IEC 60335-2-107

Edition 2.2 2021-11
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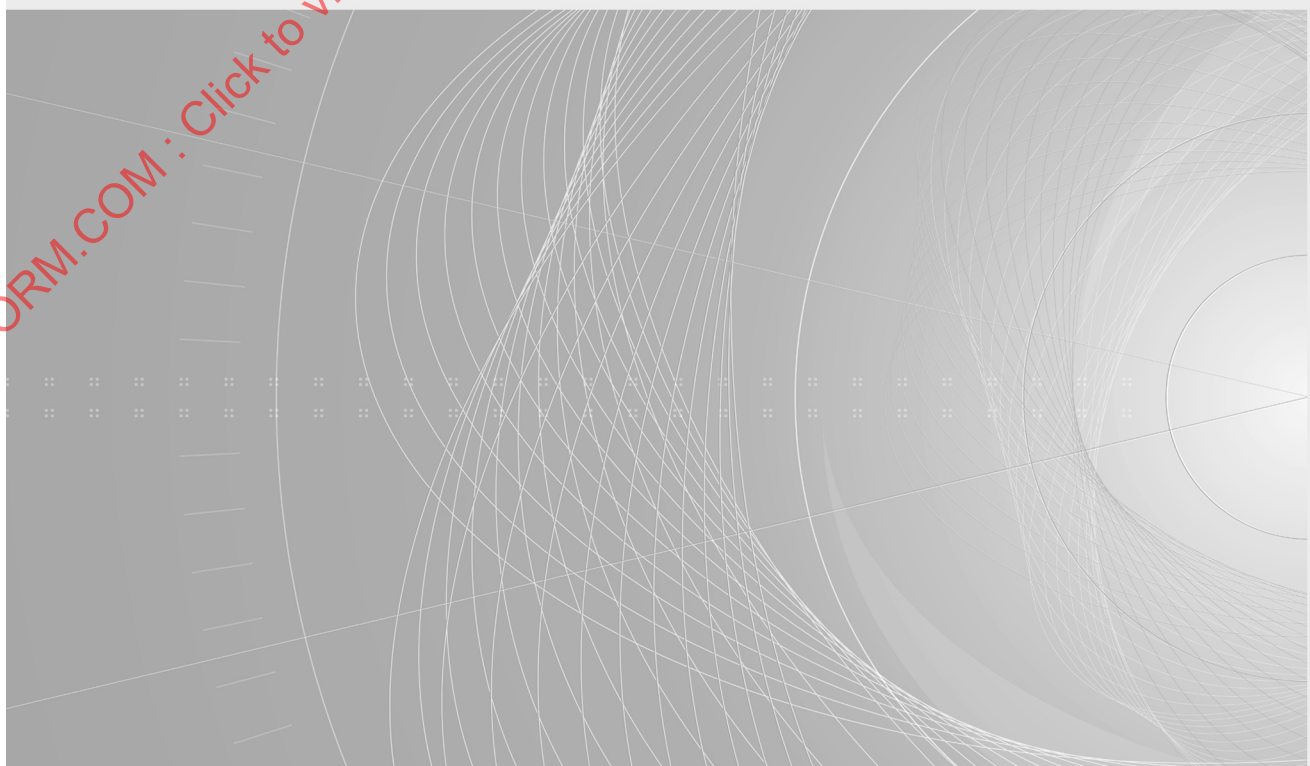
Household and similar electrical appliances – Safety – Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers



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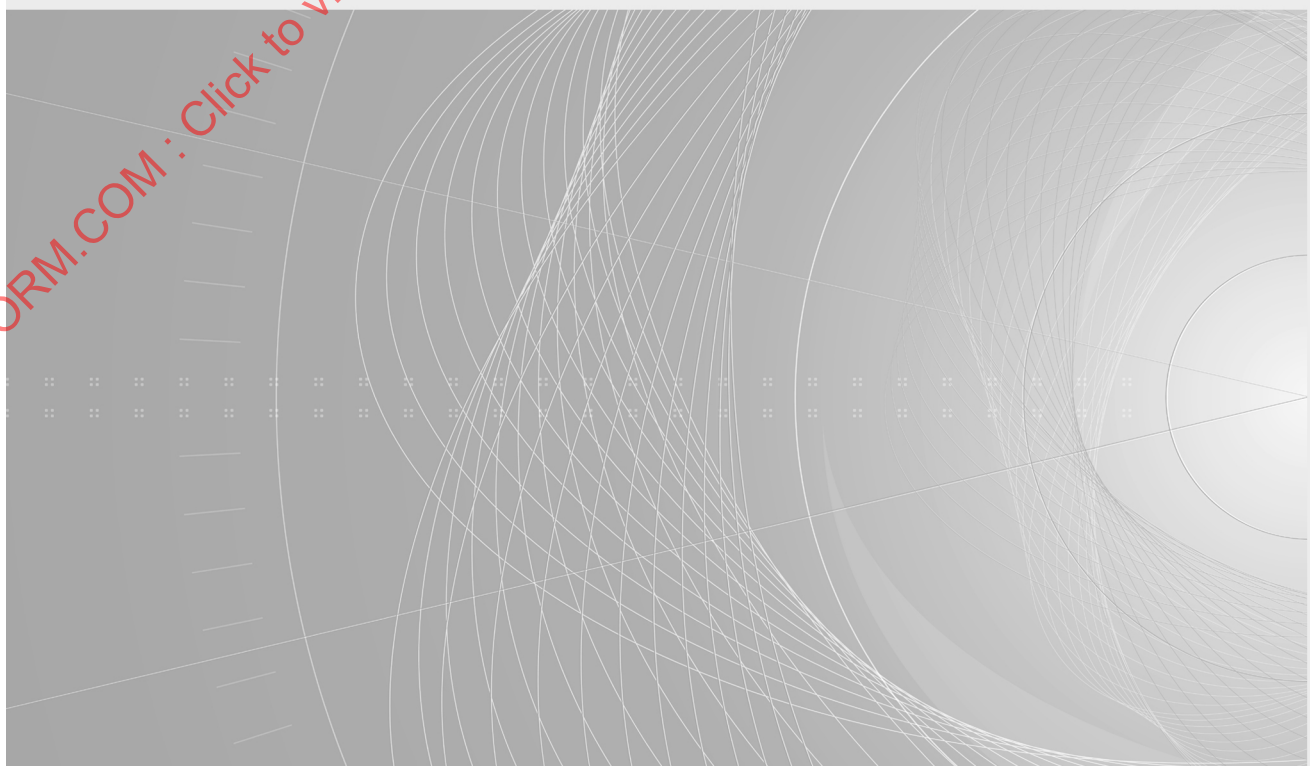

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers

FOREWORD

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This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60335-2-107 edition 2.2 contains the second edition (2017-12) [documents 116/350/FDIS and 116/354/RVD], its amendment 1 (2020-02) [documents 116/429/FDIS and 116/443/RVD] and its amendment 2 (2021-11) [documents 116/516/CDV and 116/540/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60335-2-107 has been prepared by IEC technical committee 116: Safety of motor-operated electric tools.

This second edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Clause 7: Markings and instructions, new requirements for markings, warnings and the instruction manual;

b) Clause 8: Protection against access to live parts, new requirements for protection against electric shock for hazardous battery voltages;

c) Clause 20: Stability and mechanical hazards, revised requirements for manual controller, manual stop, cutting means stopping time, traction drive stopping and restart procedures, as well as a new standing child foot probe test;

d) Clause 22: Construction, revised requirements for disabling devices, working area, perimeter delimiter, sensors and manual controller, as well as new requirements for machine connectors used for charging and contact surfaces used as obstruction sensing devices;

e) Clause 24: Components, revised requirements for switches;

f) Clause 29: Clearances, creepage distances and solid insulation, revised requirements for the machine and non-mains-powered peripherals.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This Part 2-107 is to be used in conjunction with the fifth edition (2010) of IEC 60335-1 and its amendments.

NOTE When “Part 1” is mentioned in this standard, it refers to IEC 60335-1.

This Part 2-107 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert it into the IEC standard: Particular requirements for robotic battery powered electrical lawnmowers.

When a particular subclause of Part 1 is not mentioned in this Part 2-107, that subclause applies as far as is relevant. Where this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

The following print types are used:

– requirements: in roman type;

– *test specifications: in italic type;*

– notes: in small roman type.

The terms defined in Clause 3 are printed in **bold typeface**.

Subclauses, notes and figures which are additional to those in Part 1 are numbered starting from 101. Additional annexes are lettered AA, BB, etc.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 36 months from the date of publication.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

It has been assumed in the drafting of this document that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This document recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of machines when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of machines.

This document takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the machine is connected to the supply mains. However, national wiring rules may differ.

If a machine within the scope of this document also incorporates functions that are covered by another Part 2 of IEC 60335, the relevant Part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a Part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the Part 2 standards have determined that it is not necessary to specify particular requirements for the machine in question over and above the general requirements.

This standard series is a product family standard series dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 2 Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards. For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or Part 2 documents.

A machine that complies with the text of this document will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

A machine employing materials or having forms of construction differing from those detailed in the requirements of this document may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the document.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers

1 Scope

Replacement:

This document specifies safety requirements and their verification for the design and construction of **robotic battery** powered electrical **rotary lawnmowers** and their **peripherals** with the **rated voltage** of the **battery** being not more than 75 V d.c.

EMC and environmental aspects, except noise, have not been considered in this standard.

This document does not apply to the additional risks associated with internal combustion engine(s), hybrid and fuel cell powered machines and associated charging systems.

This document deals with all the significant hazards presented by **battery** powered **robotic lawnmowers** and their **peripherals** when they are used as intended and under conditions of misuse which are reasonably foreseeable.

Throughout this document, the term machine is used to refer to the **robotic lawnmower**, separate from its **charging station**.

This document also provides requirements for the safety of mains powered **charging stations** and signal sources for **perimeter delimiters**.

Additional **battery** operation and charging requirements for **robotic lawnmowers**, including the charging of lithium ion batteries, are specified in Annex KK which replaces Annexes B and S (except for requirements for non-rechargeable **batteries**) of Part 1.

This document is not applicable to machines which are manufactured before the date of publication of this document by IEC.

NOTE Informative Annex FF is provided as a test code for convenience to the users of this document.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

~~IEC 60335-2-29:2016, *Household and similar electrical appliances – Safety – Part 2-29: Particular requirements for battery chargers*~~

IEC 62133 (all parts), *Secondary cells and batteries containing alkaline or other non-acid electrolytes- safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*

ISO 354:2003, *Acoustics – Measurement of sound absorption in a reverberation room*

ISO 683-4:2014, *Heat-treatable steels, alloy steels and free-cutting steels – Part 4: Free-cutting steels*

ISO 3744:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane*

ISO 3767-1, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment – Symbols for operator controls and other displays – Part 1: Common symbols*

ISO 3767-3, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment – Symbols for operator controls and other displays – Part 3: Symbols for powered lawn and garden equipment*

ISO 4871:1996, *Acoustics – Declaration and verification of noise emission values of machinery and equipment*

ISO 7000:2014, *Graphical symbols for use on equipment – Index and synopsis*

ISO 7010:2011, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 8295:1995, *Plastics – Film and sheeting – Determination of the coefficients of friction*

ISO 11201:2010, *Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11203:1995, *Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

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

ISO 11688-1, *Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 1: Planning*

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

This clause of Part 1 is applicable except as follows.

3.5.1 *Addition:*

Note 101 to entry: Machines and **charging stations** are not considered to be **portable appliances**.

3.5.4 *Addition:*

Note 101 to entry: Machines are not considered to be **fixed appliances**. **Charging stations** are considered to be **fixed appliances**.

3.101
automatic mode
autonomous operation of the machine without the use of a **manual controller**

Note 1 to entry: Operation of the machine without the use of a **manual controller** and without the **cutting means** operating during set up of the **working area** is considered not to be operation in **automatic mode**.

3.102
battery
assembly of one or more **cells** intended to provide electrical current to the machine

3.103
cell
basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy

3.104
charging station
automatic **battery** charging facility located on or within the **working area**

3.105
control
means or device which will control the operation of the machine or any specific operating function thereof

3.106
cutting means
mechanism used to provide the cutting action

Note 1 to entry: The term “blade” can be used in warnings and instructions to denote “**cutting means**”.

3.107
cutting means enclosure
part or assembly which provides the protective means around the **cutting means**

3.108
cutting means tip circle
path described by the outermost point of the **cutting means** as it rotates about its shaft axis

3.109
cutting position
any height setting of the **cutting means** designated by the manufacturer for cutting grass

3.110
disabling device

3.110.1
disabling device (removable)
part, such as for example a key, which prevents operation of the **lawnmower** when it is removed

3.110.2
disabling device (code protected)
device which, when operated, prevents operation of the **lawnmower** and requires a coded input (such as via a keypad) before it can operate

Note 1 to entry: See 22.103.

3.111
discharge chute
extension of the **cutting means enclosure** from the **discharge opening**, generally used to control the discharge of material from the **cutting means**

3.112
discharge opening
gap or opening in the **cutting means enclosure** through which grass may be discharged

3.113
fully charged (battery/cell)
cell or **battery** charged to the maximum state of charge permitted by the **battery charging system** intended for use with the machine

3.114
fully discharged (battery/cell)
battery or **cell** that has been discharged at $\mathbf{C_5}$ **rate** until one of the following conditions occurs: discharge terminates due to protective circuitry or the **battery** (or **cell**) reaches a total voltage with an average voltage per **cell** equal to the end-of-discharge voltage for the **cell** chemistry being used unless a different end-of-discharge voltage is specified by the manufacturer

Note 1 to entry: The end-of-discharge voltages for common **cell** chemistries are provided in KK.5.10.

3.115
general purpose (batteries/cells)
batteries and **cells** available from a variety of manufacturers, through a variety of outlets intended for a variety of different manufacturers' products

Note 1 to entry: 12 V automotive **batteries** and AA, C and D alkaline **cells** are examples of **general purpose**.

3.116
grass catcher
part or combination of parts which provides a means for collecting grass clippings or debris

3.117
guard
part of the machine or a component incorporated to provide protection for the operator and/or bystander by means of a physical barrier

3.118
hazardous voltage
voltage between parts having an average value exceeding 60 V d.c. or exceeding 50 V peak when the peak-to-peak ripple exceeds 10 % of the average value

3.119
intended use
any use of the machine which is reasonably foreseeable, as described in the instruction manual, and which is consistent with such activities as cutting grass, starting, stopping, or connecting to (or disconnecting from) a source of power

3.120
lawnmower
grass-cutting machine where the **cutting means** operates in a plane approximately parallel to the ground and which uses the ground to determine the height of cut by means of wheels, air cushion or skids, etc., and which utilises an electric motor for a **power source**

3.121
manual controller
device supplied by the manufacturer either connected by a wire or wireless that allows manual operation of the machine

3.122
manual stop
manually actuated device using software-based or hardware-based components that overrides all other **controls** and removes power to the motor(s) and brings all moving parts to a stop

3.123
maximum operating motor speed
the highest motor speed obtainable when adjusted in accordance with the manufacturers specifications and/or instructions, with the **cutting means** engaged

3.124
mulching lawnmower
rotary lawnmower without **discharge openings** in the **cutting means enclosure**

3.125
operator control
any **control** requiring operator actuation to perform specific functions

Note 1 to entry: This includes **controls** on a **manual controller**.

3.126
operator presence control
control on a **manual controller** designed so that it will automatically interrupt the **cutting means** when the operator's actuating force is removed

3.127
perimeter delimiter
device(s) that defines the perimeter of the **working area** within which the machine can operate automatically

Note 1 to entry: An example of a **perimeter delimiter** is a boundary wire that emits a signal to indicate the limit of the **working area**.

3.128
peripherals
equipment additional to the machine itself that is provided by the manufacturer for intended use of the machine, e.g. charging station(s), manual controller, signal source for **perimeter delimiter**

3.129
power source
motor which provides mechanical energy for linear or rotational movement

3.130
remote setting device
setting device which is not connected by wire to the machine and designed to set the basic functions of the machine

Note 1 to entry: A **remote setting device** is not a **manual controller**.

3.131
robotic lawnmower
unattended **lawnmower** that operates automatically

Note 1 to entry: When the term 'machine' is used in the text of this standard, it is used to denote a **robotic lawnmower**.

3.132
rotary lawnmower
lawnmower in which the **cutting means**, cutting by impact, rotate about an axis (axes) normal to the cutting plane

3.133
sensor
device that responds to physical stimuli (such as, but not limited to, heat, light, sound, pressure, magnetism, motion) and transmits the resulting signal or data providing a measurement, operating a **control**, or both

3.133.1
lift sensor
device that senses when all or part of the machine is lifted from the ground

3.133.2
obstruction sensor
device that senses when the machine contacts a person or an obstruction

3.133.3
tilt sensor
device that senses when the machine is at or above a predetermined angle of incline

3.133.4
rollover sensor
device that senses when the machine is inverted

3.134
stopping time
time elapsed between the instant when either a **sensor** is activated or the actuator on a **manual controller** is released and the instant at which the machine or component comes to a stop

3.135
thrown object hazard
potential for injury caused by object(s) propelled by the moving **cutting means**

3.136
traction drive
means (system) used to transmit power from the **power source** to the ground drives means

3.137
working area
any defined area in which the machine can function automatically

3.138
switched circuit
circuit that is a low-power circuit when the **power switch** is in the "off" position

Note 1 to entry: The requirements for a low-power circuit are given in 19.11.1.

3.139
power switch
device that electrically activates the **cutting means** and/or **traction drive** of the machine in the "on" position and deactivates the same function of the machine in its "off" position

Note 1 to entry: The device is comprised of all primary and ancillary components (e.g. tactile switch, relays, load switches) of the electrical control circuit that activates the **cutting means** and/or **traction drive** of the machine.

4 General requirement

This clause of Part 1 is applicable.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.1 *Addition:*

Where an electronic speed **control** device can be adjusted, it is set for the highest speed.

5.2 *Modification*:

A new sample shall be used for each of the tests of Clause 21. However, at the manufacturer's discretion, fewer samples may be used.

Addition:

*The cumulative stress resulting from successive tests on the **battery** is to be avoided.*

If several tests are conducted on a single sample, then the results shall not be affected by previous tests.

5.8.1 *Replacement:*

*Unless otherwise specified, a **fully charged battery** shall be used for each test. Where for consecutive tests the same **battery** is specified, there shall be a minimum of 1 min rest time between tests.*

5.17 *Replacement:*

*Machines and **peripherals** powered by rechargeable **batteries** are evaluated to the additional requirements in Annex KK.*

***Peripherals** powered by **batteries** that are non-rechargeable are tested in accordance with Annex S.*

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 *Replacement:*

This subclause is not applicable for machines and non-mains-powered **peripherals**.

NOTE ~~101~~ Machines and non-mains-powered **peripherals** covered by this standard are limited to those where the only power source is a **battery** and are therefore considered not to be a **class I appliance**, **class II appliance**, or a **class III appliance** and are not required to have **basic insulation**, **supplementary insulation** or **reinforced insulation**. Electric shock hazard is considered to exist only between parts of opposite polarity where **hazardous voltage** is present.

Mains-powered **peripherals** shall be of one of the following classes with respect to protection against electric shock:

– ~~with a **rated voltage** above 42 V shall be~~ **class II appliance**;

– ~~supplied with **SELV** shall be at least~~ **class III appliance**.

Compliance is checked by inspection and by the relevant tests.

6.2 *Addition:*

Enclosures of machines shall be at least IPX1, except enclosures containing parts having a **working voltage** that is a **hazardous voltage**, which shall be at least IPX4. Enclosures of **charging stations** and other **peripherals** intended to be installed outdoors~~, if of **class III construction**, shall be at least IPX1 or shall otherwise be at least IPX4~~ (e.g. a signal source for a **perimeter delimiter**) shall be at least IPX1 if of **class III construction**. Constructions other than **class III construction** shall be at least IPX4.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 *Replacement:*

Machines and **peripherals** shall be marked as indicated below and additionally, as required, by 7.1.101. Additional markings are allowed provided they do not give rise to misunderstanding. Warnings shall be located in easily visible positions. If the first numeral for the IP numbering is omitted, the omitted numeral shall be replaced by the letter X, for example IPX4.

On the machine:

– IP number according to degree of protection against ingress of water, other than IPX0;

– symbol IEC 60417-5180 (2003-02), for **class III appliances**, if treated as a **class III** appliance during charging. This marking is not necessary for machines that are operated only by batteries (primary batteries or secondary batteries that are recharged outside of the machine);

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– the mass of the machine if it is greater than 25 kg;

– designation of the machine, where designation of the machine may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as “battery powered robotic lawnmowers” etc. in the instructions supplied with the machine.

NOTE 1 An example of such code is “A123B”.

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the machine;

NOTE 2 The term “designation of series or type” is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 3 For machines and their related products intended to be put on the market in the EEA, CE-marking as defined in the applicable European Directive(s), e.g. the Machinery Directive.

– cutting width in centimetres.

– “WARNING – Read instruction manual before operating the machine”.

– “WARNING – Keep a safe distance from the machine when operating”.

– “WARNING – Do not ride on the machine”.

– “WARNING – Remove (or operate) the **disabling device** before working on or lifting the machine”.

NOTE 4 Use “Remove” or “Operate” as appropriate to the type of **disabling device** that is fitted to the machine.

– “WARNING – Do not touch rotating blade”.

– where replaceable during normal use, the **cutting means** shall be marked to identify the part number(s) and the manufacturer, importer or supplier. This marking is not required to be clearly discernible from the outside of the machine;

NOTE 5 In Canada and the United States of America, the above **cutting means** marking is not applicable.

– if a **grass catcher** requires an adapter to be used, instructions shall be affixed to the machine near the **discharge opening** and to the **grass catcher** adapter stating that the machine shall not be operated without the adapter and **grass catcher** in place.

On the **charging station** and other mains powered **peripherals**, even if of **class III**:

– **rated voltage** or **rated voltage range** in volts;

– symbol for nature of supply, unless the rated frequency is marked;

– **rated power input** in watts or **rated current** in amperes;

– symbol IEC 60417-5172 (2003-02) for **charging stations** having parts of **class II construction**;

– symbol IEC 60417-5180 (2003-02) for **charging stations** having parts of **class III construction**;

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– designation of the **charging station** or **peripheral**, where designation of the **charging station** or **peripheral** may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as “charging station” etc. in the instructions supplied with the machine;

NOTE 6 An example of such code is “A123B”.

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the **charging station** or **peripheral**;

NOTE 7 The term “designation of series or type” is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 8 ~~For machines and their related products intended to be put on the market in the EEA, CE-marking as defined in the applicable European Directive(s), e.g. the Machinery Directive.~~ Void

On the **manual controller**, for machines equipped with a **manual controller**, except when permanently connected to the machine:

– symbol IEC 60417-5172 (2003-02) for **class II appliances** only;

– symbol IEC 60417-5180 (2003-02), for **class III appliances**. This marking is not necessary for **manual controllers** that are operated only by batteries (primary batteries or secondary batteries that are recharged outside of the **manual controller**);

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– designation of the **manual controller**, where designation of the **manual controller** may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as “manual controller” etc. in the instructions supplied with the machine;

NOTE 9 An example of such code is “A123B”.

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the **manual controller**;

NOTE 10 The term “designation of series or type” is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 11 ~~For machines and their related products intended to be put on the market in the EEA, CE-marking as defined in the applicable European Directive(s), e.g. the Machinery Directive.~~ Void

– “WARNING – Read instruction manual before operating the machine”.

– “WARNING – Keep a safe distance from the machine when operating”.

The required markings on **manual controllers** may be incorporated into an electronic display, provided the markings are continuously displayed during manual control.

Compliance is checked by inspection.

7.1.101 Marking giving cautionary information shall be located as close as practicable to the relevant hazard. Such marking shall be in one of the official languages of the country in which the machine is to be sold. Instead of written markings, symbols according to Annex EE are allowed. Symbols according to ISO 3767-1, ISO 3767-3, ISO 11684 and ISO 7010:2011 may also be used as appropriate. Contrasting colours shall be used unless the symbols are cast, embossed or stamped when colours are not required.

Class II appliances and **class III appliances** incorporating a functional earth shall be marked with the symbol IEC 60417-5018 (2011-07).

Controls which may give rise to a hazard (e.g. **operator presence controls** in accordance with 20.101.1) when operated shall be marked or so placed as to indicate clearly which part of the machine they control.

Where a **guard** is designed to be opened or removed and which exposes a hazard, a safety sign warning of the hazard shall be located on the **guard** or adjacent to the **guard**.

Compliance is checked by inspection.

7.6 *Addition:*

Additional symbols are shown in Annex EE.

7.8 *Addition:*

If a **cell** or **battery** is intended to be replaced by the user and it is possible for it to be put in a reverse polarity then the correct location and polarity shall be marked at its intended location.

7.9 *Modification:*

Replace the first paragraph by the following:

Operator controls shall have the function, direction and/or method of operation clearly identified by a durable label or mark.

The **manual stop** shall be marked with the word "STOP" and be coloured red, no other externally visible **controls** shall be coloured red.

7.11 *Replacement:*

Controls intended to be adjusted during installation or **intended use** shall be provided with an indication for the direction of adjustment.

NOTE An indication of + and – is considered to be sufficient.

Compliance is checked by inspection.

7.12 *Replacement:*

An instruction manual shall be supplied with the machine, giving operating, servicing, maintenance and safety instructions that comply as appropriate with 6.4 of ISO 12100:2010. The words 'Original instructions' shall appear on the language version(s) verified by the manufacturer or his authorized representative. Where no 'Original instructions' exist in the official language(s) of the country where the machine is to be used, a translation into that/those language(s) shall be provided by the manufacturer or his authorized representative or by the person bringing the machine into the language area in question. The translations shall bear the words 'Translation of the original instructions', and they shall be accompanied by a copy of the 'Original instructions'.

This instruction manual shall include:

a) a repeat of those warnings required to be marked on the machine together with further explanation, where appropriate. Where safety signs are used in the marking on the machine, their function shall be explained;

b) a warning to never allow children, persons with reduced physical, sensory or mental capabilities or lack of experience and knowledge or people unfamiliar with these instructions to use the machine, local regulations may restrict the age of the operator;

c) a warning, not to allow children to be in the vicinity or play with the machine when it is operating;

d) a general description of the machine and its **peripherals**, the **intended use**, instructions for the proper use of the machine including advice on what the machine and its **peripherals** should be used for, how to use it for the intended purpose(s) and any reasonably foreseeable misuse thereof;

e) warnings concerning ways – that experience has shown might occur – in which the machinery shall not be used;

f) instructions for the proper assembly and disassembly of the machine and its **peripherals** for use, if the machine and/or its **peripherals** are not supplied in a completely assembled form;

g) instructions for proper adjustment and any necessary **user maintenance** of the machine and its **peripherals**, including timescales and a warning of the danger of moving hazardous parts;

h) instructions for the proper setting out the perimeter of the **working area**;

i) instructions for the recommended replacement or repair of, or service attention to, critical components. Where parts are consumable, the spare part shall be clearly identified, e.g. by the use of a part number or other means;

j) instructions on the operation of all **controls**;

k) information how to start and operate the machine safely;

l) instructions for the operating position and the correct and safe operation of the machine and its **peripherals** such as moving, safe positioning, handling, clearing blockages, and if a collecting facility is provided keeping the **discharge chute** clear of processed material, for use, preparation, maintenance and storage of the machine;

m) an advice during manual control to not overreach and to maintain balance at all times, to always be sure of footing on slopes and to walk, never run while operating the machine or its **peripherals**, if applicable;

n) a warning not to touch moving hazardous parts before these have come to a complete stop;

o) details of the **battery** charger to be used and advice on the safe disposal of **batteries** at the end of their life;

p) if designed for use with an extension cord, an advice on the use, length and type of extension cords to be used (not lighter than required by Subclause 25.7);

q) if a collecting facility is provided with the machine, instructions for when and how to attach and detach the collection device to and from the machine;

r) instructions for fitting and use of attachments, if any;

s) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;

t) instructions to always wear substantial footwear and long trousers while operating the machine with a **manual controller**;

u) instructions to disconnect the supply (e.g. remove the plug from the mains or remove/operate the **disabling device**)

- before clearing a blockage on the machine;
- before checking, cleaning or working on the machine or **charging station**;
- after striking a foreign object to inspect the machine for damage;
- if the machine starts to vibrate abnormally, and to check for damage before restarting;

v) instructions when, where and how to inspect the machine and its **peripherals**, the supply and extension cord for signs of damage or ageing and, if permitted, how to make repairs;

w) a warning never to operate the machine and/or its **peripherals** with defective **guards** or shields, or without safety devices, or if the cord is damaged or worn;

x) an advice not to connect a damaged cord to the supply or touch a damaged cord before it is disconnected from the supply for the reason that damaged cords can lead to contact with **live parts**;

y) advice to keep any supply and/or extension cords away from the **working area** to avoid damage to the cords which can lead to contact with **live parts**;

z) instructions on the action to take in the event of accident or breakdown;

aa) instructions on the action to take in the event of leakage of electrolyte;

bb) instructions how to disconnect the **peripherals** from the mains, if the cord becomes damaged during use;

cc) recommendations

- to connect the **peripherals** only to a supply circuit protected by a residual current device (RCD) with a tripping current of not more than 30 mA;

NOTE It is possible to replace the term “residual current device (RCD) with a tripping current of not more than 30 mA” with the term “class A ground fault circuit interrupter (GFCI)”.

- to avoid using the machine and its **peripherals** in bad weather conditions especially when there is a risk of lightning;

dd) information about airborne noise emissions of the machine according to Annex FF. This includes:

- the A-weighted emission sound pressure level L_{pA} and its uncertainty K_{pA} as determined according to Annex FF, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact shall be indicated;
- the A-weighted sound power level emitted by the machinery L_{WA} and its uncertainty K_{WA} as determined according to Annex FF, where the A-weighted sound pressure level L_{pA} exceeds 80 dB(A);

ee) instructions how to proceed in case of abnormal vibrations;

ff) mass in kilograms;

gg) information for machines used in public areas, that warning signs shall be placed around the **working area** of the machine. They shall show the substance of the following text:

"Warning! Automatic lawnmower! Keep away from the machine! Supervise children!"

7.12.1 This subclause of Part 1 is applicable.

7.12.2 This subclause of Part 1 is not applicable.

7.12.3 This subclause of Part 1 is not applicable.

7.12.4 This subclause of Part 1 is not applicable.

7.12.5 This subclause of Part 1 is applicable.

7.12.6 This subclause of Part 1 is applicable.

7.12.7 This subclause of Part 1 is not applicable.

7.12.8 This subclause of Part 1 is not applicable.

8 Protection against access to live parts

This clause of Part 1 is applicable, except as follows.

8.1 This subclause of Part 1 is

- applicable for **charging stations** and **perimeter delimiter**; and
- not applicable for machines, **manual controllers** and **remote setting devices**.

8.2 This subclause of Part 1 is

- applicable for **charging stations** and **perimeter delimiter**; and
- not applicable for machines, **manual controllers** and **remote setting devices**.

8.101 **Protection against electric shock**

8.101.1 Machines and their **battery** packs shall be so constructed and enclosed that there is adequate protection against electric shock.

Compliance is checked by inspection and by the requirements of 8.101.2 and 8.101.3, as applicable.

8.101.2 It shall not be permissible to have two conductive, simultaneously **accessible parts** where there is **hazardous voltage** between them unless they are provided with an impedance that limits current to a safe value.

In the case of an impedance that limits current to a safe value, the short circuit current between the parts shall not exceed 2 mA for d.c. or 0,7 mA peak for a.c. and there shall not be more than 0,1 μF capacitance directly between the parts.

Compliance for accessibility is checked by applying the test probe B of IEC 61032:1997 to each conductive part.

The test probe B of IEC 61032:1997 is applied with a force not exceeding 5 N through openings to any depth that the test probe will permit, and it is rotated or angled before, during and after insertion to any position.

If the opening does not allow the entry of the probe, a rigid test probe with the dimensions of the test probe B of IEC 61032:1997, but without any articulation, is used, the force on the probe is increased to 20 N and the test with the articulated test probe B of IEC 61032:1997 is repeated.

*Contact with the test probe is determined with all **detachable parts** removed and the machine operated in any position of **intended use**.*

*Lamps located behind detachable covers are not removed, providing the lamp may be de-energized by means of a user operable plug, **battery** pack disconnection or a switch.*

8.101.3 Materials providing insulation from electric shock shall be adequate.

Compliance is checked by subjecting the insulating material to an electric strength test as specified in 16.3, but with a test voltage of 750 V. This provision does not exclude the testing of the material as situated within the machine, providing care is taken to ensure that materials not under consideration are not subjected to the test voltage.

*This test applies only to materials which, if they were to fail to insulate, would subject the user to a shock hazard from a **hazardous voltage**. This test does not apply to materials that provide only a physical barrier to contact. As such, an uninsulated energized part shall be within 1,0 mm of the material surface to be considered for this requirement.*

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

This clause of Part 1 is not applicable.

11 Heating

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

14 Transient overvoltages

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

15 Moisture resistance

This clause of Part 1 is applicable except as follows.

15.1 *Addition:*

*The machine shall be tested according to its IP rating both separately and while in its **charging station**.*

*The **charging station** shall be tested according to its IP rating both separately and while the machine is in its charging position.*

*Compliance for the machine and **charging station** is assessed individually according to its IP rating. The test of 16.3 is not performed on the machine.*

15.1.2 *Modification:*

*Machines or **peripherals** classified as IPX4 shall be rotated during the test along its vertical axis. The rate of rotation shall be 1,2 ± 0,2 r/min.*

15.2 *Addition:*

*Machines or **peripherals** fitted with an appliance inlet or cable coupler shall be tested with the appropriate mating connector in place.*

Air filters are not removed.

15.3 This subclause is not applicable, except for mains-powered **peripherals**.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 This subclause is not applicable, except for mains-powered **peripherals**.

16.2 This subclause is not applicable, except for mains-powered **peripherals**.

16.3 *Replacement of the first paragraph:*

*For mains-powered **peripherals**, immediately after the test of 16.2, the insulation is subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min in accordance with IEC 61180-1. The values of the test voltage for different types of insulation are given in Table 7.*

*For machines and non-mains powered **peripherals**, as required by the test of 8.101.3, the insulation is subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min in accordance with IEC 61180-1. The values of the test voltage are given in 8.101.3.*

17 Overload protection of transformers and associated circuits

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

18 Endurance

This clause of Part 1 is not applicable.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.1 *Addition to the first paragraph:*

This includes leakage of electrolyte from the **battery**.

19.7 This subclause is not applicable.

19.8 This subclause is not applicable.

19.9 This subclause is not applicable.

19.10 This subclause is not applicable.

19.11 *Addition:*

The first fault may be applied at any time. If an additional fault in a protective electronic circuit has to be applied, it shall not be applied before a new operating cycle of the machine. This sequence of applied failures is also applicable for the tests specified in Clause 20 and 22 if tests according 19.11.2 are required.

This subclause is not applicable for lithium-ion **charging systems**.

NOTE 101 The requirements for lithium-ion **charging systems** are specified in KK.19.1.

19.11.1 This subclause is not applicable for lithium-ion **charging systems**.

19.11.2 This subclause is not applicable for lithium-ion **charging systems**.

19.11.3 *Addition:*

*However the test is not repeated, if the **protective electronic circuit** provides a non-self-resetting interruption of the supply of the machine's part that would render the machine unsafe during the relevant test.*

This subclause is not applicable for lithium-ion **charging systems**.

19.11.4 This subclause is not applicable for lithium-ion **charging systems**.

19.11.4.1 to 19.11.4.8 These subclauses are not applicable for lithium-ion **charging systems**.

19.14 This subclause is not applicable, except for mains-powered **peripherals**.

19.15 This subclause is not applicable, except for mains-powered **peripherals**.

20 Stability and mechanical hazards

This clause of Part 1 is applicable except as follows.

20.1 This subclause is not applicable.

20.2 *Replacement:*

To prevent unexpected operation which may result in a hazard, the **cutting means** shall not start until either,

a) the machine is restarted as described in the restart procedure in 20.102.6; or

b) the **cutting means** start-up indication procedure as described in 22.110 is completed; or

c) for manual control, as described in 20.101.1.

All power driven components except the **cutting means** and the ground contacting parts shall be guarded to prevent inadvertent contact. Any apertures or safety distances shall comply with 4.2.4.2 and 4.2.4.3 of ISO 13857:2008.

To prevent inadvertent access to the **cutting means** these are guarded by the **cutting means enclosure**. The **cutting means enclosure** shall comply with the requirements of 20.102.1 and 20.102.4.

All **guards**, including the **cutting means enclosure** as specified in 20.102.1, shall be permanently attached to the machine and shall not be detachable without the use of **tools**. Exceptions to this are the opening of or removing interlocked **guards** which disable the protected moving parts, as specified in 20.102.1.2.

Fixed **guards** that the user is instructed to remove for regular maintenance shall have their fixing means retained on either the **guard** or the body of the machine.

After restoring an interlocked **guard** to its normal position, restarting the **cutting means** and **traction drive** shall only be possible by fulfilling the requirements of the restart procedure in 20.102.6.

Compliance is checked by inspection and by measurement.

20.101 Controls

20.101.1 Manual controller

Manual controllers, if any, shall be fitted with an **operator presence control** on the **manual controller** which will automatically stop rotation of the **cutting means** when the operator's hands are removed. This may be accomplished either by stopping the drive motor or by an intermediate clutch/brake mechanism. Starting of the **cutting means** shall require two separate and dissimilar actions, one of which shall be the actuation of the **operator presence control**. If these actions can be carried out by using the same hand then the actions shall be totally distinct thus to prevent accidental "switch on".

Any actuator on the **manual controller** for the **traction drive** shall automatically stop or disengage the **traction drive** when the operator releases the actuator.

During manual operation, the **obstruction sensor** and the **sensor** detecting when the machine is outside the **working area** may be deactivated, the **lift sensors, tilt sensors** and **rollover sensors** shall remain functional.

If a **manual controller** is provided, it shall meet the requirements of 22.107 and 21.101.5.

Compliance is checked by inspection, by practical tests and by the tests of 22.107 and 21.101.5.

20.101.2 Remote setting device

If a **remote setting device** is provided it may be used to carry out "off-machine" adjustments of the settings, movement within the **working area**, as well as starting and stopping the machine in **automatic mode**.

A **remote setting device** shall maintain all of the requirements for automatic operation.

Compliance is checked by inspection and by practical test.

20.101.3 Void

20.101.4 Manual stop

A single action clearly identifiable **manual stop** shall be provided on the machine in a prominent position on the top surface. The actuator of the **manual stop** shall have at least 20% of its surface raised at least 5 mm above the immediate surrounding area. The minimum width of the immediate surrounding area shall be not less than 15 mm. The geometric minor dimension of the actuator of the **manual stop** shall be not less than 35 mm and the surface area of the actuator shall be not less than 700 mm^2.

The operating force of the actuator of the **manual stop** shall not exceed 30 N on any part of its surface that is raised at least 5 mm above the immediate surrounding area.

The **manual stop** shall override all other **controls** and cause the **traction drive** to stop as specified in 20.102.5.2 and the **cutting means** in accordance with 20.102.2.

*Compliance is checked by inspection and by measurement, and if the compliance relies on the operation of an **electronic circuit**, it is checked under the following conditions applied separately:*

1) *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*
2) *the electromagnetic phenomena tests of Clause 19.11.4.1 and 19.11.4.2 applied to the machine.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

Restarting of the mower following a **manual stop** shall only be possible after the restart procedure in 20.102.6 is completed.

Compliance is checked by inspection and by practical tests.

20.102 Safety requirements

20.102.1 Cutting means enclosure

20.102.1.1 General

Except as allowed below, the **cutting means enclosure** shall extend at least 3 mm below the plane of the **cutting means tip circle**. The bolt heads of **cutting means** securing screws may extend below the **cutting means enclosure** providing these are located within the inner 50 % **cutting means tip circle** diameter.

Openings may be provided in the **cutting means enclosure**.

NOTE Requirements for inadvertent access to the **cutting means** are specified in 20.102.4.

Compliance is checked by inspection and by measurement.

This requirement shall not apply to machines where the **cutting means** is a generally circular drive unit on which is mounted one or more pivoting cutting elements or filament lines. These cutting elements shall rely on centrifugal force to achieve cutting and have a kinetic energy not exceeding 2 J per cutting element.

For the purposes of this clause, the kinetic energy of a pivoting cutting element shall be calculated according to Annex AA.

Compliance is checked by inspection, by measurement and by calculation.

20.102.1.2 Guards and grass catchers

Guards which have to be displaced in order to fit the **grass catcher** shall be interlocked to meet the requirements of 20.102.2. The **guards** shall be considered as forming part of the **cutting means enclosure**.

Compliance is checked by inspection and by practical tests.

20.102.2 Cutting means stopping time

The **cutting means** shall stop from their maximum rotational speed within 2 s if a **cutting means** stopping command is generated from any of the following:

– **tilt sensor**;

– **lift sensor**;

– ~~**rollover sensor**~~;

– **obstruction sensor** (when activated for more than 3 s according to 22.105.2);

– **manual stop** is activated;

– after the operator releases the **cutting means operator presence control**; or

– the opening of or removing interlocked **guards**, which disable the protected moving parts.

Compliance is checked by the tests of 20.102.2.1 to 20.102.2.3.

*If compliance relies on the operation of an **electronic circuit**, the compliance is checked under the following condition:*

*1) the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the **electronic circuit**;*

*The total **stopping time**, as a result of condition 1) and an attempted **cutting means** stopping command, shall either*

– *comply with the **stopping time** limit value above; or*

– *not exceed 0,1 joules (J) of rotational energy at the end of an interval of twice of the value given above. In this case, the test is repeated and either the **cutting means** stopping command shall comply with the **stopping time** limit value above or the **cutting means***

*shall be permanently disabled such that the **cutting means** cannot be reactivated by the operator and requires repair by qualified service personnel.*

The calculation of rotational energy shall be made using Annex AA or $E = ½Iω^2$ as appropriate.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

*For machines where the **cutting means stopping time** is not monitored by an **electronic circuit**, the durability test according to 20.102.2.2 and 20.102.2.3 shall be carried out.*

20.102.2.1 Cutting means stopping time test

*Prior to the test, the machine shall be assembled and adjusted according to the manufacturer's instructions for use. The machine shall be started and stopped 10 times before commencing the test. If possible, machines shall be powered from an external source of power to simulate a **fully charged battery**.*

The time recording measurement system shall have a total accuracy of 25 ms and any tachometers used shall have an accuracy of ± 2,5 %. The ambient test temperature shall be 20 °C ± 5 °C. The machine shall be mounted and instrumented in such a manner that the results of the test are not affected.

