INTERNATIONAL STANDARD

ISO 21876

First edition
2020-09

Machinery for forestry — Saw chain shot protective windows — Test method and performance criteria

Machines forestières — Ecran de protection contre la projection d'éléments de scies à chaîne — Méthodes d'essai et critères de performance

Reference number
ISO 21876:2020(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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*.

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

On the basis of a risk analysis, the types of saw chain breakage can be determined and a saw chain shot protective window selected that provides protection against these risks.

Saw chain shots can be generated if the saw chain is broken on the upper or lower side of the guide bar as well as when broken at the nose sprocket. ISO 11837 provides requirements for a saw chain guarding system that provides protection against saw chain breakage on the cutting (lower) side of the bar. When a saw chain is broken on the upper side or at the nose sprocket, the guarding system according to ISO 11837 does not protect from saw chain shots generated in the direction of the guide bar seen from position of the drive sprocket.

This document establishes a test method and performance criteria for windows intended to provide protection against saw chain shot.

The test apparatus specified in this document is designed to simulate the situation in which the saw chain is broken. The end of the saw chain passes the drive sprocket in the guide bar plane. At different saw chain speeds and combinations of distance to the saw chain breakage, the break force, guide bar geometry and saw chain preload will throw the saw chain in a curve, producing a whiplash that can create a saw chain shot.

Machinery for forestry — Saw chain shot protective windows — Test method and performance criteria

CAUTION — The test method specified in this document involves the use of processes which can lead to a hazardous situation. The test creates saw chain shots. Under no circumstances shall the test be performed without the protective enclosure for the test apparatus in place. The protective enclosure is only to be removed when rotating parts are standing still.

1 Scope

This document specifies a test method and corresponding performance requirements for saw chain shot protective windows on forestry machines equipped with a chain saw for cutting, harvesting or processing as defined in ISO 6814. It also applies to machines that have been modified to perform cutting, harvesting or processing (such as excavator) with a chain saw cutting attachment.

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 536, *Paper and board — Determination of grammage*

ISO 11837, *Machinery for forestry — Saw chain shot guarding systems — Test method and performance criteria*

EN 13984, *Flexible sheets for waterproofing — Plastic and rubber vapour control layers — Definitions and characteristics*

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
saw chain shot
object flying with high speed and consisting of one or more parts (drive links, side links, cutters) of a broken saw chain

3.2
relevant saw chain shot
saw chain shot (3.1)

— consisting of an assembly of one or more pieces of saw chain joined by up to two rivets;

— consisting of no more than one assembly (excluding additional loose parts of saw chain generated during the breakage event);

— that does not hit the test sample clearly sideways; and

— with *shot angle* (3.9) of 0° ± 12°.

3.3
maximum saw chain speed
C
highest saw chain speed under no load, recommended for a given combination of *cutting attachment* (3.4) and machine

3.4
cutting attachment
combination of saw chain, guide bar and drive sprocket mounted on the harvester head or grip saw

3.5
saw chain shot protective window
window that provides protection to the operator of the forestry machine from *saw chain shots* (3.1) generated from a broken saw chain

3.6
shot measurement panels
two planes used for detecting and measuring the *saw chain shot* (3.1) direction and shot speed

3.7
shot indication panel
plane used for indicating a *saw chain shot* (3.1) passed through the window test sample

3.8
shot through
saw chain shot (3.1) completely passing through the *saw chain shot protective window* (3.5) and the *shot indication panel* (3.7)

3.9
shot angle
angle between the *saw chain shot* (3.1) direction and a perpendicular line to the window test sample

Note 1 to entry: See item G in Figure 3.

4 Test equipment

4.1 Test apparatus, as described in ISO 11837 or equivalent, shall be used for generating the saw chain shots against the window test sample. The saw chain guarding system including saw casing shall not be attached. A device for mounting the window test sample shall be attached to the test rig.

4.2 Drive unit, shall be capable of maintaining a constant saw chain speed of ±2 m/s during breakage, taking into account the increased force involved in the breakage of the saw chain.

