BRITISH STANDARD

BS EN
12965:2009

Tractors and machinery for agriculture and forestry — Power take-off (PTO) drive shafts and their guards — Safety

The European Standard EN 12965:2003 has the status of a British Standard

ICS 65.060.01

National foreword

This British Standard is the official English language version of EN 12965:2003.

The UK participation in its preparation was entrusted to Technical Committee AGE/6, Agricultural tractors and forestry machinery, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Users may wish to note that the committee voted against the implementation of this standard because they did not deem it to be a comprehensive coverage of the topic.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 26 June 2003

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 21 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 42155 4

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12965

June 2009

ICS 65.060.01

English version

Tractors and machinery for agriculture and forestry - Power take-off (PTO) drive shafts and their guards - Safety

Tracteurs et matériels agricoles et forestiers - Arbres de transmission à cardans de prise de force et leurs protecteurs - Sécurité

Traktoren und Maschinen für die Land- und Forstwirtschaft - Gelenkwellen und ihre Schutzeinrichtungen - Sicherheit

This European Standard was approved by CEN on 13 February 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 12965:2009 E

Contents

Foreword

This document (EN 12965:2003) has been prepared by Technical Committee CEN /TC 144, "Tractors and machinery for agriculture and forestry", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2003, and conflicting national standards shall be withdrawn at the latest by December 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative annex ZA, which is an integral part of this document.

EN 1152:1994 *"Tractors and machinery for agriculture and forestry — Guards for power take-off (PTO) drive shafts — Wear and strength tests"* complements this European Standard which gives definitions and requirements concerning PTO drive shafts and their guards.

Annex A is normative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

0 Introduction

This European Standard is a type C standard as defined in EN 1070.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this document.

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 hazards that are common to agricultural machines (self-propelled, mounted, semi-mounted and trailed) are dealt with in EN 1553.

1 Scope

This standard specifies safety requirements and their verification for the design and construction of power take-off (PTO) drive shafts and their guards linking self-propelled machinery (or tractor) to the first fixed bearing of recipient machinery, by describing methods for the elimination or reduction of risks which need specific requirements. This standard concerns only the PTO drive shafts and those guards which are mechanically linked to the PTO drive shaft by at least two bearings.

In addition, it specifies the type of information on safe working practices to be provided by the manufacturer.

This standard does not deal with:

- the guards totally covering, but not mechanically linked to, the PTO drive shaft. As these devices are not at present widely established on the market, they should be dealt with in a future revision of this standard;
- the mechanical characteristics of PTO drive shafts, overrun devices and torque limiters;
- general hazards which are dealt with in EN 1553 (see introduction).

Environmental aspects have not been considered in this standard.

This document is not applicable to PTO drive shafts and their guards which are manufactured before the date of publication of this document by CEN.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 292-1:1991, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology.*

EN 292-2:1991, *Safety of machinery – Basic concepts, general principles for design – Part 2 : Technical principles and specifications (including amendment A1:1995).*

EN 294:1992, *Safety of machinery – Safety distance to prevent danger zones being reached by the upper limbs.*

EN 1070: 1998, *Safety of machinery – Terminology*.

EN 1152, *Tractors and machinery for agriculture and forestry – Guards for power take-off (PTO) drive shafts – Wear and strength tests.*

ISO 5673:1993, *Agricultural tractors and machinery – Power take-off drive shafts and position of power-input connection.*

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

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1070:1998 and ISO 5673:1993 and the following apply.

3.1
restraining system
part of the PTO drive shaft guard which prevents rotation of the guard when the PTO drive shaft rotates

NOTE See Figure 1a [14] - only shown as an example.

3.2
wide-angle universal joint
constant-velocity joint allowing operation with an articulation generally higher than 50°

NOTE See Figure 1b [9] - only shown as an example.

3.3
overrun device
device that permits the transmission of motion only in one direction (from the tractor towards the recipient machinery). See Figure 2

NOTE It is normally used with recipient machine having high value inertia.

3.4
torque limiter
device that cuts or limits the transmission of motion between tractor and recipient machinery, when the torque reaches a prefixed value. See Figure 3