***Stopping time** is measured from the moment of actuation of a **sensor** until either*

– *the last time a **cutting means** passes the sensing device of the test equipment; or*
– *the residual energy of the **cutting means** is below 0,1J;*

whichever is sooner.

*The means of initiating the **cutting means** stopping procedure during the test shall be such that:*

– *for the **operator presence control** for the **cutting means** – the **control** shall be released abruptly from the full "on" position so that it returns to the "idle" or "**off**" **position** by itself;*
– *for the **obstruction sensors** – each **sensor** is activated such that a **cutting means** stopping command is generated as specified in 22.105.2;*
– *for **tilt sensors** – the machine shall be tilted to activate and deactivate the **sensor** in the directions as required in 22.105.1;*
– *for **lift sensors** – the machine shall be lifted to activate and deactivate the **sensor** as required in 22.105.3;*
– *for **manual stops** – the **manual stop** shall be activated.*

*Individual **cutting means stopping times** shall be measured five times from the moment of each of the following:*

– *release of the **cutting means operator presence control**,*
– *activation of the **obstruction sensor** by contact with the solid object according to 22.105.2,*
– *operation of the **tilt sensor**. The primary direction giving the longest average value shall be the orientation used for measuring the **cutting means stopping time** of the machine,*
– *actuation of the **manual stop**, and*
– ***lift sensor** is actuated.*

*The sensor or manual action giving the longest average value from these options shall be the method used for measuring the **cutting means stopping time** of the machine according to 20.102.2.2.*

20.102.2.2 Cutting means stopping time durability test – Method

For machines where the **cutting means stopping time** is not monitored by an **electronic circuit**, the machine shall be subjected to a sequence of 5 000 stop/start cycles. The 5 000 test cycles are not required to be continuous and the machine shall be maintained and adjusted during the test in accordance with the manufacturers published instructions for use. There shall be no maintenance or adjustment after 4 500 cycles have been completed.

Figure 101 gives a schematic representation of two cycles. Each cycle shall consist of the following sequence:

- *accelerate the **cutting means** from rest to the **maximum operating motor speed** (n) – (time = t_s);*
- *hold it at this speed for a short time to ensure that it is stable – (time = t_r);*
- *operate the machine and allow the **cutting means** to come to rest – (time = t_b);*
- *allow a short time at rest before commencing the next cycle – (time = t_o).*

If the total time for one cycle is t_c then $t_c = t_s + t_r + t_b + t_o$. The test cycle times for "on" (t_s+t_r) and "off" (t_b+t_o) shall be decided by the manufacturer but shall not exceed 100 s "on" and 20 s "off".

NOTE This test is not representative of normal use and therefore the cycle times are specified by the manufacturer to avoid unnecessary wear or damage to the machine.

20.102.2.3 Cutting means stopping time durability test – Verification

*For machines subjected to the test of 20.102.2.2, the **cutting means stopping time** shall be measured for the following:*

- *each of the first five cycles of the 5 000 cycle test sequence (i.e. not including the preparatory operations nor the trial stops used to determine which stop initiator to test);*
- *each of the last five cycles prior to any brake maintenance or adjustment carried out during the test;*
- *each of the first 5 cycles of each 500 cycles of operation; and*
- *each of the last five cycles of the 5 000 test cycles.*

*No other **stopping times** shall be recorded.*

*Each of the measured **stopping times** (t_b) shall comply with the requirement of 20.102.2. If the test sample fails to complete the full number of cycles but otherwise meets the requirements of this test, either:*

- *the machinery may be repaired, if the brake mechanism is not affected and the test continued;*
- *if the machine cannot be repaired, one further sample may be tested which shall then comply fully with the requirements.*

20.102.3 Thrown object hazard

Robotic lawnmowers shall be so constructed to provide adequate protection against risk of injury to persons from foreign objects that may be thrown out by the rotating **cutting means**.

Compliance is checked by the following test:

When conducting this test, personnel should either be kept out of the test area or otherwise protected from the hazard of thrown objects.

The machine is placed in the test enclosure described in Annex BB with the base of the enclosure being as described in Annex CC. The target panel construction used shall be checked by the tests contained in Clause BB.3 of Annex BB immediately before and after this test. The target panels shall be divided into elevation zones by horizontal lines as indicated in Figure BB.1 and described in Annex DD.

The projectiles used in the test shall be 6,35 mm diameter balls of hardened steel 45 HRC minimum (e.g. balls used as ball bearings).

*Injection points for the steel balls shall be provided as positioned in Figure BB.2 and located midway along the **cutting means** cutting edge.*

The injection tube outlets shall be fixed and flush with the upper surface of the coconut mat see Annex CC (Figure CC.1) and the system shall be so arranged that the ball may be ejected with variable velocity.

Where necessary, the machine may be elastically restrained to prevent horizontal movement.

*During the tests, the machine shall be operated at **maximum operating motor speed** (as defined by 3.120) and supplied, if possible, by an external power supply having the same characteristics as a **fully charged battery**.*

*Tests shall be conducted for each **cutting means** assembly.*

The machine shall be tested in all operational configurations (e.g. both with and without attachments and accessories such as grass collectors or mulching parts).

*The **cutting means** shall be adjusted to a 30 mm cut height or the next higher **cutting position** when set on a hard level surface. Machines with a maximum height setting of 30 mm or less shall be set at their maximum height setting.*

*Before the test, adjust the velocity with which the ball is ejected so that the ball rises not less than 30 mm above the surface of the coconut matting and within an angle of 10° of the vertical axis. Then with the machine in place, allow balls one at a time into the machine. Increase the velocity of the balls in small increments until each ball is hit by the machine **cutting means**. Start the test when this minimum velocity is established. Chipped or damaged balls shall be replaced.*

*Inject 500 steel balls into each injection point for each test. On multi-spindle machines, the test shall be run for each spindle with the results evaluated for each test, with all spindles running. A new set of **cutting means** shall be used for each test.*

During any of the tests, in the event of excessive hits in a localised area, it may be necessary to repair or replace a target panel before continuing with the tests. Replace the target panels if hits from previous tests leave holes that cannot be covered by a 40 mm square gummed label. Not more than one thickness of gummed labels (patch) shall be placed over any one area.

Balls remaining within the test enclosure (on test surface) may be removed at the option of the tester to minimise ricochet hits. Balls passing over the top of the test enclosure shall be ignored.

Count and record hits on data sheet shown in Annex DD. A test projectile passing completely through all layers of the target material is counted as a hit. Steel balls that hit and damage the centreline of the target area height line shall be scored with the target area below that line.

For each test (500 steel balls), there shall be no hits above the 300 mm line (top elevation area) and not more than 2 hits in each target panel between the base and the 300 mm line.

The test does not require that the machine shall be suitable for use after test.

In the event of a test failure, two additional machines may be tested both of which must then pass the test.

20.102.4 Inadvertent access to the cutting means

20.102.4.1 Inadvertent foot access to the cutting means

20.102.4.1.1 General

Inadvertent access to the **cutting means** by the feet during operation shall be prevented, so far as reasonably practicable by the **cutting means enclosure**.

Compliance is checked by the tests of 20.102.4.1.2, 20.102.4.1.3 and 20.102.4.1.4.

*The tests are made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

~~*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of these tests. The tests are conducted under static conditions.*~~

20.102.4.1.2 Adult foot probe test

*The machine shall be placed on a hard, flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of these tests. The tests are conducted under static conditions.*

*The foot probe of Figure 102 shall be inserted towards the **cutting means** around the ~~outer periphery of the machine~~ machine's external enclosure ~~(see Figure 102)~~. The base of the probe is ~~inserted~~ held horizontally at any height and then inclined up to 15° forward or backward from the horizontal (see Figure 102). The probe is applied around the entire machine as described in Figure 102 until a horizontal force of 20 N maximum is reached, or until ~~any portion of the machine is displaced~~ the machine's enclosure lifts or moves from ~~its~~ the original position, or until contact is made with the cutting means path, whichever occurs first.*

*The test probe shall not enter the path of the **cutting means** assembly.*

20.102.4.1.3 Foot probe test for standing child

*The machine shall be placed on a hard, flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of these tests. The tests are conducted under static conditions.*

*The foot probe of Figure 107 shall be inserted towards the **cutting means** around the ~~outer periphery of the machine~~ machine's external enclosure ~~(see Figure 102)~~. The base of the probe is ~~inserted~~ held horizontally at any height and then inclined up to 15° forward or backward from the horizontal (see Figure 102). The probe is applied around the entire machine as described in Figure 102 until a horizontal force of 20 N maximum is reached, or until ~~any portion of the machine is displaced~~ machine's enclosure lifts or moves from ~~its~~ the original position, or until contact is made with the **cutting means** path, whichever occurs first.*

*The test probe shall not enter the path of the **cutting means** assembly.*

20.102.4.1.4 Foot probe test for kneeling child

The machine is placed on a test surface as described in Annex CC, except that

– *the minimum size as described in Clause CC.2 shall be such that the machine is capable of attaining its maximum **traction drive** speed in automatic mode during normal use with **the cutting means** operating; and*

– *an injection tube as shown in Figure CC.1 need not be incorporated into the test surface.*

The machine is tested by means of the foot probe shown in Figure 109. The sole of the foot probe shall be constructed of a material with a 70 Shore A hardness (nominal) and a thickness of (3 ± 0,5) mm. The sole of the foot probe shall be free from dust and grease. Prior to the series of tests, the sole of the foot probe in Figure 109 shall be checked to ensure a dynamic coefficient of friction of (0,6 ± 0,06) with respect to the same material surface in accordance with ISO 8295:1995.

*The machine is operated in automatic mode with the **cutting means** operating. While the machine is operating, the foot probe of Figure 109 is placed in each of the ten test positions shown in Figure 110, as applicable to the anticipated movement of the machine, such that*

– *the foot probe is aligned with the direction of the machine's movement with the toe pointing toward the machine; and*

– *the foot probe is placed on the test surface and care is taken that foot probe movement is minimised if the machine comes into contact with the foot probe;*

NOTE A spike or other feature located on the knee of the probe has been shown to be helpful in minimising movement of the foot probe during the test.

– *an injection tube, if any, in the coconut matting does not influence the test result.*

If, in automatic mode, it is not possible for the machine to move in accordance with any of the test positions shown in Figure 110, then it is not necessary to conduct the test for those test positions.

The foot probe remains in place at each test position until

– *the machine has moved completely away from the foot probe; or*

– *the foot probe has been in place for 20 s; or*

– *the machine stops such that a manual reset is required,*

whichever occurs first.

*For each test position, the foot probe shall not contact the **cutting means** whilst the **cutting means** is rotating. If the sole of the foot probe is damaged during the test, it shall be repaired or replaced as necessary.*

20.102.4.2 Inadvertent hand access to cutting means

20.102.4.2.1 General

Inadvertent access to the **cutting means** by the hand during operation shall be prevented, so far as reasonably practicable by means of the **cutting means enclosure**.

Compliance is checked by the tests of 20.102.4.2.2 and 20.102.4.2.3.

20.102.4.2.2 Hand and arm probe tests

The **cutting means enclosure** shall provide guarding to reduce the possibility of inadvertent contact with the **cutting means** when reaching under the **cutting means enclosure**.

Compliance is checked by the following tests.

20.102.4.2.2.1 Hand probe test

A mechanical test probe ~~that is similar to test probe B of IEC 61032 but having a circular stop face with a diameter of 50 mm, instead of the non-circular face shall be used~~ as shown in Figure 111 is used for the test. The joints shall be locked firmly into their straight positions or replaced by a solid portion.

NOTE The probe of Figure 111 is similar to test probe B of IEC 61032 but having a circular stop face with a diameter of 50 mm, instead of the non-circular face.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The probe shall be inserted towards the **cutting means** around and under the outer periphery of the machine. The axis of the probe is held horizontally at any height and then inclined up to ±15° from the horizontal. The vertical height of the probe is maintained when the probe is inserted under the machine. The probe is applied until a force of 5 N maximum is reached or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal movement.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

20.102.4.2.2.2 Child arm probe test

Test probe 18 (Figure 12) of IEC 61032:1997 shall be used, but with the extension handle attached throughout the test. The joints shall be allowed to articulate.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The probe shall be inserted towards the **cutting means** around and under the periphery of the machine. The axis of the probe is inclined 45° ± 1° from the horizontal. The probe is applied until a force of 5 N maximum is reached or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first. The articulated finger joints shall be moved through their full range of angular movements when under the machine.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal movement.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

~~20.102.4.2.2.3~~ 20.102.4.2.3 Finger probe test

Guarding to reduce the possibility of contact with the **cutting means** during an attempted lift shall be provided.

Compliance is checked by the following test.

~~*A mechanical test probe that is similar to test probe B of IEC 61032 but having a circular stop face with a diameter of 50 mm, instead of the non-circular face shall be used.*~~

A mechanical test probe as shown in Figure 111 is used for the test.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the cutting means path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The finger portion of the probe shall be inserted towards the **cutting means** around and under the edge of the outer periphery of the machine until the 50 mm stop face contacts the outer periphery of the machine in any area where the machine can be lifted. For test purposes, the machine may be supported in its normal orientation above the hard flat supporting surface so that the insertion of the probe is not limited by the hard flat surface. The axis of the probe is held horizontally. The articulated finger joints shall be moved through their full range of angular movements. The probe is applied with a force not exceeding 5 N until contact is made by the 50 mm stop face of the probe with the outer periphery of the machine or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first. For examples of the intended application of the probe, see Figure 105.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal position.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

NOTE The positioning of the stop face of the probe is determined by assessing what parts of the enclosure are most likely to be grasped when lifting the stationary machine from the ground and noting where the root of the fingers are placed.

20.102.5 Traction drive stopping

20.102.5.1 General

The machine shall be provided with a means to stop the **traction drive** when a stopping command is generated from any of the following:

- **manual stop;**
- **manual controller;**
- **lift sensor;**
- **tilt sensor;**
- **obstruction sensor** (when activated for more than 10 s according to 22.105.2).

*Compliance is checked by 20.102.5.2 for the **manual stop** and **manual controller,** by 20.102.5.3 for the **lift sensor** and **tilt sensor** and by ~~20.102.5.4 for the **rollover sensor**~~ 22.105.2 for the **obstruction sensor**.*

*If compliance relies on the operation of an **electronic circuit**, the test of 20.102.5.2~~,~~ and 20.102.5.3 ~~and 20.102.5.4~~, as applicable, is repeated under the following condition:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*The total distance or stopping time, as applicable, as a result of condition 1) and an attempted **traction drive** stopping command, shall either comply with the limit values below, or not exceed twice of the value given below providing this occurs for one attempt only.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

20.102.5.2 After the initiation of any **traction drive** stopping command which is generated from any of the following:

- activation of the manual stop;
- after the operator releases the actuator on the **manual controller** for the **traction drive**, if any;

the machine shall stop within a distance of

– 200 mm; or

– 0,11 m per km/h up to a maximum of 1 m;

whichever is higher.

Compliance is checked by the following test.

*Use each available means of initiating a stop using the **manual stop** and **manual controller** (if any), in turn. The test stops shall be conducted on a substantially level (not to exceed 1 % gradient) dry, smooth, hard surface of concrete (or equivalent test surface). The test shall be carried out in both forward and reverse directions at the maximum ground speed attainable.*

20.102.5.3 When a **tilt sensor** and/or **lift sensor** is activated, the **traction drive** shall stop in the direction of travel within 2 s.

When in **automatic mode**, the machine may then attempt to recover from the condition that caused the activation of the **sensor(s)** for a period of 10 s, provided the machine moves in a different direction than the original direction of travel.

When in **automatic mode**, if the machine is unable to recover within the 10 s period, the **traction drive** shall stop, but may be restarted providing the restart procedure in 20.102.6 is completed.

Compliance is checked by inspection, by measurement and by manual test.

20.102.5.4 ~~When a **rollover sensor** is activated, the **traction drive** shall stop within 2 s.~~

~~*Compliance is checked by inspection, by measurement and by manual test.*~~

Void

20.102.6 Restart procedure

Restarting of the **traction drive** and **cutting means** due to

– activation of a **sensor(s)** as specified in 22.105.1 to 22.105.4; or

– activation of a **manual stop** as specified in 20.101.4; or

– changing of the **working area** as specified in 22.104;

shall only be possible following either:

a) two separate actions; or

b) the introduction of an alpha-numeric code of at least four characters; or

c) multiple key strokes in response to prompts.

Compliance is checked by inspection and by practical tests.

20.102.7 Void

20.102.7.1 Void

20.102.7.1.1 Void

20.102.7.1.2 Void

20.102.7.1.3 Void

NOTE In Europe (EN 60335-2-107), the following additional subclauses apply:

20.102.Z101 Noise

20.102.Z101.1 Noise reduction as a safety requirement

20.102.Z101.1.1 Noise reduction at source by design and by protective measures

The machine shall be designed to generate a noise level as low as practicable. The main sources causing noise are:

– air intake system;

– cutting system;

– vibrating surfaces.

ISO 11688-1 gives general technical information on widely recognised technical rules and means to be followed in the design of machines with low-noise emission.

20.102.Z101.1.2 Noise reduction by information

If, after taking all possible technical measures for reducing noise at the design stage, a manufacturer considers that further protection is necessary, then the instruction manual shall:

– recommend the use of low-noise operating modes, and/or limited time of operation;

– give a warning of noise level and recommend the use of ear protection.

20.102.Z101.1.3 Verification of requirements on noise – Noise measurement

For the determination of the sound power level and of the emission sound pressure level when using a **manual controller**, the measurement methods given in Annex FF shall be used.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 *Modification:*

The impact energy applied to all enclosures (including the **peripherals**) shall be (1,0 ± 0,05) J.

This subclause does not apply to

– **remote setting device(s)**; and

~~– **peripherals** that are covered by a separate end product standard, such as power supplies or **battery** chargers.~~

– power supplies or **battery** chargers that are covered by a separate end product standard.

21.101 Additional requirements for robotic lawnmowers

21.101.1 General

For the tests of this subclause the machine is operated at maximum speed and may be elastically restrained to prevent horizontal movement.

21.101.2 Strength of cutting means and cutting means mountings

Cutting means and their mountings shall have adequate strength to withstand impact with solid objects.

Compliance is checked by the following test:

*The machine shall be placed in the test enclosure described in Annex BB using an impact test fixture such as the one shown in Figure 103. The machine shall be positioned over a 25 mm diameter (nominal) steel rod that has been placed in the test fixture (see Figure 103). The **cutting means** of the test machine shall be adjusted to the cutting height closest to 50 mm and so positioned that when the rod is inserted into the path of the rotating **cutting means**, the **cutting means** will strike the exposed portion of the rod within 10 mm to 15 mm of the **cutting means** tip (see Figure 103). The rod shall be inserted once into the path of each **cutting means** assembly. A new piece of rod shall be used for each test.*

The machine shall be run for 15 s, or until the cutter stops or the rod is severed.

Where it is not possible to insert the rod due to machine design, the machine shall be moved the minimum distance necessary to permit the rod to be inserted.

*During the test, no complete **cutting means**, arm or disc to which it is mounted shall become detached nor shall any part of the machine pass through all layers of the wall of the fibreboard enclosure. Also, any breakage of the **cutting means** or **cutting means** retaining device shall be considered failure of the test. Breakage of the drive shearing device or chipping of the **cutting means** cutting edge are not considered a test failure.*

The test does not require that the machine shall be suitable for use after test.

21.101.3 Imbalance

Robotic lawnmowers shall withstand the out of balance forces that may occur due to wear etc. of the **cutting means** or its assembly.

Compliance is checked by the following test:

The machine shall be placed in the test enclosure described in Annex BB. The test shall be conducted on a smooth hard level surface.

*For machines using rigid **cutting means**, the **cutting means** imbalance, in kilogram metres, is first determined by the formula*

$$0{,}024\ L^3$$

*where L is the diameter of the **cutting means tip circle**, in metres.*

*The calculated imbalance is created by removing material from, or adding it to, the **cutting means** until the desired imbalance is obtained.*

*For machines using freely pivoting **cutting means** on a generally circular disc, the imbalance shall be created by removing a **cutting means**.*

*The test is run for 1 h in the test enclosure for each **cutting means** assembly. If possible, the machine is operated from an external power supply having the same characteristics as a **fully charged battery**.*

*All **cutting means** assemblies of a multi-spindle machine are tested singly. It is permissible to test all **cutting means** assemblies of a multi-spindle machine simultaneously at the discretion of the manufacturer. At the discretion of the manufacturer, a new machine may be used for each test.*

During the test, the machine shall not lose any component necessary for compliance with the requirements of this standard nor shall any component or part of the machine pass through all layers of the wall of the test enclosure. The test does not require that the machine shall be suitable for use after test.

21.101.4 Structural integrity

21.101.4.1 General

Cutting means enclosures, **discharge chutes**, **guards** and **grass catchers** of **robotic lawnmowers** shall have sufficient strength to withstand the impact from foreign objects which may be thrown out by the **cutting means**.

Compliance is checked by the test described in 21.101.4.2 to 21.101.4.4. During the test, personnel should be protected against possible thrown objects.

21.101.4.2 Test equipment

21.101.4.2.1 Test fixture (see Figure 104)

The test fixture base shall consist of a steel plate of at least 1,5 mm thickness backed by a 19 mm plywood panel. The steel plate shall be large enough to extend at least 25 mm beyond the **cutting means enclosure** of the machine.

An air inlet hole shall be provided that is concentric with each **cutting means tip circle** with an approximate diameter, as given in Table 101.

Table 101 – Sizing of test fixture air inlet holes

Lawnmower type	Cutting means tip circle diameter (BTCD)	Air inlet diameter
Non-mulching	All	0,3 × BTCD
Mulching	< 635 mm	BTCD – 127 mm
Mulching	≥ 635 mm	0,8 × BTCD

The machine shall be constrained in a suitable manner such that its specified position relative to the injection point is maintained throughout the test. The constraint(s) shall not obstruct free passage of the balls from under the machine.

21.101.4.2.2 Injection points

The location of one injection point B shall be:

– for mulching machines, at the 12 o'clock position and located midway along the **cutting means** cutting edge as detailed in Figure BB.2.

– for non-mulching machines, the injection point shall be located midway along the **cutting means** cutting edge on a line BC which is 45° from a line AC, in a direction counter to the direction of **cutting means** rotation, where A is the centre of the **discharge chute** exit and C is the centre of the **cutting means tip circle**. See Figure 104.

Ten injection points shall be equally spaced apart starting from point B on the centre of the **cutting means tip circle** C. See Figure 104. The injection points of approximately 15 mm diameter shall be used for the introduction of balls (see 21.101.4.2.3).

Alternatively, instead of using ten injection points the machine may be rotated in 36° increments from injection point B.

The injection tubes shall not protrude above the steel plate.

21.101.4.2.3 Test balls

One hundred hardened (12,75 ± 0,25) mm diameter balls of steel, 45 HRC minimum (e.g. balls used as ball bearings) shall be used.

21.101.4.2.4 Injection method

Means shall be provided to inject the steel balls with variable velocity. Adjust the velocity with which the ball is injected so that the ball rises a minimum of 13 mm and a maximum of 300 mm above the cutting plane of the **cutting means**.

21.101.4.3 Test method

The machine to be tested shall be positioned on the steel plate with the **cutting means** axis C over the centre of the test fixture base. The **cutting means** shall be set at the lowest adjustable cutting height but not less than 30 mm. If the maximum height of cut is less than 30 mm, then the machine shall be tested when adjusted to its maximum height.

The 100 balls shall be divided into 10 lots of 10. One lot shall be injected through each of the 10 injection points.

The test shall be conducted once for each **cutting means**.

A new machine housing may be used for each test of a multi-spindle machine. A full set of new **cutting means** shall be fitted before each spindle is tested.

21.101.4.4 Test acceptance

The **cutting means enclosure**, **guard** or **grass catcher** shall be considered to have failed the test if any of the following occurs:

a) a hole in the **cutting means enclosure**, **guard**(s) or **grass catcher**(s) which has allowed the ball to pass through. A hole in a secondary enclosure, such as an internal baffle, shall not be considered a failure;

b) deformation of any part of the **cutting means enclosure**, **guard**(s) or **grass catcher** into the path of the **cutting means**;

c) the dislodging of the **grass catcher** or **guard** from its adapter;

d) the **grass catcher** or **guard** falling from its normal operating position.

In the event of a test failure, two additional identical machines shall be tested. If either of the additional machines fails a test, the model shall have failed the test.

The test does not require that the machine has to be suitable for use after the test.

21.101.5 Strength of cutting means enclosure

The **cutting means enclosure** and ground support system shall be able to withstand possible extra loading.

Compliance is checked by the following test:

*A weight of 20 kg shall be placed on top of any **accessible part** of the top of the machine. The machine shall be on a smooth level hard surface and the load shall be evenly distributed over an area of 10 cm x 5 cm applied through a layer of foam with a thickness of 50 mm ± 5 mm having a density of 32 kg/m^3 backed by a rigid flat 12 mm thick plywood backing plate for a period of 30 s. The machine shall be considered to have passed the test if either of the following occurs:*

a) there is no visible damage to the machine and it continues to function correctly after the test, or

*b) if there is visible damage, the **cutting means** shall not function, or the guarding of the **cutting means** shall be sufficient to pass all the tests of 21.101.3 and 21.101.4.*

21.101.6 Drop test – Manual controller

A **manual controller**, if any, shall be dropped three times from a height of 1,0 m onto a smooth concrete floor in the position most likely to damage the controller, while powered on and communicating with the machine.

The **manual controller** shall have failed the test if one or more of the following occurs:

– there is access to a **working voltage**, exceeding **hazardous voltage**, using test probe 13 of IEC 61032;

– loss of **operator presence control**, either through mechanical or electrical damage;

– unintended motion of the machine; or

– any breakage that allows access to uninsulated parts that could short due to the loss of the enclosure.

22 Construction

This clause of part 1 is applicable except as follows.

22.6 *Addition:*

Any drain holes provided to prevent accumulation of water in an enclosure shall be at least 5 mm in diameter or 20 mm² area with a width of at least 3 mm.

Compliance is checked by inspection.

22.12 *Addition:*

If carrying means are provided for the machine or other lifted items, they shall have adequate strength.

Compliance is checked by inspection and the following test.

Carrying means are subjected to a force corresponding to three times the weight of the machine or lifted item, e.g. ***battery.*** *The force is applied in the direction of lifting uniformly over a 70 mm width at the centre of the carrying means. The force is steadily increased so that the test value is attained within 10 s and maintained for a period of 1 min.*

If more than one carrying means is provided or if a portion of the weight is distributed over a wheel, the force is distributed between the carrying means in the same proportion as in the normal transportation position. If the machine is provided with more than one carrying means, but so designed that it may readily be carried by only one carrying means, each carrying means shall be capable of sustaining the total force.

The carrying means shall not break loose from the machine and there shall not be any permanent distortion, cracking or other evidence of failure.

22.36 This subclause is not applicable.

22.40 This subclause is not applicable.

NOTE 101 This requirement is covered by 20.101.1 and 20.101.4.

22.46

NOTE 101 Hazards that can be created due to the loss of functional control are addressed in the relevant subclauses. Other electronic fault conditions of 19.11.2 that result in dangerous malfunction are understood to not require an evaluation of software using Annex R.

22.49 This subclause is not applicable.

NOTE 101 This requirement is covered in 20.101.2 for **remote setting devices**.

22.50 This subclause is not applicable.

NOTE 101 This requirement is covered by 20.101.4.

22.51 This subclause is not applicable.

NOTE 101 This requirement is covered in 22.107 for **manual controller**.

22.101 Battery charging

Except for **batteries** charged by contactless means e.g. solar panels, it shall not be possible to operate the **cutting means** or the **traction drive** of the machine while the **battery** is being charged.

NOTE Operation of the **traction drive** to maintain contact pressure during charging is not considered to be operation of the **traction drive**.

Compliance is checked by inspection, practical test and if the compliance relies on the operation of an ***electronic circuit****, it is checked under the following conditions applied separately:*

1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the ***electronic circuit****;*

2) the electromagnetic phenomena tests of 19.11.4.1 to 19.11.4.7 applied to the ***charging station****, excluding the* ***perimeter delimiter****, if any.*

If the ***electronic circuit*** *is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.102 Air filters

Air filters which are designed to be removed for cleaning purposes shall be so designed that they are unlikely to come off in **intended use**.

Compliance is checked by inspection and the following practical tests:

– *the air filter can only be removed with the aid of a* ***tool****, or*

– *is provided with a spring that prevents it from falling away in **intended use** due to vibration, or*

– *needs a deliberate action by the user for its removal.*

22.103 Disabling device

22.103.1 General

A **disabling device** shall be provided which shall prevent operation of the machine when it is removed or operated. The **disabling device** shall not be easily overridden.

The **disabling device** shall be according to either 22.103.2 or 22.103.3.

22.103.2 Removable disabling device

When a **removable disabling device** is removed, it shall not be possible for the machine to be operable. A **removable disabling device** may be fulfilled by removal of all detachable **battery** pack(s), provided

– any individual **battery** pack does not have a mass exceeding 5,0 kg; and

– the detachable **battery** pack(s) are removable without the use of **tools**.

The machine is not considered to be operating when displaying, communicating, transmitting or storing data (e.g. error codes) whilst the **removable disabling device** is removed or operated.

Compliance is checked by inspection and by the following tests:

*With the **disabling device** removed and without undue force:*

*a) the **operator presence control** is operated if possible, and*

*b) an appropriately sized flat metal bar is used to try to override the **disabling device**.*

The machine shall not be operable.

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.103.3 Code protected disabling device

When the machine is disabled by operating the **code protected disabling device**, there shall be a clear and lasting indication that the machine is disabled and it shall not be possible for the machine to be operable until a specific “key sequence” (e.g. an alpha and/or numerical code of at least 4 characters) has been entered into the key pad.

The machine is not considered to be operating when displaying, communicating, transmitting or storing data (e.g. error codes) whilst the machine is disabled by the **code protected disabling device**.

It shall only be possible to de-activate the **code protected disabling device** from the machine. If the **manual controller** is the only **control**, the **code protected disabling device** may be de-activated from the **manual controller**.

It shall not be possible to de-activate the **code protected disabling device** from the **remote setting device**.

*Compliance is checked by inspection and if the compliance relies on the operation of an **electronic circuit**, the compliance is checked under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.104 Working area

When the machine is operating in **automatic mode**, the machine shall not be able to leave the **working area**. It shall not be possible for the machine to cross the boundary of the **working area** by a distance greater than one full length of the machine when operating in **automatic mode**.

The boundary of the **working area** may be established by the use of a **perimeter delimiter** as specified in 22.104.2 or by a pre-programmed area.

If the machine is placed outside the **working area**, it shall not be able to operate at a distance of more than 1 m from the boundary of the **working area** to the nearest part of the machine, unless under manual control.

If the machine fails to receive any signal that is required to recognise the **working area**, the machine shall travel not more than 1 m and the **cutting means** shall stop within 5 s from the instant the machine fails to receive any signal that is required to recognise the **working area** to the time that the **cutting means** stops in accordance with 20.102.2.

If the machine regains recognition of the **working area**, the machine may operate in **automatic mode**, providing the **cutting means** start-up indication procedure in 22.110 is completed.

If the **working area** is changed, it shall not be possible for the machine to operate in **automatic mode** unless the restart procedure in 20.102.6 is completed. This requirement is not applicable for **perimeter delimiters**.

Compliance is checked by inspection, by measurement and by practical tests.

*If the compliance relies on the operation of an **electronic circuit**, it is checked under the following condition:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*The total traveling distance and/or the total stopping time, as a result of condition 1), shall not exceed twice of the values given above. Under this condition, a manual operation shall be required to restart the **cutting means**, such a restart shall only be allowed for one attempt.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.104.1 Void

22.104.2 Perimeter delimiter

If a **perimeter delimiter** is provided which uses a boundary wire that emits a signal to indicate the limit of the **working area**, the maximum voltage shall not exceed SELV.

Compliance is checked by measurement.

NOTE The European Garden Machinery Federation (EGMF) Robotic Mowers Boundary Wire Standard RLM003-1.1/2016 addresses compatibility between adjacent **robotic lawnmower** installations that incorporate **perimeter delimiters**. It is anticipated that it will be superseded in Europe by ETSI EN 303 447, which is currently under development.

22.105 Sensors

22.105.1 Tilt sensors

The machine shall be provided with a **tilt sensor**. It shall activate at least 3° before the machine becomes unstable.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

Compliance is checked by inspection and by the following test.

Place the machine on a variable single-slope, plane, tilt table with the machine supported on its wheels. The wheels of the machine shall be blocked to prevent sliding down the slope. Place a strip of steel 1 mm thick under each uphill wheel. Tilt the table until lift-off occurs. Lift-off is when the steel strip can be removed sideways from under all of the (uphill) wheels with a force of 1 N or less.

Tests shall be conducted with the machine positioned in each of the following positions:

– *facing downhill;*
– *facing uphill;*
– *right hand side downhill;*
– *left hand side downhill.*

If there is likely to be a more unfavourable orientation than these then the test shall also be carried out in this position.

*The **tilt sensor** shall operate at least 3° before the angle at which lift-off occurs for each position.*

If compliance relies on the operation of an electronic circuit, the test is repeated under the following condition:

*1) the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the **electronic circuit**;*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

When a **tilt sensor** is activated, the **cutting means** shall stop in accordance with 20.102.2.

In **automatic mode**, if within 10 s the **sensor**(s) have become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

In **automatic mode**, if the **sensor**(s) have not become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the restart procedure in 20.102.6 is completed.

During manual control, the **cutting means** may only be restarted in accordance with 20.101.1 after the **sensor**(s) have become deactivated.

Compliance is checked by inspection and by measurement.

22.105.2 Obstruction sensors

The machine shall be provided with an **obstruction sensor**(s). In **automatic mode**, the **sensor**(s) shall be active and capable of performing its intended function in all operating positions and in all directions of travel, except those directions of travel where

– the **cutting means** is not operating and the distance travelled does not exceed 2,0 times the length of the machine; or

– the **cutting means** is operating and the distance travelled does not exceed the distance from the edge of the machine in the direction of travel to the nearest **cutting means tip circle**.

NOTE 101 The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

~~The maximum kinetic energy of a machine that could be imparted to an obstruction upon impact when travelling in **automatic mode** shall be 5 joules.~~

The maximum force applied by the machine against an obstruction in **automatic mode** shall not be greater than

– 260 N during the first 0,5 s after impact and a minimum of 50 N is exceeded; and

– 130 N thereafter.

NOTE 102 ISO/TS 15066~~:2016~~ provides guidance on relevant values of maximum force.

If an **obstruction sensor** is activated, the **traction drive** in the direction of travel shall stop within

$t_{ts} = D/v$, where

t_{ts} is the **traction drive stopping time**;

D is the distance from the front edge of the machine to the nearest edge of the nearest **cutting means tip circle**; and

v is the velocity of the machine upon approach.

The machine shall then restart in a different direction to allow the machine to move away from the object such that the **sensor** is deactivated within 3 s of initial activation. If the **sensor** is not deactivated within 3 s of initial activation, the **cutting means** shall stop as required by 20.102.2.

An additional non-contact **sensor**, if relied upon to reduce speed in order to fulfil the requirement for maximum force upon impact, is permitted providing that it responds to a rigid non-metallic target ~~of~~:

– of cylindrical shape;

– of (70 ± 2) mm diameter by (400 ± 5) mm ~~high~~ height, standing on end;

– of a colour or shade that matches the background; and

– normalized to the ambient temperature.

Compliance is checked by inspection, by measurement, by the following test and by 20.102.2.

*The machine is placed on a level test surface as described in Clause CC.3. The machine shall be made to collide with a force measuring means. The force to operate the **obstruction sensor** at impact shall be measured parallel to the ground plane and vertically aligned with the point of contact with the force measuring means. The point of contact shall not be higher than 150 mm from the ground plane. Friction, misalignment and other factors associated with the mounting of the force measuring means shall minimise error in the measurement.*

The force is measured by means of an instrument which incorporates a rigid impact plate having a diameter of (90 ± 10) mm and a spring having a spring constant of (60 ± 2) N/mm. The spring acts on a sensing element which is connected to a measuring instrument having a bandwidth limited to (150 ± 50) Hz and with an accuracy of 5 %. The sampling rate shall be at least double ~~of~~ the bandwidth. A typical arrangement is shown in Figure 106.

The test is performed a total of five times. The maximum forces during the first 0,5 s after impact and thereafter are computed as the average of each of the five measurements.

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following condition:*

- ~~1)~~ *the fault conditions in a) to g) of ~~Clause~~ 19.11.2 applied one at a time to the* ***electronic circuit****;*

If the ***electronic circuit*** *is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

Alternatively, a non-contact **sensor** may fulfil the requirements of an **obstruction sensor**, providing that it responds to a rigid non-metallic target ~~of~~:

– of cylindrical shape;

– of (25 ± 2) mm diameter by (145 to 150) mm ~~high~~ height, standing on end;

– of a colour or shade that matches the background; and

– normalized to the ambient temperature.

Compliance is checked by the following test and by 20.102.2.

The machine is placed on a level test surface as described in Clause CC.3. It shall not be possible for the machine to contact the rigid non-metallic target.

If compliance relies on the operation of an ***electronic circuit****, the test is repeated under the following condition:*

- ~~1)~~ *the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the* ***electronic circuit****;*

If the ***electronic circuit*** *is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

If within 10 s of the machine stopping due to contact or avoidance of an object, the **obstruction sensor**(s) has become deactivated, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

If after 10 s of the machine stopping due to contact or avoidance of an object, the **obstruction sensor**(s) has not become deactivated, the **traction drive** shall be deactivated. Restarting the **cutting means** and **traction drive** shall only be possible by fulfilling the requirements the restart procedure in 20.102.6.

Compliance is checked by inspection and by practical tests.

22.105.3 Lift sensor

The machine shall be provided with a **lift sensor**. The **lift sensor** shall detect when the machine is lifted both fully from the ground and when it is lifted from only a single point causing it to be tilted.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

If a **lift sensor** is operated, the **cutting means** shall stop as specified in 20.102.2 and the **traction drive** shall stop as specified in 20.102.5.

Compliance is checked by inspection and by the following tests:

a) The machine is placed on a hard, smooth horizontal surface. The machine is lifted by any parts of the external housing, except the ground contacting parts, in a uniformly horizontal manner, normal to the surface. The rate of lifting shall be (20 ± 10) mm/s. The ***lift sensor*** *shall have activated after all the ground contacting parts lose contact with the surface and when the lowest ground contacting part is no more than 10 mm above the surface.*

b) The machine is placed on a hard, smooth horizontal surface. The machine is lifted from a single point on any part of the machine's external housing, except the ground contacting parts. The rate of lifting shall be (100 ± 20) mm/s. The ***lift sensor*** *shall have activated*

after at least one of the ground contacting parts loses contact with the surface and the highest ground contacting part is no more than 300 mm above the surface.

*The operation of the **lift sensor** is verified by lifting the machine from different locations around the external housing that are likely to be grasped by users.*

*If compliance relies on the operation of an **electronic circuit**, the tests are repeated under the following conditions applied separately:*

1) *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*
2) *the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine when the **lift sensor** has been activated for more than 10 s.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

When a **lift sensor** is activated, the **cutting means** shall stop in accordance with 20.102.2.

In **automatic mode**, if within 10 s the **sensor**(s) have become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

In **automatic mode**, if the **sensor**(s) have not become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the restart procedure in 20.102.6 is completed.

During manual control, the **cutting means** may only be restarted in accordance with 20.101.1 after the **sensor**(s) have become deactivated.

Compliance is checked by inspection and by measurement.

22.105.4 Rollover sensor

A **rollover sensor** shall be provided on all machines. The **rollover sensor** shall prevent the **traction drive** and **cutting means** starting when the machine is inverted.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

~~If a **rollover sensor** is operated, the **cutting means** shall stop as defined in 20.102.2 and the **traction drive** shall stop as specified in 20.102.5.~~

Compliance is checked by inspection and the following test.

*The machine shall be inverted and placed on a flat level surface, within 1 m either side of the **working area**. It shall not be possible to start the **traction drive** and/or the **cutting means**. For the purposes of this test, the machine shall not be moved from its inverted resting position.* ~~*For machines equipped with a **manual controller**, it shall not be possible to start the **traction drive** and/or the **cutting means** when the operator is able to use the **manual controller**.*~~

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following conditions applied separately:*

1) *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*
2) *the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine when the **rollover sensor** has been activated for more than 10 s.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

*For machines equipped with a **manual controller**, it shall not be possible to start the **traction drive** and/or the **cutting means** when the operator is able to use the **manual controller.***

If the machine is placed back in its correct orientation, the **cutting means** and **traction drive** may only be restarted by fulfilling the requirements of the restart procedure in 20.102.6.

Compliance is checked by inspection and by practical tests.

22.106 Charging station

All connections between a **charging station** and the machine shall not exceed SELV.

This requirement is not applicable for wireless (inductive) charging.

Compliance is checked by inspection and by measurement.

22.107 Manual controller

22.107.1 General

A **manual controller**, if any, shall require the operator to be close to the machine and be capable of withstanding **intended use** including foreseeable misuse.

The machine or the **manual controller** shall be provided with a means to select between manual mode and **automatic mode**.

The mode of operation shall not change in case of an **electronic component** on an **electronic circuit** being rendered inoperative.

Compliance is checked by inspection and by the following test conditions applied separately:

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine and the **manual controller**.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.107.2 Wired manual controller

If the **manual controller** is connected by wire, it shall be between 1,5 m and 3 m long.

If during manual control the cable to the **manual controller** is disconnected or the **manual controller** loses power, the **traction drive** shall stop as required in 20.102.5 and the **cutting means** shall stop as required in 20.102.2.

After the **manual controller** is reconnected or power is restored,

– the **traction drive** may restart; and

– the **cutting means** may only be restarted as specified in 20.101.1.

Compliance is checked by inspection and by practical test.

22.107.3 Wireless manual controller

The selection of wireless manual control from **automatic mode** shall require the operator to either

– initially activate the wireless **manual controller** within 6 m of the machine, or

– complete an action on the machine itself.

After selection, the wireless **manual controller** may be capable of operating the machine provided the wireless **manual controller** is within

– 6 m of the machine when the **cutting means** is enabled; or

– 20 m of the machine if the **cutting means** is disabled.

The wireless **manual controller** shall not communicate with the machine through an intermediate retransmission means such as a repeater or internet connection.

The wireless **manual controller** shall be paired or have an encrypted signal unique to the machine it is to be used with.

If during manual control the wireless **manual controller** loses communication with the machine for more than 2 s, the **traction drive** shall stop as required in 20.102.5 and the **cutting means** shall stop as required in 20.102.2.

After communication between the wireless **manual controller** and the machine is restored,

– the **traction drive** may restart; and

– the **cutting means** may only be restarted as specified in 20.101.1.