NOTE One way to accommodate this is using an electric motor (15 kW and 50 r/s) with a belt transmission gearing up the speed four times and with a flywheel mass of 15 kg mounted on the drive shaft (360 mm in diameter and 19 mm in thickness).

4.3 Saw chain speed control, shall be possible to run and adjust the saw chain speed with a maximum tolerance of ±2 m/s.

4.4 Drive shaft speed measurement, used to verify the saw chain speed with a maximum uncertainty of ±1,0 % of the reading.

4.5 Saw chain lubrication system, shall lubricate the saw chain.

4.6 Saw chain stopping device, as specified in Annex A or an equivalent means.

4.7 Protective window test sample fixture, shot indication panel and saw chain shot vector measurement

4.7.1 Protective window test sample fixture

A test sample (see 6.1) shall be mounted by clamps or equivalent fastening equipment on a rigid frame to hold the test sample in position without deflecting more than 1 mm when a force of 300 N is applied perpendicular to and in the centre of the test sample.

4.7.2 Shot indication panel

The indication panel shall be made of plastic folio equivalent to EN 13984 of 0,1 to 0,2 mm thickness or Kraft paper in accordance with ISO 536 of the same thickness. The shot indication panel shall be positioned 75 mm ± 2 mm from the surface of the window test sample opposite of the drive sprocket, D. See Figure 3.

4.7.3 Saw chain shot vector measurement

4.7.3.1 The saw chain shot speed may be calculated using the distance and time to pass between the two shot measurement panels described in 4.7.3.2.

4.7.3.2 There shall be two shot measurement panels parallel to each other in front of the window test sample with a parallel distance of 200 mm ± 2 mm (see items A1 and A2 in Figure 3) with a width of 360 mm ± 20 mm and a length of 1 000 mm ± 20 mm. These shot measurement panels can be either for optical detecting or consisting of thin metallic films of 0,05 mm thickness separated by a thin layer 0,3 mm isolating PVC sheet, detecting the passing saw chain shots. Based on the angles measured in 7.4, the shot measurement panels shall be inclined towards the sprocket for fulfilment of relevant shot angles (3.2). The location and orientation of the two shot measurement panels shall be as described in Figure 3. The shot angle shall be measured with an accuracy of ±1°.

4.7.3.3 Optical or other equivalent methods may be used for measuring saw chain shot speed and angle provided the accuracy of angle and saw chain shot speed are met.

4.8 Protective enclosure shall be provided to enclose the equipment and test fixturing. The protective enclosure shall be designed such that no projectiles can exit the enclosed equipment and test fixturing while testing is in process.

5 Cutting attachment

5.1 Guide bar

The longest guide bar length recommended for use with the saw chain shot protective windows on the machines shall be chosen for the test runs.

The guide bar shall be mounted identical to or with practical equivalence to the function of the cutting attachment manufacturer's intent.

5.2 Chain speed

The drive unit and drive sprocket combination shall be capable of providing the maximum saw chain speed specified by the cutting attachment manufacturer's intent multiplied by 1,2 (test saw chain speed).

5.3 Saw chain

The saw chain pitch is determined in relation to the guide bar. The number of chain drive links is determined in relation to the guide bar length referred to in 5.1 and sprocket referred to in 5.2.