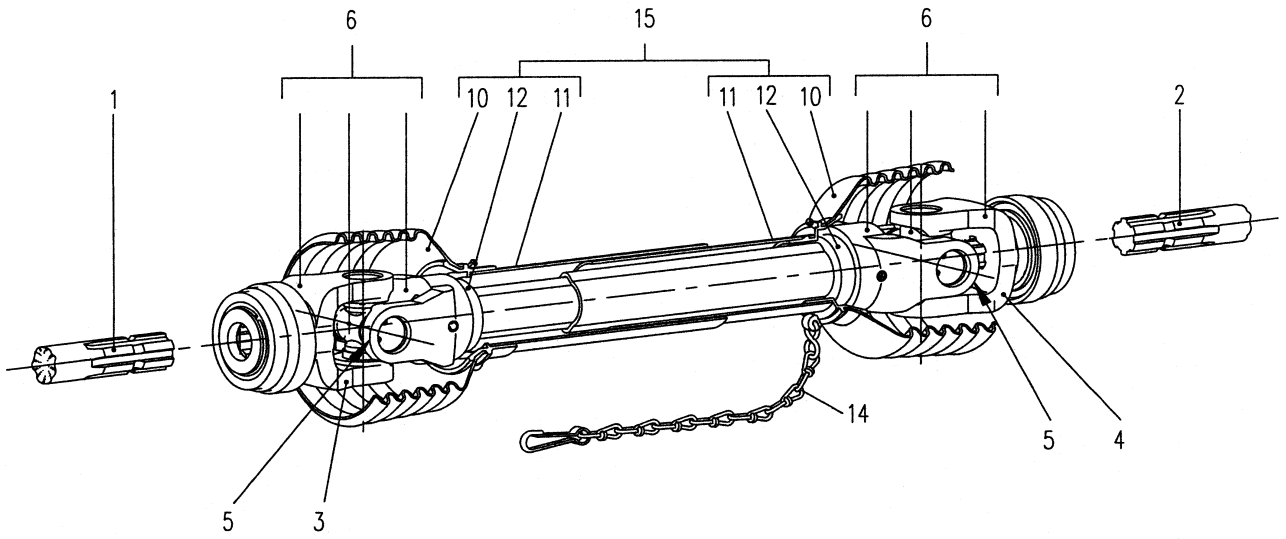


Figure 1a

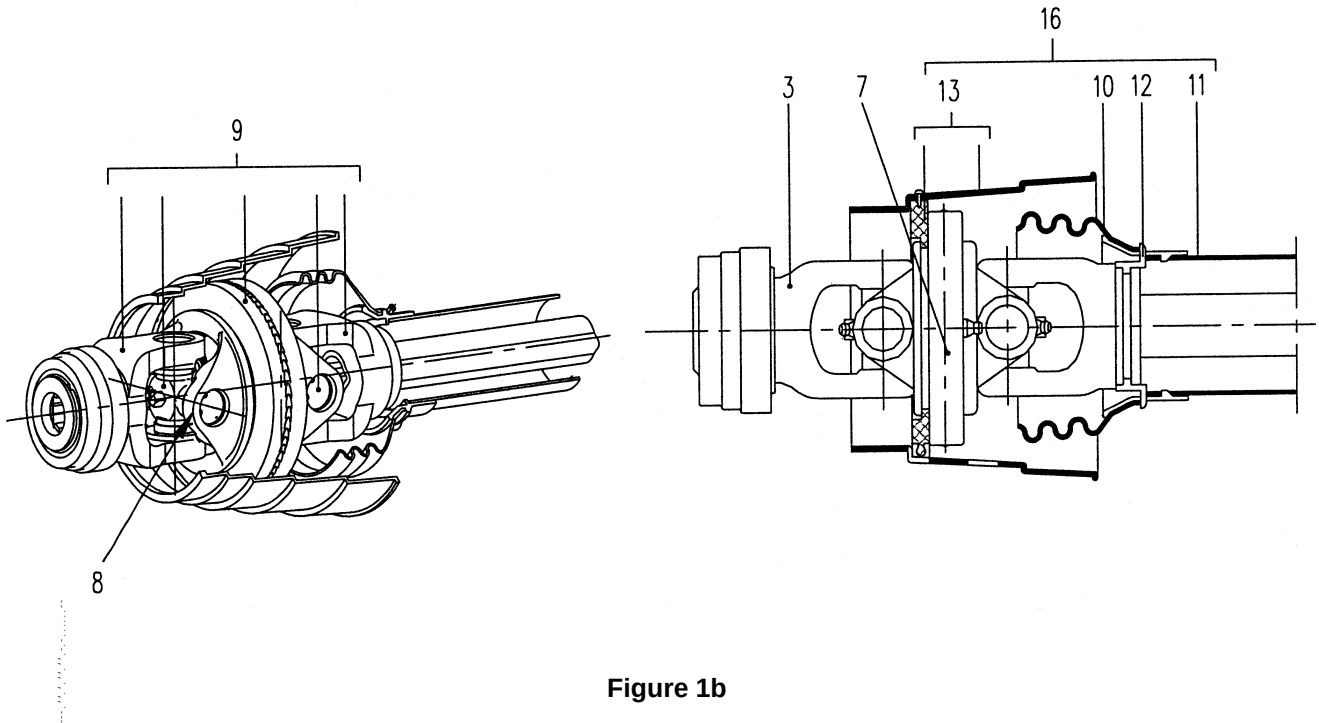
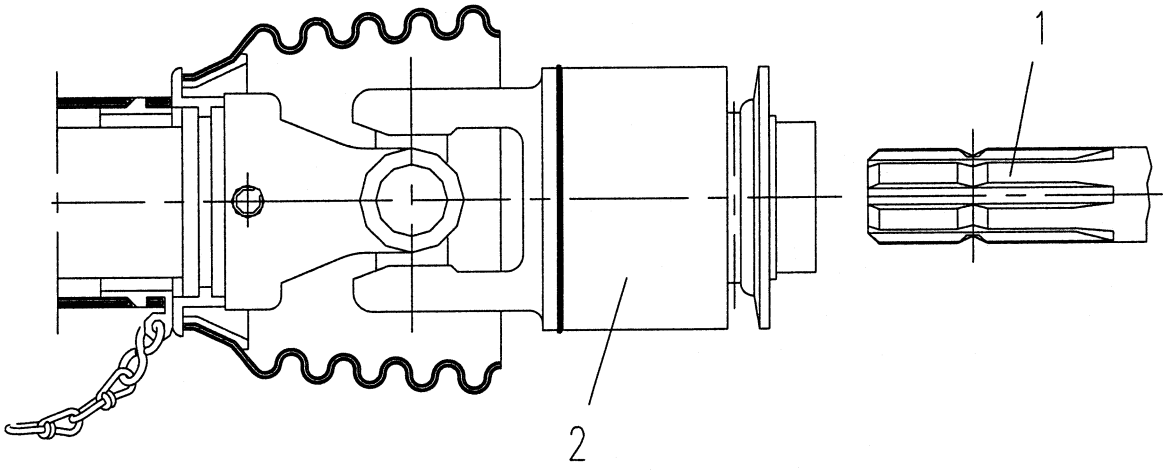