Compliance is checked by inspection. by measurement and by manual test.

22.108 Batteries and accumulators

22.108.1 Void

22.108.2 Terminal protection

Battery terminals and connections shall be so located or enclosed that they are not likely to be short circuited. Exposed terminals shall be separated by an insulating barrier that provides 6 mm minimum total distance between the parts of opposite polarity.

Compliance is checked by inspection and the following test:

It shall not be possible for the terminals to be bridged by a 6 mm diameter test pin of any convenient length inserted through any opening in the enclosure.

22.109 Mounting of components

Except as indicated below, any component that is handled by the user shall be mounted securely and shall be prevented from turning by means other than friction between surfaces.

Exception No. 1: The requirement that a switch be prevented from turning is able to be waived if all three of the following conditions are met.

a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.

b) Spacings are not reduced below the minimum acceptable values if the switch rotates.

c) Normal operation of the switch is by mechanical means rather than by direct contact by persons.

Exception No. 2: A lamp-holder of the type in which the lamp is not able to be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a non-removable jewel, need not be prevented from turning if rotation does not reduce spacings below the minimum values.

22.110 Cutting means start-up indication

Before the **cutting means** can begin automatic operation, unless the machine is restarted as described in the restart procedure in 20.102.6 or, for manual control, as described in 20.101.1, either

a) a flashing light shall be provided. The light shall be visible when viewed from a distance of 3 m within a 360° circumference at a height of 1 m and shall operate for a minimum period of 2 s prior to **cutting means** starting; or

b) an audible indicator shall be provided. The audible warning indicator shall be either a single continuous tone, multiple tones or be intermittent at a rate of at least 2 cycles per second. The audible warning indicator shall operate for a minimum period of 2 s prior to **cutting means** starting. The sound pressure of audible warning indicators shall be at least 35 dB(A) at a minimum distance of 1,5 m in any direction from the centre of the machine and at a height of 1,75 m.; or

c) the machine shall move for at least 5 s before the **cutting means** starts.

Compliance is checked by inspection and by practical test.

22.111 Charging station connectors

Machines provided with connectors for connecting to the **charging station** shall not be interchangeable with mains plugs and socket-outlets listed in IEC 60884, IEC/TR 60083 or IEC 60906-1 or with connectors and appliance inlets complying with the standard sheets of IEC 60320-1.

Compliance is checked by inspection.

22.112 Obstruction sensor contact surfaces

~~Potential contact surfaces of machines used as obstruction sensing devices shall be designed to minimize the risk of injury upon contact.~~

~~The surface contacted when striking an obstruction shall not have a perpendicular protrusion greater than 5 mm unless the protrusion has~~

The surface contacted when striking an obstruction shall be designed to minimize the risk of injury and shall not have a perpendicular protrusion greater than 5 mm unless the protrusion has

– a surface area greater than 20 mm^2; and
– a minor dimension greater than 5 mm.

All protrusions shall have rounded edges.

The surface contacted when striking an obstruction shall be located ~~to detect objects~~ at a height not greater than 150 mm from the ground plane.

Compliance is checked by inspection and by measurement.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.1.3 *Replacement:*

Switches shall comply with IEC 61058-1:2008 under the load conditions experienced by the switch in the machine. The number of cycles of operation declared for 7.1.4 of IEC 61058-1:2008 shall be at least 10 000. Switches may be alternatively tested in the machine, with only functional performance required for acceptance at the conclusion of the test.

If the switch operates a relay, contactor or electronic power device, the complete switching system is subjected to the test.

For switches or switching systems that control motor loads for a drive, these may be tested in the machine with no additional mechanical load applied to the drive output.

NOTE The declared number of operating cycles is only applicable for switches required for compliance with this standard.

If the switch only operates a motor starting relay complying with IEC 60730-2-10 with the number of cycles of operation declared for 6.10 and 6.11 of IEC 60730-1:2007 of at least 10 000 cycles, the complete switching system need not be tested.

If the switch or switching system controls a motor load, it shall also be tested for breaking capability by the test of 24.1.3.101.

24.1.3.101 *The switch is subjected to 50 operation cycles of making and breaking the current that the switch would carry when the output mechanism is locked in the machine with*

*a **fully charged battery**. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s.*

After this test, the switch shall have no electrical or mechanical failure. If the switch operates properly in the "on" and "off" states at the end of the test, it is considered to have no mechanical or electrical failure.

25 Supply connection and external flexible cords

This clause of Part 1 is not applicable, except for mains-powered **peripherals**. This clause of Part 1 is applicable for mains-powered **peripherals**, except as follows.

25.1 *Replacement:*

Mains-powered **peripherals** shall be provided with a **supply cord** or an appliance inlet.

Compliance is checked by inspection.

26 Terminals for external conductors

This clause of Part 1 is not applicable, except for the mains connections of mains-powered **peripherals**.

27 Provision for earthing

This clause of Part 1 is applicable.

28 Screws and connections

This clause of Part 1 is applicable.

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable except as follows.

29.1 This subclause is applicable for mains-powered **peripherals**.

29.2 This subclause is applicable for mains-powered **peripherals**, except as follows.

Modification:

Pollution degree 3 applies unless precautions have been taken to protect the insulation, in which case pollution degree 1 applies.

29.3 This subclause is applicable for mains-powered **peripherals**.

29.101 For the machine and non-mains-powered **peripherals**, **creepage distances** and **clearances** shall not be less than the values in millimetres shown in Table 102. The **clearances** specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the **clearances** vary with the movement of the contacts. **Creepage distances** and **clearances** also do not apply to the construction of battery cells or the interconnections between cells in a battery pack. The values specified in Table 102 do not apply to cross-over points of motor windings.

The values in Table 102 are equal or larger than the values required by IEC 60664-1, when

– an overvoltage category ~~II~~ I;
– a material group III;
– a pollution degree 3;
– inhomogeneous electric field

are applied.

Protection against deposition of dirt may be achieved through the use of

– encapsulation with a minimum thickness of 0,5 mm; or
– protective coatings that prevent the combined deposition of fine particles and moisture on surfaces between conductors. Requirements for these types of protective coatings are described in IEC 60664-3; or
– enclosures that prevent the ingress of dust by means of filters or seals, provided that no dust is generated within the enclosure itself.

NOTE 1 An example of encapsulation is potting.

For parts of different ~~polarity~~ potential in **switched circuits** only, **clearance** and **creepage distances** less than those given in Table 102 are acceptable if the shorting of the two parts does not result in the machine starting.

NOTE ~~1~~2 The risk of fire due to spacings below the required values is covered by the requirements of KK.19.4.

Table 102 – Minimum creepage distances and clearances between parts of different potential

Dimensions in millimetres

Conditions	Working voltage ≤ 15 V		Working voltage > 15 V and ≤ 32 V		Working voltage > 32 V and ≤ 130 V		Working voltage > 130 V and ≤ 280 V		Working voltage > 280 V and ≤ 480 V	
	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
Protected against deposition of dirt										
– **Switched circuits**	0,8	0,8	1,0	1,0	1,0	1,0	2,0	2,0	2,0	2,0
– **Non-switched circuits**	0,8	0,8	1,5	1,5	1,5	1,5	2,0	2,0	2,0	2,0
Not protected against deposition of dirt	1,1	0,8	1,5	1,5	2,5	1,5	4,0	2,5	8,0	3,0

For conductive patterns on printed circuit boards, except at their edges, providing functional insulation, the values given in Table 102 between parts of different potential may be reduced, as long as the peak value of the working voltage does not exceed:

– 150 V per mm with a minimum distance of 0,2 mm, if protected against the deposition of dirt;
– 100 V per mm with a minimum distance of 0,5 mm, if not protected against the deposition of dirt.

When the limits mentioned above lead to higher values than those of the Table 102, the values of Table 102 apply.

NOTE 3 The above values are equal or larger than the values required by IEC 60664-3.

For parts having a **hazardous voltage** between them, the sum total of the measured distances between each of these parts and their nearest accessible surface shall not be less than ~~1,5 mm **clearance** and 2,0 mm **creepage distance**~~ the values shown in Table 103.

NOTE ~~2~~4 Figure ~~108~~ 109 provides clarification on the measurement method.

Table 103 – Minimum total sum of creepage distances and clearances to accessible surfaces for hazardous voltages

Dimensions in millimetres

Hazardous voltage with a working voltage of					
≤ 130 V		> 130 V and ≤ 280 V		> 280 V and ≤ 480 V	
Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
5,0	1,5	8,0	3,0	16,0	4,0

Compliance is checked by measurement.

Distances through slots or openings in external parts of insulating material are measured to the metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test probe B of IEC 61032:1997, but is not pressed into openings.

The sum total of distances *measured between parts operating at* **working voltage** *that is a* **hazardous voltage** *and* **accessible surfaces** *is determined by measuring the distance from each part to the* **accessible surface**. *The distances are to be added together to determine the sum total. See Figure ~~108~~ 109. ~~For the purpose of this determination, one of the distances shall be 1,0 mm or greater.~~*

In addition, one of the **creepage distances** *or* **clearances** *to the nearest* **accessible surface** *shall be at least 1 mm.*

If necessary, a force is applied to any point on bare conductors and to the outside of metal enclosures, in an endeavour to reduce the **creepage distances** *and* **clearances** *while taking the measurements.*

The force is applied by means of the test probe B of IEC 61032:1997 and has a value of:

– 2 N for bare conductors;

– 30 N for enclosures.

~~**Table 102 – Minimum creepage distances and clearances between parts of opposite polarity**~~

~~*Dimensions in millimetres*~~

~~Working voltage ≤ 15 V~~		~~Working voltage > 15 V and ≤ 32 V~~		~~Working voltage > 32 V~~	
~~Creepage distance~~	~~Clearance~~	~~Creepage distance~~	~~Clearance~~	~~Creepage distance~~	~~Clearance~~
~~0,8~~	~~0,8~~	~~1,5~~	~~1,5~~	~~2,4~~	~~1,5~~

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2 *Addition:*

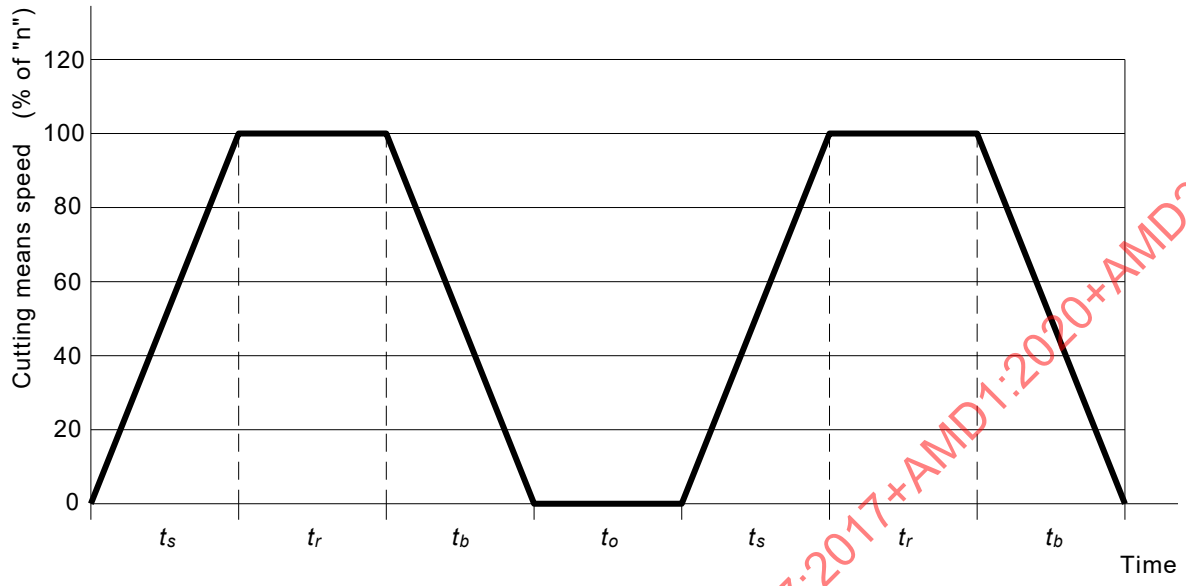
Machines and **peripherals** are considered to be unattended appliances.

31 Resistance to rusting

This clause of Part 1 is applicable.

32 Radiation, toxicity and similar hazards

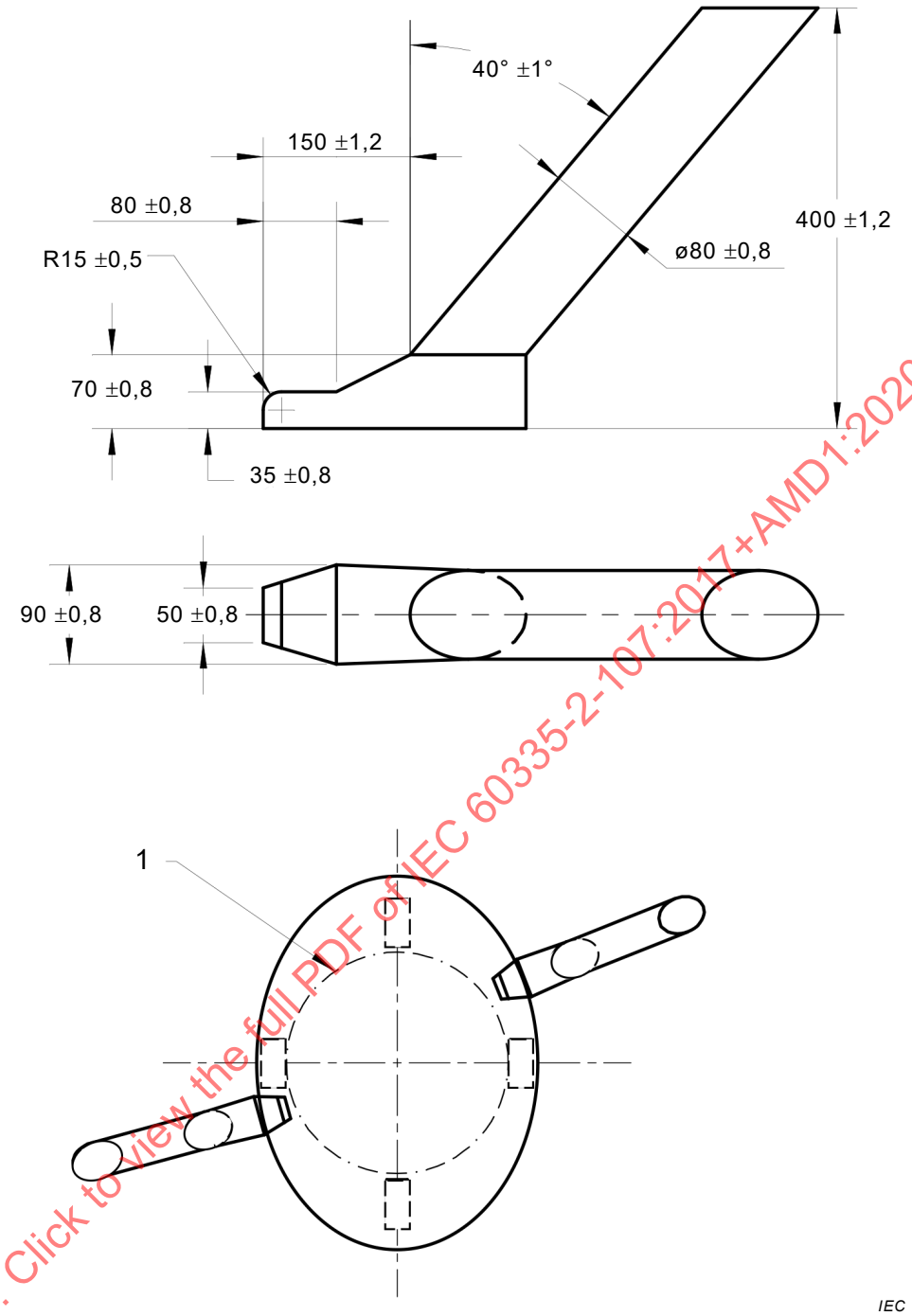
This clause of Part 1 is not applicable.



NOTE "n" = **cutting means** speed at **maximum operating motor speed**.

Figure 101 – Example of test cycles (see 20.102.2.2)

Dimensions in millimetres

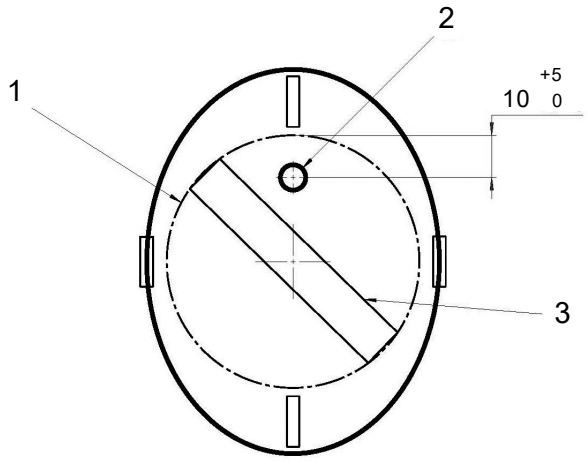


Key

1 cutting means tip circle

Figure 102 – Foot probe test (see 20.102.4.1.2 and 20.102.4.1.3)

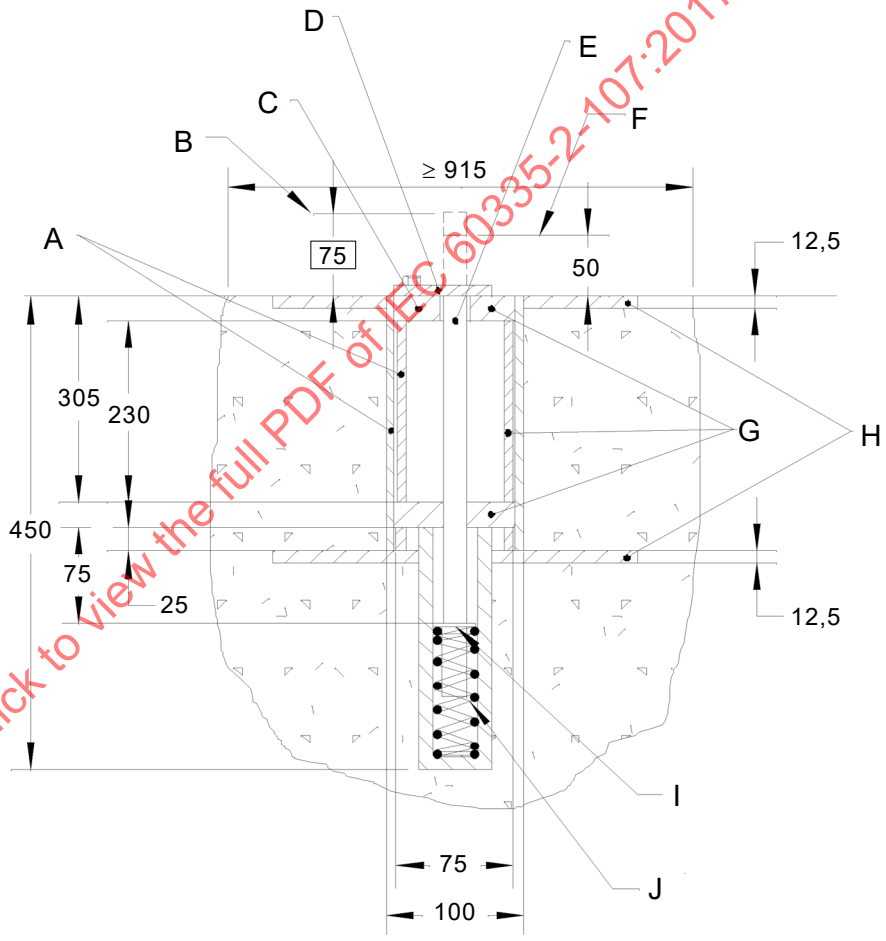
Dimensions in millimetres
(all dimensions are nominal unless otherwise stated)



Schematic view from above

Key

1	**cutting means tip circle**
2	steel rod (see a) below)
3	**cutting means**
A	standard pipe
B	release position of tube
C	end fittings (see b) below)
D	remote control actuating lever (metal plate)
E	steel rod see a) below)
F	cutting means height
G	removable cylinder assembly
H	steel plates x 2
I	pin or washer fixed to tube
J	compression spring (see c) below for details)



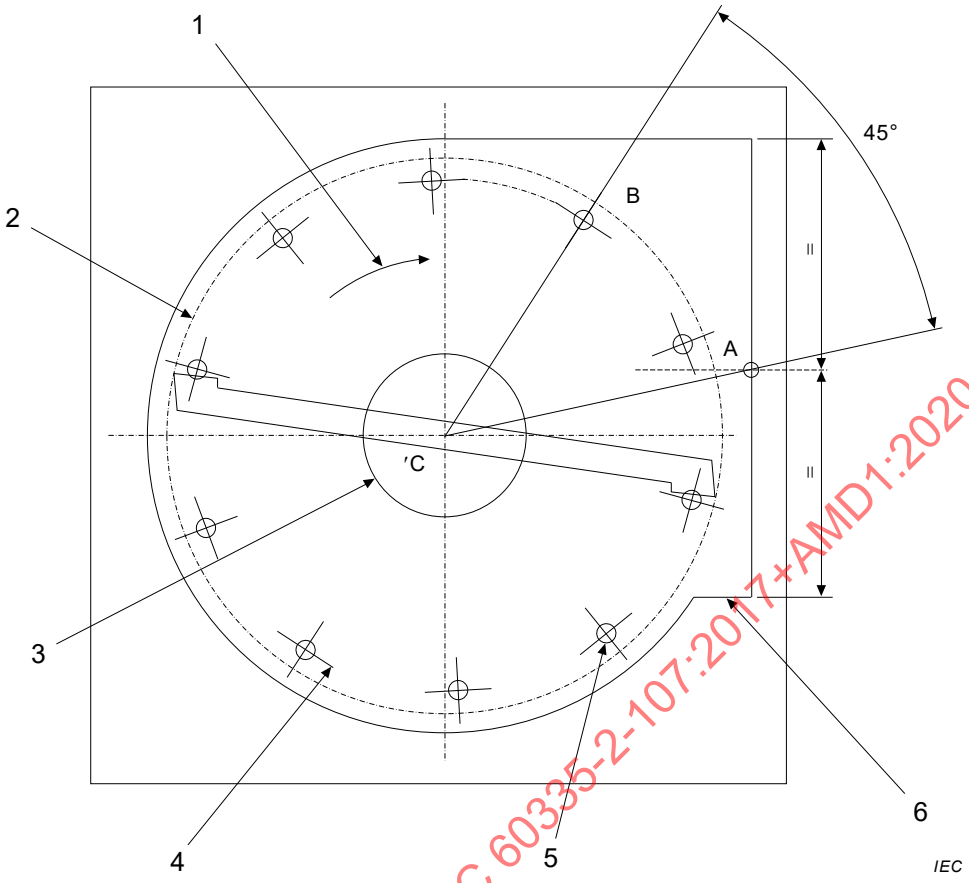
a) Steel rod 25 mm ± 0,5 mm diameter of grade 1 according to ISO 683-4:2014.

b) End fittings inside nominal 100 mm diameter standard pipe (1,5 to 3 clearance) with central hole 33 mm diameter. Identical parts both ends 25 mm thick – hardness = 350 HB.

c) Compression spring dimensions: free length = 165 mm; wire diameter = 3,2 mm; total number of coils = 11,75; mean diameter = 36 mm; spring rate = 2,27 N/mm; ends to be ground and squared.

Figure 103 – Impact test fixture (see 21.101.2)

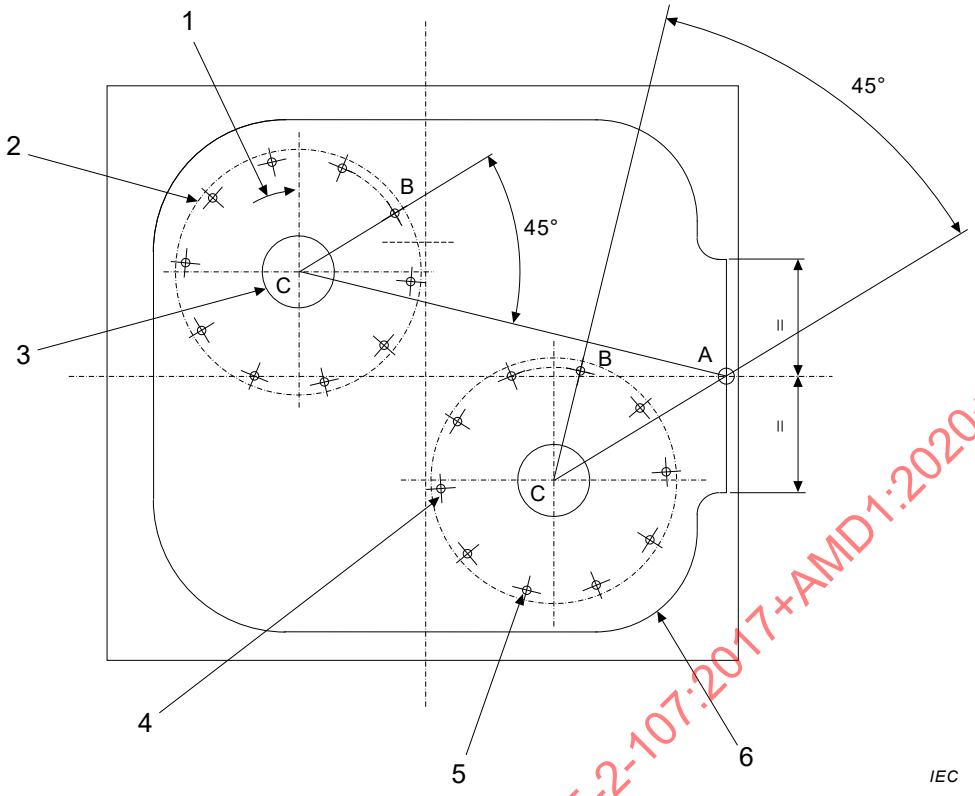
Linear dimensions in millimetres



Key

1 direction of rotation
2 **cutting means tip circle**
3 air inlet hole
4 injection hole centreline
5 10 x ∅ 15 mm injection points equally spaced
6 **cutting means enclosure**
A centre of the **discharge chute** exit
B injection point(s)
C centre of the **cutting means tip circle**

Figure 104a – Single cutting means

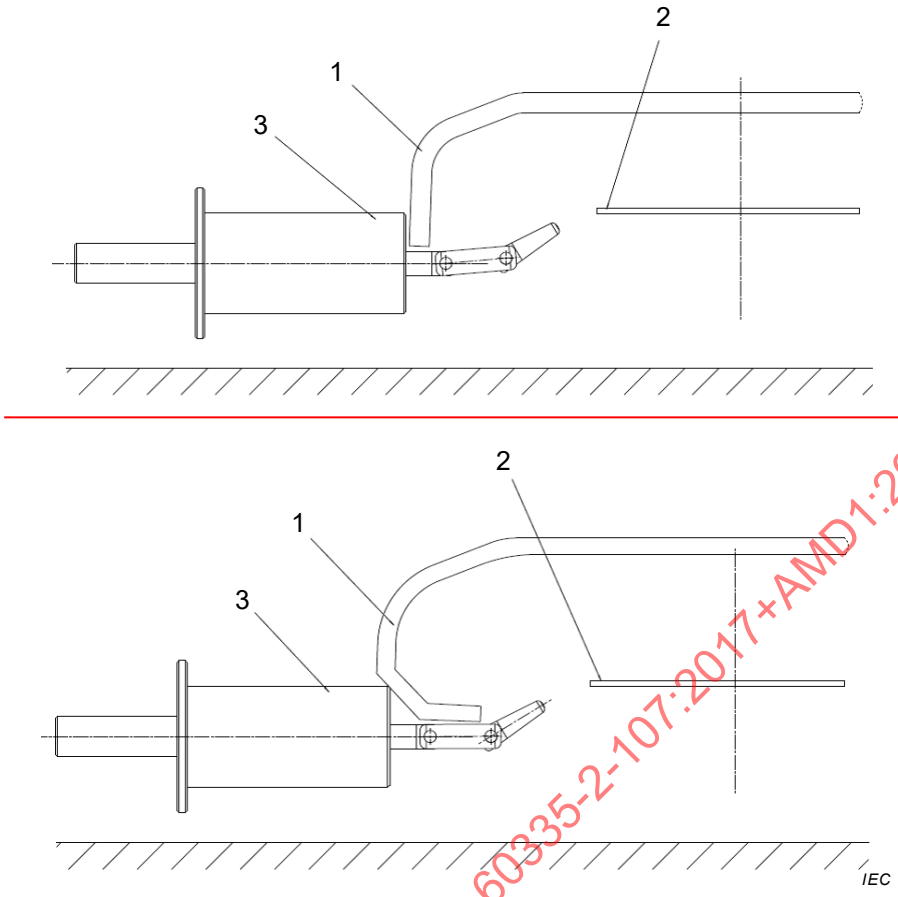


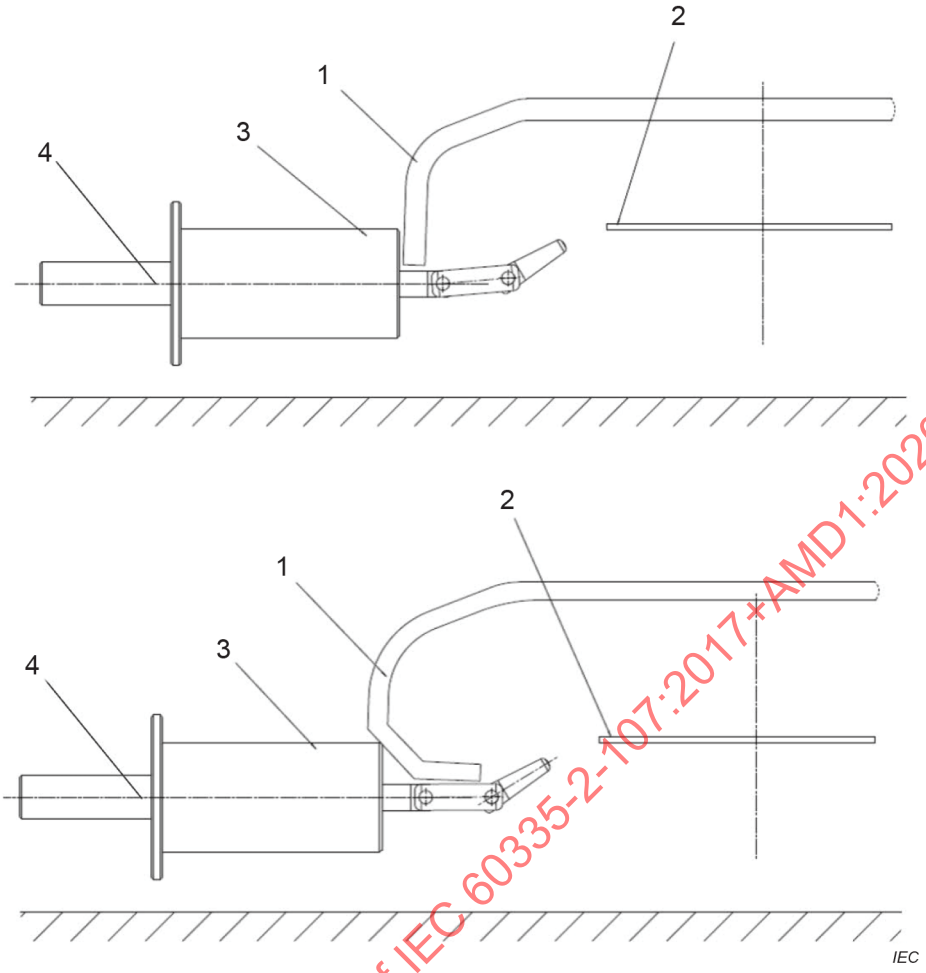
Key

1 direction of rotation
2 **cutting means tip circle**
3 air inlet hole
4 injection hole centreline
5 10 × ∅ 15 mm injection points equally spaced on each spindle
6 **cutting means enclosure**
A centre of the **discharge chute** exit
B injection point(s)
C centre of the **cutting means tip circle**

Figure 104b – Twin cutting means

Figure 104 – Example of structural integrity test fixtures (see 21.101.4.2.1)





Key

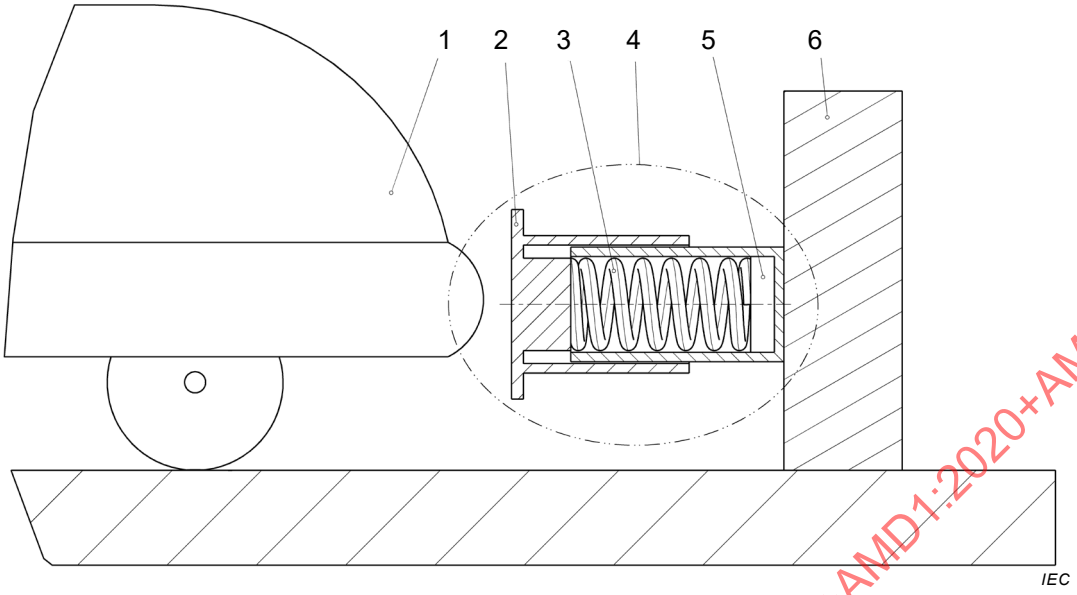
1 machine external enclosure

2 **cutting means**

3 mechanical test probe

4 axis of the test probe held horizontally

Figure 105 – Finger probe test – Illustrations showing application of probe, insertion depth limited according to the geometry of the enclosure



Key

1 machine
2 impact plate
3 spring
4 force measuring means
5 sensing element
6 rigid support

Figure 106 – Obstruction sensor test – Illustration showing typical arrangement (see 22.105.2)

Linear dimensions in millimetres

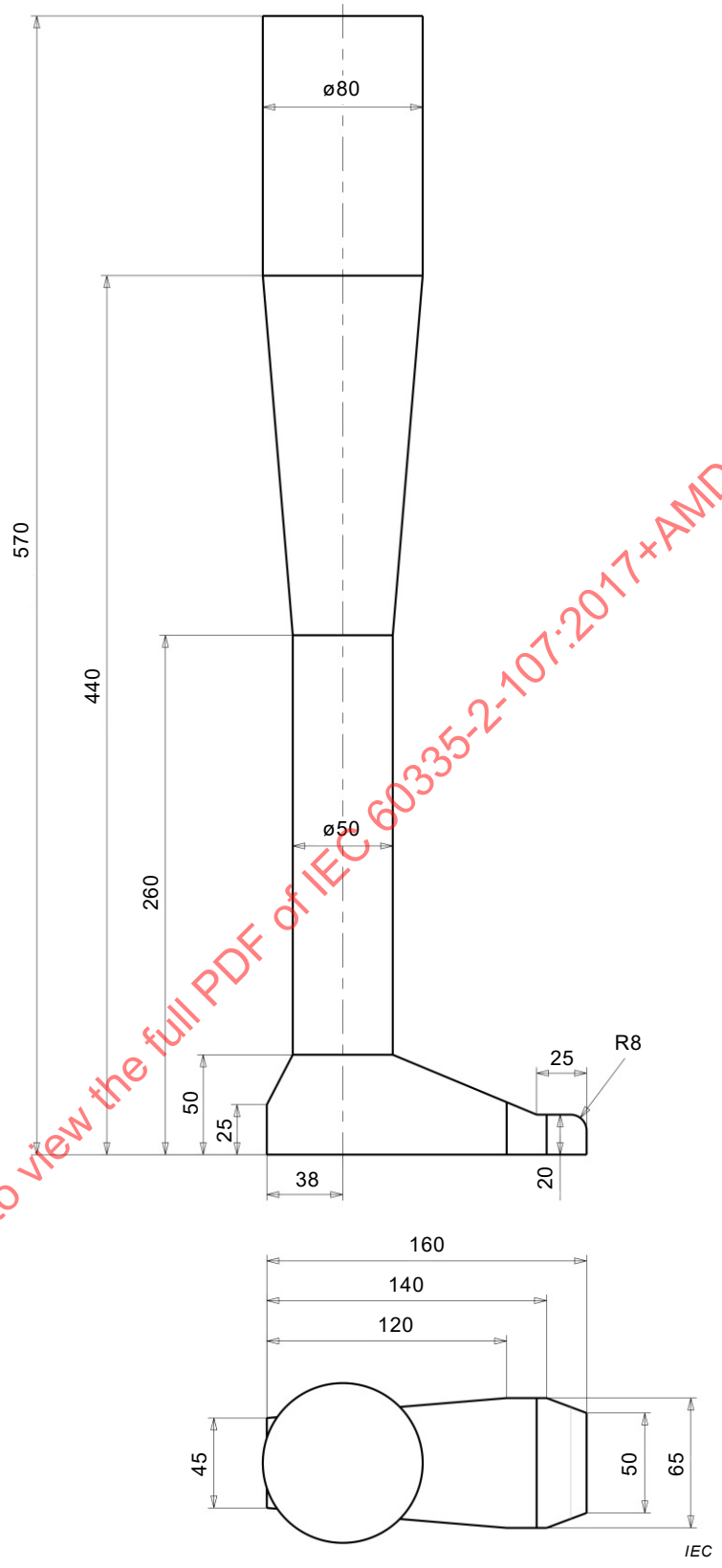
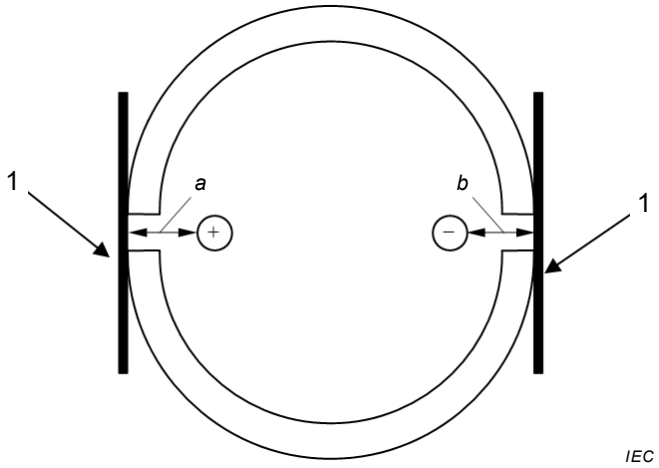


Figure 107 – Foot probe for standing child



Key

1 metal foil

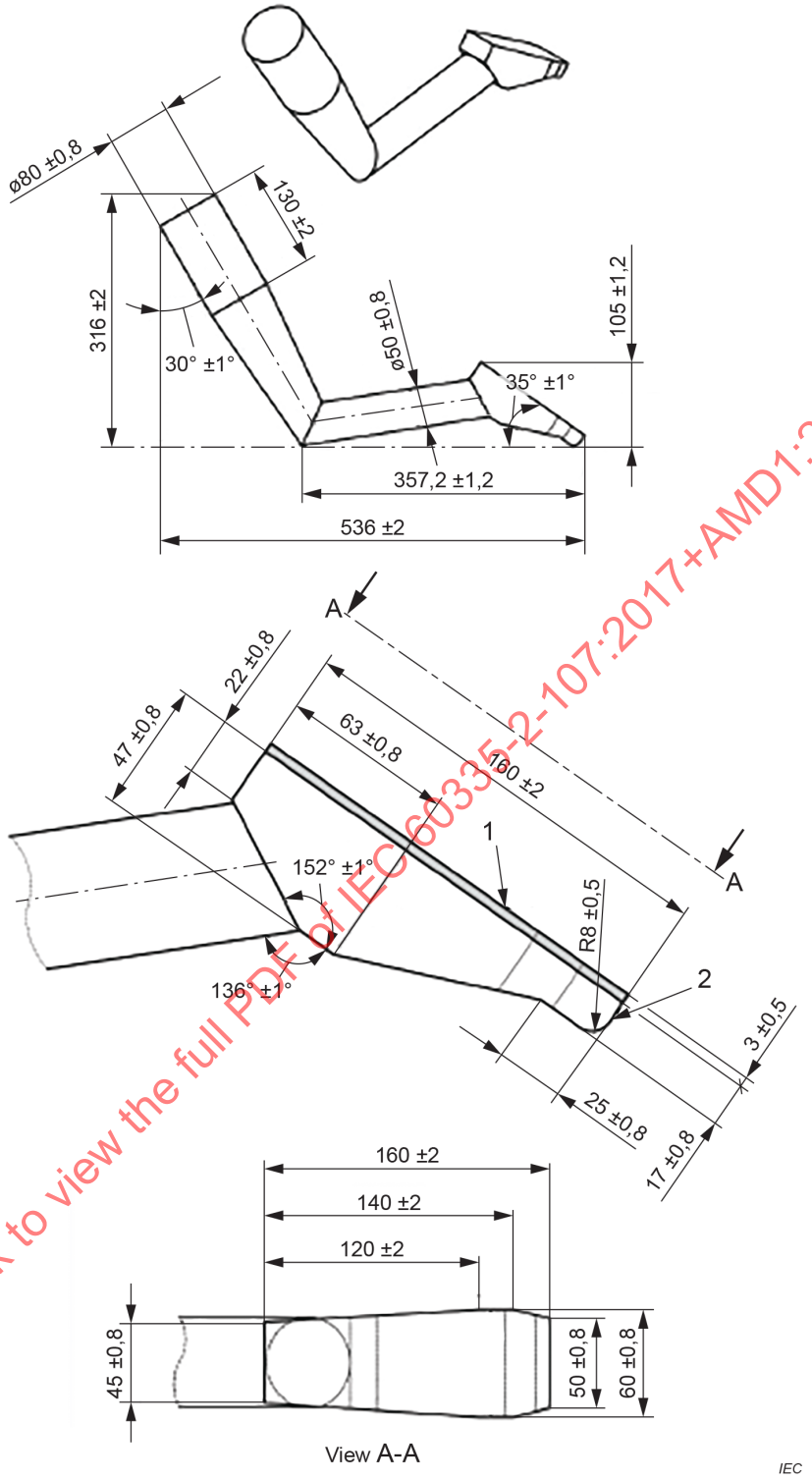
Dimension *a* = distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension *b* = distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

a + *b* is the sum total as defined in 29.101.