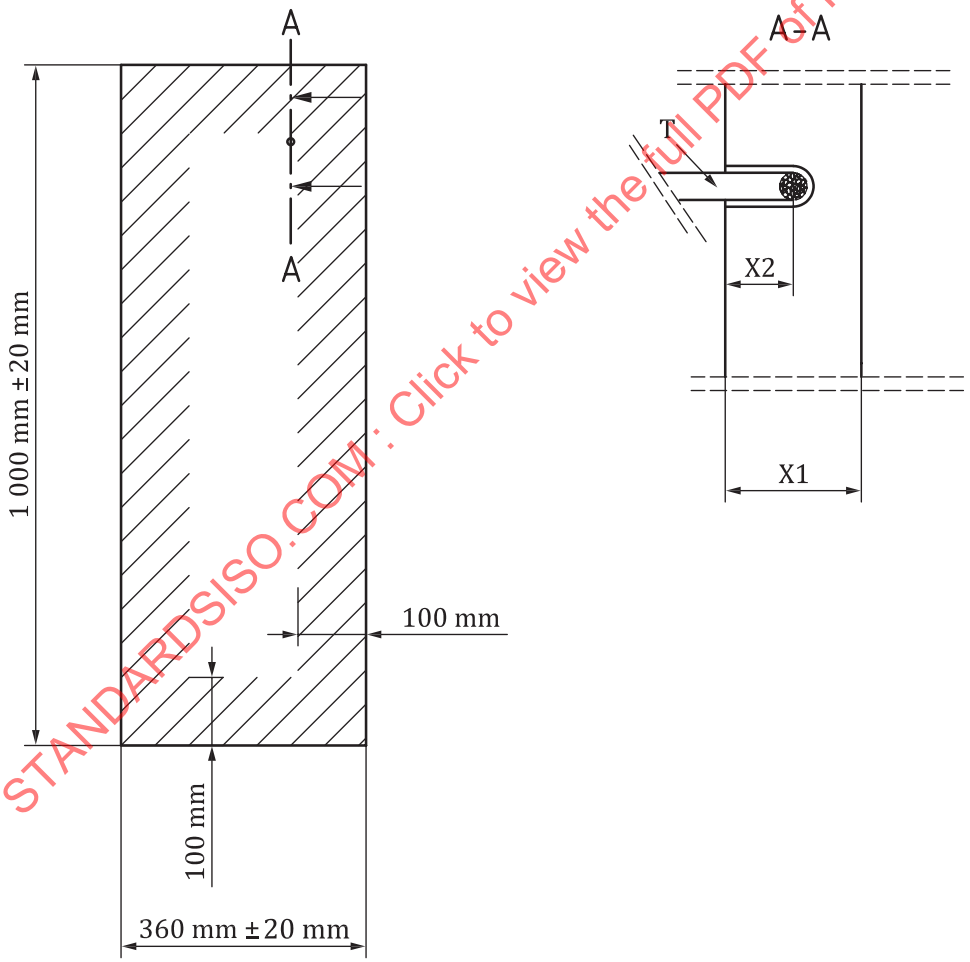
6 Test samples and pre-conditioning

6.1 Test samples

Samples of the window with a width of 360 mm ± 20 mm and a length of 1 000 mm ± 20 mm shall be tested. The window test samples shall be flat.

6.2 Test temperature

The test shall be performed at 20 °C ± 2 °C measured in the middle of the thickness of the sample. The window test samples shall be conditioned before the test to reach homogenous temperature. The test temperature is the temperature in the middle of the thickness measured 100 mm from edge of the short and the long side of the window test sample. See Figure 1.



Key

T thermocouple
X1 thickness of the window test sample
X2 middle of the thickness of the window test sample

Figure 1 — Test temperature measurement position

7 Pre-calibration of test arrangement

7.1 The pre-calibration is performed to determine the saw chain stopping device position X (see Figure 2), shot angle, and secure the statistical confidence of the test results.

7.2 Perform 10 test runs without the test sample mounted to evaluate the functioning of the test arrangement.

7.2.1 The position of the saw chain stopping device (4.6) shall depend on the guide bar length X_S, measured from the centre of the sprocket to the guide bar tip. See Figure 2. The initial distance X shall be $0{,}8 \times X_S \pm 10$ mm.

7.2.2 Test runs shall be performed at maximum saw chain speed, C, multiplied by 1,2 (test saw chain speed).

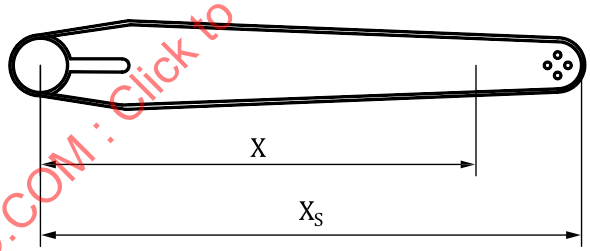
7.2.3 Measure the saw chain shot speed and the angle of the shot direction in relation to a line perpendicular to the shot measurement panels.