Figure 1b

Key

1 Power take-off (PTO)
2 Power-input connection (PIC)
3 PTO yoke
4 PIC yoke
5 End of inner yoke of universal joint
6 Universal joint
7 Double yoke
8 End of double yoke of outer joint
9 Wide-angle universal joint
10 Guard cone
11 Guard tube
12 Guard bearing
13 Separate guard of wide angle universal joint
14 Restraining system
15 PTO drive shaft guard
16 PTO wide-angle drive shaft guard

Figure 1 — Parts of drive shaft and guard

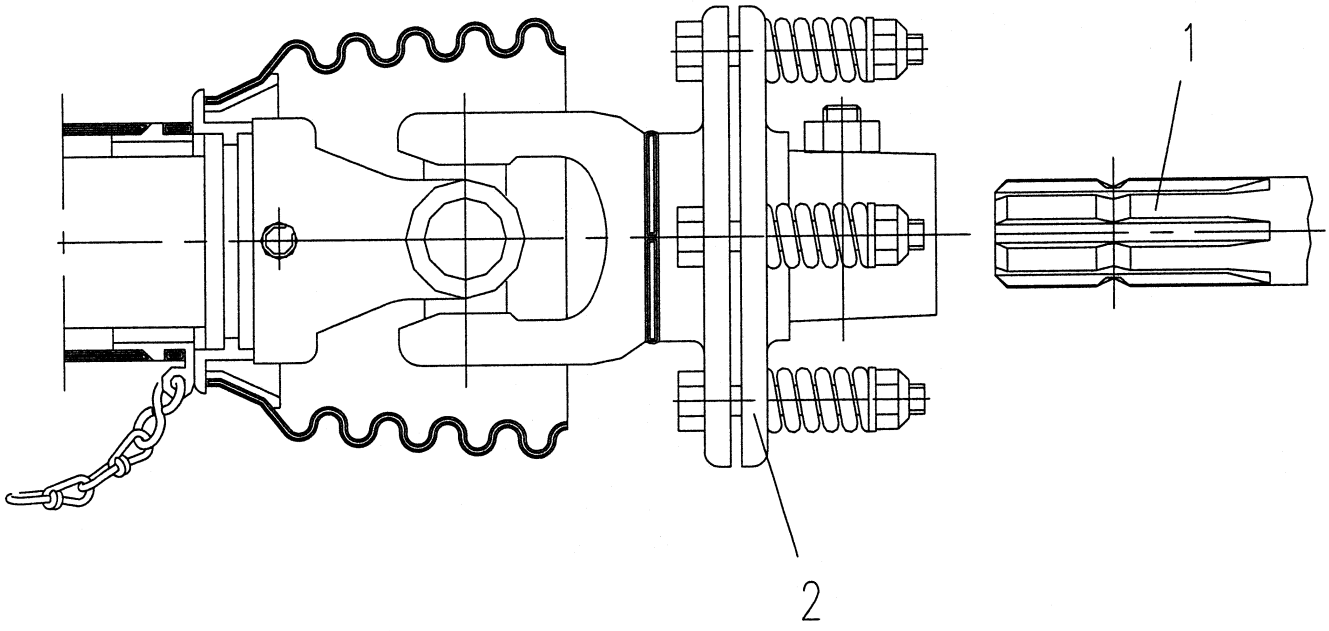


Key

1 PIC

2 Overrun device

Figure 2 — Example of overrun device



Key

1 PIC

2 Torque limiter

Figure 3 — Example of torque limiter

4 Requirements and/or safety measures

4.1 General requirements

The PTO drive shafts and their guards shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of EN 292 for hazards relevant but not significant, which are not dealt with by this standard (e.g. thermal hazards).

The list of significant hazards dealt with in this standard is given in annex A. Annex A also indicates the hazards which have not been dealt with.

The manufacturer shall provide data in the instruction handbook (see 6.1) defining the limiting use that can be made of the drive shaft and its guards. This shall include operating data and warnings against misuse (see 6.2).

The guard shall be designed to prevent contact with the moving components of the drive shaft whilst the drive shaft being operated in accordance with the instruction handbook and whilst the drive shaft being connected in the appropriate way between a tractor or self-propelled machine and a recipient machine.

The outside parts of the guard shall not turn with the transmission shaft.