Figure 108 – Measurement of clearances

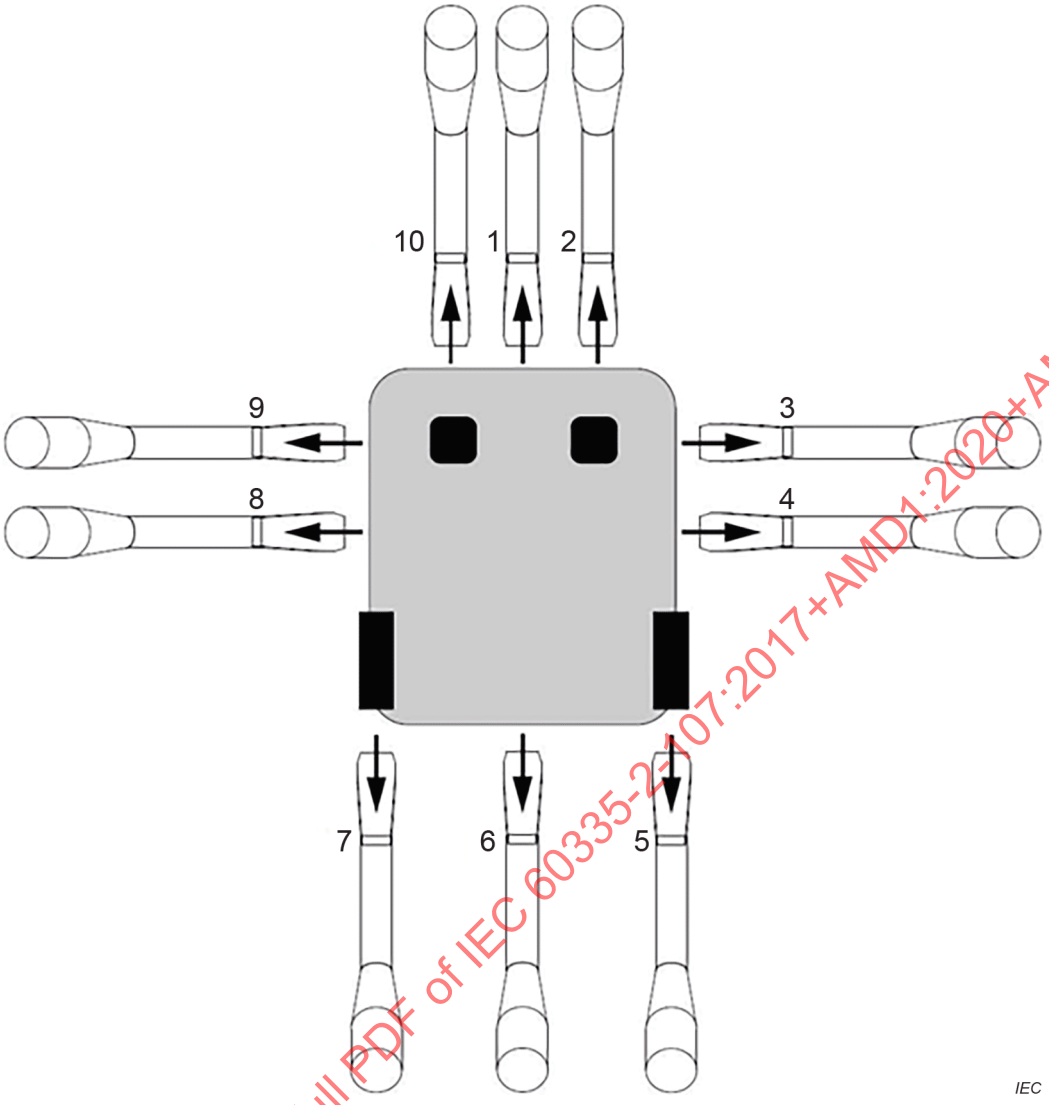
Dimensions in millimetres



Key

1 sole
2 toe

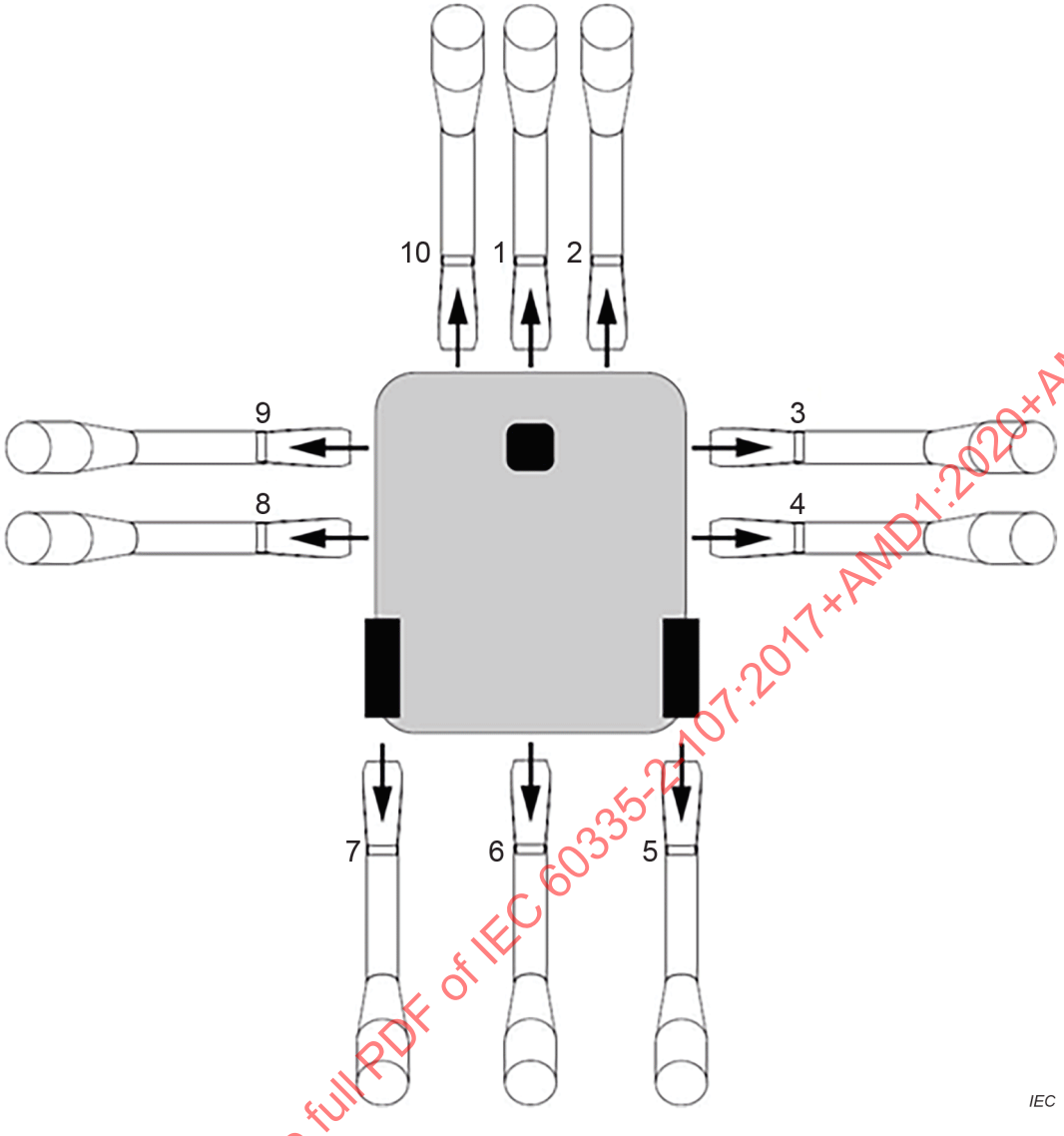
Figure 109 – Foot probe for kneeling child



Key

1 test position between undriven supports
2 test position aligned with undriven support
3 test position aligned with undriven support
4 test position between traction drive wheel and undriven support
5 test position aligned with traction drive wheel
6 test position between traction drive wheels
7 test position aligned with traction drive wheel
8 test position between traction drive wheel and undriven support
9 test position aligned with undriven support
10 test position aligned with undriven support

a) Example of foot probe for kneeling child test positions (two undriven supports)



Key

1 test position aligned with undriven support
2 test position aligned to the side of undriven support
3 test position aligned with undriven support
4 test position between traction drive wheel and undriven support
5 test position aligned with traction drive wheel
6 test position between traction drive wheels
7 test position aligned with traction drive wheel
8 test position between traction drive wheel and undriven support
9 test position aligned with undriven support
10 test position aligned to the side of undriven support

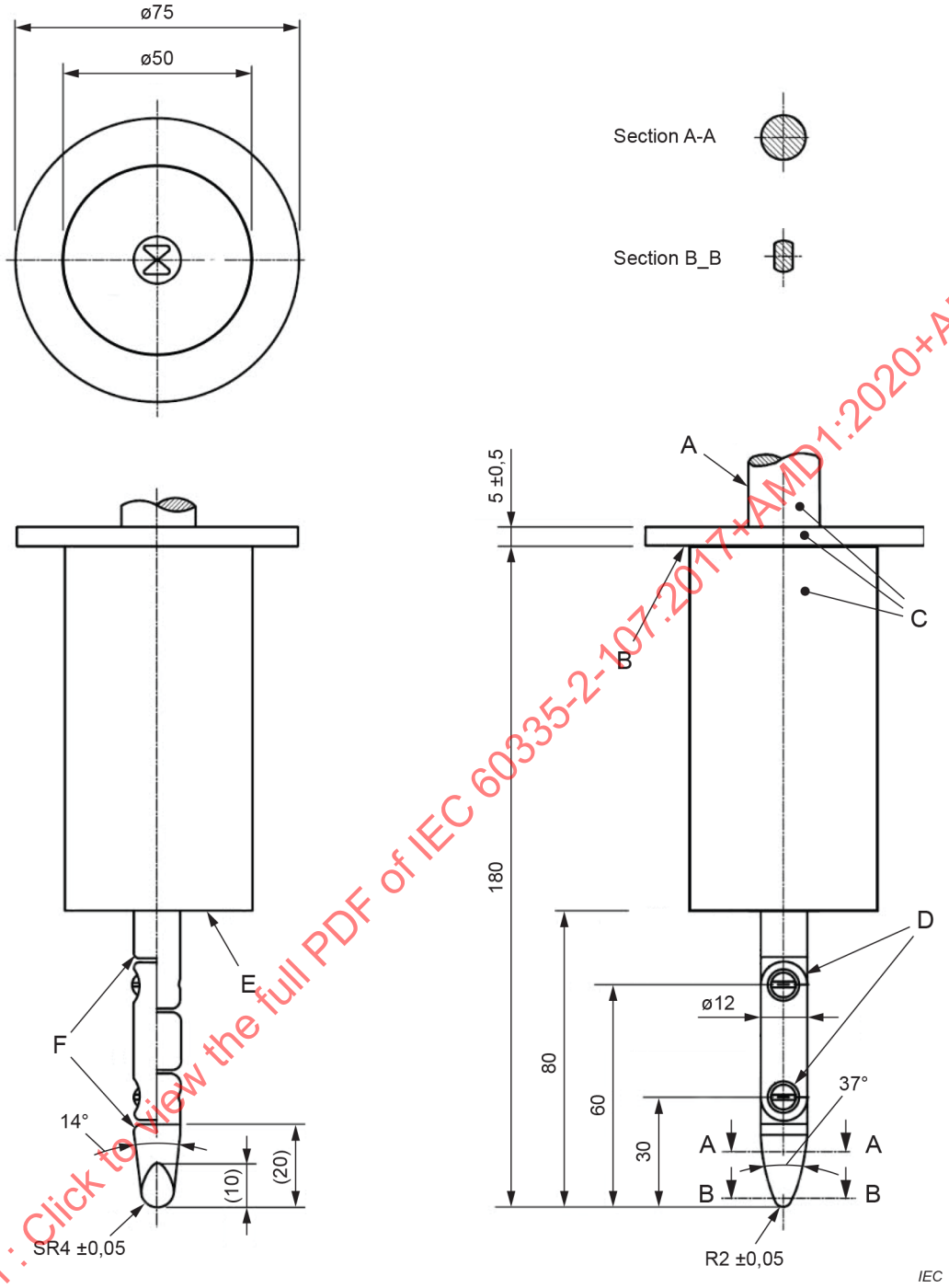
b) Example of foot probe for kneeling child test positions (one front support)

NOTE 1 The arrows in the above examples represent the direction of machine movement.

NOTE 2 The above examples can be used as a guide for other machine configurations.

Figure 110 – Foot probe for kneeling child test positions

Linear dimensions in millimetres



Key

A handle
B guard
C insulating material
D joints
E stop face
F chamfer all edges

Material: Metal, except where otherwise specified

Both joints shall permit movement in the same plane and the same direction through an angle of 90° with a 0° to +10° tolerance.

Tolerances except where otherwise specified:

Angles: $^{0}_{-10}$ °

Linear dimensions up to 25 mm: $^{0}_{-0,05}$ mm

Linear dimensions over 25 mm: ± 0,2 mm

Figure 111 – Test probe for the tests of 20.102.4.2.2.1 and 20.102.4.2.3

Annexes

The annexes of Part 1 are applicable except as follows:

Annex B
(normative)

Appliances powered by rechargeable batteries

This annex of Part 1 is not applicable.

NOTE 101 Additional **battery** operation and charging requirements for **robotic lawnmowers** are specified in Annex KK.

Annex R
(normative)

Software evaluation

Replacement of first paragraph and NOTE:

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 shall be validated in accordance with the requirements in this annex.

NOTE Table R.1 is based on Table H.11.12.7 of IEC 60730-1 for general fault/error conditions.

R.2.1 General

Replacement of the first paragraph:

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 shall use measures to control and avoid software-related faults/errors in safety-related data and safety-related segments of the software.

R.2.1.1 *Replacement:*

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 shall have one of the following structures:

– single channel with functional test (see IEC 60730-1, H.2.16.5);
– single channel with periodic self-test (see IEC 60730-1, H.2.16.6);
– dual channel without comparison (see IEC 60730-1, H.2.16.1).

Compliance is checked by the inspections and tests of the software architecture in R.3.2.2.

R.2.2.2 This subclause is not applicable.

R.2.2.3 *Replacement of the first paragraph:*

For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1, means shall be provided for the recognition and control of errors in transmissions to external safety-related data paths. Such means shall take into account errors in data, addressing, transmission timing and sequence of protocol.

R.2.2.4 *Replacement of the first paragraph:*

For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1, the programmable **electronic circuits** shall incorporate measures to address the fault/errors in safety-related segments and data indicated in Table R.1 as appropriate.

R.2.2.5 *Replacement:*

For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1, detection of a fault/error shall occur before compliance with Clause 19, 20 and 22 is impaired.

Compliance is checked by inspection and testing of the source code.

R.2.2.9 *Modification:*

The software and safety-related hardware under its control shall be initialized and shall terminate before compliance with Clause 19, 20 and 22 is impaired.

R.3.1 General

Replacement:

For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1, the following measures to avoid systematic faults in the software shall be applied.

Software that incorporates measures used to control the fault/error conditions specified in Table R.2 is inherently acceptable for software required to control the fault/error conditions specified in Table R.1.

NOTE The content of these requirements is extracted from IEC 61508-3 and adapted to the needs of this Standard.

Annex S
(normative)

Battery-operated appliances powered by batteries that are non-rechargeable or not recharged in the appliance

This annex of Part 1 is only applicable for non-rechargeable **batteries**.

NOTE The requirements for **batteries** that are not recharged in the machine are specified in Annex KK.

Annex AA
(normative)

Calculation of kinetic energy of pivoting cutting elements

For the purposes of this standard, the kinetic energy of a cutting element shall be determined by means of the following formula (see Figure AA.1):

$E_k = ½\ mv^2$

where

E_k is the kinetic energy, in Joules;

m is the mass, of the reckonable length L of the cutting element, in kilograms;

v is the maximum attainable velocity of the point z which is half way along the reckonable length 'L' of the cutting element, in metres per second.

therefore $v = 0{,}1047n\left[r - \frac{L}{2}\right]$

where

n is the maximum rotational speed with a full length of line or a new cutter fitted, in revolutions per minute;

r is the distance from the axis of rotation of the cutting head to the outer tip of the cutting element, in metres;

L is the reckonable length of the cutting element, in metres.

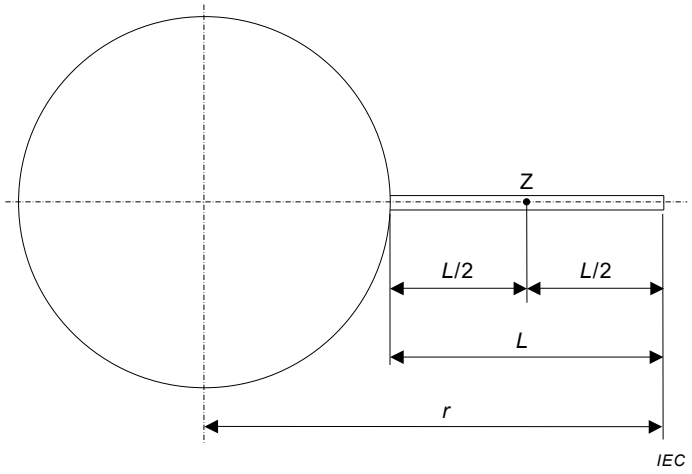


Figure AA.1a – Filament line

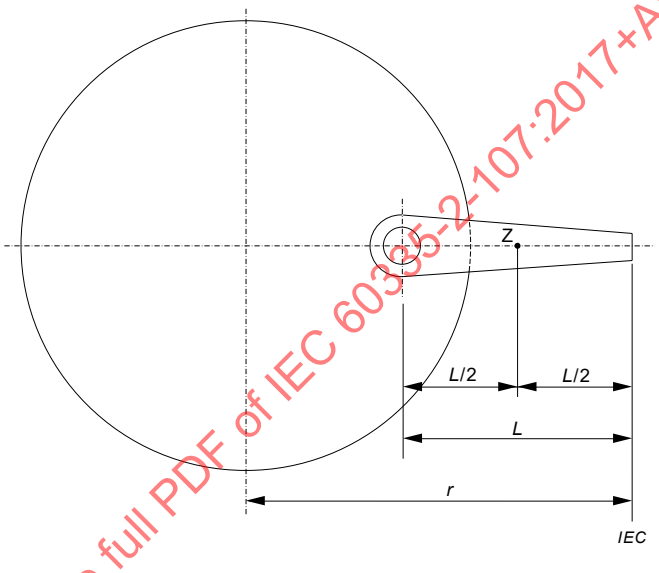


Figure AA.1b – Pivoting cutter

Figure AA.1 – Measurement of the reckonable length *L*

Annex BB
(normative)

Test enclosure construction

BB.1 General construction

The test enclosure shall be constructed generally as shown on Figures BB.1 and BB.2.

The walls shall consist of eight target panels, each 2 000 mm high, perpendicular to the base of the test enclosure, see Figure BB.3, so as to form an octagon. The composition of the target panels up to a height of 900 mm shall meet the material specification of Clause BB2. The target in the area above 900 mm shall consist of a single sheet of Kraft paper rising to a height of 2 000 mm. In order to facilitate the counting of hits, the panel supports should be designed to allow sliding in and out of at least one target panel.

The target panels shall be generally located perpendicular to a radial line extending 750 mm ± 50 mm from the **cutting means tip circle** of single spindle machine or to the nearest **cutting means tip circle** of multi-spindled machines. The flutes of the corrugated fibreboard shall be vertical. If a target panel interferes with a part of the machine such as grass box, or wheel, the target shall be moved back to avoid such interference.

BB.2 Target panel construction

A target panel shall meet the tests of Clause BB.3 and preferably be a single sheet of double flute fibreboard. If necessary, a single sheet of double flute fibreboard with extra sheet(s) of Kraft paper added in front of the target face may be used but this is not recommended. The fibreboard shall be a maximum of 9 mm thickness. To obtain the most consistent results the fibreboard should be as thin as practicable consistent with the requirements for the test.

If Kraft paper is used, it shall be “spot” glued to the fibreboard just sufficiently to ensure that the whole of the paper stays in close proximity to the surface of the fibreboard when it is in position in the test enclosure. The Kraft paper shall be of nominal 80 g/m^2 construction.

BB.3 Target panel material testing

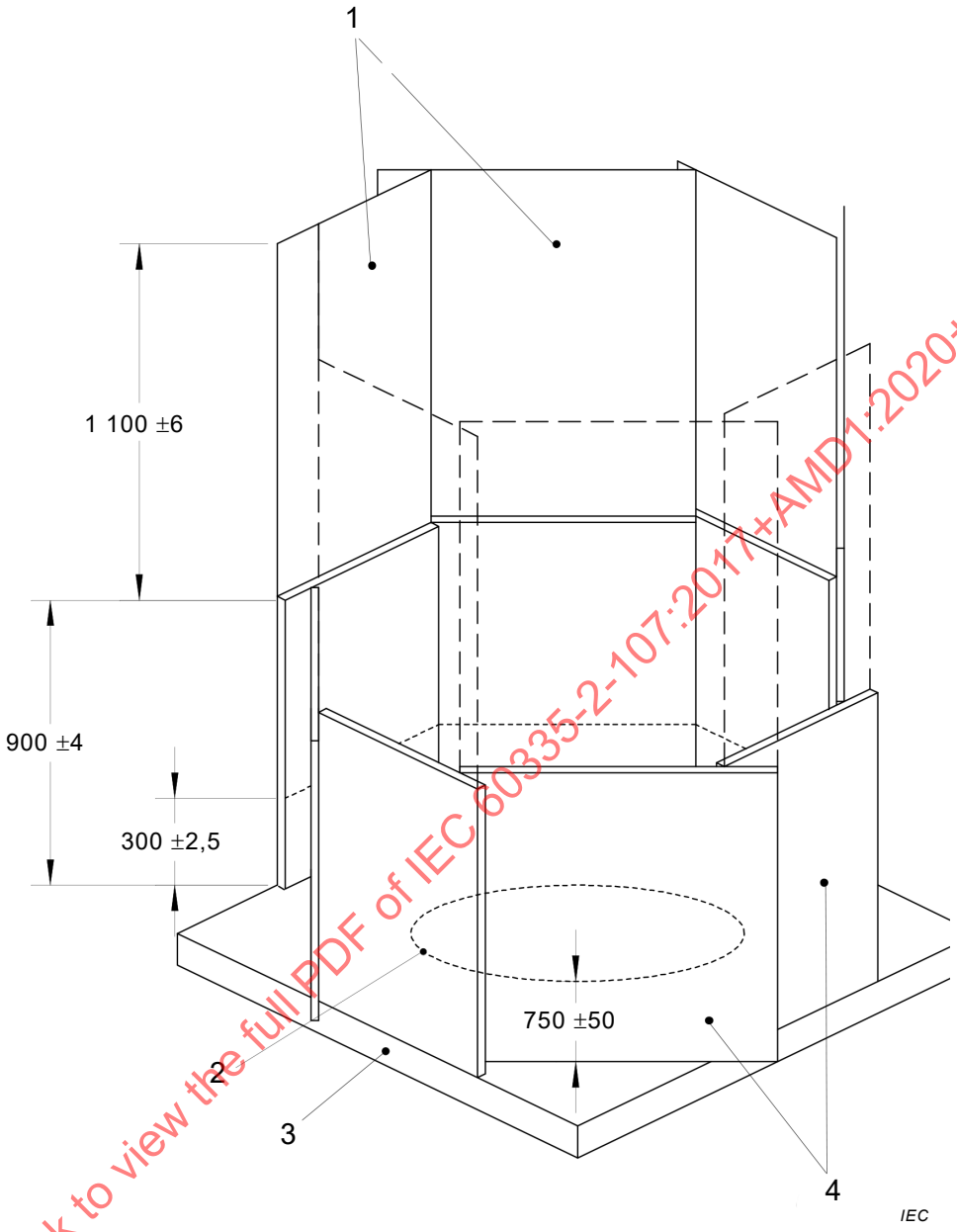
Samples of the target panel construction used shall be cut into 150 mm × 150 mm squares and tested in the fixture shown in Figure BB.4 as follows.

– The samples are placed centrally on the bottom plate, the edges of the square samples may be secured by adhesive or tape. Cover with the top plate, making sure that the central holes in the top and bottom plates are aligned and that the fibre board is flattened by the steel plate.
– The penetrator is raised to the required height and allowed to fall onto the target panel sample.
– The test is carried out on five samples at a height of 300 mm and then on a further five samples at a height of 400 mm.

When dropped from 300 mm, the penetrator shall not penetrate completely through the target panel in more than two out of five samples.

When dropped from 400 mm, the penetrator shall pass completely through the target panel in at least four out of five samples.

Dimensions in millimetres

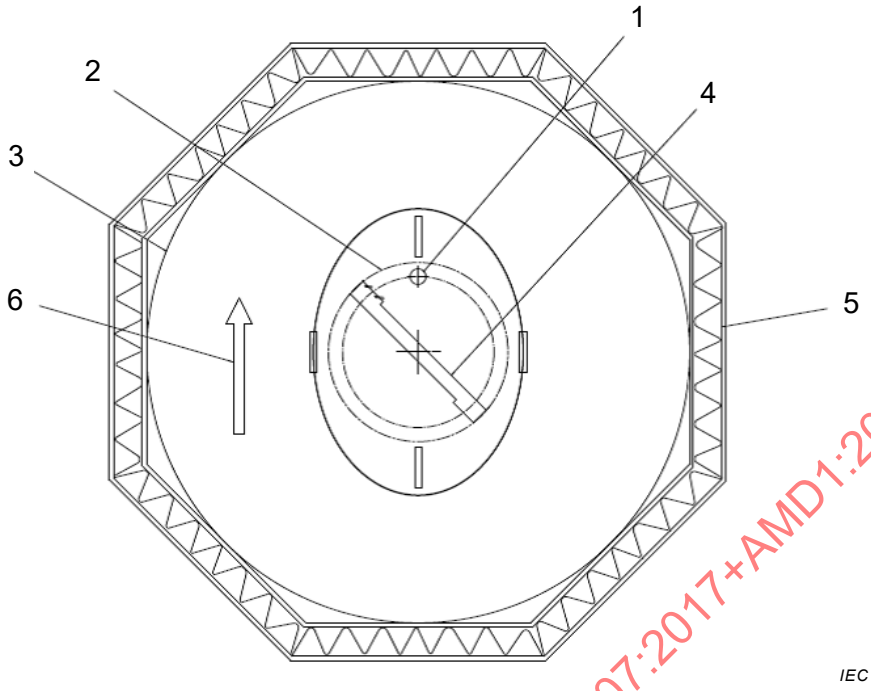


Key

1 kraft paper target panels (80 g/m^2 extending full 360°)
2 **cutting means tip circle**
3 base (see Annex BB and Figure BB.3)
4 corrugated fibreboard target panels with flutes vertical (see Figures BB.2 and BB.3)

Figure BB.1 – Thrown object test enclosure – General layout

Dimensions in millimetres



Key

1 injection point

2 **cutting means tip circle**

3 radius = (**cutting means tip circle** radius + 750) ± 50

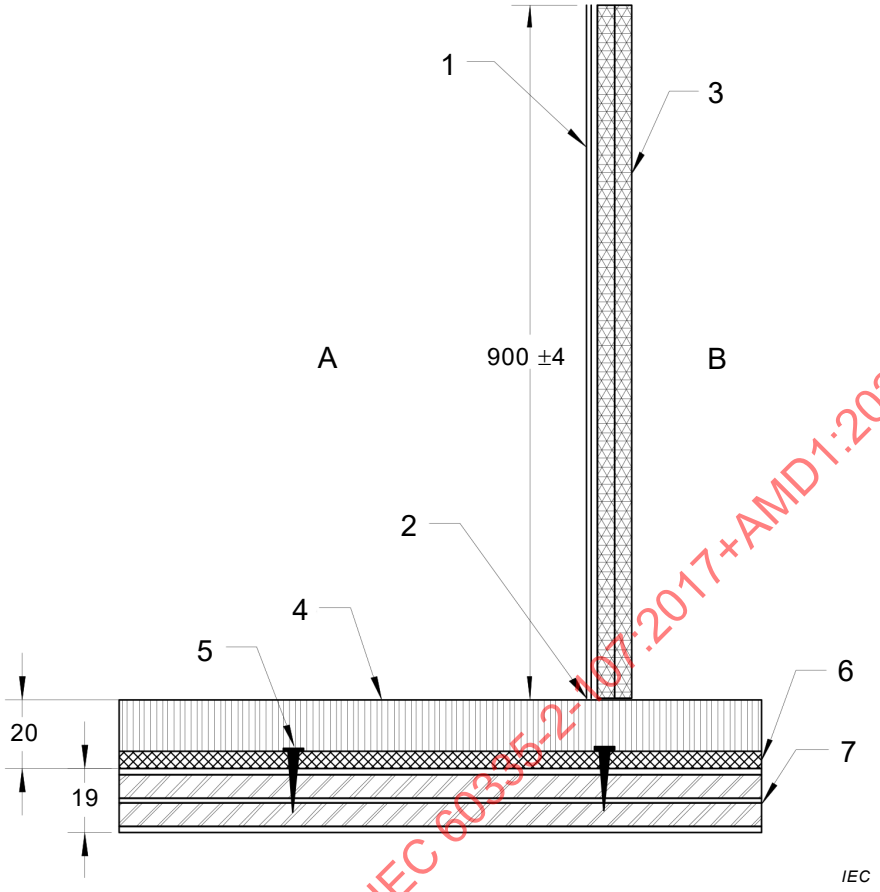
4 **cutting means**

5 eight target panels with flutes vertical

6 normal direction of travel of machine

Figure BB.2 – Thrown object test enclosure

Dimensions in millimetres
(all dimensions are nominal unless otherwise stated)



Key

1 kraft paper, used if necessary and spot glued to the inside surface of the target panels to ensure close proximity over the whole area

2 target panel edges fit snugly to base surface to prevent balls from escaping from test enclosure

3 target panels made of double flute corrugated fibreboard of 9 mm maximum thickness with flutes running vertically

4 coconut matting

5 nail

6 PVC

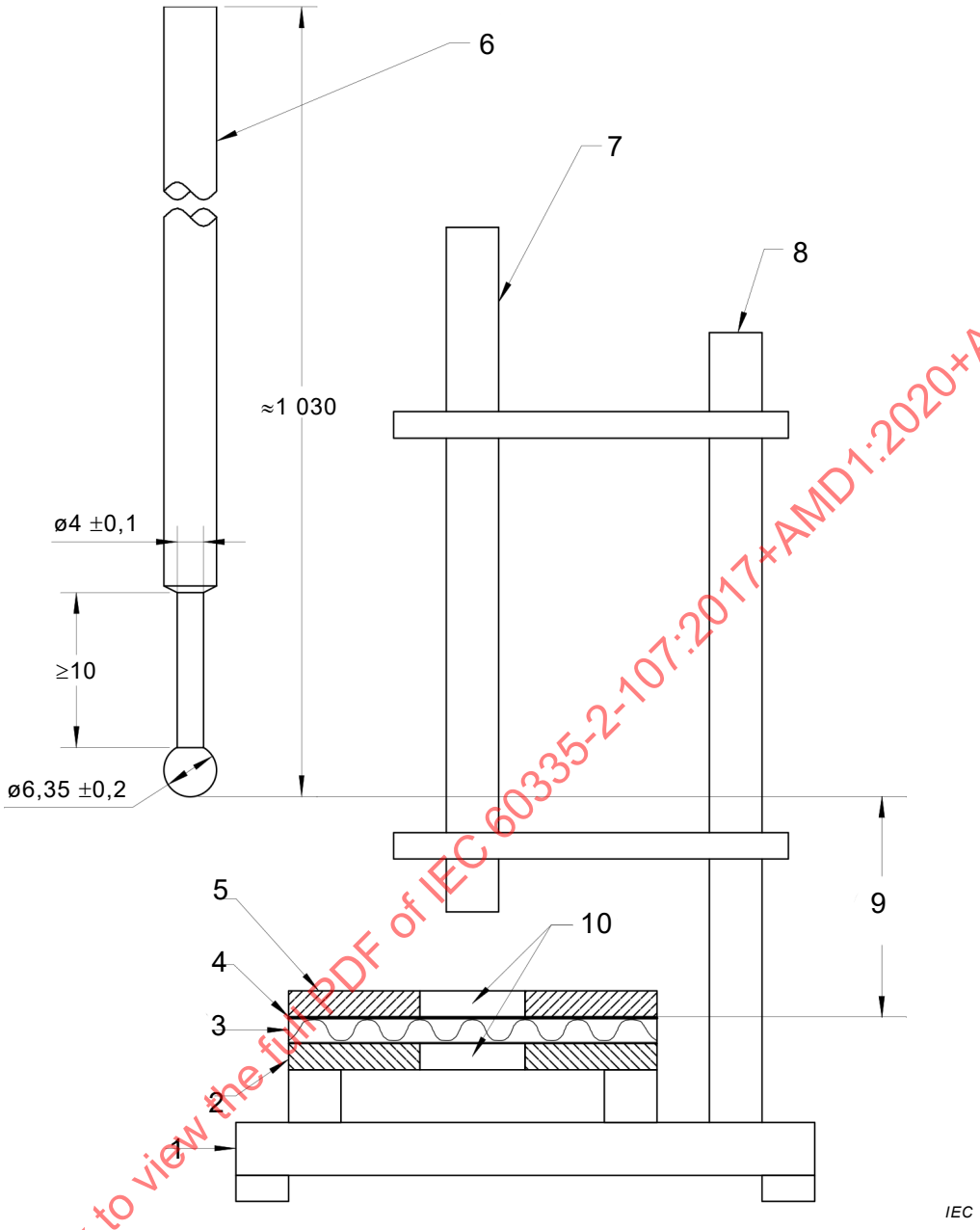
7 plywood base

A inside of test enclosure

B outside of test enclosure

Figure BB.3 – Test enclosure walls and base

Dimensions in millimetres



Key

1	base	6	penetrator made from 6,35 mm ± 0,2 mm diameter steel rod and of mass 0,25 kg ± 0,005 kg
2	steel bottom plate (6,35 × 150 × 150)	7	guide tube – vertical ± 2°
3	fibreboard sample	8	support tube
4	add extra Kraft paper here if needed	9	drop height
5	steel top plate (20 × 150 × 150)	10	two holes 50 mm ± 0,3 mm diameter

Figure BB.4 – Test fixture for corrugated fibreboard penetration test

Annex CC
(normative)

Base for thrown object test enclosure

CC.1 Construction

The test enclosure base shall consist of 19 mm plywood covered with squares of coconut matting of dimensions 500 mm × 500 mm in accordance with Clause CC.3, nailed to the plywood as shown in Figure CC.1 with nails spaced as shown in Figure CC.2.

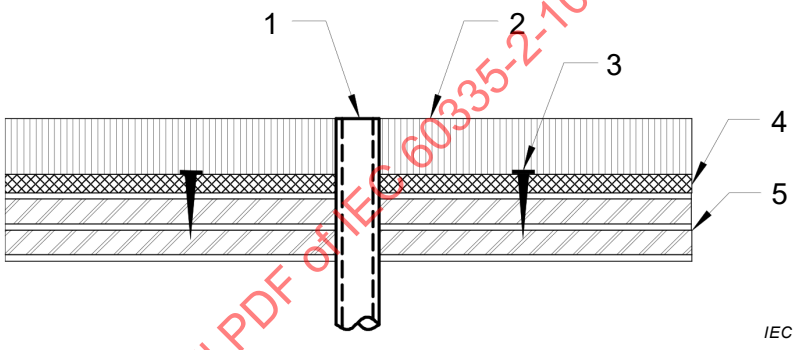
Any square of coconut matting showing a worn area where there is evidence of 50 % or more reduction in the height or number of fibres shall be replaced.

CC.2 Minimum size

The minimum base size shall be such that with the test enclosure constructed in accordance with Clause BB.1, the target panels rest completely on the coconut matting base.

CC.3 Coconut matting

The coconut matting shall have approximately 20 mm high fibres embedded in a PVC base and shall weigh approximately 7 000 g/m^2.



Key

1 injection tube

2 coconut matting approximately 20 mm thick– fibres set in PVC base

3 nail

4 PVC

5 plywood base nominally 19 mm thick

Figure CC.1 – Thrown object test enclosure – Base detail

Dimensions in millimetres
(all dimensions are approximate)

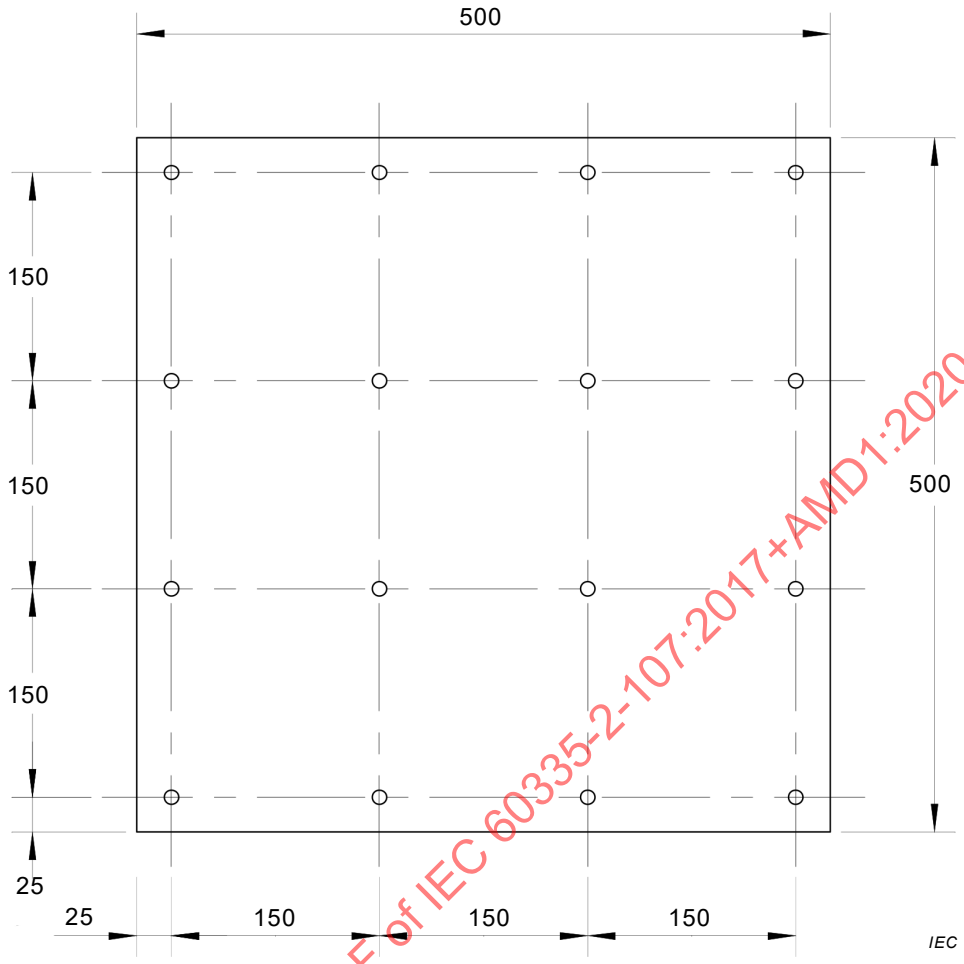


Figure CC.2 – Nail plan of test enclosure base

Annex DD
(normative)

Target panel elevation zones and recommended test report for thrown object test

DD.1 Target elevation zones

The fibreboard sections of the target panels shall be divided horizontally into two elevation zones as shown in Figure BB.1 of Annex BB.

DD.2 Lower elevation zone

The area between the base and the 300 mm line.

DD.3 Upper elevation zone

The area between the 300 mm line and the top of the Kraft paper section of the target panel

DD.4 Recommended test data sheet

The format suggested allows for counting hits after lots of 100 steel balls and summarising the results at the bottom of the sheet. See Figure DD.1.

RESULTS OF THROWN OBJECT TEST

Manufacturer:		
Model:	**Type:**	
	Serial No.:	
Size:		
Discharge location:		
Blades –	**Number:**	
	r/min:	

IEC

Lot	Elevation area	Total hits
1	Upper	
	Lower	
2	Upper	
	Lower	
3	Upper	
	Lower	
4	Upper	
	Lower	
5	Upper	
	Lower	
Test summary	Upper Total	
	Lower Total	
	Total all areas	

IEC

Figure DD.1 – Recommended test data sheet

Annex EE
(normative)

Safety signs

If safety signs are used, they shall be as shown in Figures EE.1 to EE.7:

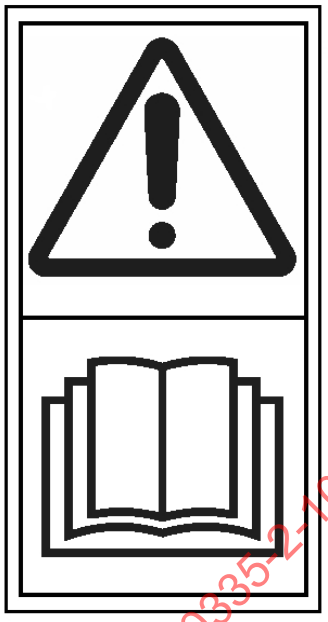


Figure EE.1 – Safety sign illustrating – "WARNING – Read user instructions before operating the machine"

The symbol in the lower half of the safety sign in Figure EE.1 may be replaced by symbol 1641 of ISO 7000, as shown below.