7.2.4 At least eight test runs shall result in a saw chain shot.

7.3 No obstructions shall be in the way of the free broken saw chain.

7.4 Shot angles shall be within ±10° from the average shot angle.

7.5 If 7.2.4 and 7.4 are not met, reduce the saw chain stopping device position X in increments of 0,05 times X_S (e.g. $0{,}75 \times X_S$, $0{,}70 \times X_S$) towards the drive sprocket until these criteria are met.



Key

X position of the saw chain stopping device

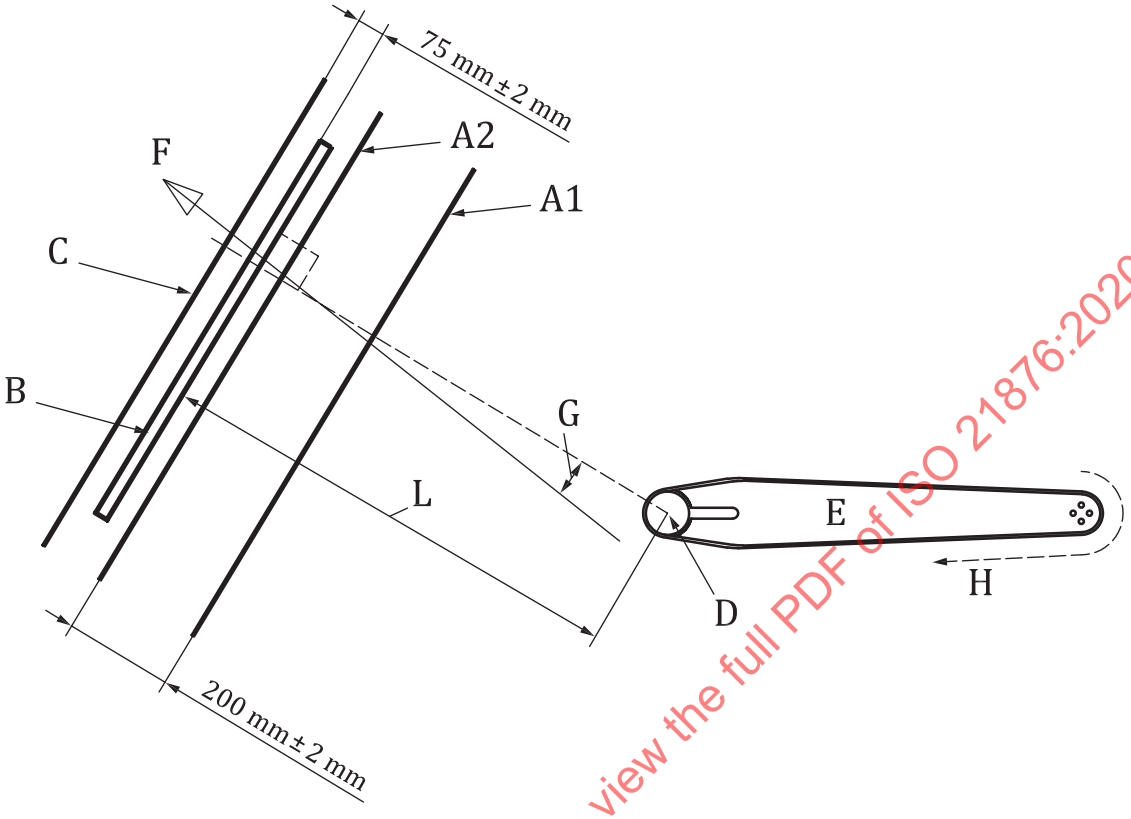
X_S guide bar length from the centre of the sprocket to the guide bar tip

Figure 2 — Saw chain stopping device position

8 Set up of window test sample in test rig

8.1 The window test sample shall be mounted to the test mount per 4.7.1. It shall not be glued. The intended outside face of the sample shall be facing the drive sprocket. For identifying the position of the test sample see Figure 3.