The guard shall comply with acceptance criteria of EN 1152.

The locking system of the PTO yoke (see Figure 1a and Figure 1b) shall have no point which can cause entanglement (e.g. by collar design).

If there is a torque limiter and/or an overrun device on the drive shaft it shall be positioned only on the PIC side of the drive shaft as shown in Figures 2 and 3. Relevant marking shall be provided.

Unless otherwise specified in this standard, all the apertures and safety distances shall comply with the requirements of Tables 1, 3, 4 and 6 of EN 294:1992.

Warnings shall be provided on the guards specifying the necessity to read the instruction handbook.

4.2 Universal joint

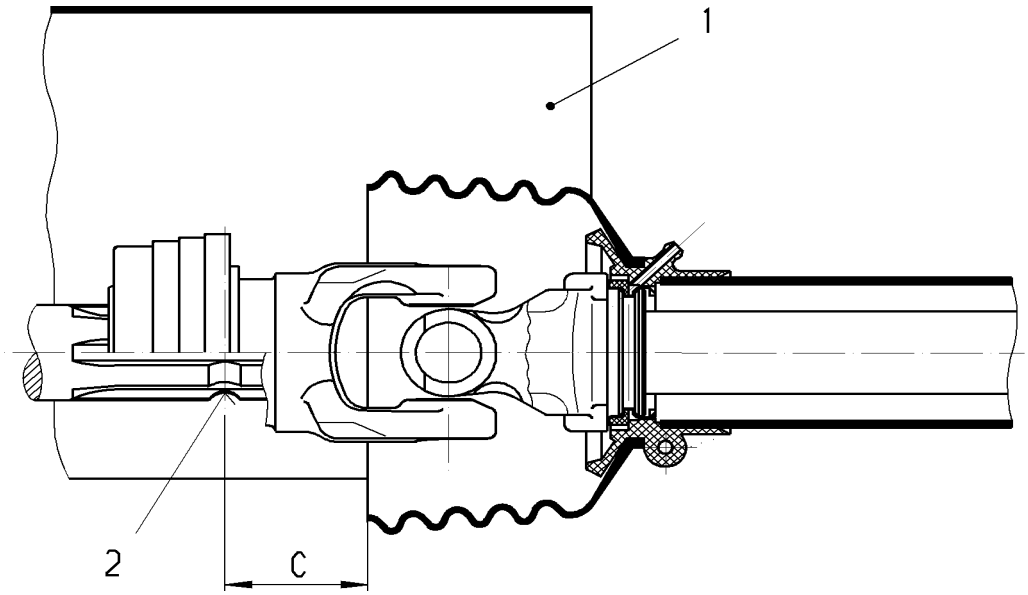
The guard shall cover the drive shaft at least up to the end of the inner yoke of the universal joint (see Figure 1a and Table 1 for dimension *c* in Figure 4).

Table 1 — Maximum distance between the end of the PTO drive shaft guard and the axis of the locking device

Dimensions in millimetres

PTO type	*c* (maximum)
1	73
2	61
3	88

NOTE Dimension *c* is under study by CEN/TC 144/WG 1.



Key

1 Master shield of tractor power take-off (PTO)

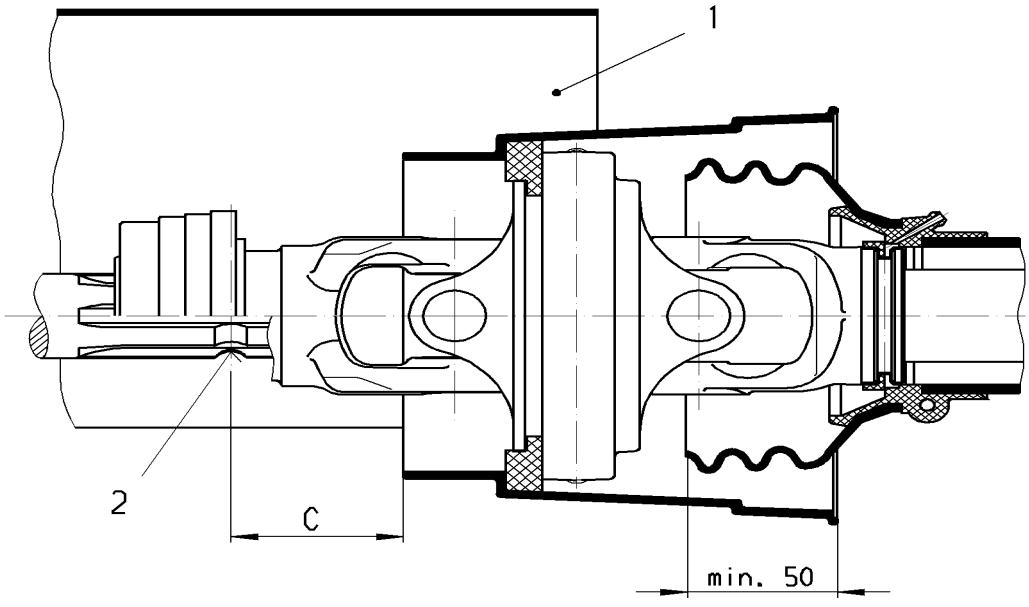
2 Axis of locking device

Figure 4 — Guarding of universal joints on PTO drive shafts on tractor side (side view).