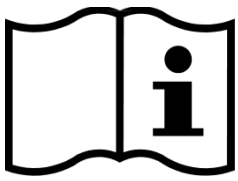


Figure EE.2 – Alternative safety sign for the supplementary safety information panel of EE.1 (safety sign 1641 of ISO 7000)

or by symbol M002 of ISO 7010, as shown below:

Figure EE.3 – Alternative safety sign for the supplementary safety information panel of EE.1 (safety sign M002 of ISO 7010)

Figure EE.4 – Safety signs illustrating – "WARNING – Keep a safe distance from the machine when operating"

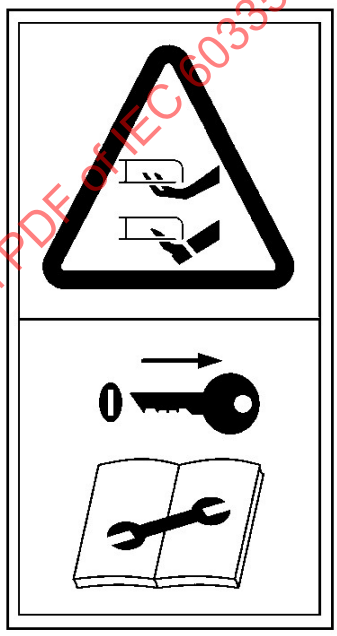


Figure EE.5 – Safety sign illustrating – "WARNING – Remove the disabling device before working on or lifting the machine"

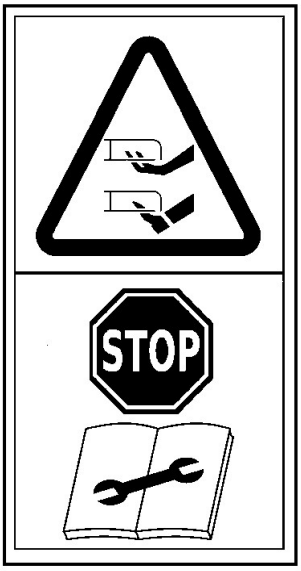


Figure EE.6 – Safety sign illustrating – "WARNING – Operate the disabling device before working on or lifting the machine"

Figure EE.7 – Safety sign illustrating – "WARNING – Do not ride on the machine"

Annex FF
(informative)

Noise test code –
Engineering method (grade 2)

FF.1 Scope

This noise test code specifies the information necessary to carry out efficiently and under standardised conditions the determination of the noise emission characteristics of **battery** powered **robotic lawnmowers**. Noise emission characteristics include the emission sound pressure level and the sound power level. The determination of these quantities is necessary for:

– manufacturers to declare the noise emitted;

– comparing the noise emitted by machines in the family concerned;

– purposes of noise control at the source at the design stage.

The use of this noise test code ensures reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise measurement methods allowed by this standard give results with grade 2 of accuracy.

FF.2 A-weighted sound power level determination

For the determination of A-weighted sound power level, ISO 3744:2010 shall be used subject to the following modifications or additional requirements:

– the reflecting surface shall be replaced by an artificial surface which complies with FF.4.1 or by natural grass which complies with FF.4.2. Reproducibility of results using natural grass is likely to be lower than that required for grade 2 of accuracy. In the case of dispute, measurements shall be carried out in the open air and on the artificial surface;

– the measurement surface shall be a hemisphere with a radius, r, which depends on the width of cut of the machine under test and which shall be:

  r = 4 m for machines with a width of cut up to 1,2 m;

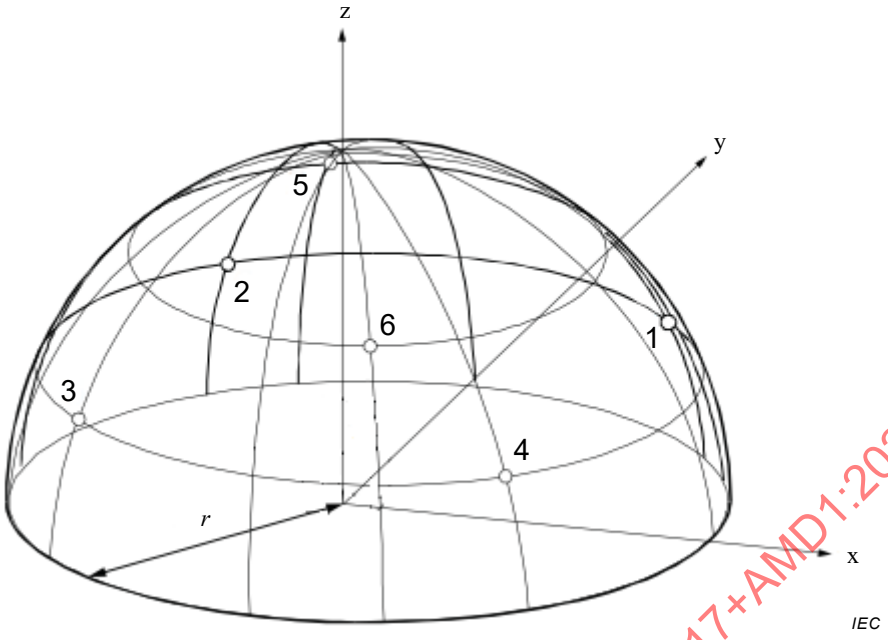
  r = 10 m for machines with a width of cut exceeding 1,2 m;

– the microphone array shall be six microphone positions as defined in Figure FF.1 and Table FF.1;

– environmental conditions shall be within the limits specified by the manufacturers of the measuring equipment. The ambient air temperature shall be in the range from 5 °C to 30 °C and the wind speed shall be less than 8 m/s and preferably less than 5 m/s;

– for measurements in the open air, K_{2A} shall be taken as 0;

– for measurements indoors, the value of K_{2A}, determined without artificial surface and in accordance with Annex A of ISO 3744:2010, shall be ≤ 2 dB, in which case K_{2A} shall be taken as 0.



Key

r radius of hemisphere

Figure FF.1 – Microphone positions on the hemisphere (see Table FF.1)

Table FF.1 – Co-ordinates of microphone positions

Position No.	*x*	*y*	*z*
1	+0,65 *r*	+0,65 *r*	0,38 *r*
2	–0,65 *r*	+0,65 *r*	0,38 *r*
3	–0,65 *r*	–0,65 *r*	0,38 *r*
4	+0,65 *r*	–0,65 *r*	0,38 *r*
5	–0,28 *r*	+0,65 *r*	0,71 *r*
6	+0,28 *r*	–0,65 *r*	0,71 *r*

For the determination of the measured sound power level microphones shall be set at the positions specified in Table FF.1.

FF.3 A-weighted ~~emission~~ sound pressure level measurement

The A-weighted emission sound pressure level at the robotic electrical **battery**-powered **lawnmower**, L_{pA}, shall be determined in accordance with ISO 11203:1995 as follows:

$$L_{pA} = L_{WA} - Q \text{, in dB}$$

where

~~Q = 11, in dB~~

Q = 8, in dB.

NOTE This value of Q has been determined, during experimental investigations, to be applicable to robotic electrical **battery**-powered **lawnmowers**. The resulting A-weighted emission sound pressure level at the robotic electrical **battery**-powered **lawnmowers** is equivalent to the value of the surface sound pressure level at a distance of 1 m from the robotic electrical **battery**-powered **lawnmowers**. This distance has been chosen to give satisfactory reproducibility of results, and to permit comparison of the acoustic performance of different robotic electrical **battery**-powered **lawnmowers**.

FF.4 Requirements for test floor

FF.4.1 Artificial surface

The artificial surface shall have absorption coefficients as given in Table FF.2, measured in accordance with ISO 354:2003.

Table FF.2 – Absorption coefficients

Frequencies Hz	Absorption coefficients	Tolerance
125	0,1	± 0,1
250	0,3	± 0,1
500	0,5	± 0,1
1 000	0,7	± 0,1
2 000	0,8	± 0,1
4 000	0,9	± 0,1

The artificial surface shall be placed on a hard, reflecting surface and have a size of at least 3,6 m × 3,6 m placed at the centre of the test environment. The construction of the supporting structure shall be such that the requirements for the acoustic properties are also met with the absorptive material in place. The structure shall support the operator to avoid compression of the absorbing material.

NOTE See Annex GG for an example of a material and construction which can be expected to fulfil these requirements.

FF.4.2 Natural grass

The test environment shall be covered, at least for the horizontal projection of the measurement surface used, with high quality natural grass. Before the measurements are taken, the grass shall be cut with a mower to a height of cut as near as possible to 30 mm. The surface shall be clean of grass clippings and debris and shall be visibly free of moisture, frost or snow.

FF.5 Installation, mounting and operating conditions

Measurements shall be carried out on a new, normal production machine featuring standard equipment as provided by the manufacturer. If a catcher is provided or available for the machine from the manufacturer, it shall be fitted and empty.

The machine shall be tested in a stationary position with any **traction drive** disengaged and shall be set to the height of cut position nearest to 30 mm. If the **traction drive** cannot be disengaged, the machine shall be raised on support blocks sufficient to just ensure ground clearance. The blocks shall be as small as is practicable consistent with safety during the test and shall be well clear of the **cutting means**.

Noise measurements shall be started with **fully charged batteries** as specified by the manufacturer but shall not be continued when the **battery** voltage under load drops to lower than 0,9 times the **battery** voltage under load at the beginning of the measurements for lead-acid **batteries**, or to lower than 0,8 times for other **batteries**;

The **battery** voltage shall be measured at the **battery** terminals.

During the test, the **cutting means** shall be engaged and unloaded.

The test shall be carried out at the **maximum operating motor speed**.

A motor speed indicator shall be used to check the speed of the motor. It shall have an accuracy of ± 2,5 % of the reading. The indicator and its engagement with the machine shall not affect the operation during the test.

For the sound power level determination, machines shall be measured by placing them on the surface in such a way that the projection of the geometrical centre of their main parts coincides with the origin of the co-ordinate system of the microphone positions. If an artificial surface in accordance with FF.4.1 is used, it shall be placed so that its geometrical centre also coincides with the origin of the co-ordinate system of the microphone positions. The longitudinal axis of the machine shall be on the x axis. The measurement shall be carried out without an operator.

FF.6 Measurement uncertainties

The total measurement uncertainty of the emission sound pressure level respectively sound power level is depending on the standard deviation σ_{R0} given by the applied noise emission measurement method and the uncertainty associated with the instability of the operating and mounting conditions σ_{omc}. The resulting total uncertainty is then calculated from

$$\sigma_{tot} = \sqrt{\sigma_{R0}^2 + \sigma_{omc}^2}$$

NOTE 1 σ_{tot} was formerly denoted as σ_R.

The upper bound value of σ_{R0} is about 1,5 dB for a grade 2 measurement method, assuming a noise source which emits sound without significant tones.

NOTE 2 For machines with a rather constant noise emission a value of 0,5 dB for σ_{omc} can apply. In other cases, e.g. a large influence of the material flow into and out of the machine or material flow that varies in an unpredictable manner, it is possible that a value of 2 dB may be more appropriate. Methods to determine σ_{omc} are described in the basic measurement standards.

The expanded measurement uncertainty U, in decibels, shall be calculated from $U = k\,\sigma_{tot}$, with k the coverage factor.

NOTE 3 The expanded measurement uncertainty depends on the degree of confidence that is desired. For the purpose of comparing the result with a limit value, it is appropriate to apply the coverage factor for a one-sided normal distribution. In that case, the coverage factor $k = 1,6$ corresponds to a 95 % confidence level. Further information is given in ISO 4871:1996. Please note that the expanded measurement uncertainty U is denoted as K in ISO 4871:1996.

NOTE 4 The expanded measurement uncertainty as described in this European Standard does not include the standard deviation of production which is used in ISO 4871:1996 for the purpose of making a noise declaration for batches of machines.

FF.7 Information to be recorded

The information to be recorded shall cover all of the technical requirements of this noise test code. Any deviations from this noise test code or from the basic standards that have been applied are to be recorded together with the technical justification for such deviations.

FF.8 Information to be reported

The information included in the test report shall cover at least that which is required to prepare a noise declaration or to verify the declared values.

As a minimum, the following information shall be included:

– reference to the basic noise emission standards used;
– description of mounting and operating conditions used;
– locations of work stations and other specified positions determining L_{pA};
– noise emission values obtained;
– uncertainties.

It shall be confirmed that all requirements of the noise test code according to this standard have been fulfilled, or, if this is not the case, any unfulfilled requirements shall be identified. Deviations from the requirements shall be stated and technical justification for the deviations shall be given.

FF.9 Declaration and verification of noise emission values

The declaration of the noise emission values shall be made as a dual number noise emission declaration according to ISO 4871:1996. It shall declare the emission sound pressure level L_{pA} and the sound power level L_{WA} together with their respective uncertainties K_{pA} and K_{WA}.

NOTE Based on experiences it is assumed that the uncertainties K_{pA} and K_{WA} have values about 3 dB.

The noise emission values shall be rounded to the nearest whole decibel.

The noise declaration shall state that the noise emission values have been obtained according to this noise test code and to the basic standards ISO 11203:1995 and ISO 3744:2010.

If this statement is not true, the noise emission declaration shall indicate clearly what the deviations are from this standard and/or from the basic standards.

If undertaken, verification shall be done according to ISO 4871:1996 by using the same mounting, installation and operating conditions as those used for the initial determination of the noise emission values.

Annex GG
(informative)

Example of a material and construction fulfilling the requirements for an artificial surface

GG.1 Material

Mineral fibre, 20 mm thick, having an airflow resistance of 11 kN.s/m^4 and a density of 25 kg/m^3.

GG.2 Construction

As is shown in Figure GG.1, the artificial flooring of the measurement site is sub-divided into nine joint planes, each of approximately 1,20 m × 1,20 m. The backing layer (a) of the construction as shown in Figure GG.1 consists of chipboard, 19 mm thick, coated with a plastics material on both sides. Such boards are used, for example, for the construction of kitchen furniture. The cut edges of the chipboards should be protected against moisture by applying a coat of plastic paint. The outsides of the flooring are bordered by a two-legged aluminium section (d), its leg height being 20 mm. Sections of this profile material are also screwed to the edges of the joint planes where they serve as spacers and attachment points.

On the middle joint plane on which the machine is placed during measurement as well as any other place on which the operator can get to stand on, aluminium T-sections (c) with a leg length of 20 mm are mounted as spacers. These sections also provide exact markings which facilitate the alignment of the machine in the middle of the measurement site. The prepared boards are then covered with the insulating felt material (b) cut to size.

The felt flooring of the joint planes which are neither stood on nor driven over (type A surface in Figure GG.1) are covered with a simple wire mesh fastened to the edge strips and to the attachment points; for this purpose, the sections should be provided with holes. Thus, the material is adequately attached, but it remains possible to replace the felt material should it become soiled. As a wire mesh, a so-called aviary wire (e) with a mesh width of 10 mm and a wire diameter of 0,8 mm has proved to be suitable. This wire appears to protect the surface adequately without affecting the acoustic conditions.

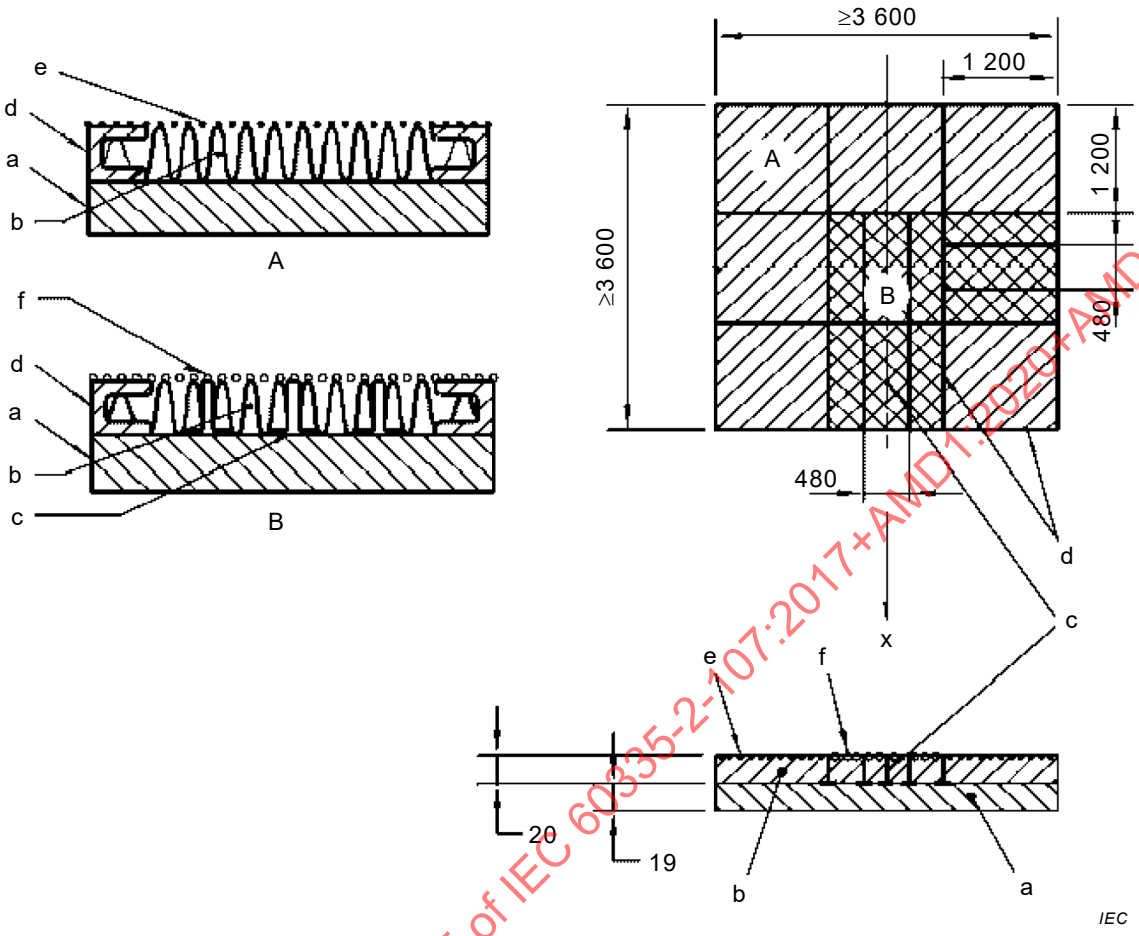
Protection by simple wire mesh is not, however, sufficient in the area subjected to traffic (type B surface in Figure GG.1). For these surfaces, the use of wire grating of corrugated steel wire (f) with a diameter of 3,1 mm and a mesh width of 30 mm has proved to be suitable.

The construction of the measurement site as described above offers two advantages: it can be prepared without much time and effort, and all the materials are easily obtainable.

The fact that the microphone positions are not situated directly above the flooring of the measurement site allows the microphones to be easily mounted on stands, assuming that the ground is even and hard as, for example, an asphalt or concrete site.

When arranging the microphones, account has to be taken of the fact that the height of the microphones has to be determined in relation to the surface of the flooring of the measurement site. It shall, therefore, be 40 mm higher when measuring from the ground under the microphone.

Dimensions in millimetres
(unless otherwise stated all dimensions are approximate)



Key

A surface not suitable to carry weight. Do not stand on or drive over.
B surface suitable to carry weight. May be stood on or driven over.
a backing layer of plastics coated chipboard (nominally 19 thick)
b mineral wool fibre layer (nominally 20 thick)
c aluminium T-sections (nominally 3 mm thick × 20 mm high)
d aluminium U-sections (nominally 3 mm thick × 20 mm high)
e wire mesh (nominally 10 mm × 10 mm mesh made of 0,8 mm diameter steel wire)
f wire grating (nominally 30 mm × 30 mm mesh made of 3,1 mm diameter steel wire)
x axis x according to Annex FF (see Figure FF.1)

Figure GG.1 – Sketch of the measurement surface covered with an artificial surface (not to scale)

Annex HH

Void

Annex II

Void

Annex JJ
(informative)

Operation of the lift sensor, tilt sensor, obstruction sensor and rollover sensor

Figures JJ.1 to JJ.3 demonstrate the operation of the lift sensor, tilt sensor, obstruction sensor and rollover sensor.

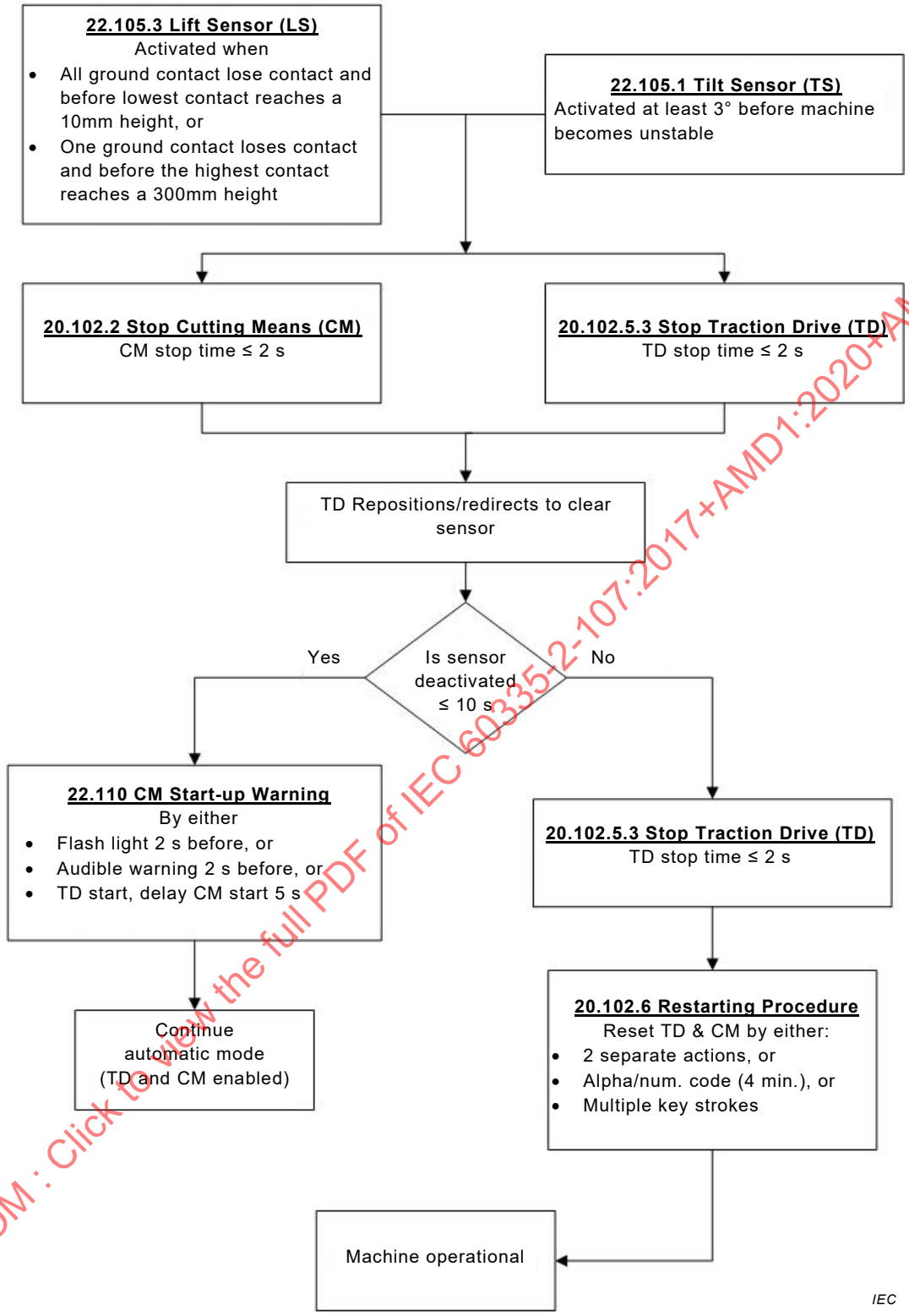


Figure JJ.1 – 22.105.3 Lift sensor (LS) and 22.105.1 Tilt sensor (TS)

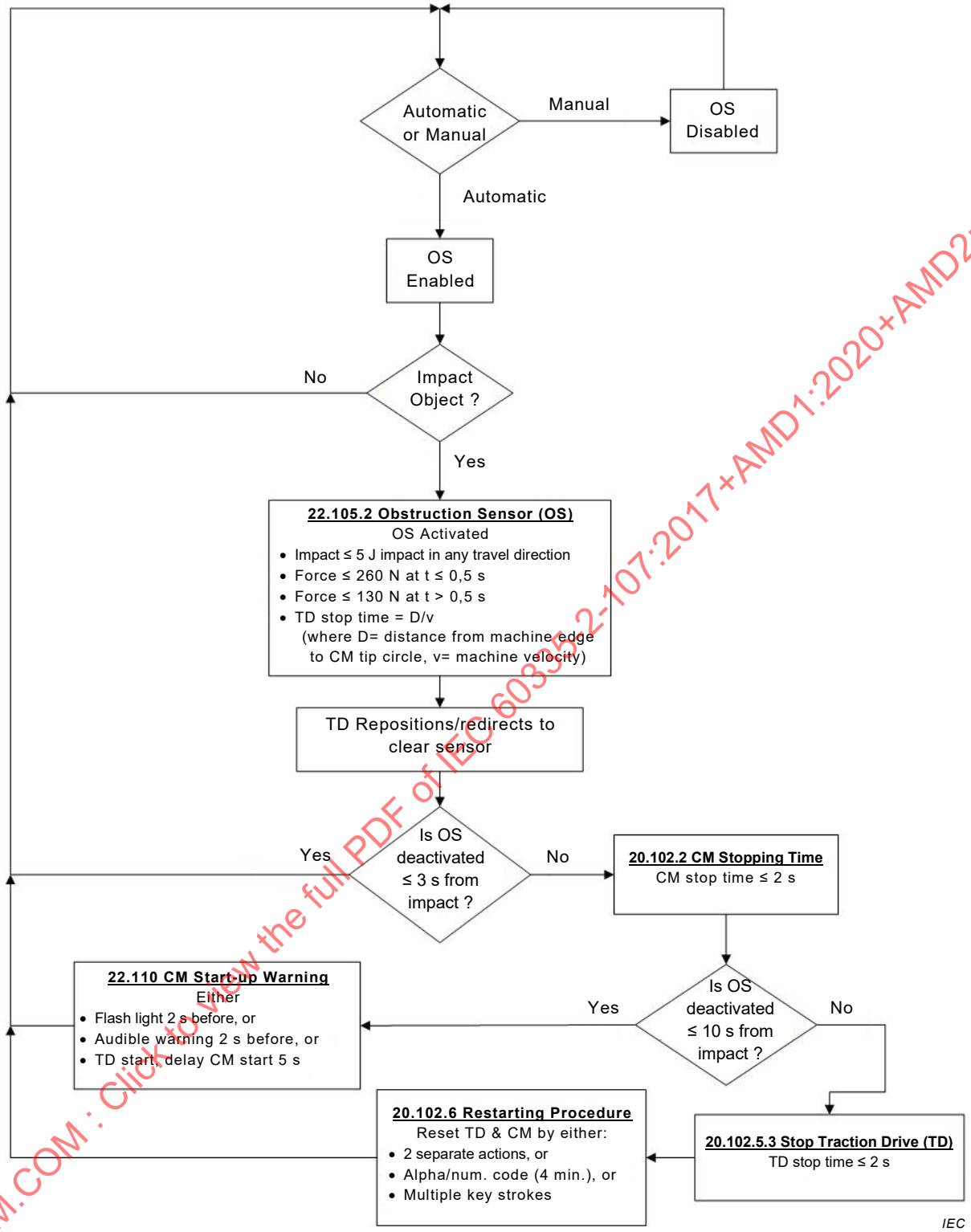
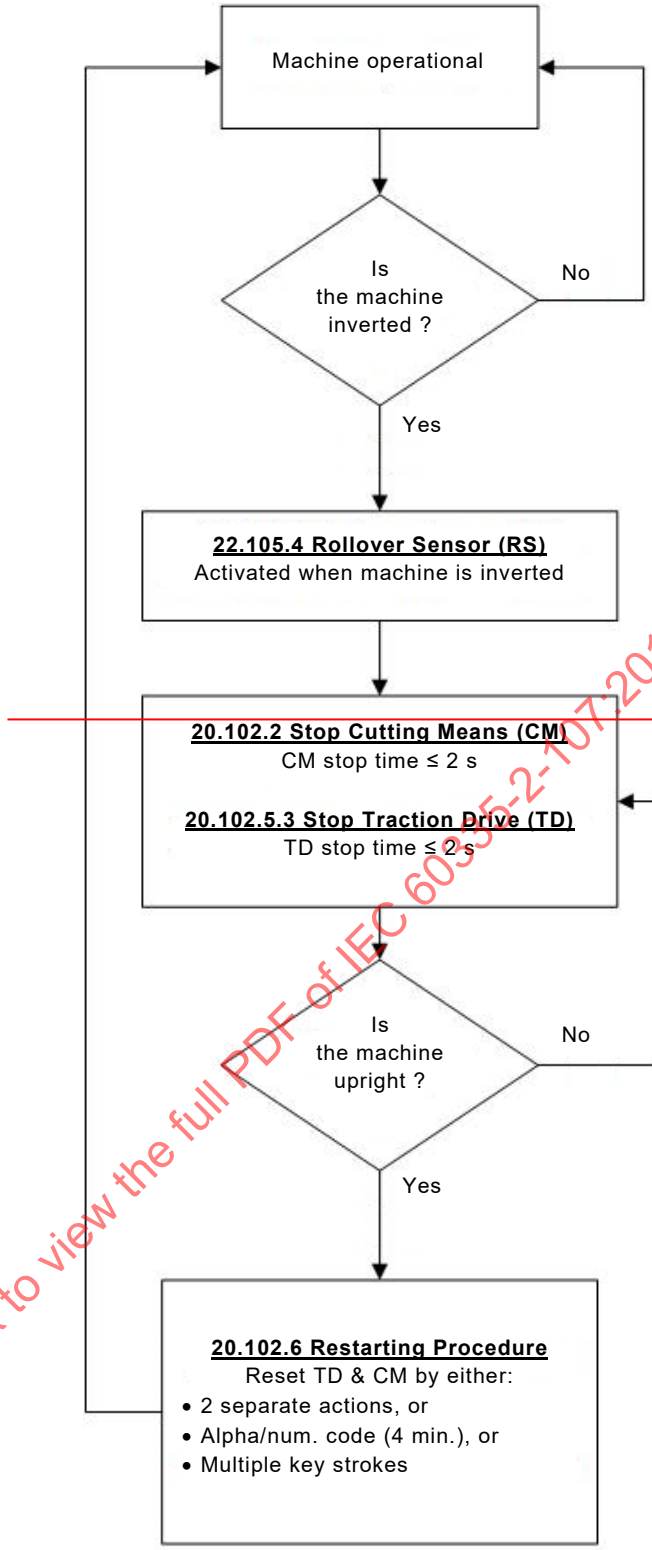


Figure JJ.2 – 22.105.2 Obstruction sensor (OS)



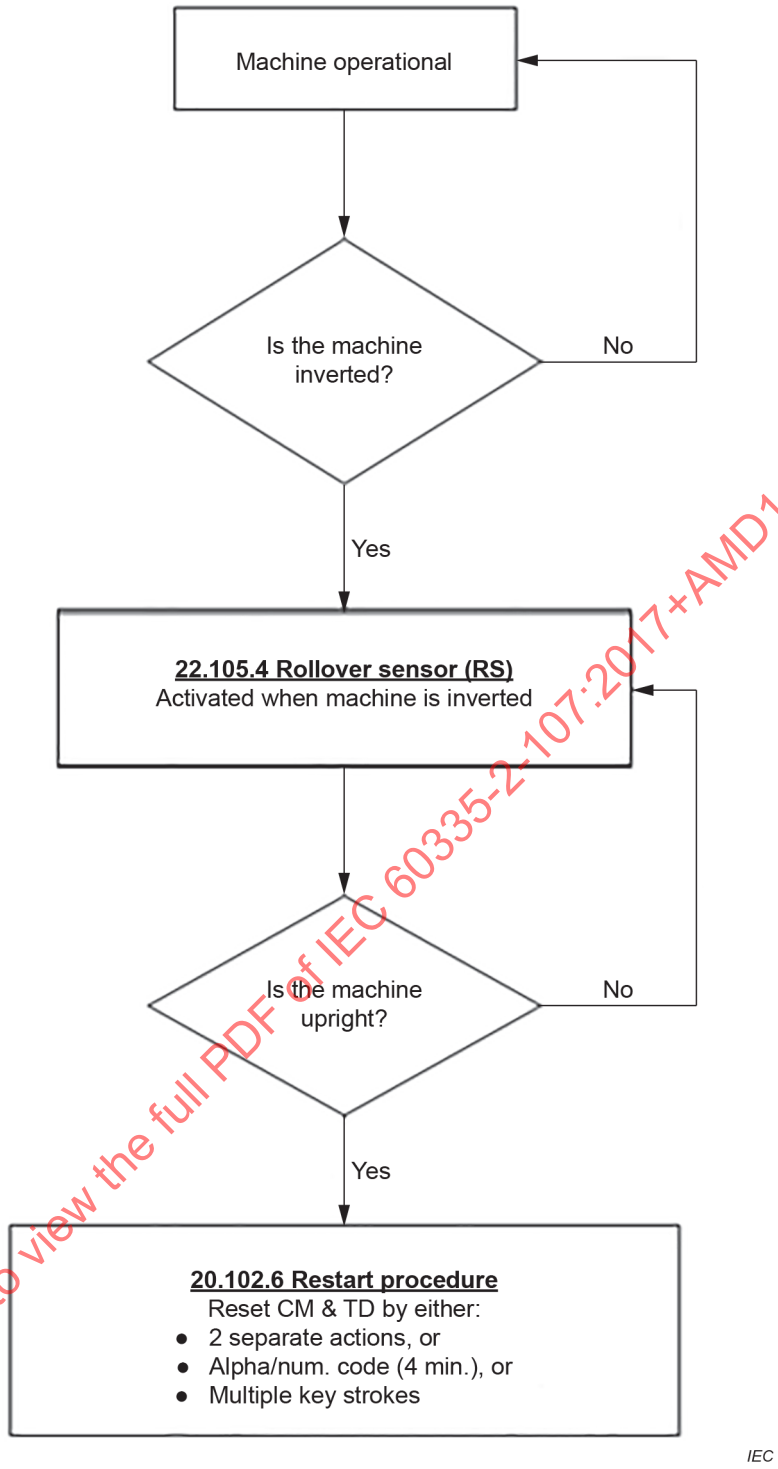


Figure JJ.3 – 22.105.4 Rollover sensor (RS)

Annex KK
(normative)

Additional requirements for battery operation and charging

The clauses in this annex are additional to the requirements of the main body of this document.

NOTE The clauses of this annex are not directly linked to the clauses of the main body of this document, but the clause numbering system has been retained for consistency.

KK.1 Scope

This annex addresses additional requirements for **battery** operation and charging, not included in the main body of this document.

KK.2 Void

KK.3 Terms and definitions

For the purpose of this annex, the following additional definitions apply.

KK.3.1
charger
part or all of the **charging system** contained in a separate enclosure

Note 1 to entry: As a minimum, the **charger** includes some of the power conversion circuitry. Not all **charging systems** include a separate **charger** as in the case where a machine and/or **peripheral**(s) may be charged utilizing a mains **supply cord** or may incorporate a plug for attachment to a mains receptacle.

KK.3.2
charging system
combination of circuitry intended to charge, balance and/or maintain the state of charge of the **battery**

KK.3.3
C_5 rate
current, in amperes, that a **cell** or **battery** can be discharged at for 5 h to the voltage cut-off point specified by the **cell** manufacturer

KK.3.4
explosion
failure that occurs, when an enclosure opens violently and major components are forcibly expelled in a manner that could result in injury

KK.3.5
fire
emission of flames from a **battery**

KK.3.6
integral battery
battery which is contained within the machine and/or **peripheral**(s) and is not removed from the machine and/or **peripheral**(s) for charging purposes

Note 1 to entry: A **battery** that is to be removed from the machine and/or peripheral(s) for disposal or recycling purposes only is considered to be an **integral battery**.

Note 2 to entry: The **batteries** of robotic lawnmowers are considered to be **integral batteries**.

KK.3.7
lithium-ion battery system
combination of a lithium-ion **battery**, the **charging system**, the machine and/or **peripheral**(s) and the interfaces between them as existing during operation of the machine and/or **peripheral**(s) or during charging

KK.3.8
maximum charging current
highest current that a lithium-ion **cell** is permitted to pass during charging for a specified range of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

KK.3.9
specified operating region
range of permissible operation of lithium-ion **cells**, expressed by **cell** parameter limits

KK.3.9.1
specified operating region for charging
conditions for voltage and current during charging in which the lithium-ion **cell** is permitted to operate as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

KK.3.10
upper limit charging voltage
highest voltage that a lithium-ion **cell** is permitted to attain during normal charging for a specified range of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

KK.3.11
venting
condition that occurs, when a **cell** releases excessive internal pressure intended by design to preclude **explosion**

KK.4 Void

KK.5 General conditions for the tests

KK.5.1 *When measuring voltage, the peak value of any superimposed ripple exceeding 10 % of the average value shall be included. Transient voltages are ignored, such as a temporary increase of voltage, for example after the **battery** pack is removed from the **charger**.*

KK.5.2 *Measurements of **cell** voltages during the tests of **lithium-ion battery systems** shall be made using a single pole resistive-capacitive low pass filter with a cut-off frequency of 5 KHz ± 500 Hz. If charging voltage limits have been exceeded, the peak value of the voltage measured after this network shall be used. The measurement shall have measurement tolerance within ± 1 %.*

KK.5.3 *Some of the tests may result in **fire** or **explosion**. It is therefore important that personnel be protected from the flying fragments, explosive force, sudden release of heat, chemical burns, intense light and noise that may result from such **explosions**. The test area is to be well ventilated to protect personnel from possible harmful fumes or gases.*

KK.5.4 *Unless otherwise specified, all **batteries** shall be fully conditioned as follows: **batteries** shall be **fully discharged** and then charged in accordance with the manufacturer's instructions. The sequence shall be repeated one more time with an interval of at least two hours after each discharge.*

KK.5.5 *The location of thermocouples for lithium-ion **cell** temperature measurements shall be on the outer surface, half way along the longest dimension, of the **cell** that results in the highest temperature.*

KK.5.6 *Currents measured during **battery** charging shall be average currents with an averaging period of 1 s to 5 s.*

KK.5.7 *If not otherwise specified, a **fully charged battery** shall be used. After removal from the charging system and before starting a test, the **fully charged battery** shall be allowed to rest for at least 2 h but no more than 6 h at an ambient temperature of (20 ± 5) °C.*

KK.5.8 *When a **battery** comprising of a single **cell** is employed, instructions in this standard referring to special preparations of a **cell** in a series configuration shall be ignored.*

KK.5.9 *For **battery** designs where there is a series arrangement of parallel clusters of **cells**, the cluster shall be treated as a single **cell** for those tests that require altering the amount of charge on a single **cell** prior to conducting the test.*

KK.5.10 *The end-of-discharge voltages for common **cell** chemistries are:*

– *0,9 V/**cell** for nickel cadmium or nickel metal-hydride **batteries**;*

– *1,75 V/**cell** for lead-acid **batteries**;*

– *2,5 V/**cell** for lithium-ion **batteries**, unless the manufacturer specifies a different voltage.*

KK.6 Void

KK.7 Void

KK.8 Void

KK.9 Void

KK.10 Void

KK.11 Void

KK.12 Normal charging of lithium-ion battery systems

Charging a lithium-ion **battery** under normal conditions shall not exceed the **specified operating region for charging** of the **cell**.

Compliance is checked by the following tests.

*The **battery** is charged in accordance with the **charging system** instructions starting with a **fully discharged battery**. Testing is carried out at an ambient temperature of (20 ± 5) °C and*

– *if the machine and/or **peripheral**(s) are recommended to be operated at a minimum temperature lower than 4 °C, the test is also conducted at that minimum temperature $^{0}_{-5}$ °C;*

– *if the machine and/or **peripheral**(s) are recommended to be operated at a maximum temperature greater than 40 °C, the test is also conducted at that maximum temperature $^{+5}_{0}$ °C.*

*For all individual **cells**, the voltage, the temperature measured in accordance with K.5.5 and the charging current are monitored. In the case of parallel configurations, analysis may be used to avoid measuring the individual branch currents. The result shall not exceed their **specified operating region for charging** (e.g. limits of voltage and current dependant on the temperature).*

NOTE 1 The following is an example result of such analysis: the charging current for each branch of a parallel connection would not need to be monitored, if the maximum deliverable current of the **charger** did not exceed the **maximum charging current** of a single **cell**.

*For **batteries** employing series configurations, the test is repeated with a deliberately imbalanced **battery**. The imbalance is introduced into a **fully discharged battery** by charging one **cell** to approximately 50 % of full charge.*

*If it can be demonstrated through testing and/or design evaluation that an imbalance less than 50 % would actually occur in **intended use**, then this lower imbalance may be used.*

NOTE 2 Examples are those designs that employ circuitry intended for maintaining balance between **cells** in the **battery** pack. Systems with a small number of **cells** in series may be shown to exhibit limited imbalance in practice, if the product ceases to operate with a **battery** prepared with a smaller initial imbalance.

NOTE 3 An example for a testing is repeated charging and discharging a **battery** in accordance with the manufacturer's instructions until its capacity has decreased to 80 % of the rated capacity, using the imbalance at the end of the test.

KK.13 Void

KK.14 Void

KK.15 Void

KK.16 Void

KK.17 Void

KK.18 Void

KK.19 Abnormal operation

KK.19.1 Lithium-ion charging systems

This subclause applies only to machines with lithium-ion **batteries**.

The **charging system** and **battery** of a **lithium-ion battery system** shall be so designed that the risk of **fire** and **explosion** as a result of abnormal operation during charging is obviated as far as is practical.

Compliance is checked by the following test.

*A sample containing the machine and the **charging station** or the **peripheral**(s) and its charger(s) containing the associated assemblies of the **charging system** are placed on a soft wood surface covered by two layers of tissue paper; the sample is covered by one layer of untreated 100 % cotton medical gauze. The **lithium-ion battery system** is operated as specified in the instruction manual with all of the categories of abnormal conditions listed below in a) to d).*

a) *Components in the **charging system** are faulted as in K.19.6 a) to f), one at a time, if the outcome of such a fault is uncertain based upon analysis. For each fault condition introduced, the state of the **battery** before charging is as follows:*
   - *a series configured **battery** shall have a deliberate imbalance. The imbalance is introduced into a **fully discharged battery** by charging one **cell** to approximately 50 % of full charge; or*
   - *if the test of KK.12 is conducted with an imbalance of less than 50 %, a series configured **battery** shall have a deliberate imbalance as established in KK.12; or*
   - *a single **cell** or parallel only configuration **battery** shall be **fully discharged**.*

b) *If the test of KK.12 is conducted with an imbalance of less than 50 % due to the function of circuit(s), and if a single fault of any component within that circuit(s) is shown to result in the loss of that function, then a series configured **battery** shall be charged with a deliberate imbalance. The imbalance is introduced into a **fully discharged battery** by charging one **cell** to approximately 50 % of full charge.*

c) *For a **battery** with a series configuration, all **cells** are at approximately 50 % charge, except for one which is shorted. The **battery** is then charged.*

d) *With a **fully charged battery** connected to the **charger**, a short is introduced to the **charging system** across a component or between adjacent PCB tracks at a location expected to produce the most unfavourable results to evaluate the effect of back-feed from the **battery**. For a **charger** with a cord that connects to the **battery**, the short shall be introduced at the point likely to produce the most adverse effects. The resistance of the short shall not exceed 10 mΩ.*

*During the tests, each **cell** voltage is continuously monitored to determine if it has exceeded the limit condition. **Venting** of the **cell**s is permitted.*

The test is conducted until the sample under test experiences a failure, returns to within 5 K of the ambient temperature or, if neither of these, until at least 7 h or twice the normal charge period has elapsed, whichever is longer.