8.2 The test sample may be moved from the sprocket providing that the shot meets the test sample and the shot angle meets the criteria in Clause 7. The distance, L, of the window test sample to the sprocket centre shall be 0,5 × X_s to 2 × X_s. All remaining tests shall be run at this position.



Key

A1 shot measurement panel nearest sprocket
A2 shot measurement panel nearest window test sample
B window test sample
C shot indication panel
D drive sprocket
E guide bar
F direction of saw chain shot
G shot angle
H saw chain rotation direction
L distance from drive sprocket centre to test sample

Figure 3 — Guide bar and location of panels

9 Test procedure

The test shall be performed as follows.

a) For each test, install a test sample into the test frame in accordance with Clause 8. A test panel may be reused for a second run. If the test panel is being reused for a second run, the target impact area for the second run should be located away from impact area of the first run as any shot through of a reused panel shall be considered a failure.

b) Assemble the cutting attachment (guide bar, saw chain and drive sprocket) in the test rig. Use only new saw chains.

c) Connect the drive sprocket to the drive system and activate the saw chain lubrication system.

d) Prepare the equipment for measuring saw chain shot speed.

e) Position the saw chain stopping device (4.6) at the final distance X as determined in Clause 7.

f) Preload the saw chain stopping device and block it in the start position while allowing the saw chain to move freely. See Figure A.1.

g) Position and arm the saw chain stopping device and put the protective enclosure in place before performing any test runs.

CAUTION — Under no circumstances shall the test be performed without the protective enclosure for the test apparatus in place. The protective enclosure is only to be removed when rotating parts are standing still.

h) Adjust the saw chain tension and, with the protective enclosure in place allow the cutting attachment to run in and warm up.

i) Adjust the saw chain speed to the test saw chain speed, maintaining speed constant to within ±2 m/s before releasing the saw chain stopping device.

j) Release the saw chain stopping device and measure or calculate the speed of the shot.

k) Turn off the power source to the drive system and allow all rotating parts to come to a complete stop.

l) Open the protective enclosure.

m) Evaluate all measurement and shot indication panels. Document if the shot indication panel has been penetrated. Measure and document the shot angle.

n) Record results for each relevant saw chain shot (see Table 1 for example).

o) Identify and report the type of saw chain shot, pass or fail per Clause 11.

p) Photograph each test sample of broken saw chain, including all loose parts.

10 Total number of test runs

Use all test runs with relevant saw chain shots to calculate the shot speed and the standard deviation, σ. A test run is not relevant if the shot speed is below x_{min}. See Formula (1).

$$x_{min} = \mu - 1{,}96 \times \sigma \tag{1}$$

Standard deviation is shown as Formula (2)

$$\sigma = \sqrt{\frac{1}{N}\left((x_1-\mu)^2+(x_2-\mu)^2+\ldots+\left(x_N-\mu\right)^2\right)} \tag{2}$$

where mean is as shown in Formula (3)

$$\mu = \frac{1}{N}\left(x_1+\ldots+x_N\right) \tag{3}$$

where

x_1 to x_N are the different shot speeds;

N is the number of relevant test runs.

Continue with the next test run in accordance with Clause 9 until 10 relevant test runs are done.

Report the 10 relevant test runs.

11 Performance requirements

The saw chain shot protective window shall be considered to have passed the test if no shot through occurred in any of the individual test runs.

12 Labelling

12.1 A label of permanent type shall be applied to every saw chain shot protective window that meets this document. It shall be located on the saw chain shot protective window so that it can be easily read and so that it is protected from defacing by the weather.

12.2 The label shall provide the following minimum information:

a) name of the saw chain shot protective window manufacturer;

b) part number;

c) International Standard for which the saw chain shot protective window meets all of the performance requirements;

d) performance criteria which the saw chain shot protective window achieved, i.e. saw chain pitch (e.g. 0,404", 3/4"), maximum saw chain speed (m/s), maximum guide bar length (cm).