4.3 Wide-angle universal joint

The drive shaft shall be guarded in the straight-line position at least up to the end of the outer joint of the double yoke (see Figure 1b and Table 1 dimension *c* in Figure 5).

Dimensions in millimetres



Key

1 Master shield of tractor power take-off (PTO)

2 Axis of locking device

Figure 5 — Guarding of joints

When a wide-angle joint is guarded by means of a separate guard independent of the guard of the other parts of the drive shaft (see Figure 1b), the guarding of this wide-angle joint shall be ensured as follows:

— at the maximum angular position of the rotating drive shaft, as specified by the manufacturer in the instruction handbook, the opening resulting from the angular movement shall not be more than 30 mm (see Figure 6). This requirement is verified by the use of a 31 mm diameter rod. If the rod can be inserted into the opening without being in contact with the guards on both sides then the opening is too large to be acceptable;

and

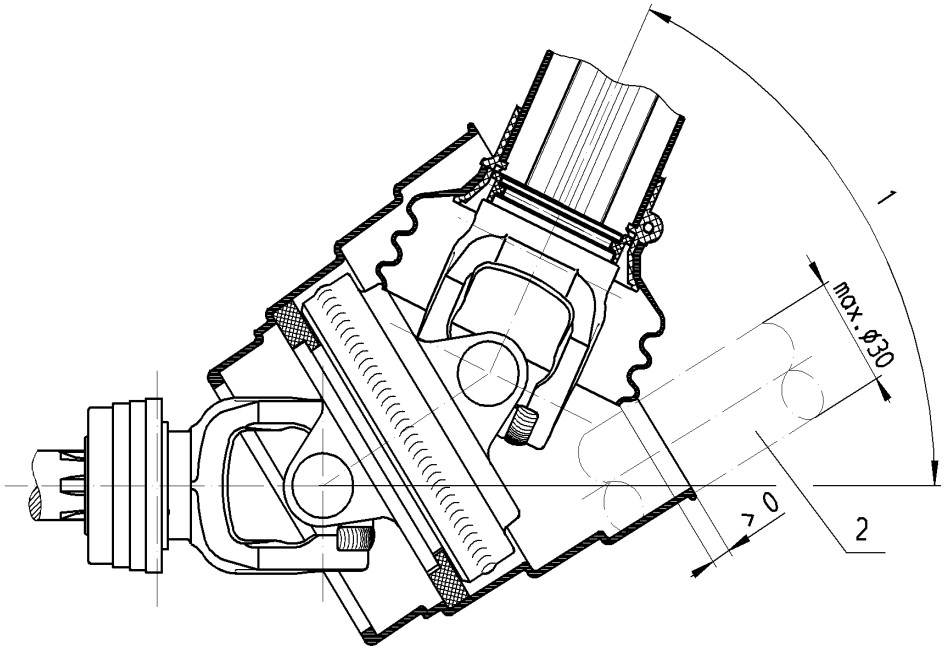
— an overlap between the separate guard and the guard cone shall be given viewed perpendicular to the axis of the drive shaft assembly when in the maximum angular position (see Figure 6);

and

— the overlap between the separate guard and the guard cone shall be at least 50 mm with the drive shaft in the straight-line position (see Figure 5).

Where the gap between the shaft guard and the wide angle guard does not exceed 4 mm at any angular position up to the maximum, then the 50 mm overlap may be reduced to 10 mm in the straight-line position.

Dimensions in millimetres



Key

1 Maximum joint angle
2 Checking gauge ∅ 31

Figure 6 — Guarding of wide angle universal joint at maximum joint angle

4.4 Guard

The guard shall be designed so that it cannot be detached from the drive shaft without the use of a tool.

To enable the drive shaft to be fitted to and locked onto or removed from the PTO manually and to have a sufficient overlap between the master shield of the tractor power take-off and the guard of the universal joint or of the wide angle universal joint, the dimension *c* of Figure 4 and Figure 5 shall be in accordance with Table 1.

The dimensions of the cone guarding the universal joints shall be such that the cone will not be damaged by contact with the master shield of the tractor power take-off or of the self-propelled machinery when the drive shaft and its guard are at the maximum angular position given by the manufacturer in the instruction handbook. To verify this requirement a test shall be performed according to 5.2.

NOTE Further requirements for the cone guarding the universal joints on the recipient machinery side will be added in a future revision taking into account the requirements of 4.3.2.3 of EN 1553:1999.

4.5 Intervention points

By design it shall be possible for user to replace the guard by following the instructions given in the instruction handbook.

If greasing applications are necessary, the universal joints and the bearings between the shaft and the guard shall be easily greased by direct access to all the lubricating nipples.

If the lubricating operations require holes to be present, the dimensions shall not be greater than 25 mm.

4.6 Restraining system

A restraining system shall be provided to prevent the guard rotating with the shaft. The member(s) of the restraining system (e.g. a chain or a wire rope) shall be securely attached to the guard and provided with a fitting that will enable it to be attached to a stationary part of the machine without coming detached without an intended action, e.g. a hook with a self closing spring or a shackle.