Tests are considered passed if all of the following are true:

– *there has been no **explosion** during the test;*

– *no charring or burning of the gauze or tissue paper has resulted. Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable. Charring or igniting of the tissue paper or gauze from the shorting means is not considered a failure;*

– *the **cells** shall not have exceeded the **upper limit charging voltage** by more than 150 mV or, if they have, then the **charging system** shall be permanently disabled from recharging the **battery**. To determine if recharging is disabled, the **battery** shall be discharged by using the machine and/or **peripheral**(s) (in the case of an integral system) or by using a new sample of the machine and/or **peripheral**(s) (in the case of a detachable **lithium-ion battery system**) to approximately 50 % charge, followed by an attempt to recharge the **battery** normally. There shall be no charging current after 10 min or after 25 % of the nominal capacity has been delivered, whichever occurs first; and*

– *there shall be no evidence of damage to the **cell** vent to impair compliance with KK.22.2.*

KK.19.2 Lithium-ion battery short circuit

This subclause applies only to **lithium-ion battery systems**.

There shall be no risk of **fire** or **explosion** when the main discharge connections of a series configured **integral battery** within the machine and/or **peripheral**(s) are shorted under conditions of extreme imbalance.

Compliance is checked by the following test.

*The test is conducted with all the **cells** of the **battery fully charged** and one **cell fully discharged**.*

*The machine and/or **peripheral**(s) containing an **integral battery** are placed on a soft wood surface covered by two layers of tissue paper and the sample(s) is then covered by one layer of untreated 100 % cotton medical gauze.*

*The main discharge connections of the **battery** are shorted with a resistance not to exceed 10 mΩ. The test is conducted until the test sample(s) experiences a failure or until the test sample(s) returns to within 5 K of the ambient temperature. There shall be no **explosion** during or after the test. As a result of the test, there shall be no charring or burning of the gauze or tissue paper. **Venting** of **cells** is acceptable.*

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable. Charring or igniting of the tissue paper or gauze from the shorting means is not considered a failure.

*Fuses, **thermal cut-outs**, **thermal links, temperature limiters**, electronic devices or any component(s) or conductor(s) that interrupt the discharge current may operate during the above tests. If these devices are relied upon to pass the test, the test is to be repeated two more times, using two additional samples, and shall open the circuit in the same manner, unless the test is otherwise satisfactorily completed. Alternatively, the test may be repeated with the open-circuited device bridged.*

KK.19.3 Batteries other than lithium-ion – overcharging

Batteries comprised of **cells** other than the lithium-ion type shall withstand abusive overcharging without risk of **fire** or **explosion**.

Compliance is checked by the following test.

*The machine and/or **peripheral**(s) containing the **battery** are placed on a soft wood surface covered by two layers of tissue paper and the sample(s) is then covered by one layer of untreated 100 % cotton medical gauze and charged at a rate of 10 times the **C_5 rate** for the **battery** for 1,25 h. There shall be no **explosion** and no charring or burning of the gauze or tissue paper. Charring is defined as a blackening of the gauze caused by combustion.*

Discolouration of the gauze caused by smoke is acceptable. ***Venting*** *of the* ***cell****s is acceptable.*

KK.19.4 Abnormal discharge

Machines and/or **peripheral**(s), when operating under **battery** power, and their **battery** packs, shall be so designed that the risk of **fire** or electric shock as a result of abnormal operation is obviated as far as is practical.

Compliance is checked by the following tests.

The abnormal conditions a) to e) below shall be applied.

The machine and/or ***peripheral****(s),* ***battery*** *pack and the cords of d), as appropriate, are placed on a soft wood surface covered by two layers of tissue paper; the sample is covered by one layer of untreated 100 % cotton medical gauze. For the tests b), c) and e), the machine and/or* ***peripheral****(s) are switched on and no additional mechanical load is applied. The test is conducted until failure or until the test sample(s) returns to within 5 K of the ambient temperature or, if neither of these occurs, until at least 3 h has elapsed. A new sample(s) may be used for each fault listed below. No* ***explosion*** *shall occur during or after the test. There shall be adequate protection against electric shock as defined in clause 8. No charring or burning of the gauze or tissue paper shall result.* ***Venting*** *of the* ***cells*** *is permitted.*

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable. The resistance for the short in items a), b), d), and e) shall not exceed 10 mΩ. Charring or igniting of the tissue paper or gauze from the shorting means is not considered a failure.

Fuses, ***thermal cut-outs****,* ***thermal links, temperature limiters****, electronic devices or any component(s) or conductors(s) that interrupt the discharge current may operate during the above tests. If these devices are relied upon to pass the test, the test is to be repeated two more times, using two additional samples, and shall open the circuit in the same manner, unless the test is otherwise satisfactorily completed. Alternatively, the test may be repeated with the open-circuited device bridged.*

a) Combinations of exposed terminals of a removable ***battery*** *are shorted so as to produce the worst result.* ***Battery*** *pack terminals that can be contacted using either test probe B of IEC 61032:1997 or test probe 13 of IEC 61032:1997 are considered exposed. The means of shorting shall be selected or positioned such that charring or ignition of the tissue paper or gauze is not influenced.*

b) The terminals of each motor are shorted one at a time.

c) The rotor of each motor is locked one at a time.

d) Any cord provided between the machine and the ***charger*** *or the* ***peripheral****(s) and its charger(s) shall be shorted at the point likely to produce the most adverse effects.*

e) A short is introduced between any two uninsulated parts of opposite polarity not in accordance with the spacings given in ~~Clause 29~~ 29.101. A circuit analysis may be used to determine where a short shall or shall not be applied. The test is not conducted on uninsulated parts that are encapsulated.

KK.19.5 For machines and/or **peripheral**(s) having **batteries** that can be removed without the aid of a **tool**, and having terminals that can be short-circuited by a thin straight bar, the terminals of the **battery** are short-circuited, the **battery** being **fully charged**.

KK.19.6 *The following fault conditions are considered and, if necessary, applied one at a time, consequential faults being taken into consideration:*

a) open circuit at the terminals of any component;

b) short circuit of capacitors, unless they comply with IEC 60384-14;

c) short circuit of any two terminals of an ***electronic component****, other than an integrated circuit. This fault condition is not applied between the two circuits of an optocoupler;*

d) failure of triacs in the diode mode;

e) failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals are considered for faults occurring within the component. If it can be shown that a particular output signal is unlikely to occur, then the relevant fault is not considered.

f) failure of an electronic power switching device in a partial turn-on mode with loss of gate (base) control.

NOTE 1 This mode may be simulated by disconnecting the electronic power switching device gate (base) terminal and connecting an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply is then varied so as to achieve a current that will not damage the electronic power switching device but will give the most onerous conditions of test.

NOTE 2 Examples of electronic power switching devices are field effect transistors (FET's and MOSFET's) and bipolar transistors (including IGBT's).

Fault condition e) is applied to encapsulated and similar components if the circuit cannot be assessed by other methods.

KK.20 Mechanical hazards

KK.20.1 Lithium-ion enclosure pressure test

This subclause applies only to lithium-ion **batteries**.

An enclosure for lithium-ion **batteries** shall be designed such that it will safely release gases that may be generated as a result of **venting**.

Compliance is checked by measurement in the case of a) or by the test of b):

a) the total area of the openings in the enclosure allowing gases to pass without obstruction shall be equal to or greater than 20 mm^2; or

b) the enclosure shall be tested as follows.

*A total of 21 ml ± 10 % of air shall be delivered at an initial pressure of 2 070 kPa ± 10 % through a (2,87 ± 0,05) mm diameter orifice to the enclosure of a machine and/or **peripheral**(s) with an **integral battery**(ies). The pressure within the enclosure shall drop below 70 kPa in 30 s. There shall be no rupturing that would cause the enclosure to fail to meet the requirements of this standard. An additional volume, not to exceed 3 ml, is allowed to be added to the enclosure volume as may be required for test fittings.*

KK.21 Void

KK.22 Construction

KK.22.1 Machines shall not readily accept **general purpose batteries** (either primary or rechargeable) as an energy source for their primary function.

Compliance is checked by inspection.

KK.22.2 Vents of lithium-ion **cells** shall not be obstructed in such a way as to defeat their operation if **venting** is relied upon for safety.

*Compliance is checked by inspection or, if in doubt, by inspecting the **cells** after conclusion of the abnormal tests of KK.19.4 a), b) and c) to ensure that **cells** have not vented by any means other than through the **cell** vent.*

KK.23 Void

KK.24 Components

KK.24.1 Rechargeable **cells** containing alkaline or other non-acid electrolytes employed in machines and/or **peripheral**(s) shall comply with IEC 62133.

KK.24.2 Rechargeable **cells** employed in machines or in their **battery** packs shall not be of lithium-metal type.

Compliance is checked by inspection.

NOTE Lithium-ion **cells** are not lithium metal **cells**.

KK.24.3 Cells employed in machines and/or **peripheral**(s) or **cells** employed in **battery** packs shall be sealed.

Compliance is checked by inspection.

NOTE The term sealed is understood to indicate that the **cell** contents are not at atmospheric pressure. It does not preclude the use of vents to prevent excessive internal pressure.

Bibliography

The bibliography of Part 1 is applicable, except as follows:

Addition:

ANSI/ITSDF B56.5-2012, *Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles*

EGMF RLM003-1.1/2016, *Robotic Mowers Boundary Wire Standard*

ETSI EN 303 447, *Short Range Devices (SRD); Inductive loop systems for robotic mowers in the frequency range 0 Hz to 148,5 kHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU*[1]

ISO 2758:2003, *Paper – Determination of bursting strength*

ISO 3304:1985, *Plain end seamless precision steel tubes – Technical conditions for delivery*

ISO 3305:1985, *Plain end welded precision steel tubes – Technical conditions for delivery*

ISO 3306:1985, *Plain end as-welded and sized precision steel tubes – Technical conditions for delivery*

ISO 4046:2002, *Paper, board, pulp and related terms – Vocabulary*

ISO 4200:1991, *Plain end steel tubes, welded and seamless – General tables of dimensions and masses per unit length*

ISO/TS 15066:2016, *Robots and robotic devices – Collaborative robots*

[1] Under consideration.

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Household and similar electrical appliances – Safety – Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60335-2-107 edition 2.2 contains the second edition (2017-12) [documents 116/350/FDIS and 116/354/RVD], its amendment 1 (2020-02) [documents 116/429/FDIS and 116/443/RVD] and its amendment 2 (2021-11) [documents 116/516/CDV and 116/540/RVC].

This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 60335-2-107 has been prepared by IEC technical committee 116: Safety of motor-operated electric tools.

This second edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Clause 7: Markings and instructions, new requirements for markings, warnings and the instruction manual;

b) Clause 8: Protection against access to live parts, new requirements for protection against electric shock for hazardous battery voltages;

c) Clause 20: Stability and mechanical hazards, revised requirements for manual controller, manual stop, cutting means stopping time, traction drive stopping and restart procedures, as well as a new standing child foot probe test;

d) Clause 22: Construction, revised requirements for disabling devices, working area, perimeter delimiter, sensors and manual controller, as well as new requirements for machine connectors used for charging and contact surfaces used as obstruction sensing devices;

e) Clause 24: Components, revised requirements for switches;

f) Clause 29: Clearances, creepage distances and solid insulation, revised requirements for the machine and non-mains-powered peripherals.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This Part 2-107 is to be used in conjunction with the fifth edition (2010) of IEC 60335-1 and its amendments.

NOTE When “Part 1” is mentioned in this standard, it refers to IEC 60335-1.

This Part 2-107 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert it into the IEC standard: Particular requirements for robotic battery powered electrical lawnmowers.

When a particular subclause of Part 1 is not mentioned in this Part 2-107, that subclause applies as far as is relevant. Where this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

The following print types are used:

– requirements: in roman type;

– *test specifications: in italic type;*

– notes: in small roman type.

The terms defined in Clause 3 are printed in **bold typeface**.

Subclauses, notes and figures which are additional to those in Part 1 are numbered starting from 101. Additional annexes are lettered AA, BB, etc.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 36 months from the date of publication.

INTRODUCTION

It has been assumed in the drafting of this document that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This document recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of machines when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of machines.

This document takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the machine is connected to the supply mains. However, national wiring rules may differ.

If a machine within the scope of this document also incorporates functions that are covered by another Part 2 of IEC 60335, the relevant Part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a Part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the Part 2 standards have determined that it is not necessary to specify particular requirements for the machine in question over and above the general requirements.

This standard series is a product family standard series dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 2 Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards. For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or Part 2 documents.

A machine that complies with the text of this document will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

A machine employing materials or having forms of construction differing from those detailed in the requirements of this document may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the document.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers

1 Scope

Replacement:

This document specifies safety requirements and their verification for the design and construction of **robotic battery** powered electrical **rotary lawnmowers** and their **peripherals** with the **rated voltage** of the **battery** being not more than 75 V d.c.

EMC and environmental aspects, except noise, have not been considered in this standard.

This document does not apply to the additional risks associated with internal combustion engine(s), hybrid and fuel cell powered machines and associated charging systems.

This document deals with all the significant hazards presented by **battery** powered **robotic lawnmowers** and their **peripherals** when they are used as intended and under conditions of misuse which are reasonably foreseeable.

Throughout this document, the term machine is used to refer to the **robotic lawnmower**, separate from its **charging station**.

This document also provides requirements for the safety of mains powered **charging stations** and signal sources for **perimeter delimiters**.

Additional **battery** operation and charging requirements for **robotic lawnmowers**, including the charging of lithium ion batteries, are specified in Annex KK which replaces Annexes B and S (except for requirements for non-rechargeable **batteries**) of Part 1.

This document is not applicable to machines which are manufactured before the date of publication of this document by IEC.

NOTE Informative Annex FF is provided as a test code for convenience to the users of this document.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

IEC 62133 (all parts), *Secondary cells and batteries containing alkaline or other non-acid electrolytes- safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*

ISO 354:2003, *Acoustics – Measurement of sound absorption in a reverberation room*

ISO 683-4:2014, *Heat-treatable steels, alloy steels and free-cutting steels – Part 4: Free-cutting steels*

ISO 3744:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane*

ISO 3767-1, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment – Symbols for operator controls and other displays – Part 1: Common symbols*

ISO 3767-3, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment – Symbols for operator controls and other displays – Part 3: Symbols for powered lawn and garden equipment*

ISO 4871:1996, *Acoustics – Declaration and verification of noise emission values of machinery and equipment*

ISO 7000:2014, *Graphical symbols for use on equipment – Index and synopsis*

ISO 7010:2011, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 8295:1995, *Plastics – Film and sheeting – Determination of the coefficients of friction*

ISO 11201:2010, *Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11203:1995, *Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

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

ISO 11688-1, *Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 1: Planning*

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

This clause of Part 1 is applicable except as follows.

3.5.1 *Addition:*

Note 101 to entry: Machines and **charging stations** are not considered to be **portable appliances**.

3.5.4 *Addition:*

Note 101 to entry: Machines are not considered to be **fixed appliances**. **Charging stations** are considered to be **fixed appliances**.

3.101
automatic mode
autonomous operation of the machine without the use of a **manual controller**

Note 1 to entry: Operation of the machine without the use of a **manual controller** and without the **cutting means** operating during set up of the **working area** is considered not to be operation in **automatic mode**.

3.102
battery
assembly of one or more **cells** intended to provide electrical current to the machine

3.103
cell
basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy

3.104
charging station
automatic **battery** charging facility located on or within the **working area**

3.105
control
means or device which will control the operation of the machine or any specific operating function thereof

3.106
cutting means
mechanism used to provide the cutting action

Note 1 to entry: The term "blade" can be used in warnings and instructions to denote "**cutting means**".

3.107
cutting means enclosure
part or assembly which provides the protective means around the **cutting means**

3.108
cutting means tip circle
path described by the outermost point of the **cutting means** as it rotates about its shaft axis

3.109
cutting position
any height setting of the **cutting means** designated by the manufacturer for cutting grass

3.110
disabling device

3.110.1
disabling device (removable)
part, such as for example a key, which prevents operation of the **lawnmower** when it is removed

3.110.2
disabling device (code protected)
device which, when operated, prevents operation of the **lawnmower** and requires a coded input (such as via a keypad) before it can operate

Note 1 to entry: See 22.103.

3.111
discharge chute
extension of the **cutting means enclosure** from the **discharge opening**, generally used to control the discharge of material from the **cutting means**

3.112
discharge opening
gap or opening in the **cutting means enclosure** through which grass may be discharged

3.113
fully charged (battery/cell)
cell or **battery** charged to the maximum state of charge permitted by the **battery charging system** intended for use with the machine

3.114
fully discharged (battery/cell)
battery or **cell** that has been discharged at $\mathbf{C_5}$ **rate** until one of the following conditions occurs: discharge terminates due to protective circuitry or the **battery** (or **cell**) reaches a total voltage with an average voltage per **cell** equal to the end-of-discharge voltage for the **cell** chemistry being used unless a different end-of-discharge voltage is specified by the manufacturer

Note 1 to entry: The end-of-discharge voltages for common **cell** chemistries are provided in KK.5.10.

3.115
general purpose (batteries/cells)
batteries and **cells** available from a variety of manufacturers, through a variety of outlets intended for a variety of different manufacturers' products

Note 1 to entry: 12 V automotive **batteries** and AA, C and D alkaline **cells** are examples of **general purpose**.

3.116
grass catcher
part or combination of parts which provides a means for collecting grass clippings or debris

3.117
guard
part of the machine or a component incorporated to provide protection for the operator and/or bystander by means of a physical barrier

3.118
hazardous voltage
voltage between parts having an average value exceeding 60 V d.c. or exceeding 50 V peak when the peak-to-peak ripple exceeds 10 % of the average value

3.119
intended use
any use of the machine which is reasonably foreseeable, as described in the instruction manual, and which is consistent with such activities as cutting grass, starting, stopping, or connecting to (or disconnecting from) a source of power

3.120
lawnmower
grass-cutting machine where the **cutting means** operates in a plane approximately parallel to the ground and which uses the ground to determine the height of cut by means of wheels, air cushion or skids, etc., and which utilises an electric motor for a **power source**

3.121
manual controller
device supplied by the manufacturer either connected by a wire or wireless that allows manual operation of the machine

3.122
manual stop
manually actuated device using software-based or hardware-based components that overrides all other **controls** and removes power to the motor(s) and brings all moving parts to a stop

3.123
maximum operating motor speed
the highest motor speed obtainable when adjusted in accordance with the manufacturers specifications and/or instructions, with the **cutting means** engaged

3.124
mulching lawnmower
rotary lawnmower without **discharge openings** in the **cutting means enclosure**

3.125
operator control
any **control** requiring operator actuation to perform specific functions

Note 1 to entry: This includes **controls** on a **manual controller**.

3.126
operator presence control
control on a **manual controller** designed so that it will automatically interrupt the **cutting means** when the operator's actuating force is removed

3.127
perimeter delimiter
device(s) that defines the perimeter of the **working area** within which the machine can operate automatically

Note 1 to entry: An example of a **perimeter delimiter** is a boundary wire that emits a signal to indicate the limit of the **working area**.

3.128
peripherals
equipment additional to the machine itself that is provided by the manufacturer for intended use of the machine, e.g. charging station(s), manual controller, signal source for **perimeter delimiter**

3.129
power source
motor which provides mechanical energy for linear or rotational movement

3.130
remote setting device
setting device which is not connected by wire to the machine and designed to set the basic functions of the machine

Note 1 to entry: A **remote setting device** is not a **manual controller**.

3.131
robotic lawnmower
unattended **lawnmower** that operates automatically

Note 1 to entry: When the term 'machine' is used in the text of this standard, it is used to denote a **robotic lawnmower**.

3.132
rotary lawnmower
lawnmower in which the **cutting means**, cutting by impact, rotate about an axis (axes) normal to the cutting plane

3.133
sensor
device that responds to physical stimuli (such as, but not limited to, heat, light, sound, pressure, magnetism, motion) and transmits the resulting signal or data providing a measurement, operating a **control**, or both

3.133.1
lift sensor
device that senses when all or part of the machine is lifted from the ground

3.133.2
obstruction sensor
device that senses when the machine contacts a person or an obstruction

3.133.3
tilt sensor
device that senses when the machine is at or above a predetermined angle of incline

3.133.4
rollover sensor
device that senses when the machine is inverted

3.134
stopping time
time elapsed between the instant when either a **sensor** is activated or the actuator on a **manual controller** is released and the instant at which the machine or component comes to a stop

3.135
thrown object hazard
potential for injury caused by object(s) propelled by the moving **cutting means**

3.136
traction drive
means (system) used to transmit power from the **power source** to the ground drives means

3.137
working area
any defined area in which the machine can function automatically

3.138
switched circuit
circuit that is a low-power circuit when the **power switch** is in the “off” position

Note 1 to entry: The requirements for a low-power circuit are given in 19.11.1.

3.139
power switch
device that electrically activates the **cutting means** and/or **traction drive** of the machine in the “on” position and deactivates the same function of the machine in its “off” position

Note 1 to entry: The device is comprised of all primary and ancillary components (e.g. tactile switch, relays, load switches) of the electrical control circuit that activates the **cutting means** and/or **traction drive** of the machine.

4 General requirement

This clause of Part 1 is applicable.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.1 *Addition:*

Where an electronic speed **control** device can be adjusted, it is set for the highest speed.

5.2 *Modification*:

A new sample shall be used for each of the tests of Clause 21. However, at the manufacturer’s discretion, fewer samples may be used.

Addition:

*The cumulative stress resulting from successive tests on the **battery** is to be avoided.*

If several tests are conducted on a single sample, then the results shall not be affected by previous tests.

5.8.1 *Replacement:*

*Unless otherwise specified, a **fully charged battery** shall be used for each test. Where for consecutive tests the same **battery** is specified, there shall be a minimum of 1 min rest time between tests.*

5.17 *Replacement:*

*Machines and **peripherals** powered by rechargeable **batteries** are evaluated to the additional requirements in Annex KK.*

***Peripherals** powered by **batteries** that are non-rechargeable are tested in accordance with Annex S.*

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 *Replacement:*

This subclause is not applicable for machines and non-mains-powered **peripherals**.

NOTE Machines and non-mains-powered **peripherals** covered by this standard are limited to those where the only power source is a **battery** and are therefore considered not to be a **class I appliance**, **class II appliance**, or a **class III appliance** and are not required to have **basic insulation**, **supplementary insulation** or **reinforced insulation**. Electric shock hazard is considered to exist only between parts of opposite polarity where **hazardous voltage** is present.

Mains-powered **peripherals** shall be of one of the following classes with respect to protection against electric shock:

– **class II appliance**;

– **class III appliance**.

Compliance is checked by inspection and by the relevant tests.

6.2 *Addition:*

Enclosures of machines shall be at least IPX1, except enclosures containing parts having a **working voltage** that is a **hazardous voltage**, which shall be at least IPX4. Enclosures of **charging stations** and other **peripherals** intended to be installed outdoors (e.g. a signal source for a **perimeter delimiter**) shall be at least IPX1 if of **class III construction**. Constructions other than **class III construction** shall be at least IPX4.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 *Replacement:*

Machines and **peripherals** shall be marked as indicated below and additionally, as required, by 7.1.101. Additional markings are allowed provided they do not give rise to misunderstanding. Warnings shall be located in easily visible positions. If the first numeral for the IP numbering is omitted, the omitted numeral shall be replaced by the letter X, for example IPX4.

On the machine:

– IP number according to degree of protection against ingress of water, other than IPX0;

– symbol IEC 60417-5180 (2003-02), for **class III appliances**, if treated as a **class III** appliance during charging. This marking is not necessary for machines that are operated only by batteries (primary batteries or secondary batteries that are recharged outside of the machine);

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– the mass of the machine if it is greater than 25 kg;

– designation of the machine, where designation of the machine may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as “battery powered robotic lawnmowers” etc. in the instructions supplied with the machine.

NOTE 1 An example of such code is “A123B”.

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the machine;

NOTE 2 The term “designation of series or type” is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 3 For machines and their related products intended to be put on the market in the EEA, CE-marking as defined in the applicable European Directive(s), e.g. the Machinery Directive.

– cutting width in centimetres.

– "WARNING – Read instruction manual before operating the machine".

– "WARNING – Keep a safe distance from the machine when operating".

– "WARNING – Do not ride on the machine".

– "WARNING – Remove (or operate) the **disabling device** before working on or lifting the machine".

NOTE 4 Use "Remove" or "Operate" as appropriate to the type of **disabling device** that is fitted to the machine.

– "WARNING – Do not touch rotating blade".

– where replaceable during normal use, the **cutting means** shall be marked to identify the part number(s) and the manufacturer, importer or supplier. This marking is not required to be clearly discernible from the outside of the machine;

NOTE 5 In Canada and the United States of America, the above **cutting means** marking is not applicable.

– if a **grass catcher** requires an adapter to be used, instructions shall be affixed to the machine near the **discharge opening** and to the **grass catcher** adapter stating that the machine shall not be operated without the adapter and **grass catcher** in place.

On the **charging station** and other mains powered **peripherals**, even if of **class III**:

– **rated voltage** or **rated voltage range** in volts;

– symbol for nature of supply, unless the rated frequency is marked;

– **rated power input** in watts or **rated current** in amperes;

– symbol IEC 60417-5172 (2003-02) for **charging stations** having parts of **class II construction**;

– symbol IEC 60417-5180 (2003-02) for **charging stations** having parts of **class III construction**;

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– designation of the **charging station** or **peripheral**, where designation of the **charging station** or **peripheral** may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as "charging station" etc. in the instructions supplied with the machine;

NOTE 6 An example of such code is "A123B".

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the **charging station** or **peripheral**;

NOTE 7 The term "designation of series or type" is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 8 Void

On the **manual controller**, for machines equipped with a **manual controller**, except when permanently connected to the machine:

– symbol IEC 60417-5172 (2003-02) for **class II appliances** only;

– symbol IEC 60417-5180 (2003-02), for **class III appliances**. This marking is not necessary for **manual controllers** that are operated only by batteries (primary batteries or secondary batteries that are recharged outside of the **manual controller**);

– business name and full address of the manufacturer and, where applicable, his authorized representative;

– year of construction;

– designation of the **manual controller**, where designation of the **manual controller** may be achieved by a combination of letters and/or numbers provided that this code is explained by giving the explicit designation such as “manual controller” etc. in the instructions supplied with the machine;

NOTE 9 An example of such code is “A123B”.

– designation of series or type, allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the **manual controller**;

NOTE 10 The term “designation of series or type” is also known as model number.

– serial number, if any;

– other mandatory markings;

NOTE 11 Void

– “WARNING – Read instruction manual before operating the machine”;

– “WARNING – Keep a safe distance from the machine when operating”.

The required markings on **manual controllers** may be incorporated into an electronic display, provided the markings are continuously displayed during manual control.

Compliance is checked by inspection.

7.1.101 Marking giving cautionary information shall be located as close as practicable to the relevant hazard. Such marking shall be in one of the official languages of the country in which the machine is to be sold. Instead of written markings, symbols according to Annex EE are allowed. Symbols according to ISO 3767-1, ISO 3767-3, ISO 11684 and ISO 7010:2011 may also be used as appropriate. Contrasting colours shall be used unless the symbols are cast, embossed or stamped when colours are not required.

Class II appliances and **class III appliances** incorporating a functional earth shall be marked with the symbol IEC 60417-5018 (2011-07).

Controls which may give rise to a hazard (e.g. **operator presence controls** in accordance with 20.101.1) when operated shall be marked or so placed as to indicate clearly which part of the machine they control.

Where a **guard** is designed to be opened or removed and which exposes a hazard, a safety sign warning of the hazard shall be located on the **guard** or adjacent to the **guard**.

Compliance is checked by inspection.

7.6 *Addition:*

Additional symbols are shown in Annex EE.

7.8 *Addition:*

If a **cell** or **battery** is intended to be replaced by the user and it is possible for it to be put in a reverse polarity then the correct location and polarity shall be marked at its intended location.

7.9 *Modification:*

Replace the first paragraph by the following:

Operator controls shall have the function, direction and/or method of operation clearly identified by a durable label or mark.

The **manual stop** shall be marked with the word "STOP" and be coloured red, no other externally visible **controls** shall be coloured red.

7.11 *Replacement:*

Controls intended to be adjusted during installation or **intended use** shall be provided with an indication for the direction of adjustment.

NOTE An indication of + and – is considered to be sufficient.

Compliance is checked by inspection.

7.12 *Replacement:*

An instruction manual shall be supplied with the machine, giving operating, servicing, maintenance and safety instructions that comply as appropriate with 6.4 of ISO 12100:2010. The words 'Original instructions' shall appear on the language version(s) verified by the manufacturer or his authorized representative. Where no 'Original instructions' exist in the official language(s) of the country where the machine is to be used, a translation into that/those language(s) shall be provided by the manufacturer or his authorized representative or by the person bringing the machine into the language area in question. The translations shall bear the words 'Translation of the original instructions', and they shall be accompanied by a copy of the 'Original instructions'.

This instruction manual shall include:

a) a repeat of those warnings required to be marked on the machine together with further explanation, where appropriate. Where safety signs are used in the marking on the machine, their function shall be explained;

b) a warning to never allow children, persons with reduced physical, sensory or mental capabilities or lack of experience and knowledge or people unfamiliar with these instructions to use the machine, local regulations may restrict the age of the operator;

c) a warning, not to allow children to be in the vicinity or play with the machine when it is operating;

d) a general description of the machine and its **peripherals**, the **intended use**, instructions for the proper use of the machine including advice on what the machine and its **peripherals** should be used for, how to use it for the intended purpose(s) and any reasonably foreseeable misuse thereof;

e) warnings concerning ways – that experience has shown might occur – in which the machinery shall not be used;

f) instructions for the proper assembly and disassembly of the machine and its **peripherals** for use, if the machine and/or its **peripherals** are not supplied in a completely assembled form;

g) instructions for proper adjustment and any necessary **user maintenance** of the machine and its **peripherals**, including timescales and a warning of the danger of moving hazardous parts;

h) instructions for the proper setting out the perimeter of the **working area**;

i) instructions for the recommended replacement or repair of, or service attention to, critical components. Where parts are consumable, the spare part shall be clearly identified, e.g. by the use of a part number or other means;

j) instructions on the operation of all **controls**;

k) information how to start and operate the machine safely;

l) instructions for the operating position and the correct and safe operation of the machine and its **peripherals** such as moving, safe positioning, handling, clearing blockages, and if a collecting facility is provided keeping the **discharge chute** clear of processed material, for use, preparation, maintenance and storage of the machine;

m) an advice during manual control to not overreach and to maintain balance at all times, to always be sure of footing on slopes and to walk, never run while operating the machine or its **peripherals**, if applicable;

n) a warning not to touch moving hazardous parts before these have come to a complete stop;

o) details of the **battery** charger to be used and advice on the safe disposal of **batteries** at the end of their life;

p) if designed for use with an extension cord, an advice on the use, length and type of extension cords to be used (not lighter than required by Subclause 25.7);

q) if a collecting facility is provided with the machine, instructions for when and how to attach and detach the collection device to and from the machine;

r) instructions for fitting and use of attachments, if any;

s) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;

t) instructions to always wear substantial footwear and long trousers while operating the machine with a **manual controller**;

u) instructions to disconnect the supply (e.g. remove the plug from the mains or remove/operate the **disabling device**)

- before clearing a blockage on the machine;
- before checking, cleaning or working on the machine or **charging station**;
- after striking a foreign object to inspect the machine for damage;
- if the machine starts to vibrate abnormally, and to check for damage before restarting;

v) instructions when, where and how to inspect the machine and its **peripherals**, the supply and extension cord for signs of damage or ageing and, if permitted, how to make repairs;

w) a warning never to operate the machine and/or its **peripherals** with defective **guards** or shields, or without safety devices, or if the cord is damaged or worn;

x) an advice not to connect a damaged cord to the supply or touch a damaged cord before it is disconnected from the supply for the reason that damaged cords can lead to contact with **live parts**;

y) advice to keep any supply and/or extension cords away from the **working area** to avoid damage to the cords which can lead to contact with **live parts**;

z) instructions on the action to take in the event of accident or breakdown;

aa) instructions on the action to take in the event of leakage of electrolyte;

bb) instructions how to disconnect the **peripherals** from the mains, if the cord becomes damaged during use;

cc) recommendations

- to connect the **peripherals** only to a supply circuit protected by a residual current device (RCD) with a tripping current of not more than 30 mA;

NOTE It is possible to replace the term “residual current device (RCD) with a tripping current of not more than 30 mA” with the term “class A ground fault circuit interrupter (GFCI)”.

- to avoid using the machine and its **peripherals** in bad weather conditions especially when there is a risk of lightning;

dd) information about airborne noise emissions of the machine according to Annex FF. This includes:

- the A-weighted emission sound pressure level L_{pA} and its uncertainty K_{pA} as determined according to Annex FF, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact shall be indicated;
- the A-weighted sound power level emitted by the machinery L_{WA} and its uncertainty K_{WA} as determined according to Annex FF, where the A-weighted sound pressure level L_{pA} exceeds 80 dB(A);

ee) instructions how to proceed in case of abnormal vibrations;

ff) mass in kilograms;

gg) information for machines used in public areas, that warning signs shall be placed around the **working area** of the machine. They shall show the substance of the following text:

"Warning! Automatic lawnmower! Keep away from the machine! Supervise children!"

7.12.1 This subclause of Part 1 is applicable.

7.12.2 This subclause of Part 1 is not applicable.

7.12.3 This subclause of Part 1 is not applicable.

7.12.4 This subclause of Part 1 is not applicable.

7.12.5 This subclause of Part 1 is applicable.

7.12.6 This subclause of Part 1 is applicable.

7.12.7 This subclause of Part 1 is not applicable.

7.12.8 This subclause of Part 1 is not applicable.

8 Protection against access to live parts

This clause of Part 1 is applicable, except as follows.

8.1 This subclause of Part 1 is

– applicable for **charging stations** and **perimeter delimiter**; and
– not applicable for machines, **manual controllers** and **remote setting devices**.

8.2 This subclause of Part 1 is

– applicable for **charging stations** and **perimeter delimiter**; and
– not applicable for machines, **manual controllers** and **remote setting devices**.

8.101 **Protection against electric shock**

8.101.1 Machines and their **battery** packs shall be so constructed and enclosed that there is adequate protection against electric shock.

Compliance is checked by inspection and by the requirements of 8.101.2 and 8.101.3, as applicable.

8.101.2 It shall not be permissible to have two conductive, simultaneously **accessible parts** where there is **hazardous voltage** between them unless they are provided with an impedance that limits current to a safe value.

In the case of an impedance that limits current to a safe value, the short circuit current between the parts shall not exceed 2 mA for d.c. or 0,7 mA peak for a.c. and there shall not be more than 0,1 μF capacitance directly between the parts.

Compliance for accessibility is checked by applying the test probe B of IEC 61032:1997 to each conductive part.

The test probe B of IEC 61032:1997 is applied with a force not exceeding 5 N through openings to any depth that the test probe will permit, and it is rotated or angled before, during and after insertion to any position.

If the opening does not allow the entry of the probe, a rigid test probe with the dimensions of the test probe B of IEC 61032:1997, but without any articulation, is used, the force on the probe is increased to 20 N and the test with the articulated test probe B of IEC 61032:1997 is repeated.

*Contact with the test probe is determined with all **detachable parts** removed and the machine operated in any position of **intended use**.*

*Lamps located behind detachable covers are not removed, providing the lamp may be de-energized by means of a user operable plug, **battery** pack disconnection or a switch.*

8.101.3 Materials providing insulation from electric shock shall be adequate.

Compliance is checked by subjecting the insulating material to an electric strength test as specified in 16.3, but with a test voltage of 750 V. This provision does not exclude the testing of the material as situated within the machine, providing care is taken to ensure that materials not under consideration are not subjected to the test voltage.

*This test applies only to materials which, if they were to fail to insulate, would subject the user to a shock hazard from a **hazardous voltage**. This test does not apply to materials that provide only a physical barrier to contact. As such, an uninsulated energized part shall be within 1,0 mm of the material surface to be considered for this requirement.*

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

This clause of Part 1 is not applicable.

11 Heating

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

14 Transient overvoltages

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

15 Moisture resistance

This clause of Part 1 is applicable except as follows.

15.1 *Addition:*

*The machine shall be tested according to its IP rating both separately and while in its **charging station**.*

*The **charging station** shall be tested according to its IP rating both separately and while the machine is in its charging position.*

*Compliance for the machine and **charging station** is assessed individually according to its IP rating. The test of 16.3 is not performed on the machine.*

15.1.2 *Modification:*

*Machines or **peripherals** classified as IPX4 shall be rotated during the test along its vertical axis. The rate of rotation shall be 1,2 ± 0,2 r/min.*

15.2 *Addition:*

*Machines or **peripherals** fitted with an appliance inlet or cable coupler shall be tested with the appropriate mating connector in place.*

Air filters are not removed.

15.3 This subclause is not applicable, except for mains-powered **peripherals**.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 This subclause is not applicable, except for mains-powered **peripherals**.

16.2 This subclause is not applicable, except for mains-powered **peripherals**.

16.3 *Replacement of the first paragraph:*

*For mains-powered **peripherals**, immediately after the test of 16.2, the insulation is subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min in accordance with IEC 61180-1. The values of the test voltage for different types of insulation are given in Table 7.*

*For machines and non-mains powered **peripherals**, as required by the test of 8.101.3, the insulation is subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min in accordance with IEC 61180-1. The values of the test voltage are given in 8.101.3.*

17 Overload protection of transformers and associated circuits

This clause of Part 1 is not applicable, except for mains-powered **peripherals**.

18 Endurance

This clause of Part 1 is not applicable.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.1 *Addition to the first paragraph:*

This includes leakage of electrolyte from the **battery**.

19.7 This subclause is not applicable.

19.8 This subclause is not applicable.

19.9 This subclause is not applicable.

19.10 This subclause is not applicable.

19.11 *Addition:*

The first fault may be applied at any time. If an additional fault in a protective electronic circuit has to be applied, it shall not be applied before a new operating cycle of the machine. This sequence of applied failures is also applicable for the tests specified in Clause 20 and 22 if tests according 19.11.2 are required.

This subclause is not applicable for lithium-ion **charging systems**.

NOTE 101 The requirements for lithium-ion **charging systems** are specified in KK.19.1.

19.11.1 This subclause is not applicable for lithium-ion **charging systems**.

19.11.2 This subclause is not applicable for lithium-ion **charging systems**.

19.11.3 *Addition:*

*However the test is not repeated, if the **protective electronic circuit** provides a non-self-resetting interruption of the supply of the machine's part that would render the machine unsafe during the relevant test.*

This subclause is not applicable for lithium-ion **charging systems**.

19.11.4 This subclause is not applicable for lithium-ion **charging systems**.

19.11.4.1 to 19.11.4.8 These subclauses are not applicable for lithium-ion **charging systems**.

19.14 This subclause is not applicable, except for mains-powered **peripherals**.

19.15 This subclause is not applicable, except for mains-powered **peripherals**.

20 Stability and mechanical hazards

This clause of Part 1 is applicable except as follows.

20.1 This subclause is not applicable.

20.2 *Replacement:*

To prevent unexpected operation which may result in a hazard, the **cutting means** shall not start until either,

a) the machine is restarted as described in the restart procedure in 20.102.6; or
b) the **cutting means** start-up indication procedure as described in 22.110 is completed; or
c) for manual control, as described in 20.101.1.

All power driven components except the **cutting means** and the ground contacting parts shall be guarded to prevent inadvertent contact. Any apertures or safety distances shall comply with 4.2.4.2 and 4.2.4.3 of ISO 13857:2008.

To prevent inadvertent access to the **cutting means** these are guarded by the **cutting means enclosure**. The **cutting means enclosure** shall comply with the requirements of 20.102.1 and 20.102.4.

All **guards**, including the **cutting means enclosure** as specified in 20.102.1, shall be permanently attached to the machine and shall not be detachable without the use of **tools**. Exceptions to this are the opening of or removing interlocked **guards** which disable the protected moving parts, as specified in 20.102.1.2.

Fixed **guards** that the user is instructed to remove for regular maintenance shall have their fixing means retained on either the **guard** or the body of the machine.

After restoring an interlocked **guard** to its normal position, restarting the **cutting means** and **traction drive** shall only be possible by fulfilling the requirements of the restart procedure in 20.102.6.

Compliance is checked by inspection and by measurement.

20.101 Controls

20.101.1 Manual controller

Manual controllers, if any, shall be fitted with an **operator presence control** on the **manual controller** which will automatically stop rotation of the **cutting means** when the operator's hands are removed. This may be accomplished either by stopping the drive motor or by an intermediate clutch/brake mechanism. Starting of the **cutting means** shall require two separate and dissimilar actions, one of which shall be the actuation of the **operator presence control**. If these actions can be carried out by using the same hand then the actions shall be totally distinct thus to prevent accidental "switch on".

Any actuator on the **manual controller** for the **traction drive** shall automatically stop or disengage the **traction drive** when the operator releases the actuator.

During manual operation, the **obstruction sensor** and the **sensor** detecting when the machine is outside the **working area** may be deactivated, the **lift sensors, tilt sensors** and **rollover sensors** shall remain functional.

If a **manual controller** is provided, it shall meet the requirements of 22.107 and 21.101.5.

Compliance is checked by inspection, by practical tests and by the tests of 22.107 and 21.101.5.

20.101.2 Remote setting device

If a **remote setting device** is provided it may be used to carry out "off-machine" adjustments of the settings, movement within the **working area**, as well as starting and stopping the machine in **automatic mode**.

A **remote setting device** shall maintain all of the requirements for automatic operation.

Compliance is checked by inspection and by practical test.

20.101.3 Void

20.101.4 Manual stop

A single action clearly identifiable **manual stop** shall be provided on the machine in a prominent position on the top surface. The actuator of the **manual stop** shall have at least 20% of its surface raised at least 5 mm above the immediate surrounding area. The minimum width of the immediate surrounding area shall be not less than 15 mm. The geometric minor dimension of the actuator of the **manual stop** shall be not less than 35 mm and the surface area of the actuator shall be not less than 700 mm^2.

The operating force of the actuator of the **manual stop** shall not exceed 30 N on any part of its surface that is raised at least 5 mm above the immediate surrounding area.

The **manual stop** shall override all other **controls** and cause the **traction drive** to stop as specified in 20.102.5.2 and the **cutting means** in accordance with 20.102.2.