The above performance criteria are to be listed in the order as presented above.

The manufacturer may include such other information as deemed appropriate.

13 Test report

The test report shall contain at least all the 10 or more test results recorded, as well as the following information:

a) description of test facility or test location, name of the tester, date of the test;

b) a reference to this document, i.e. ISO 21876:2020;

c) identification of the saw chain shot protective window tested (manufacturer, photographs, window material, type identification or part number);

d) thickness of window;

e) temperature of window test samples at test;

f) cutting attachment (saw chain, guide bar and sprocket);

g) type of saw chain lubrication;

h) description of the test set up [target test saw chain speed, position of the saw chain stopping device, and distance from drive sprocket centre to test sample (L)];

i) results for each relevant saw chain shot test run (see example in Table 1);

j) number of shot throughs (see Clause 11);

k) photos of each test run sample of broken saw chain, including all loose parts;

l) photos of each damage on window test sample.

m) a concluding statement on the test results, including information on the saw chain shot protective window to which the test results are applicable;

n) any modification of the test arrangement and test procedure that might have been necessary, including justification for such modification.

Table 1 — Example of test run results

Test run No.	Test saw chain speed m/s	Test temperature[a]	Distance for positioning saw chain stopping device[b]	Guide bar No.	Sprocket No.	Saw chain No.	Shot through Yes/no	No. of cutter links contacted	Shot speed m/s	Shot angle °
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
N										

[a] Test sample temperature, see 6.2.

[b] Position of the saw chain stopping device, X, see Annex A, 7.5 and Figure 2.

Annex A
(normative)

Saw chain stopping device

The function of the saw chain stopping device is to grab and block the moving saw chain within half the pitch, without clamping the saw chain up to the guide bar.

The saw chain stopping device consists of the following:

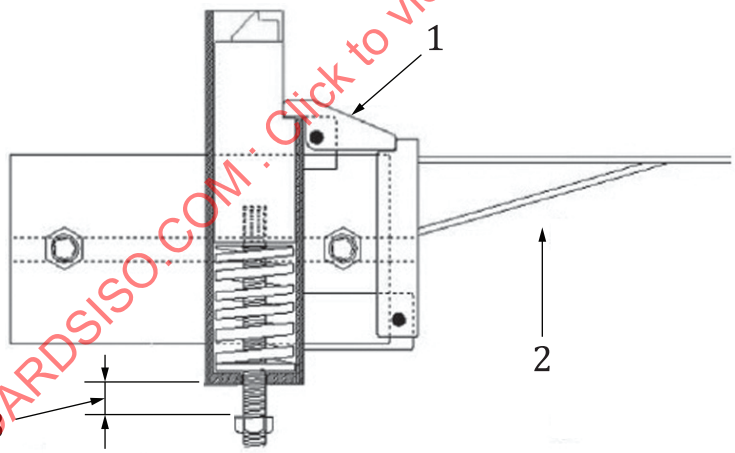
a) a mechanism for positioning the stopping device in relation to the guide bar at specified locations;

b) a stroke limiter (see Figure A.1) for adjusting the height of the saw chain stopping device tip so that it, in its released position (see Figure A.2), grabs and blocks the moving saw chain without clamping the saw chain up to the guide bar (see Figure A.3);

c) a mechanism to hold the saw chain stopping device tip preloaded and blocked in a start position (see Figure A.1);

d) a mechanism to release the saw chain stopping device tip from its start position, preferably by remote control (see Figure A.2).

The shape of the tip of the stopping device shall be modified to fit the shape of the saw chain cutting link (see Figure A.3). The height of the tip shall be 1,5 times the height of the saw tooth. The tip design shall be strong enough for the forces involved.



Key

1 blocking mechanism in blocked position
2 release mechanism
3 stroke limiter

Figure A.1 — Preloaded and blocked saw chain stopping device