test results shall be reported using the content contained with Annex A.