*Compliance is checked by inspection and by measurement, and if the compliance relies on the operation of an **electronic circuit**, it is checked under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

2) the electromagnetic phenomena tests of Clause 19.11.4.1 and 19.11.4.2 applied to the machine.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

Restarting of the mower following a **manual stop** shall only be possible after the restart procedure in 20.102.6 is completed.

Compliance is checked by inspection and by practical tests.

20.102 Safety requirements

20.102.1 Cutting means enclosure

20.102.1.1 General

Except as allowed below, the **cutting means enclosure** shall extend at least 3 mm below the plane of the **cutting means tip circle**. The bolt heads of **cutting means** securing screws may extend below the **cutting means enclosure** providing these are located within the inner 50 % **cutting means tip circle** diameter.

Openings may be provided in the **cutting means enclosure**.

NOTE Requirements for inadvertent access to the **cutting means** are specified in 20.102.4.

Compliance is checked by inspection and by measurement.

This requirement shall not apply to machines where the **cutting means** is a generally circular drive unit on which is mounted one or more pivoting cutting elements or filament lines. These

cutting elements shall rely on centrifugal force to achieve cutting and have a kinetic energy not exceeding 2 J per cutting element.

For the purposes of this clause, the kinetic energy of a pivoting cutting element shall be calculated according to Annex AA.

Compliance is checked by inspection, by measurement and by calculation.

20.102.1.2 Guards and grass catchers

Guards which have to be displaced in order to fit the **grass catcher** shall be interlocked to meet the requirements of 20.102.2. The **guards** shall be considered as forming part of the **cutting means enclosure**.

Compliance is checked by inspection and by practical tests.

20.102.2 Cutting means stopping time

The **cutting means** shall stop from their maximum rotational speed within 2 s if a **cutting means** stopping command is generated from any of the following:

– **tilt sensor**;
– **lift sensor**;
– **obstruction sensor** (when activated for more than 3 s according to 22.105.2);
– **manual stop** is activated;
– after the operator releases the **cutting means operator presence control**; or
– the opening of or removing interlocked **guards**, which disable the protected moving parts.

Compliance is checked by the tests of 20.102.2.1 to 20.102.2.3.

*If compliance relies on the operation of an **electronic circuit**, the compliance is checked under the following condition:*

*1) the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the **electronic circuit**;*

*The total **stopping time**, as a result of condition 1) and an attempted **cutting means** stopping command, shall either*

– *comply with the **stopping time** limit value above; or*
– *not exceed 0,1 joules (J) of rotational energy at the end of an interval of twice of the value given above. In this case, the test is repeated and either the **cutting means** stopping command shall comply with the **stopping time** limit value above or the **cutting means** shall be permanently disabled such that the **cutting means** cannot be reactivated by the operator and requires repair by qualified service personnel.*

The calculation of rotational energy shall be made using Annex AA or $E = ½I\omega^2$ as appropriate.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

*For machines where the **cutting means stopping time** is not monitored by an **electronic circuit**, the durability test according to 20.102.2.2 and 20.102.2.3 shall be carried out.*

20.102.2.1 Cutting means stopping time test

*Prior to the test, the machine shall be assembled and adjusted according to the manufacturer's instructions for use. The machine shall be started and stopped 10 times before commencing the test. If possible, machines shall be powered from an external source of power to simulate a **fully charged battery**.*

The time recording measurement system shall have a total accuracy of 25 ms and any tachometers used shall have an accuracy of ± 2,5 %. The ambient test temperature shall be 20 °C ± 5 °C. The machine shall be mounted and instrumented in such a manner that the results of the test are not affected.

***Stopping time** is measured from the moment of actuation of a **sensor** until either*

– *the last time a **cutting means** passes the sensing device of the test equipment; or*

– *the residual energy of the **cutting means** is below 0,1J;*

whichever is sooner.

*The means of initiating the **cutting means** stopping procedure during the test shall be such that:*

– *for the **operator presence control** for the **cutting means** – the **control** shall be released abruptly from the full "on" position so that it returns to the "idle" or "**off**" **position** by itself;*

– *for the **obstruction sensors** – each **sensor** is activated such that a **cutting means** stopping command is generated as specified in 22.105.2;*

– *for **tilt sensors** – the machine shall be tilted to activate and deactivate the **sensor** in the directions as required in 22.105.1;*

– *for **lift sensors** – the machine shall be lifted to activate and deactivate the **sensor** as required in 22.105.3;*

– *for **manual stops** – the **manual stop** shall be activated.*

*Individual **cutting means stopping times** shall be measured five times from the moment of each of the following:*

- *release of the **cutting means operator presence control**,*
- *activation of the **obstruction sensor** by contact with the solid object according to 22.105.2,*
- *operation of the **tilt sensor**. The primary direction giving the longest average value shall be the orientation used for measuring the **cutting means stopping time** of the machine,*
- *actuation of the **manual stop**, and*
- ***lift sensor** is actuated.*

*The sensor or manual action giving the longest average value from these options shall be the method used for measuring the **cutting means stopping time** of the machine according to 20.102.2.2.*

20.102.2.2 Cutting means stopping time durability test – Method

For machines where the **cutting means stopping time** is not monitored by an **electronic circuit**, the machine shall be subjected to a sequence of 5 000 stop/start cycles. The 5 000 test cycles are not required to be continuous and the machine shall be maintained and adjusted during the test in accordance with the manufacturers published instructions for use. There shall be no maintenance or adjustment after 4 500 cycles have been completed.

Figure 101 gives a schematic representation of two cycles. Each cycle shall consist of the following sequence:

– *accelerate the **cutting means** from rest to the **maximum operating motor speed** (n) – (time = t_s);*

– *hold it at this speed for a short time to ensure that it is stable – (time = t_r);*

– *operate the machine and allow the **cutting means** to come to rest – (time = t_b);*

– *allow a short time at rest before commencing the next cycle – (time = t_o).*

If the total time for one cycle is t_c then $t_c = t_s + t_r + t_b + t_o$. The test cycle times for "on" (t_s+t_r) and "off" (t_b+t_o) shall be decided by the manufacturer but shall not exceed 100 s "on" and 20 s "off".

NOTE This test is not representative of normal use and therefore the cycle times are specified by the manufacturer to avoid unnecessary wear or damage to the machine.

20.102.2.3 Cutting means stopping time durability test – Verification

*For machines subjected to the test of 20.102.2.2, the **cutting means stopping time** shall be measured for the following:*

- *each of the first five cycles of the 5 000 cycle test sequence (i.e. not including the preparatory operations nor the trial stops used to determine which stop initiator to test);*
- *each of the last five cycles prior to any brake maintenance or adjustment carried out during the test;*
- *each of the first 5 cycles of each 500 cycles of operation; and*
- *each of the last five cycles of the 5 000 test cycles.*

*No other **stopping times** shall be recorded.*

*Each of the measured **stopping times** (t_b) shall comply with the requirement of 20.102.2. If the test sample fails to complete the full number of cycles but otherwise meets the requirements of this test, either:*

- *the machinery may be repaired, if the brake mechanism is not affected and the test continued;*
- *if the machine cannot be repaired, one further sample may be tested which shall then comply fully with the requirements.*

20.102.3 Thrown object hazard

Robotic lawnmowers shall be so constructed to provide adequate protection against risk of injury to persons from foreign objects that may be thrown out by the rotating **cutting means**.

Compliance is checked by the following test:

When conducting this test, personnel should either be kept out of the test area or otherwise protected from the hazard of thrown objects.

The machine is placed in the test enclosure described in Annex BB with the base of the enclosure being as described in Annex CC. The target panel construction used shall be checked by the tests contained in Clause BB.3 of Annex BB immediately before and after this test. The target panels shall be divided into elevation zones by horizontal lines as indicated in Figure BB.1 and described in Annex DD.

The projectiles used in the test shall be 6,35 mm diameter balls of hardened steel 45 HRC minimum (e.g. balls used as ball bearings).

*Injection points for the steel balls shall be provided as positioned in Figure BB.2 and located midway along the **cutting means** cutting edge.*

The injection tube outlets shall be fixed and flush with the upper surface of the coconut mat see Annex CC (Figure CC.1) and the system shall be so arranged that the ball may be ejected with variable velocity.

Where necessary, the machine may be elastically restrained to prevent horizontal movement.

*During the tests, the machine shall be operated at **maximum operating motor speed** (as defined by 3.120) and supplied, if possible, by an external power supply having the same characteristics as a **fully charged battery**.*

*Tests shall be conducted for each **cutting means** assembly.*

The machine shall be tested in all operational configurations (e.g. both with and without attachments and accessories such as grass collectors or mulching parts).

*The **cutting means** shall be adjusted to a 30 mm cut height or the next higher **cutting position** when set on a hard level surface. Machines with a maximum height setting of 30 mm or less shall be set at their maximum height setting.*

*Before the test, adjust the velocity with which the ball is ejected so that the ball rises not less than 30 mm above the surface of the coconut matting and within an angle of 10° of the vertical axis. Then with the machine in place, allow balls one at a time into the machine. Increase the velocity of the balls in small increments until each ball is hit by the machine **cutting means**. Start the test when this minimum velocity is established. Chipped or damaged balls shall be replaced.*

*Inject 500 steel balls into each injection point for each test. On multi-spindle machines, the test shall be run for each spindle with the results evaluated for each test, with all spindles running. A new set of **cutting means** shall be used for each test.*

During any of the tests, in the event of excessive hits in a localised area, it may be necessary to repair or replace a target panel before continuing with the tests. Replace the target panels if hits from previous tests leave holes that cannot be covered by a 40 mm square gummed label. Not more than one thickness of gummed labels (patch) shall be placed over any one area.

Balls remaining within the test enclosure (on test surface) may be removed at the option of the tester to minimise ricochet hits. Balls passing over the top of the test enclosure shall be ignored.

Count and record hits on data sheet shown in Annex DD. A test projectile passing completely through all layers of the target material is counted as a hit. Steel balls that hit and damage the centreline of the target area height line shall be scored with the target area below that line.

For each test (500 steel balls), there shall be no hits above the 300 mm line (top elevation area) and not more than 2 hits in each target panel between the base and the 300 mm line.

The test does not require that the machine shall be suitable for use after test.

In the event of a test failure, two additional machines may be tested both of which must then pass the test.

20.102.4 Inadvertent access to the cutting means

20.102.4.1 Inadvertent foot access to the cutting means

20.102.4.1.1 General

Inadvertent access to the **cutting means** by the feet during operation shall be prevented, so far as reasonably practicable by the **cutting means enclosure**.

Compliance is checked by the tests of 20.102.4.1.2, 20.102.4.1.3 and 20.102.4.1.4.

*The tests are made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

20.102.4.1.2 Adult foot probe test

*The machine shall be placed on a hard, flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of these tests. The tests are conducted under static conditions.*

*The foot probe of Figure 102 shall be inserted towards the **cutting means** around the machine's external enclosure. The base of the probe is held horizontally at any height and then inclined up to 15° forward or backward from the horizontal (see Figure 102). The probe is*

applied around the entire machine as described in Figure 102 until a horizontal force of 20 N maximum is reached, or until the machine's enclosure lifts or moves from the original position, or until contact is made with the cutting means path, whichever occurs first.

*The test probe shall not enter the path of the **cutting means** assembly.*

20.102.4.1.3 Foot probe test for standing child

*The machine shall be placed on a hard, flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of these tests. The tests are conducted under static conditions.*

*The foot probe of Figure 107 shall be inserted towards the **cutting means** around the machine's external enclosure. The base of the probe is held horizontally at any height and then inclined up to 15° forward or backward from the horizontal (see Figure 102). The probe is applied around the entire machine as described in Figure 102 until a horizontal force of 20 N maximum is reached, or until machine's enclosure lifts or moves from the original position, or until contact is made with the **cutting means** path, whichever occurs first.*

*The test probe shall not enter the path of the **cutting means** assembly.*

20.102.4.1.4 Foot probe test for kneeling child

The machine is placed on a test surface as described in Annex CC, except that

- *the minimum size as described in Clause CC.2 shall be such that the machine is capable of attaining its maximum **traction drive** speed in automatic mode during normal use with **the cutting means** operating; and*
- *an injection tube as shown in Figure CC.1 need not be incorporated into the test surface.*

The machine is tested by means of the foot probe shown in Figure 109. The sole of the foot probe shall be constructed of a material with a 70 Shore A hardness (nominal) and a thickness of (3 ± 0,5) mm. The sole of the foot probe shall be free from dust and grease. Prior to the series of tests, the sole of the foot probe in Figure 109 shall be checked to ensure a dynamic coefficient of friction of (0,6 ± 0,06) with respect to the same material surface in accordance with ISO 8295:1995.

*The machine is operated in automatic mode with the **cutting means** operating. While the machine is operating, the foot probe of Figure 109 is placed in each of the ten test positions shown in Figure 110, as applicable to the anticipated movement of the machine, such that*

- *the foot probe is aligned with the direction of the machine's movement with the toe pointing toward the machine; and*
- *the foot probe is placed on the test surface and care is taken that foot probe movement is minimised if the machine comes into contact with the foot probe;*

  NOTE A spike or other feature located on the knee of the probe has been shown to be helpful in minimising movement of the foot probe during the test.

- *an injection tube, if any, in the coconut matting does not influence the test result.*

If, in automatic mode, it is not possible for the machine to move in accordance with any of the test positions shown in Figure 110, then it is not necessary to conduct the test for those test positions.

The foot probe remains in place at each test position until

- *the machine has moved completely away from the foot probe; or*
- *the foot probe has been in place for 20 s; or*
- *the machine stops such that a manual reset is required,*

whichever occurs first.

*For each test position, the foot probe shall not contact the **cutting means** whilst the **cutting means** is rotating. If the sole of the foot probe is damaged during the test, it shall be repaired or replaced as necessary.*

20.102.4.2 Inadvertent hand access to cutting means

20.102.4.2.1 General

Inadvertent access to the **cutting means** by the hand during operation shall be prevented, so far as reasonably practicable by means of the **cutting means enclosure**.

Compliance is checked by the tests of 20.102.4.2.2 and 20.102.4.2.3.

20.102.4.2.2 Hand and arm probe tests

The **cutting means enclosure** shall provide guarding to reduce the possibility of inadvertent contact with the **cutting means** when reaching under the **cutting means enclosure**.

Compliance is checked by the following tests.

20.102.4.2.2.1 Hand probe test

A mechanical test probe as shown in Figure 111 is used for the test. The joints shall be locked firmly into their straight positions or replaced by a solid portion.

NOTE The probe of Figure 111 is similar to test probe B of IEC 61032 but having a circular stop face with a diameter of 50 mm, instead of the non-circular face.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The probe shall be inserted towards the **cutting means** around and under the outer periphery of the machine. The axis of the probe is held horizontally at any height and then inclined up to ±15° from the horizontal. The vertical height of the probe is maintained when the probe is inserted under the machine. The probe is applied until a force of 5 N maximum is reached or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal movement.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

20.102.4.2.2.2 Child arm probe test

Test probe 18 (Figure 12) of IEC 61032:1997 shall be used, but with the extension handle attached throughout the test. The joints shall be allowed to articulate.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the **cutting means** path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The probe shall be inserted towards the **cutting means** around and under the periphery of the machine. The axis of the probe is inclined 45° ± 1° from the horizontal. The probe is applied until a force of 5 N maximum is reached or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first. The articulated finger joints shall be moved through their full range of angular movements when under the machine.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal movement.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

20.102.4.2.3 Finger probe test

Guarding to reduce the possibility of contact with the **cutting means** during an attempted lift shall be provided.

Compliance is checked by the following test.

A mechanical test probe as shown in Figure 111 is used for the test.

*The machine shall be placed on a hard flat surface. The **guards** shall be in the normal operating position on the **cutting means enclosure** and the machine support members in contact with the supporting surface. Components of machines, such as wheels and frames, are where relevant considered as part of the **cutting means enclosure** for the purpose of this test. The test is conducted under static conditions.*

*The test is made with the **cutting means** in the most unfavourable **cutting position**. If the cutting means path height is different at different **cutting means** speeds, the test is conducted so as to include the extremes of **cutting means** height.*

*The finger portion of the probe shall be inserted towards the **cutting means** around and under the edge of the outer periphery of the machine until the 50 mm stop face contacts the outer periphery of the machine in any area where the machine can be lifted. For test purposes, the machine may be supported in its normal orientation above the hard flat supporting surface so that the insertion of the probe is not limited by the hard flat surface. The axis of the probe is held horizontally. The articulated finger joints shall be moved through their full range of angular movements. The probe is applied with a force not exceeding 5 N until contact is made by the 50 mm stop face of the probe with the outer periphery of the machine or until any portion of the machine is displaced from its original position, or until contact is made with the **cutting means** path, whichever occurs first. For examples of the intended application of the probe, see Figure 105.*

No vertical force shall be applied to the probe, except as necessary to maintain the horizontal position.

*The finger part of the test probe shall not enter the path of the **cutting means**. Contact with parts of the **cutting means** that are circular, smooth and unbroken is allowed.*

NOTE The positioning of the stop face of the probe is determined by assessing what parts of the enclosure are most likely to be grasped when lifting the stationary machine from the ground and noting where the root of the fingers are placed.

20.102.5 Traction drive stopping

20.102.5.1 General

The machine shall be provided with a means to stop the **traction drive** when a stopping command is generated from any of the following:

– **manual stop;**

– **manual controller;**

– **lift sensor;**

– **tilt sensor;**

– **obstruction sensor** (when activated for more than 10 s according to 22.105.2).

*Compliance is checked by 20.102.5.2 for the **manual stop** and **manual controller,** by 20.102.5.3 for the **lift sensor** and **tilt sensor** and by 22.105.2 for the **obstruction sensor**.*

*If compliance relies on the operation of an **electronic circuit**, the test of 20.102.5.2 and 20.102.5.3, as applicable, is repeated under the following condition:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*The total distance or stopping time, as applicable, as a result of condition 1) and an attempted **traction drive** stopping command, shall either comply with the limit values below, or not exceed twice of the value given below providing this occurs for one attempt only.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

20.102.5.2 After the initiation of any **traction drive** stopping command which is generated from any of the following:

– activation of the manual stop;

– after the operator releases the actuator on the **manual controller** for the **traction drive**, if any;

the machine shall stop within a distance of

– 200 mm; or

– 0,11 m per km/h up to a maximum of 1 m;

whichever is higher.

Compliance is checked by the following test.

*Use each available means of initiating a stop using the **manual stop** and **manual controller** (if any), in turn. The test stops shall be conducted on a substantially level (not to exceed 1 % gradient) dry, smooth, hard surface of concrete (or equivalent test surface). The test shall be carried out in both forward and reverse directions at the maximum ground speed attainable.*

20.102.5.3 When a **tilt sensor** and/or **lift sensor** is activated, the **traction drive** shall stop in the direction of travel within 2 s.

When in **automatic mode**, the machine may then attempt to recover from the condition that caused the activation of the **sensor(s)** for a period of 10 s, provided the machine moves in a different direction than the original direction of travel.

When in **automatic mode**, if the machine is unable to recover within the 10 s period, the **traction drive** shall stop, but may be restarted providing the restart procedure in 20.102.6 is completed.

Compliance is checked by inspection, by measurement and by manual test.

20.102.5.4 Void

20.102.6 Restart procedure

Restarting of the **traction drive** and **cutting means** due to

– activation of a **sensor(s)** as specified in 22.105.1 to 22.105.4; or

– activation of a **manual stop** as specified in 20.101.4; or

– changing of the **working area** as specified in 22.104;

shall only be possible following either:

a) two separate actions; or

b) the introduction of an alpha-numeric code of at least four characters; or

c) multiple key strokes in response to prompts.

Compliance is checked by inspection and by practical tests.

20.102.7 Void

20.102.7.1 Void

20.102.7.1.1 Void

20.102.7.1.2 Void

20.102.7.1.3 Void

NOTE In Europe (EN 60335-2-107), the following additional subclauses apply:

20.102.Z101 Noise

20.102.Z101.1 Noise reduction as a safety requirement

20.102.Z101.1.1 Noise reduction at source by design and by protective measures

The machine shall be designed to generate a noise level as low as practicable. The main sources causing noise are:

– air intake system;

– cutting system;

– vibrating surfaces.

ISO 11688-1 gives general technical information on widely recognised technical rules and means to be followed in the design of machines with low-noise emission.

20.102.Z101.1.2 Noise reduction by information

If, after taking all possible technical measures for reducing noise at the design stage, a manufacturer considers that further protection is necessary, then the instruction manual shall:

– recommend the use of low-noise operating modes, and/or limited time of operation;

– give a warning of noise level and recommend the use of ear protection.

20.102.Z101.1.3 Verification of requirements on noise – Noise measurement

For the determination of the sound power level and of the emission sound pressure level when using a **manual controller**, the measurement methods given in Annex FF shall be used.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 *Modification:*

The impact energy applied to all enclosures (including the **peripherals**) shall be (1,0 ± 0,05) J.

This subclause does not apply to

– **remote setting device(s)**; and

– power supplies or **battery** chargers that are covered by a separate end product standard.

21.101 Additional requirements for robotic lawnmowers

21.101.1 General

For the tests of this subclause the machine is operated at maximum speed and may be elastically restrained to prevent horizontal movement.

21.101.2 Strength of cutting means and cutting means mountings

Cutting means and their mountings shall have adequate strength to withstand impact with solid objects.

Compliance is checked by the following test:

The machine shall be placed in the test enclosure described in Annex BB using an impact test fixture such as the one shown in Figure 103. The machine shall be positioned over a 25 mm diameter (nominal) steel rod that has been placed in the test fixture (see Figure 103). The ***cutting means*** *of the test machine shall be adjusted to the cutting height closest to 50 mm and so positioned that when the rod is inserted into the path of the rotating* ***cutting means****, the* ***cutting means*** *will strike the exposed portion of the rod within 10 mm to 15 mm of the* ***cutting means*** *tip (see Figure 103). The rod shall be inserted once into the path of each* ***cutting means*** *assembly. A new piece of rod shall be used for each test.*

The machine shall be run for 15 s, or until the cutter stops or the rod is severed.

Where it is not possible to insert the rod due to machine design, the machine shall be moved the minimum distance necessary to permit the rod to be inserted.

During the test, no complete ***cutting means****, arm or disc to which it is mounted shall become detached nor shall any part of the machine pass through all layers of the wall of the fibreboard enclosure. Also, any breakage of the* ***cutting means*** *or* ***cutting means*** *retaining device shall be considered failure of the test. Breakage of the drive shearing device or chipping of the* ***cutting means*** *cutting edge are not considered a test failure.*

The test does not require that the machine shall be suitable for use after test.

21.101.3 Imbalance

Robotic lawnmowers shall withstand the out of balance forces that may occur due to wear etc. of the **cutting means** or its assembly.

Compliance is checked by the following test:

The machine shall be placed in the test enclosure described in Annex BB. The test shall be conducted on a smooth hard level surface.

For machines using rigid ***cutting means****, the* ***cutting means*** *imbalance, in kilogram metres, is first determined by the formula*

$$0{,}024\ L^3$$

where L is the diameter of the ***cutting means tip circle****, in metres.*

The calculated imbalance is created by removing material from, or adding it to, the ***cutting means*** *until the desired imbalance is obtained.*

For machines using freely pivoting ***cutting means*** *on a generally circular disc, the imbalance shall be created by removing a* ***cutting means****.*

The test is run for 1 h in the test enclosure for each ***cutting means*** *assembly. If possible, the machine is operated from an external power supply having the same characteristics as a* ***fully charged battery****.*

All ***cutting means*** *assemblies of a multi-spindle machine are tested singly. It is permissible to test all* ***cutting means*** *assemblies of a multi-spindle machine simultaneously at the discretion of the manufacturer. At the discretion of the manufacturer, a new machine may be used for each test.*

During the test, the machine shall not lose any component necessary for compliance with the requirements of this standard nor shall any component or part of the machine pass through all layers of the wall of the test enclosure. The test does not require that the machine shall be suitable for use after test.

21.101.4 Structural integrity

21.101.4.1 General

Cutting means enclosures, **discharge chutes**, **guards** and **grass catchers** of **robotic lawnmowers** shall have sufficient strength to withstand the impact from foreign objects which may be thrown out by the **cutting means**.

Compliance is checked by the test described in 21.101.4.2 to 21.101.4.4. During the test, personnel should be protected against possible thrown objects.

21.101.4.2 Test equipment

21.101.4.2.1 Test fixture (see Figure 104)

The test fixture base shall consist of a steel plate of at least 1,5 mm thickness backed by a 19 mm plywood panel. The steel plate shall be large enough to extend at least 25 mm beyond the **cutting means enclosure** of the machine.

An air inlet hole shall be provided that is concentric with each **cutting means tip circle** with an approximate diameter, as given in Table 101.

Table 101 – Sizing of test fixture air inlet holes

Lawnmower type	Cutting means tip circle diameter (BTCD)	Air inlet diameter
Non-mulching	All	0,3 × BTCD
Mulching	< 635 mm	BTCD – 127 mm
Mulching	≥ 635 mm	0,8 × BTCD

The machine shall be constrained in a suitable manner such that its specified position relative to the injection point is maintained throughout the test. The constraint(s) shall not obstruct free passage of the balls from under the machine.

21.101.4.2.2 Injection points

The location of one injection point B shall be:

– for mulching machines, at the 12 o'clock position and located midway along the **cutting means** cutting edge as detailed in Figure BB.2.

– for non-mulching machines, the injection point shall be located midway along the **cutting means** cutting edge on a line BC which is 45° from a line AC, in a direction counter to the direction of **cutting means** rotation, where A is the centre of the **discharge chute** exit and C is the centre of the **cutting means tip circle**. See Figure 104.

Ten injection points shall be equally spaced apart starting from point B on the centre of the **cutting means tip circle** C. See Figure 104. The injection points of approximately 15 mm diameter shall be used for the introduction of balls (see 21.101.4.2.3).

Alternatively, instead of using ten injection points the machine may be rotated in 36° increments from injection point B.

The injection tubes shall not protrude above the steel plate.

21.101.4.2.3 Test balls

One hundred hardened (12,75 ± 0,25) mm diameter balls of steel, 45 HRC minimum (e.g. balls used as ball bearings) shall be used.

21.101.4.2.4 Injection method

Means shall be provided to inject the steel balls with variable velocity. Adjust the velocity with which the ball is injected so that the ball rises a minimum of 13 mm and a maximum of 300 mm above the cutting plane of the **cutting means**.

21.101.4.3 Test method

The machine to be tested shall be positioned on the steel plate with the **cutting means** axis C over the centre of the test fixture base. The **cutting means** shall be set at the lowest adjustable cutting height but not less than 30 mm. If the maximum height of cut is less than 30 mm, then the machine shall be tested when adjusted to its maximum height.

The 100 balls shall be divided into 10 lots of 10. One lot shall be injected through each of the 10 injection points.

The test shall be conducted once for each **cutting means**.

A new machine housing may be used for each test of a multi-spindle machine. A full set of new **cutting means** shall be fitted before each spindle is tested.

21.101.4.4 Test acceptance

The **cutting means enclosure**, **guard** or **grass catcher** shall be considered to have failed the test if any of the following occurs:

a) a hole in the **cutting means enclosure**, **guard**(s) or **grass catcher**(s) which has allowed the ball to pass through. A hole in a secondary enclosure, such as an internal baffle, shall not be considered a failure;

b) deformation of any part of the **cutting means enclosure**, **guard**(s) or **grass catcher** into the path of the **cutting means**;

c) the dislodging of the **grass catcher** or **guard** from its adapter;

d) the **grass catcher** or **guard** falling from its normal operating position.

In the event of a test failure, two additional identical machines shall be tested. If either of the additional machines fails a test, the model shall have failed the test.

The test does not require that the machine has to be suitable for use after the test.

21.101.5 Strength of cutting means enclosure

The **cutting means enclosure** and ground support system shall be able to withstand possible extra loading.

Compliance is checked by the following test:

*A weight of 20 kg shall be placed on top of any **accessible part** of the top of the machine. The machine shall be on a smooth level hard surface and the load shall be evenly distributed over an area of 10 cm x 5 cm applied through a layer of foam with a thickness of 50 mm ± 5 mm having a density of 32 kg/m^3 backed by a rigid flat 12 mm thick plywood backing plate for a period of 30 s. The machine shall be considered to have passed the test if either of the following occurs:*

a) there is no visible damage to the machine and it continues to function correctly after the test, or

*b) if there is visible damage, the **cutting means** shall not function, or the guarding of the **cutting means** shall be sufficient to pass all the tests of 21.101.3 and 21.101.4.*

21.101.6 Drop test – Manual controller

A **manual controller**, if any, shall be dropped three times from a height of 1,0 m onto a smooth concrete floor in the position most likely to damage the controller, while powered on and communicating with the machine.

The **manual controller** shall have failed the test if one or more of the following occurs:

– there is access to a **working voltage**, exceeding **hazardous voltage**, using test probe 13 of IEC 61032;

– loss of **operator presence control**, either through mechanical or electrical damage;

– unintended motion of the machine; or

– any breakage that allows access to uninsulated parts that could short due to the loss of the enclosure.

22 Construction

This clause of part 1 is applicable except as follows.

22.6 *Addition:*

Any drain holes provided to prevent accumulation of water in an enclosure shall be at least 5 mm in diameter or 20 mm² area with a width of at least 3 mm.

Compliance is checked by inspection.

22.12 *Addition:*

If carrying means are provided for the machine or other lifted items, they shall have adequate strength.

Compliance is checked by inspection and the following test.

Carrying means are subjected to a force corresponding to three times the weight of the machine or lifted item, e.g. ***battery.*** *The force is applied in the direction of lifting uniformly over a 70 mm width at the centre of the carrying means. The force is steadily increased so that the test value is attained within 10 s and maintained for a period of 1 min.*

If more than one carrying means is provided or if a portion of the weight is distributed over a wheel, the force is distributed between the carrying means in the same proportion as in the normal transportation position. If the machine is provided with more than one carrying means, but so designed that it may readily be carried by only one carrying means, each carrying means shall be capable of sustaining the total force.

The carrying means shall not break loose from the machine and there shall not be any permanent distortion, cracking or other evidence of failure.

22.36 This subclause is not applicable.

22.40 This subclause is not applicable.

NOTE 101 This requirement is covered by 20.101.1 and 20.101.4.

22.46

NOTE 101 Hazards that can be created due to the loss of functional control are addressed in the relevant subclauses. Other electronic fault conditions of 19.11.2 that result in dangerous malfunction are understood to not require an evaluation of software using Annex R.

22.49 This subclause is not applicable.

NOTE 101 This requirement is covered in 20.101.2 for **remote setting devices**.

22.50 This subclause is not applicable.

NOTE 101 This requirement is covered by 20.101.4.

22.51 This subclause is not applicable.

NOTE 101 This requirement is covered in 22.107 for **manual controller**.

22.101 Battery charging

Except for **batteries** charged by contactless means e.g. solar panels, it shall not be possible to operate the **cutting means** or the **traction drive** of the machine while the **battery** is being charged.

NOTE Operation of the **traction drive** to maintain contact pressure during charging is not considered to be operation of the **traction drive**.

*Compliance is checked by inspection, practical test and if the compliance relies on the operation of an **electronic circuit**, it is checked under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*2) the electromagnetic phenomena tests of 19.11.4.1 to 19.11.4.7 applied to the **charging station**, excluding the **perimeter delimiter**, if any.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.102 Air filters

Air filters which are designed to be removed for cleaning purposes shall be so designed that they are unlikely to come off in **intended use**.

Compliance is checked by inspection and the following practical tests:

- *the air filter can only be removed with the aid of a **tool**, or*
- *is provided with a spring that prevents it from falling away in **intended use** due to vibration, or*
- *needs a deliberate action by the user for its removal.*

22.103 Disabling device

22.103.1 General

A **disabling device** shall be provided which shall prevent operation of the machine when it is removed or operated. The **disabling device** shall not be easily overridden.

The **disabling device** shall be according to either 22.103.2 or 22.103.3.

22.103.2 Removable disabling device

When a **removable disabling device** is removed, it shall not be possible for the machine to be operable. A **removable disabling device** may be fulfilled by removal of all detachable **battery** pack(s), provided

- any individual **battery** pack does not have a mass exceeding 5,0 kg; and
- the detachable **battery** pack(s) are removable without the use of **tools**.

The machine is not considered to be operating when displaying, communicating, transmitting or storing data (e.g. error codes) whilst the **removable disabling device** is removed or operated.

Compliance is checked by inspection and by the following tests:

*With the **disabling device** removed and without undue force:*

*a) the **operator presence control** is operated if possible, and*

*b) an appropriately sized flat metal bar is used to try to override the **disabling device**.*

The machine shall not be operable.

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.103.3 Code protected disabling device

When the machine is disabled by operating the **code protected disabling device**, there shall be a clear and lasting indication that the machine is disabled and it shall not be possible for the machine to be operable until a specific “key sequence” (e.g. an alpha and/or numerical code of at least 4 characters) has been entered into the key pad.

The machine is not considered to be operating when displaying, communicating, transmitting or storing data (e.g. error codes) whilst the machine is disabled by the **code protected disabling device**.

It shall only be possible to de-activate the **code protected disabling device** from the machine. If the **manual controller** is the only **control**, the **code protected disabling device** may be de-activated from the **manual controller**.

It shall not be possible to de-activate the **code protected disabling device** from the **remote setting device**.

*Compliance is checked by inspection and if the compliance relies on the operation of an **electronic circuit**, the compliance is checked under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine.

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.104 Working area

When the machine is operating in **automatic mode**, the machine shall not be able to leave the **working area**. It shall not be possible for the machine to cross the boundary of the **working area** by a distance greater than one full length of the machine when operating in **automatic mode**.

The boundary of the **working area** may be established by the use of a **perimeter delimiter** as specified in 22.104.2 or by a pre-programmed area.

If the machine is placed outside the **working area**, it shall not be able to operate at a distance of more than 1 m from the boundary of the **working area** to the nearest part of the machine, unless under manual control.

If the machine fails to receive any signal that is required to recognise the **working area**, the machine shall travel not more than 1 m and the **cutting means** shall stop within 5 s from the instant the machine fails to receive any signal that is required to recognise the **working area** to the time that the **cutting means** stops in accordance with 20.102.2.

If the machine regains recognition of the **working area**, the machine may operate in **automatic mode**, providing the **cutting means** start-up indication procedure in 22.110 is completed.

If the **working area** is changed, it shall not be possible for the machine to operate in **automatic mode** unless the restart procedure in 20.102.6 is completed. This requirement is not applicable for **perimeter delimiters**.

Compliance is checked by inspection, by measurement and by practical tests.

*If the compliance relies on the operation of an **electronic circuit**, it is checked under the following condition:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*The total traveling distance and/or the total stopping time, as a result of condition 1), shall not exceed twice of the values given above. Under this condition, a manual operation shall be required to restart the **cutting means**, such a restart shall only be allowed for one attempt.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.104.1 Void

22.104.2 Perimeter delimiter

If a **perimeter delimiter** is provided which uses a boundary wire that emits a signal to indicate the limit of the **working area**, the maximum voltage shall not exceed SELV.

Compliance is checked by measurement.

NOTE The European Garden Machinery Federation (EGMF) Robotic Mowers Boundary Wire Standard RLM003-1.1/2016 addresses compatibility between adjacent **robotic lawnmower** installations that incorporate **perimeter delimiters**. It is anticipated that it will be superseded in Europe by ETSI EN 303 447, which is currently under development.

22.105 Sensors

22.105.1 Tilt sensors

The machine shall be provided with a **tilt sensor**. It shall activate at least 3° before the machine becomes unstable.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

Compliance is checked by inspection and by the following test.

Place the machine on a variable single-slope, plane, tilt table with the machine supported on its wheels. The wheels of the machine shall be blocked to prevent sliding down the slope. Place a strip of steel 1 mm thick under each uphill wheel. Tilt the table until lift-off occurs. Lift-off is when the steel strip can be removed sideways from under all of the (uphill) wheels with a force of 1 N or less.

Tests shall be conducted with the machine positioned in each of the following positions:

– *facing downhill;*
– *facing uphill;*
– *right hand side downhill;*
– *left hand side downhill.*

If there is likely to be a more unfavourable orientation than these then the test shall also be carried out in this position.

*The **tilt sensor** shall operate at least 3° before the angle at which lift-off occurs for each position.*

If compliance relies on the operation of an electronic circuit, the test is repeated under the following condition:

*1) the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the **electronic circuit**;*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

When a **tilt sensor** is activated, the **cutting means** shall stop in accordance with 20.102.2.

In **automatic mode**, if within 10 s the **sensor**(s) have become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

In **automatic mode**, if the **sensor**(s) have not become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the restart procedure in 20.102.6 is completed.

During manual control, the **cutting means** may only be restarted in accordance with 20.101.1 after the **sensor**(s) have become deactivated.

Compliance is checked by inspection and by measurement.

22.105.2 Obstruction sensors

The machine shall be provided with an **obstruction sensor**(s). In **automatic mode**, the **sensor**(s) shall be active and capable of performing its intended function in all operating positions and in all directions of travel, except those directions of travel where

– the **cutting means** is not operating and the distance travelled does not exceed 2,0 times the length of the machine; or

– the **cutting means** is operating and the distance travelled does not exceed the distance from the edge of the machine in the direction of travel to the nearest **cutting means tip circle**.

NOTE 101 The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

The maximum force applied by the machine against an obstruction in **automatic mode** shall not be greater than

– 260 N during the first 0,5 s after impact and a minimum of 50 N is exceeded; and

– 130 N thereafter.

NOTE 102 ISO/TS 15066 provides guidance on relevant values of maximum force.

If an **obstruction sensor** is activated, the **traction drive** in the direction of travel shall stop within

$t_{ts} = D/v$, where

t_{ts} is the **traction drive stopping time**;

D is the distance from the front edge of the machine to the nearest edge of the nearest **cutting means tip circle**; and

v is the velocity of the machine upon approach.

The machine shall then restart in a different direction to allow the machine to move away from the object such that the **sensor** is deactivated within 3 s of initial activation. If the **sensor** is not deactivated within 3 s of initial activation, the **cutting means** shall stop as required by 20.102.2.

An additional non-contact **sensor**, if relied upon to reduce speed in order to fulfil the requirement for maximum force upon impact, is permitted providing that it responds to a rigid non-metallic target:

– of cylindrical shape;

– of (70 ± 2) mm diameter by (400 ± 5) mm height, standing on end;

– of a colour or shade that matches the background; and

– normalized to the ambient temperature.

Compliance is checked by inspection, by measurement, by the following test and by 20.102.2.

*The machine is placed on a level test surface as described in Clause CC.3. The machine shall be made to collide with a force measuring means. The force to operate the **obstruction sensor** at impact shall be measured parallel to the ground plane and vertically aligned with the point of contact with the force measuring means. The point of contact shall not be higher than 150 mm from the ground plane. Friction, misalignment and other factors associated with the mounting of the force measuring means shall minimise error in the measurement.*

The force is measured by means of an instrument which incorporates a rigid impact plate having a diameter of (90 ± 10) mm and a spring having a spring constant of (60 ± 2) N/mm. The spring acts on a sensing element which is connected to a measuring instrument having a bandwidth limited to (150 ± 50) Hz and with an accuracy of 5 %. The sampling rate shall be at least double the bandwidth. A typical arrangement is shown in Figure 106.

The test is performed a total of five times. The maximum forces during the first 0,5 s after impact and thereafter are computed as the average of each of the five measurements.

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following condition:*

- *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

Alternatively, a non-contact **sensor** may fulfil the requirements of an **obstruction sensor**, providing that it responds to a rigid non-metallic target:

– of cylindrical shape;

– of (25 ± 2) mm diameter by (145 to 150) mm height, standing on end;

– of a colour or shade that matches the background; and

– normalized to the ambient temperature.

Compliance is checked by the following test and by 20.102.2.

The machine is placed on a level test surface as described in Clause CC.3. It shall not be possible for the machine to contact the rigid non-metallic target.

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following condition:*

- *the fault conditions in a) to g) of Clause 19.11.2 applied one at a time to the **electronic circuit**;*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

If within 10 s of the machine stopping due to contact or avoidance of an object, the **obstruction sensor**(s) has become deactivated, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

If after 10 s of the machine stopping due to contact or avoidance of an object, the **obstruction sensor**(s) has not become deactivated, the **traction drive** shall be deactivated. Restarting the **cutting means** and **traction drive** shall only be possible by fulfilling the requirements the restart procedure in 20.102.6.

Compliance is checked by inspection and by practical tests.

22.105.3 Lift sensor

The machine shall be provided with a **lift sensor**. The **lift sensor** shall detect when the machine is lifted both fully from the ground and when it is lifted from only a single point causing it to be tilted.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

If a **lift sensor** is operated, the **cutting means** shall stop as specified in 20.102.2 and the **traction drive** shall stop as specified in 20.102.5.

Compliance is checked by inspection and by the following tests:

*a) The machine is placed on a hard, smooth horizontal surface. The machine is lifted by any parts of the external housing, except the ground contacting parts, in a uniformly horizontal manner, normal to the surface. The rate of lifting shall be (20 ± 10) mm/s. The **lift sensor** shall have activated after all the ground contacting parts lose contact with the surface and when the lowest ground contacting part is no more than 10 mm above the surface.*

*b) The machine is placed on a hard, smooth horizontal surface. The machine is lifted from a single point on any part of the machine's external housing, except the ground contacting parts. The rate of lifting shall be (100 ± 20) mm/s. The **lift sensor** shall have activated after at least one of the ground contacting parts loses contact with the surface and the highest ground contacting part is no more than 300 mm above the surface.*

*The operation of the **lift sensor** is verified by lifting the machine from different locations around the external housing that are likely to be grasped by users.*

*If compliance relies on the operation of an **electronic circuit**, the tests are repeated under the following conditions applied separately:*

*1) the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*

*2) the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine when the **lift sensor** has been activated for more than 10 s.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

When a **lift sensor** is activated, the **cutting means** shall stop in accordance with 20.102.2.

In **automatic mode**, if within 10 s the **sensor**(s) have become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the **cutting means** start-up indication procedure in 22.110 is completed.

In **automatic mode**, if the **sensor**(s) have not become deactivated as specified in 20.102.5.3, the drive to the **cutting means** may be restarted providing the restart procedure in 20.102.6 is completed.

During manual control, the **cutting means** may only be restarted in accordance with 20.101.1 after the **sensor**(s) have become deactivated.

Compliance is checked by inspection and by measurement.

22.105.4 Rollover sensor

A **rollover sensor** shall be provided on all machines. The **rollover sensor** shall prevent the **traction drive** and **cutting means** starting when the machine is inverted.

NOTE The machine does not have to incorporate discrete sensing devices for each **sensor** requirement. The various sensing functions can be achieved by fewer devices that respond to multiple stimuli. Sensing requirements can also be fulfilled by mechanical devices instead of **electrical circuits**.