This restraining system shall not be used as support of the shaft.

5 Verification of safety requirements and/or measures

5.1 General

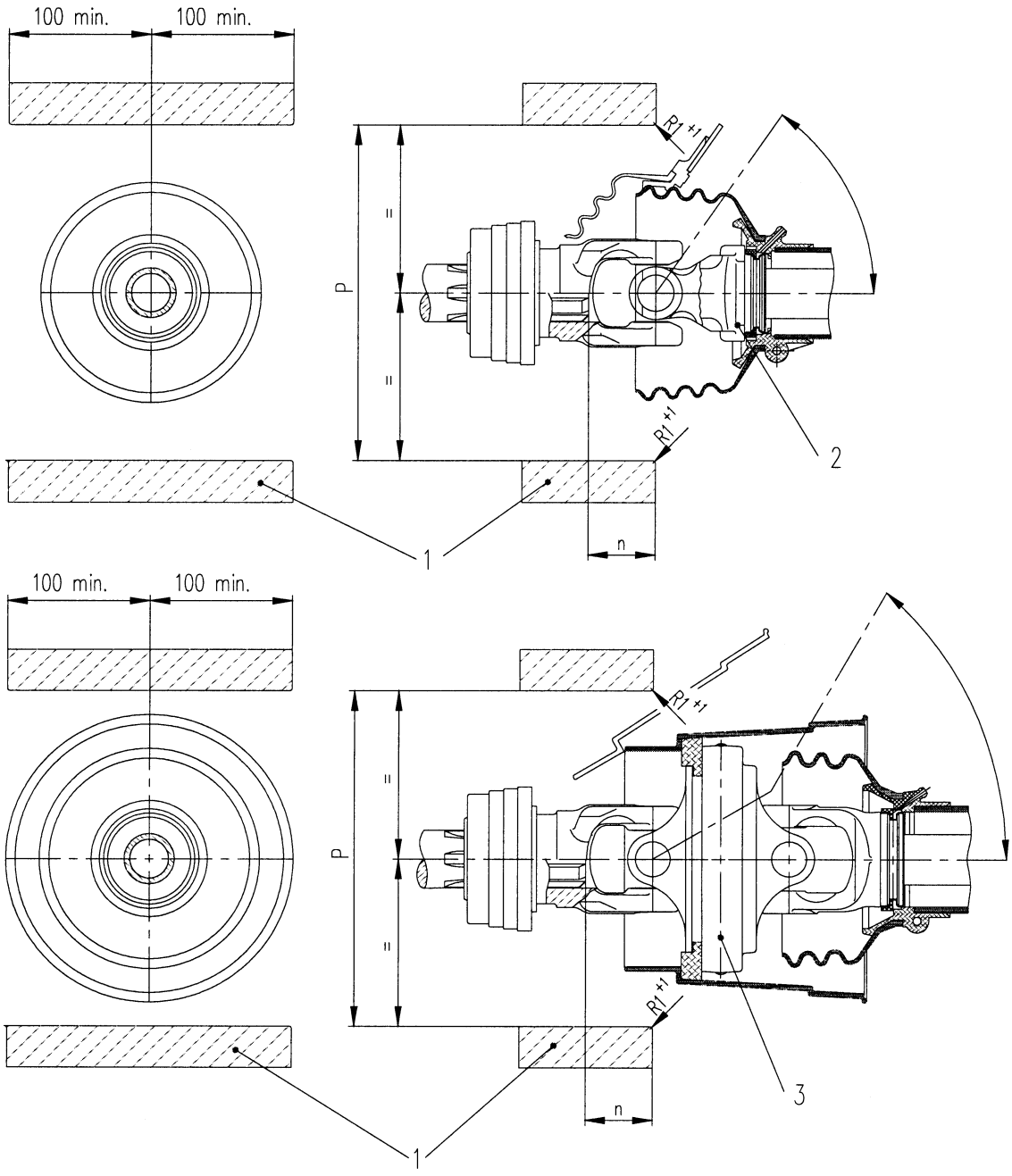
Dimensions, where given, shall be verified by measurements. Guards shall be verified by functional test.

5.2 Test for cone guarding the universal joints

The power take-off drive shaft shall rotate at the speed of 540 min^{-1}.

The power take-off drive shaft shall be coupled to a test fixture representing the master shield as shown in Figure 7. For this test, drive shafts with a nominal torque < 1000 Nm or a nominal transmitted power < 57 kW at 540 min^{-1} shall be tested, with the test fixture for PTO types 1 and 2. Drive shafts with a higher nominal torque or nominal transmitted power shall be tested with the test fixture for PTO type 3. Dimensions shall be in accordance with Table 2.

Dimensions in millimetres



Key

1 Test fixture
2 Universal joint
3 Wide angle universal joint

Figure 7 — Test fixture for PTO types 1, 2 and 3

Table 2 — Dimensions of test fixture for PTO types 1, 2 and 3.

Dimensions in millimetres

PTO type	n	P
1 and 2	85^{+2}	280^{+2}
3	105^{+2}	350^{+2}

The drive shaft and guard shall be moved with a cycle from the straight-line position in a horizontal plane to the maximum operational angle for universal and wide-angle universal joint and back. The maximum operational angles shall be specified by the manufacturer in the instruction handbook.

The movement shall be with a dwell period of (5 ± 2) s at the maximum angle position. 100 cycles shall be completed in (15 ± 3) min.

The PTO drive shaft guard is deemed to have passed the test if:

— the guard has no holes or deformation which leave the shaft unprotected;

— the guard has no breakage, crack, part separation.

6 Information for use

6.1 Instruction handbook

Comprehensive instructions and information on maintenance, transport and safe use, safe system of work, extra precautions and special equipment, shall be provided in the instruction handbook. It shall comply with 5.5 of EN 292-2:1991.

In particular the following points shall be emphasized:

a) explanation of symbols;

b) instructions on putting into service. When necessary, how to cut the guard and the shaft to the correct length to ensure that the necessary engagement required between the inner and outer profiles of the guards and shaft is maintained under all conditions of use;

c) precise instructions on the maintenance and lubrication of the guard, the shaft and the clutches (overrun device and/or torque limiter), if any;

d) the foreseen uses of the guard and the shaft including the maximum allowable angles in use from the straight-line position and the relationship between the size of the drive shaft and the type of master shield;

e) drive shaft shall not be used without a guard or with a damaged guard or without using the restraining member(s) correctly;

f) the need to use a support for the shaft when it is not in use, that is different from the restraining system and which does not cause such damage to the guard that the telescoping of the inner and outer tubes is prevented;

g) the necessity to replace any damaged part and to affix a warning against use of non-compatible parts;

h) the information about attachment of the restraining system;

i) the necessity to check in the instruction handbook of recipient machinery if the use of accessories such as torque limiter and/or overrun device is required, and how they are to be fitted;

j) the drive shaft and guard assembly shall not be used as a step;

k) the nominal power in kW to be transmitted by the drive shaft and the nominal speed of rotation shall be given in the instruction handbook;

l) the nominal torque of the drive shaft shall be given in the instruction handbook;

m) instructions for fitting the drive shaft onto the PTO of the tractor or self-propelled machine;

n) for mounted and semi-mounted implements it may be necessary to remove the drawbar of the tractor and for trailed machines to secure the lower links in a suitable position to avoid damage to the drive shaft guard;

o) instructions for the replacement of the guard.

6.2 Marking and warning

The following minimum information shall be marked legibly and indelibly on the guard:

— name and address of the manufacturer;

— designation of series or type;

— year of construction.

In addition, appropriate marking on the guard shall:

— indicate the end of the drive shaft that is to be linked to the tractor or the self-propelled machine.

The warnings shall be provided according to 5.4 of EN 292-2:1991 and ISO 11684:1995.

NOTE Example of pictogram is given in Figure 8.

Figure 8 — Example of pictogram illustrating "Read instruction handbook"

Annex A
(normative)

List of hazards

Table A.1 gives the list of hazards based on EN 292-1 and EN 292-2 and annex A of EN 292-2:1991/A1:1995.

The meaning of the different statements given in the last column (solutions given by this standard) of this Table are:

— "not relevant": the hazard does not apply to the machine;

— "dealt with": the hazard is significant. The measures given in the indicated clauses provide guidance for dealing with the hazard in accordance with the principles of safety integration of EN 292 ; that means:

  — elimination or reduction of the risk by design, as far as possible;

  — protection measures;

  — information for the residual risks.

— "partly dealt with": the hazard is significant for several parts of the machine. The measures given in the indicated clauses deal with this hazard for some of these parts. In the other parts where the hazard is significant, other measures, not included in this standard, will have to be applied in order to deal with this hazard;

— "not dealt with": the hazard is significant for the machine but has not been taken into account during the preparation of this European Standard.

Table A.1 — List of hazards

Hazards		Relevant clauses (informative)		Solutions given by this standard
		EN 292-1	EN 292-2	
1	**Mechanical hazards** (caused for example by : - shape - relative location, - mass and stability (potential energy of elements), - mass and velocity (kinetic energy of elements), - inadequacy of the mechanical strength, - accumulation of potential energy by : - elastic elements (springs), or - liquids or gases under pressure, or - vacuum of the machine parts or workpieces).	4.2	-	-
1.1	crushing hazard	4.2.1, 4.2.2	3.2	dealt with in 6.1
1.2	shearing hazard	4.2.1, 4.2.2	3.2, 4.1.1	dealt with in 4.1, 4.2, 4.4, 4.5
1.3	cutting or severing hazard	4.2.1, 4.2.2	3.2	dealt with in 4.1, 6.1
1.4	Entanglement hazard	4.2.1, 4.2.2	-	dealt with in 4.1, 4.2, 4.4, 4.5
1.5	drawing-in or trapping hazard	4.2.1	3.11, 4.1.1, 6.1.2	not relevant
1.6	impact hazard	4.2.1	-	not relevant
1.7	stabbing or puncture hazard	4.2.1	-	dealt with in 4.1, 4.2, 4.4, 4.5
1.8	friction or/abrasion hazard	4.2.1	3.3 b)	dealt with in 4.1, 4.2, 4.4, 4.5
1.9	high pressure fluid injection hazard	4.2.1	-	not relevant
1.10	ejection of parts (of machinery and processed material/workpieces)	4.2.2	3.8	not dealt with
1.11	loss of stability (of machinery and machine parts)	4.2.2	3.3, 6.2.5	not relevant
1.12	slip, trip and fall hazards in relationship with machinery (because of their mechanical nature)	4.2.3	6.2.4	dealt with in 6.1
2	**Electrical hazards**, caused for example by :	4.3	3.9	-
2.1	electrical contact (direct or indirect)	4.3	-	not relevant
2.2	Electrostatic phenomena	4.3	-	not relevant
2.3	thermal radiation or other phenomena such as ejection of molten particles, and chemical effects from short-circuits, overloads, etc.	4.3	-	not relevant
2.4	external influences on electrical equipment	4.3	3.4	not relevant

(continued)

Table A.1 (continued)

Hazards		Relevant clauses (informative)		Solution given by this standard
		EN 292-1	EN 292-2	
3	**Thermal hazards** resulting in :	4.4	3.6.3	-
3.1	burns and scalds, by a possible contact of persons, by flames or explosions and also by the radiation of heat sources	4.4	-	not relevant
3.2	health-damaging effects by hot or cold work environment	4.4	-	not relevant
4	**Hazards generated by noise**, resulting in :	4.5	3.6.3	-
4.1	hearing losses (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	4.5	-	not relevant
4.2	interference with speech communication, acoustic signals, etc.	4.5	-	not relevant
5	**Hazards generated by vibration** (resulting in a variety of neurological and vascular disorders)	4.6	3.6.3	not relevant
6	**Hazards generated by radiation,** especially by :	4.7	-	-
6.1	electrical arcs	-	-	not relevant
6.2	Lasers	-	-	not relevant
6.3	ionizing radiation sources	4.7	-	not relevant
6.4	machines making use of high frequency electromagnetic fields	-	-	not relevant
7	**Hazards generated by materials and substances processed, used or exhausted by machinery,** for example :	4.8	3.3 b)	-
7.1	hazards resulting from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	4.8	-	not relevant
7.2	fire or explosion hazard	4.8	-	not relevant
7.3	biological and micro-biological (viral or bacterial) hazards	4.8	-	not relevant
8	**Hazards generated by neglecting ergonomic principles in machine design** (mismatch of machinery with human characteristics and abilities) caused for example by :	4.9	3.6	-
8.1	unhealthy postures or excessive efforts	4.9	3.6.1, 3.6.4	dealt with in 6.1
8.2	inadequate consideration of human hand-arm or foot-leg anatomy	4.9	3.6.2	dealt with in 4.4
8.3	neglected use of personal protection equipment	5.5	-	dealt with in 6.1
8.4	inadequate area lighting	-	3.6.5	not relevant
8.5	mental overload or underload, stress, etc.	4.9	3.6.4	not relevant
8.6	human error	4.9	3.6	dealt with in 4.1, 6.1, 6.2

(continued)

Table A.1 (concluded)

Hazards		Relevant clauses (informative)		Solutions given by this standard
		EN 292-1	EN 292-2	
9	**Hazard combinations**	4.10	-	not relevant
10	**Hazards caused by failure of energy supply, breaking down of machinery parts and other functional disorders**, for example :	5.2.2	3	-
10.1	failure of energy supply (of energy and/or control circuits)	3.16	3.7	not relevant
10.2	unexpected ejection of machine parts or fluids	-	3.8, 4	not dealt with
10.3	failure, malfunction of control system (unexpected start up, unexpected overrun)	3.15, 3.16, 3.17	3.7	not relevant
10.4	errors of fitting	-	-	dealt with in 4.1, 4.5, 6.1, 6.2
10.5	overturn, unexpected loss of machine stability	4.2.2	6.2.5	not relevant
11	**Hazards caused by (temporary) missing and/or incorrectly positioned safety related measures/means,** for example **:**	-	4	-
11.1	all kinds of guard	3.22	4.2	dealt with in 6.1, 6.2
11.2	all kinds of safety related (protection) devices	3.23	4.2	dealt with in 6.1, 6.2
11.3	starting and stopping devices	-	3.7	not relevant
11.4	safety signs and signals	-	3.6.7, 5.2, 5.3, 5.4	dealt with in 6.2
11.5	all kinds of information or warning devices	-	5.4	dealt with in 6.1, 6.2
11.6	energy supply disconnecting devices	-	6.2.2	not relevant
11.7	emergency devices	-	6.1	not relevant
11.8	feeding/removal means of workpieces	-	3.11	not relevant
11.9	essential equipment and accessories for safe adjusting and/or maintaining	3.3, 3.11	3.12, 6.2.1, 6.2.3, 6.2.6	dealt with in 4.5, 6.1
11.10	equipment evacuating gases, etc.	-	-	not relevant

Annex ZA
(informative)

Relationship of this document with EC Directives

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EC Directive(s):

— Machinery Directive 98/37/EC amended by Directive 98/79/EC.

Compliance with this document provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

WARNING Other requirements and other EC Directives may be applicable to the product(s) falling within the scope of this document.

Bibliography

[1] EN 1553:1999, *Agricultural machinery – Agricultural self-propelled, mounted, semi-mounted and trailed machines – Common safety requirements.*

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