Compliance is checked by inspection and the following test.

*The machine shall be inverted and placed on a flat level surface, within 1 m either side of the **working area**. It shall not be possible to start the **traction drive** and/or the **cutting means**. For the purposes of this test, the machine shall not be moved from its inverted resting position.*

*If compliance relies on the operation of an **electronic circuit**, the test is repeated under the following conditions applied separately:*

1) *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*
2) *the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine when the **rollover sensor** has been activated for more than 10 s.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

*For machines equipped with a **manual controller**, it shall not be possible to start the **traction drive** and/or the **cutting means** when the operator is able to use the **manual controller**.*

If the machine is placed back in its correct orientation, the **cutting means** and **traction drive** may only be restarted by fulfilling the requirements of the restart procedure in 20.102.6.

Compliance is checked by inspection and by practical tests.

22.106 Charging station

All connections between a **charging station** and the machine shall not exceed SELV.

This requirement is not applicable for wireless (inductive) charging.

Compliance is checked by inspection and by measurement.

22.107 Manual controller

22.107.1 General

A **manual controller**, if any, shall require the operator to be close to the machine and be capable of withstanding **intended use** including foreseeable misuse.

The machine or the **manual controller** shall be provided with a means to select between manual mode and **automatic mode**.

The mode of operation shall not change in case of an **electronic component** on an **electronic circuit** being rendered inoperative.

Compliance is checked by inspection and by the following test conditions applied separately:

1) *the fault conditions in a) to g) of 19.11.2 applied one at a time to the **electronic circuit**;*
2) *the electromagnetic phenomena tests of 19.11.4.1 and 19.11.4.2 applied to the machine and the **manual controller**.*

*If the **electronic circuit** is programmable, the software shall contain measures to control the fault/error conditions specified in Table R.1 and is evaluated in accordance with the relevant requirements of Annex R.*

22.107.2 Wired manual controller

If the **manual controller** is connected by wire, it shall be between 1,5 m and 3 m long.

If during manual control the cable to the **manual controller** is disconnected or the **manual controller** loses power, the **traction drive** shall stop as required in 20.102.5 and the **cutting means** shall stop as required in 20.102.2.

After the **manual controller** is reconnected or power is restored,

– the **traction drive** may restart; and
– the **cutting means** may only be restarted as specified in 20.101.1.

Compliance is checked by inspection and by practical test.

22.107.3 Wireless manual controller

The selection of wireless manual control from **automatic mode** shall require the operator to either

– initially activate the wireless **manual controller** within 6 m of the machine, or

– complete an action on the machine itself.

After selection, the wireless **manual controller** may be capable of operating the machine provided the wireless **manual controller** is within

– 6 m of the machine when the **cutting means** is enabled; or

– 20 m of the machine if the **cutting means** is disabled.

The wireless **manual controller** shall not communicate with the machine through an intermediate retransmission means such as a repeater or internet connection.

The wireless **manual controller** shall be paired or have an encrypted signal unique to the machine it is to be used with.

If during manual control the wireless **manual controller** loses communication with the machine for more than 2 s, the **traction drive** shall stop as required in 20.102.5 and the **cutting means** shall stop as required in 20.102.2.

After communication between the wireless **manual controller** and the machine is restored,

– the **traction drive** may restart; and

– the **cutting means** may only be restarted as specified in 20.101.1.

Compliance is checked by inspection. by measurement and by manual test.

22.108 Batteries and accumulators

22.108.1 Void

22.108.2 Terminal protection

Battery terminals and connections shall be so located or enclosed that they are not likely to be short circuited. Exposed terminals shall be separated by an insulating barrier that provides 6 mm minimum total distance between the parts of opposite polarity.

Compliance is checked by inspection and the following test:

It shall not be possible for the terminals to be bridged by a 6 mm diameter test pin of any convenient length inserted through any opening in the enclosure.

22.109 Mounting of components

Except as indicated below, any component that is handled by the user shall be mounted securely and shall be prevented from turning by means other than friction between surfaces.

Exception No. 1: The requirement that a switch be prevented from turning is able to be waived if all three of the following conditions are met.

a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.

b) Spacings are not reduced below the minimum acceptable values if the switch rotates.

c) Normal operation of the switch is by mechanical means rather than by direct contact by persons.

Exception No. 2: A lamp-holder of the type in which the lamp is not able to be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a non-removable jewel, need not be prevented from turning if rotation does not reduce spacings below the minimum values.

22.110 Cutting means start-up indication

Before the **cutting means** can begin automatic operation, unless the machine is restarted as described in the restart procedure in 20.102.6 or, for manual control, as described in 20.101.1, either

a) a flashing light shall be provided. The light shall be visible when viewed from a distance of 3 m within a 360° circumference at a height of 1 m and shall operate for a minimum period of 2 s prior to **cutting means** starting; or

b) an audible indicator shall be provided. The audible warning indicator shall be either a single continuous tone, multiple tones or be intermittent at a rate of at least 2 cycles per second. The audible warning indicator shall operate for a minimum period of 2 s prior to **cutting means** starting. The sound pressure of audible warning indicators shall be at least 35 dB(A) at a minimum distance of 1,5 m in any direction from the centre of the machine and at a height of 1,75 m.; or

c) the machine shall move for at least 5 s before the **cutting means** starts.

Compliance is checked by inspection and by practical test.

22.111 Charging station connectors

Machines provided with connectors for connecting to the **charging station** shall not be interchangeable with mains plugs and socket-outlets listed in IEC 60884, IEC/TR 60083 or IEC 60906-1 or with connectors and appliance inlets complying with the standard sheets of IEC 60320-1.

Compliance is checked by inspection.

22.112 Obstruction sensor contact surfaces

The surface contacted when striking an obstruction shall be designed to minimize the risk of injury and shall not have a perpendicular protrusion greater than 5 mm unless the protrusion has

– a surface area greater than 20 mm^2; and

– a minor dimension greater than 5 mm.

All protrusions shall have rounded edges.

The surface contacted when striking an obstruction shall be located at a height not greater than 150 mm from the ground plane.

Compliance is checked by inspection and by measurement.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.1.3 *Replacement:*

Switches shall comply with IEC 61058-1:2008 under the load conditions experienced by the switch in the machine. The number of cycles of operation declared for 7.1.4 of IEC 61058-1:2008 shall be at least 10 000. Switches may be alternatively tested in the machine, with only functional performance required for acceptance at the conclusion of the test.

If the switch operates a relay, contactor or electronic power device, the complete switching system is subjected to the test.

For switches or switching systems that control motor loads for a drive, these may be tested in the machine with no additional mechanical load applied to the drive output.

NOTE The declared number of operating cycles is only applicable for switches required for compliance with this standard.

If the switch only operates a motor starting relay complying with IEC 60730-2-10 with the number of cycles of operation declared for 6.10 and 6.11 of IEC 60730-1:2007 of at least 10 000 cycles, the complete switching system need not be tested.

If the switch or switching system controls a motor load, it shall also be tested for breaking capability by the test of 24.1.3.101.

24.1.3.101 *The switch is subjected to 50 operation cycles of making and breaking the current that the switch would carry when the output mechanism is locked in the machine with a **fully charged battery**. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s.*

After this test, the switch shall have no electrical or mechanical failure. If the switch operates properly in the "on" and "off" states at the end of the test, it is considered to have no mechanical or electrical failure.

25 Supply connection and external flexible cords

This clause of Part 1 is not applicable, except for mains-powered **peripherals**. This clause of Part 1 is applicable for mains-powered **peripherals**, except as follows.

25.1 *Replacement:*

Mains-powered **peripherals** shall be provided with a **supply cord** or an appliance inlet.

Compliance is checked by inspection.

26 Terminals for external conductors

This clause of Part 1 is not applicable, except for the mains connections of mains-powered **peripherals**.

27 Provision for earthing

This clause of Part 1 is applicable.

28 Screws and connections

This clause of Part 1 is applicable.

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable except as follows.

29.1 This subclause is applicable for mains-powered **peripherals**.

29.2 This subclause is applicable for mains-powered **peripherals**, except as follows.

Modification:

Pollution degree 3 applies unless precautions have been taken to protect the insulation, in which case pollution degree 1 applies.

29.3 This subclause is applicable for mains-powered **peripherals**.

29.101 For the machine and non-mains-powered **peripherals**, **creepage distances** and **clearances** shall not be less than the values in millimetres shown in Table 102. The **clearances** specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the **clearances** vary with the movement of the contacts. **Creepage distances** and **clearances** also do not apply to the

construction of battery cells or the interconnections between cells in a battery pack. The values specified in Table 102 do not apply to cross-over points of motor windings.

The values in Table 102 are equal or larger than the values required by IEC 60664-1, when

– an overvoltage category I;
– a material group III;
– a pollution degree 3;
– inhomogeneous electric field

are applied.

Protection against deposition of dirt may be achieved through the use of

– encapsulation with a minimum thickness of 0,5 mm; or
– protective coatings that prevent the combined deposition of fine particles and moisture on surfaces between conductors. Requirements for these types of protective coatings are described in IEC 60664-3; or
– enclosures that prevent the ingress of dust by means of filters or seals, provided that no dust is generated within the enclosure itself.

NOTE 1 An example of encapsulation is potting.

For parts of different potential in **switched circuits** only, **clearance** and **creepage distances** less than those given in Table 102 are acceptable if the shorting of the two parts does not result in the machine starting.

NOTE 2 The risk of fire due to spacings below the required values is covered by the requirements of KK.19.4.

Table 102 – Minimum creepage distances and clearances between parts of different potential

Dimensions in millimetres

Conditions	Working voltage ≤ 15 V		Working voltage > 15 V and ≤ 32 V		Working voltage > 32 V and ≤ 130 V		Working voltage > 130 V and ≤ 280 V		Working voltage > 280 V and ≤ 480 V	
	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
Protected against deposition of dirt										
– **Switched circuits**	0,8	0,8	1,0	1,0	1,0	1,0	2,0	2,0	2,0	2,0
– **Non-switched circuits**	0,8	0,8	1,5	1,5	1,5	1,5	2,0	2,0	2,0	2,0
Not protected against deposition of dirt	1,1	0,8	1,5	1,5	2,5	1,5	4,0	2,5	8,0	3,0

For conductive patterns on printed circuit boards, except at their edges, providing functional insulation, the values given in Table 102 between parts of different potential may be reduced, as long as the peak value of the working voltage does not exceed:

– 150 V per mm with a minimum distance of 0,2 mm, if protected against the deposition of dirt;
– 100 V per mm with a minimum distance of 0,5 mm, if not protected against the deposition of dirt.

When the limits mentioned above lead to higher values than those of the Table 102, the values of Table 102 apply.

NOTE 3 The above values are equal or larger than the values required by IEC 60664-3.

For parts having a **hazardous voltage** between them, the sum total of the measured distances between each of these parts and their nearest accessible surface shall not be less than the values shown in Table 103.

NOTE 4 Figure 109 provides clarification on the measurement method.

Table 103 – Minimum total sum of creepage distances and clearances to accessible surfaces for hazardous voltages

Dimensions in millimetres

Hazardous voltage with a working voltage of					
≤ 130 V		> 130 V and ≤ 280 V		> 280 V and ≤ 480 V	
Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
5,0	1,5	8,0	3,0	16,0	4,0

Compliance is checked by measurement.

Distances through slots or openings in external parts of insulating material are measured to the metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test probe B of IEC 61032:1997, but is not pressed into openings.

The sum total of distances *measured between parts operating at* **working voltage** *that is a* **hazardous voltage** *and* **accessible surfaces** *is determined by measuring the distance from each part to the* **accessible surface**. *The distances are to be added together to determine the sum total. See Figure 109.*

In addition, one of the **creepage distances** *or* **clearances** *to the nearest* **accessible surface** *shall be at least 1 mm.*

If necessary, a force is applied to any point on bare conductors and to the outside of metal enclosures, in an endeavour to reduce the **creepage distances** *and* **clearances** *while taking the measurements.*

The force is applied by means of the test probe B of IEC 61032:1997 and has a value of:

– 2 N for bare conductors;
– 30 N for enclosures.

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2 *Addition:*

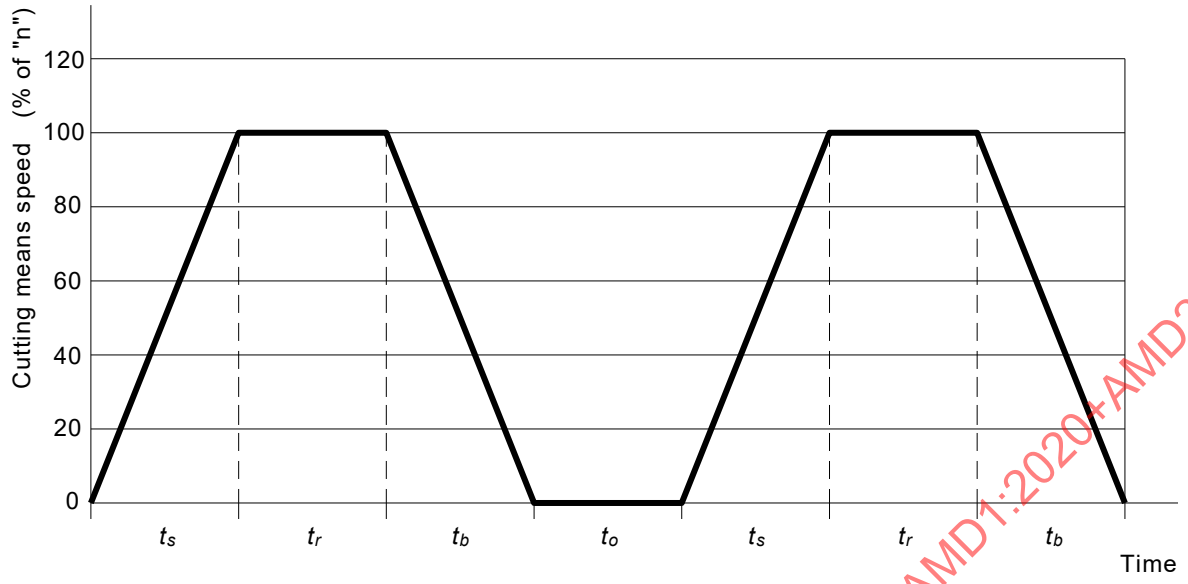
Machines and **peripherals** are considered to be unattended appliances.

31 Resistance to rusting

This clause of Part 1 is applicable.

32 Radiation, toxicity and similar hazards

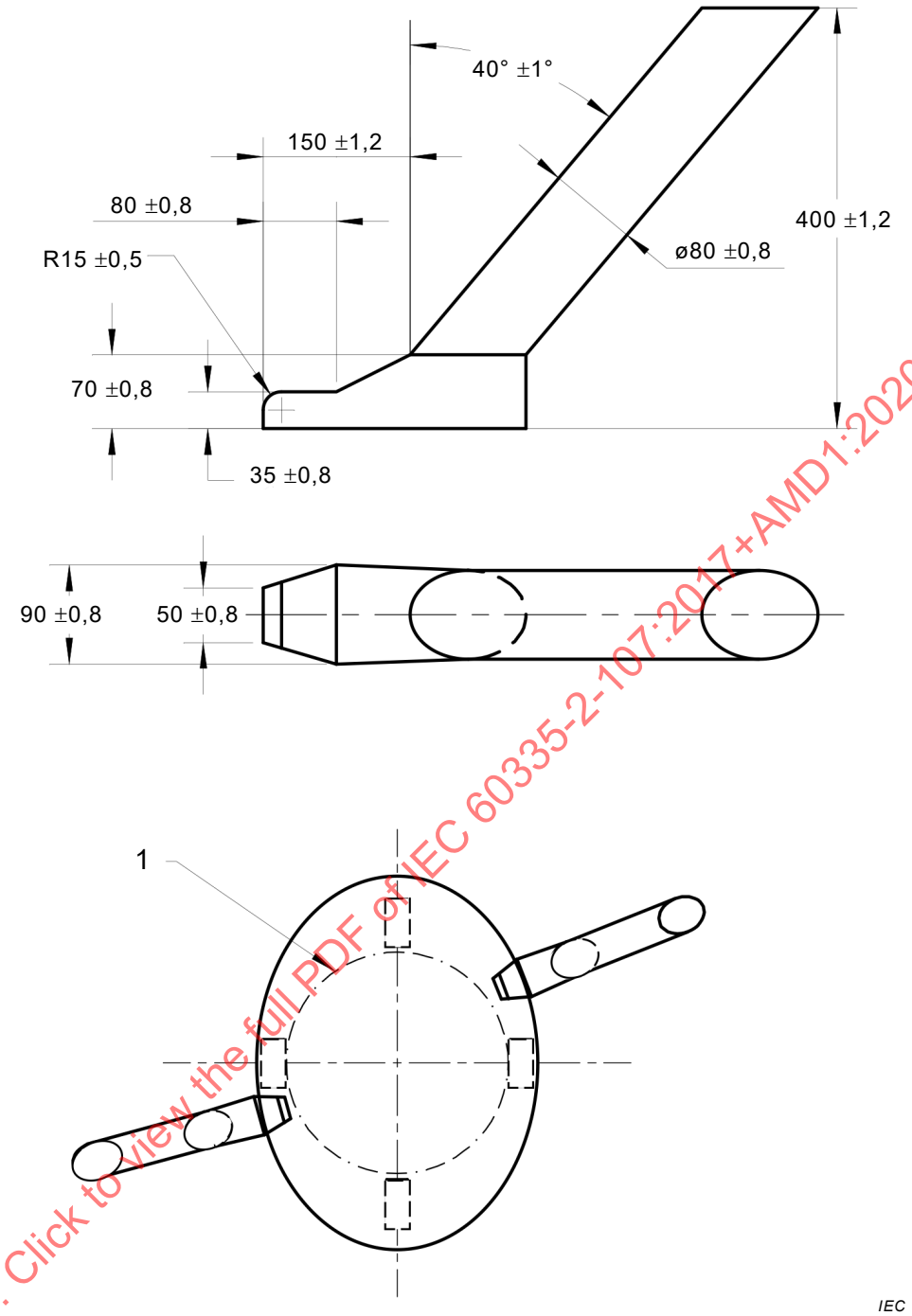
This clause of Part 1 is not applicable.



NOTE "n" = **cutting means** speed at **maximum operating motor speed**.

Figure 101 – Example of test cycles (see 20.102.2.2)

Dimensions in millimetres

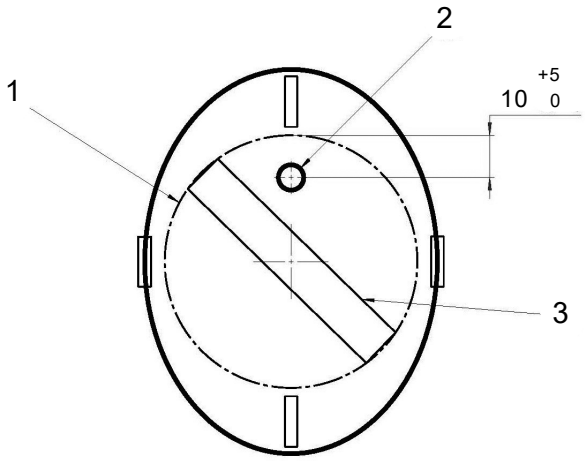


Key

1 cutting means tip circle

Figure 102 – Foot probe test (see 20.102.4.1.2 and 20.102.4.1.3)

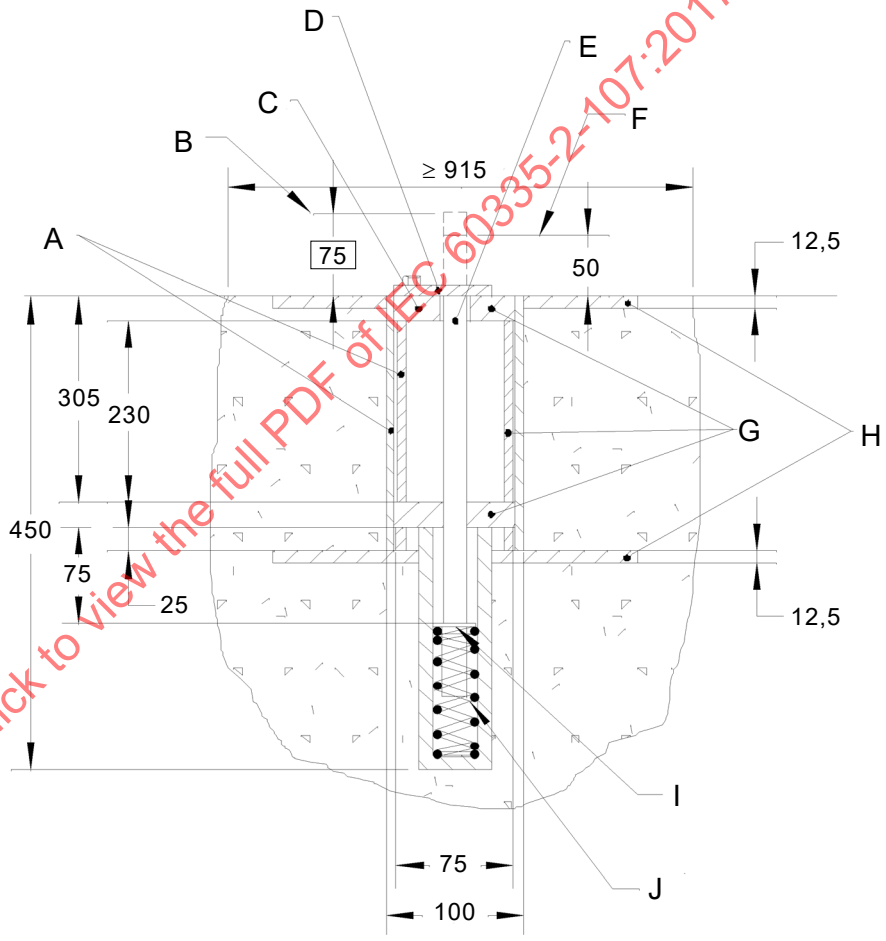
Dimensions in millimetres
(all dimensions are nominal unless otherwise stated)



Schematic view from above

Key

1	**cutting means tip circle**
2	steel rod (see a) below)
3	**cutting means**
A	standard pipe
B	release position of tube
C	end fittings (see b) below)
D	remote control actuating lever (metal plate)
E	steel rod see a) below)
F	cutting means height
G	removable cylinder assembly
H	steel plates x 2
I	pin or washer fixed to tube
J	compression spring (see c) below for details)



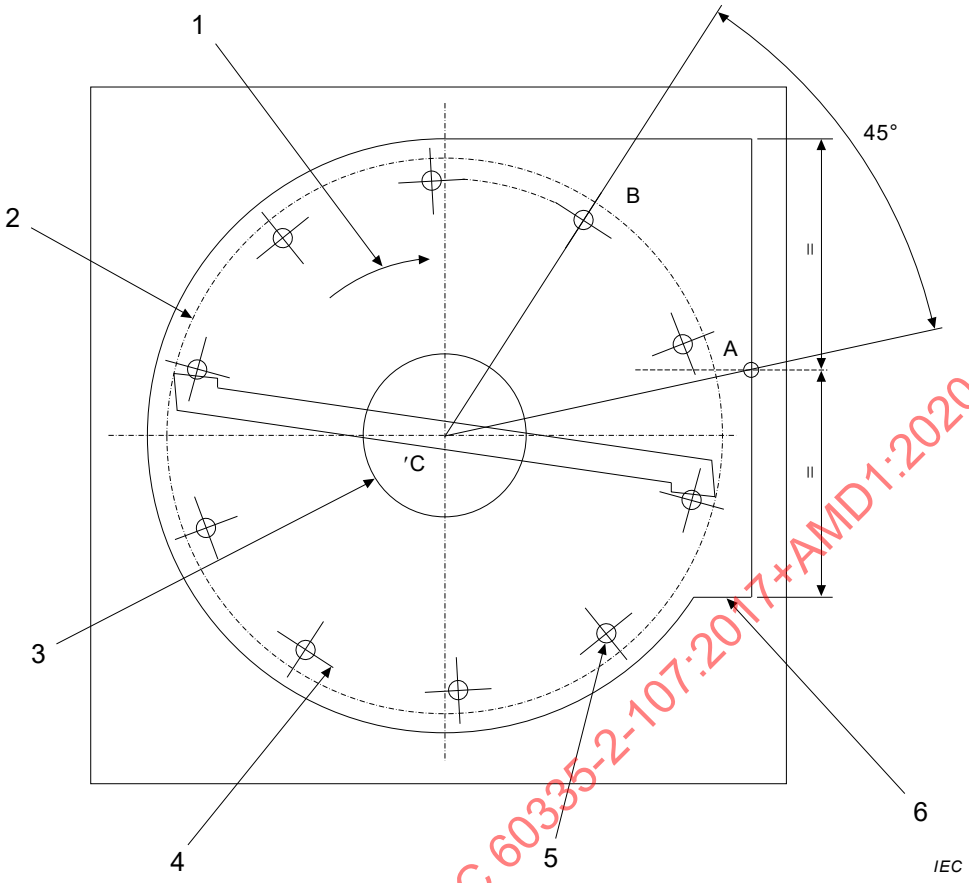
a) Steel rod 25 mm ± 0,5 mm diameter of grade 1 according to ISO 683-4:2014.

b) End fittings inside nominal 100 mm diameter standard pipe (1,5 to 3 clearance) with central hole 33 mm diameter. Identical parts both ends 25 mm thick – hardness = 350 HB.

c) Compression spring dimensions: free length = 165 mm; wire diameter = 3,2 mm; total number of coils = 11,75; mean diameter = 36 mm; spring rate = 2,27 N/mm; ends to be ground and squared.

Figure 103 – Impact test fixture (see 21.101.2)

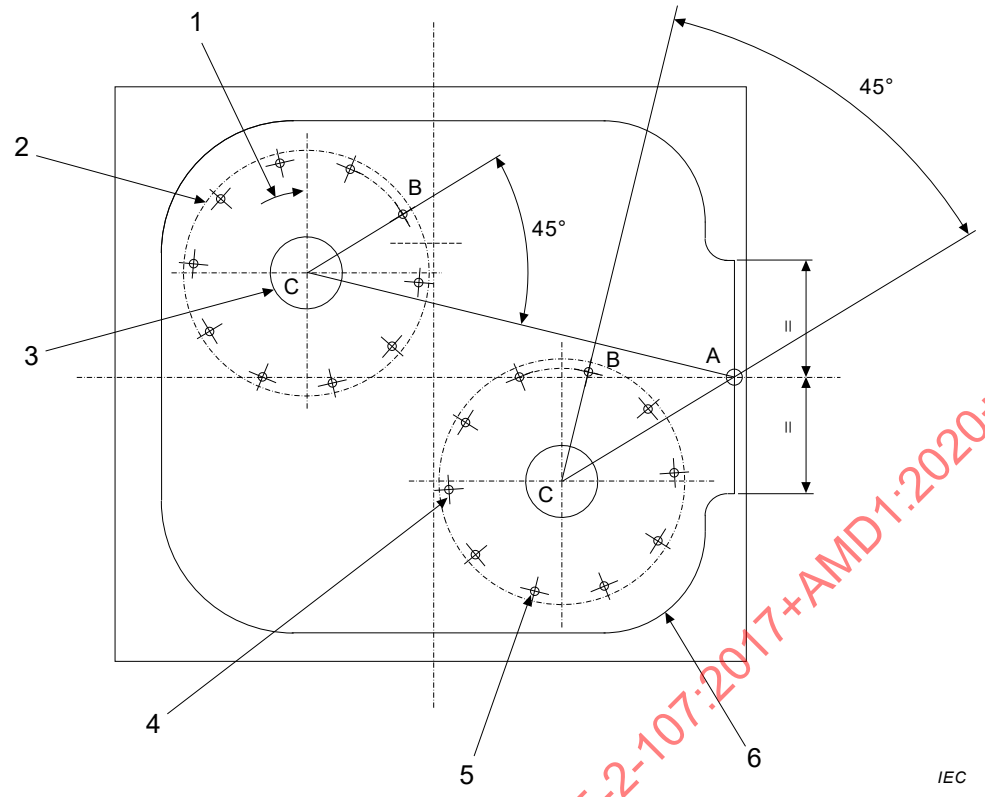
Linear dimensions in millimetres



Key

1 direction of rotation
2 **cutting means tip circle**
3 air inlet hole
4 injection hole centreline
5 10 x ∅ 15 mm injection points equally spaced
6 **cutting means enclosure**
A centre of the **discharge chute** exit
B injection point(s)
C centre of the **cutting means tip circle**

Figure 104a – Single cutting means

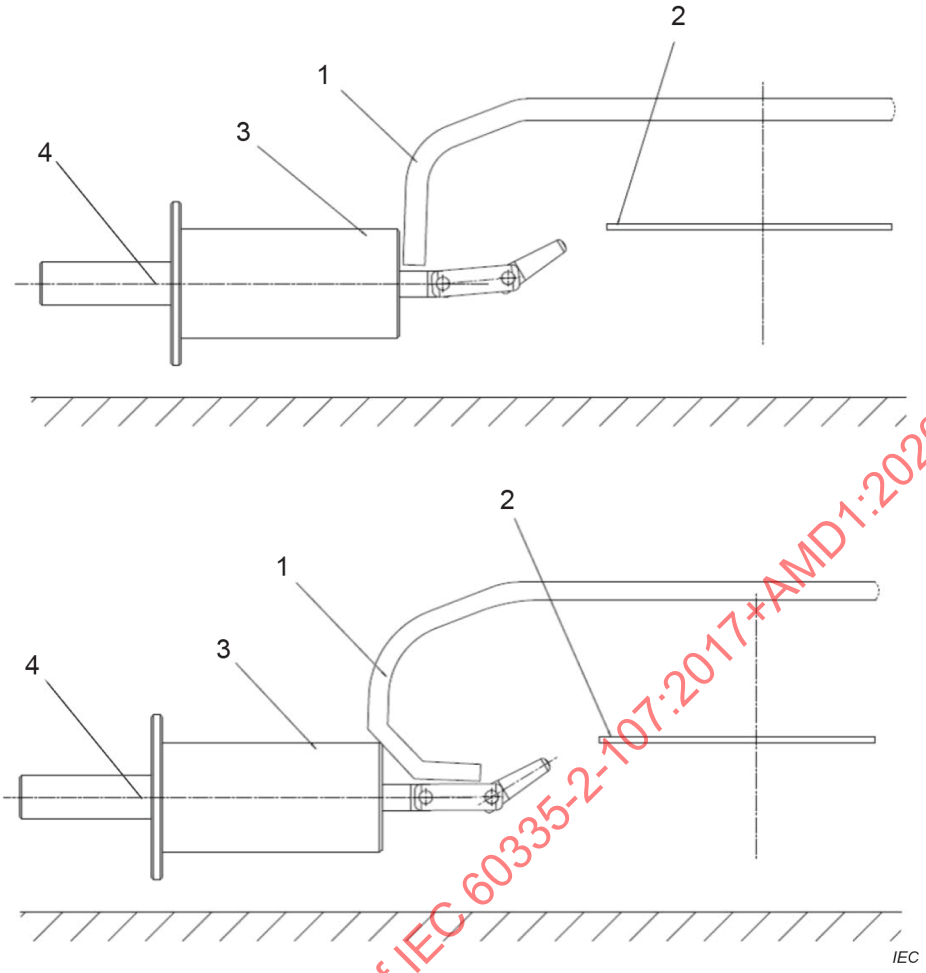


Key

1 direction of rotation
2 **cutting means tip circle**
3 air inlet hole
4 injection hole centreline
5 10 × ∅ 15 mm injection points equally spaced on each spindle
6 **cutting means enclosure**
A centre of the **discharge chute** exit
B injection point(s)
C centre of the **cutting means tip circle**

Figure 104b – Twin cutting means

Figure 104 – Example of structural integrity test fixtures (see 21.101.4.2.1)



Key

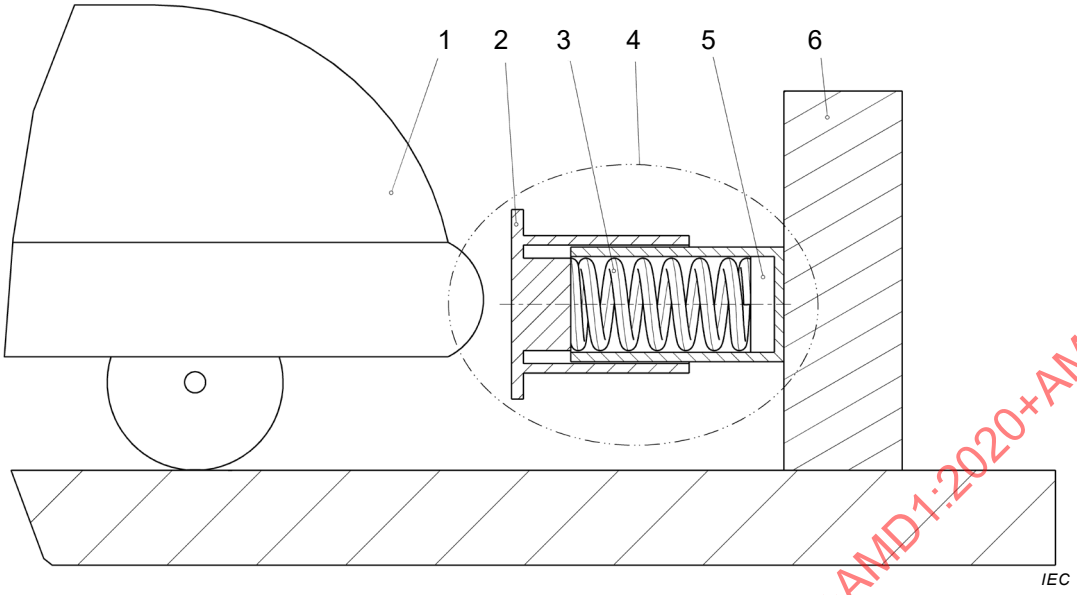
1 machine external enclosure

2 **cutting means**

3 mechanical test probe

4 axis of the test probe held horizontally

Figure 105 – Finger probe test – Illustrations showing application of probe, insertion depth limited according to the geometry of the enclosure



Key

1 machine
2 impact plate
3 spring
4 force measuring means
5 sensing element
6 rigid support

Figure 106 – Obstruction sensor test – Illustration showing typical arrangement (see 22.105.2)

Linear dimensions in millimetres

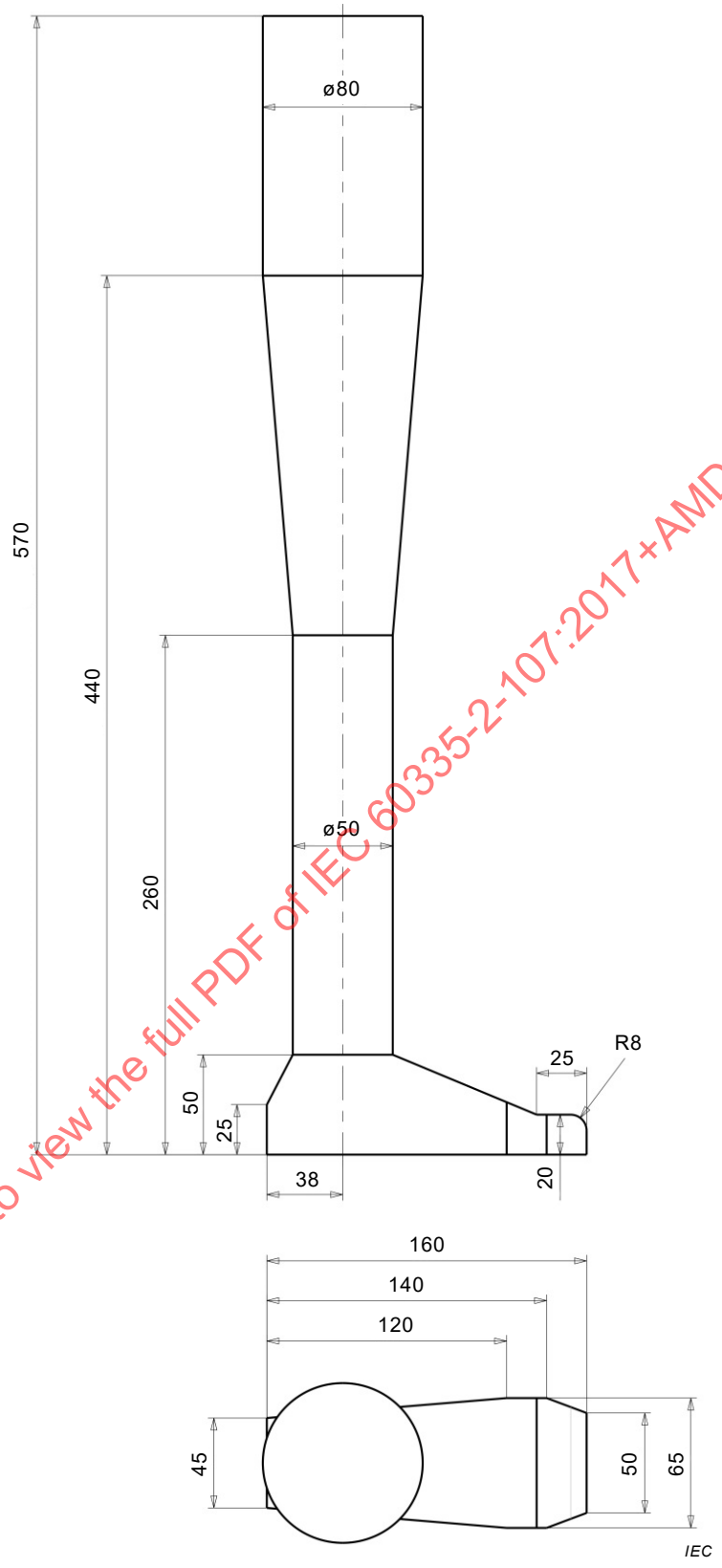
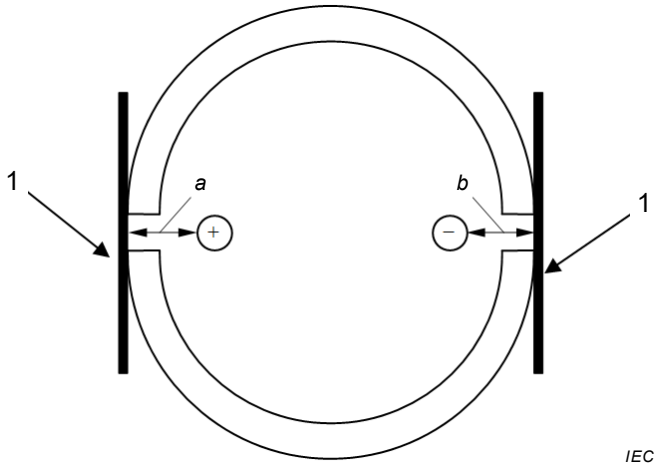


Figure 107 – Foot probe for standing child



Key

1 metal foil

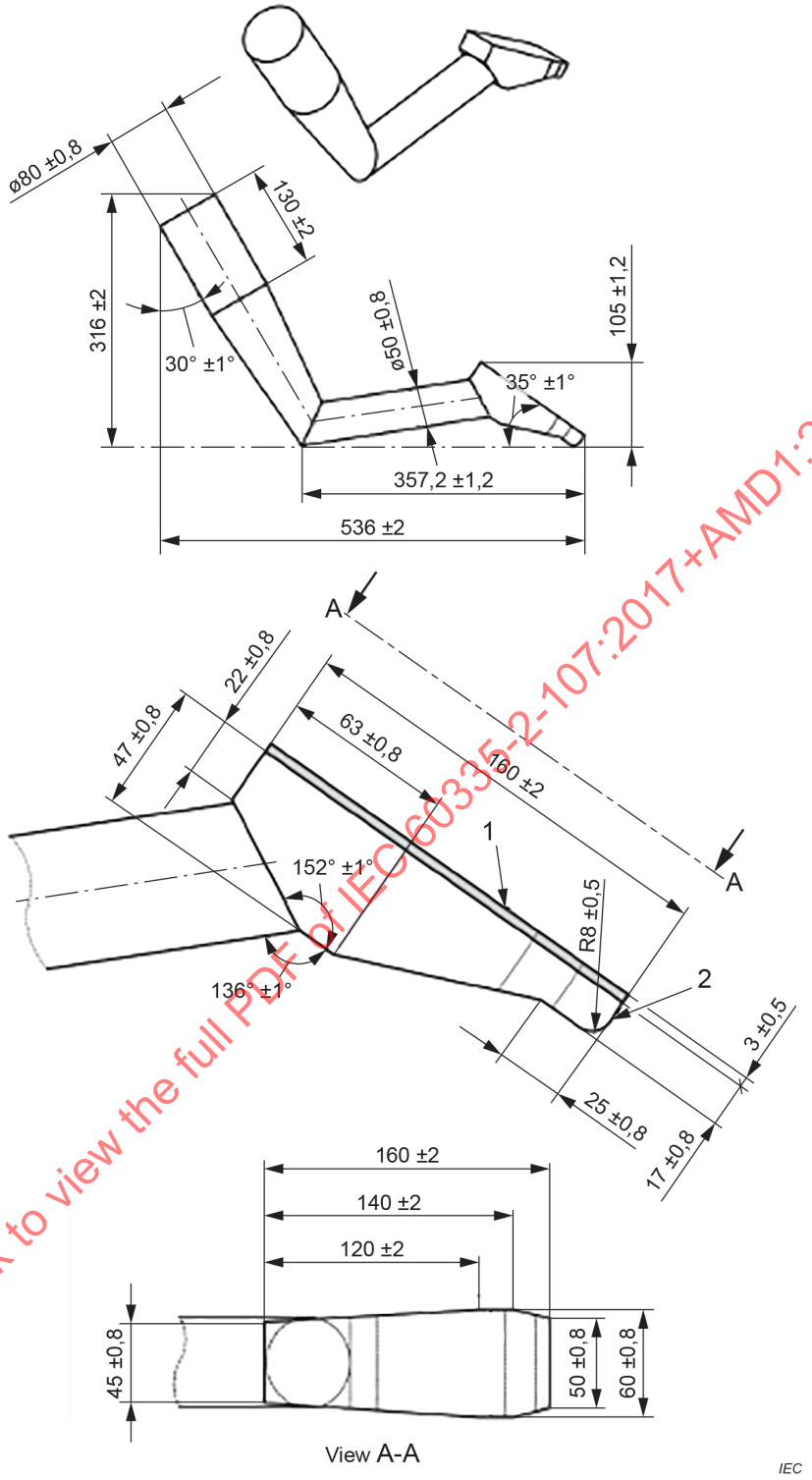
Dimension *a* = distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension *b* = distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

a + *b* is the sum total as defined in 29.101.

Figure 108 – Measurement of clearances

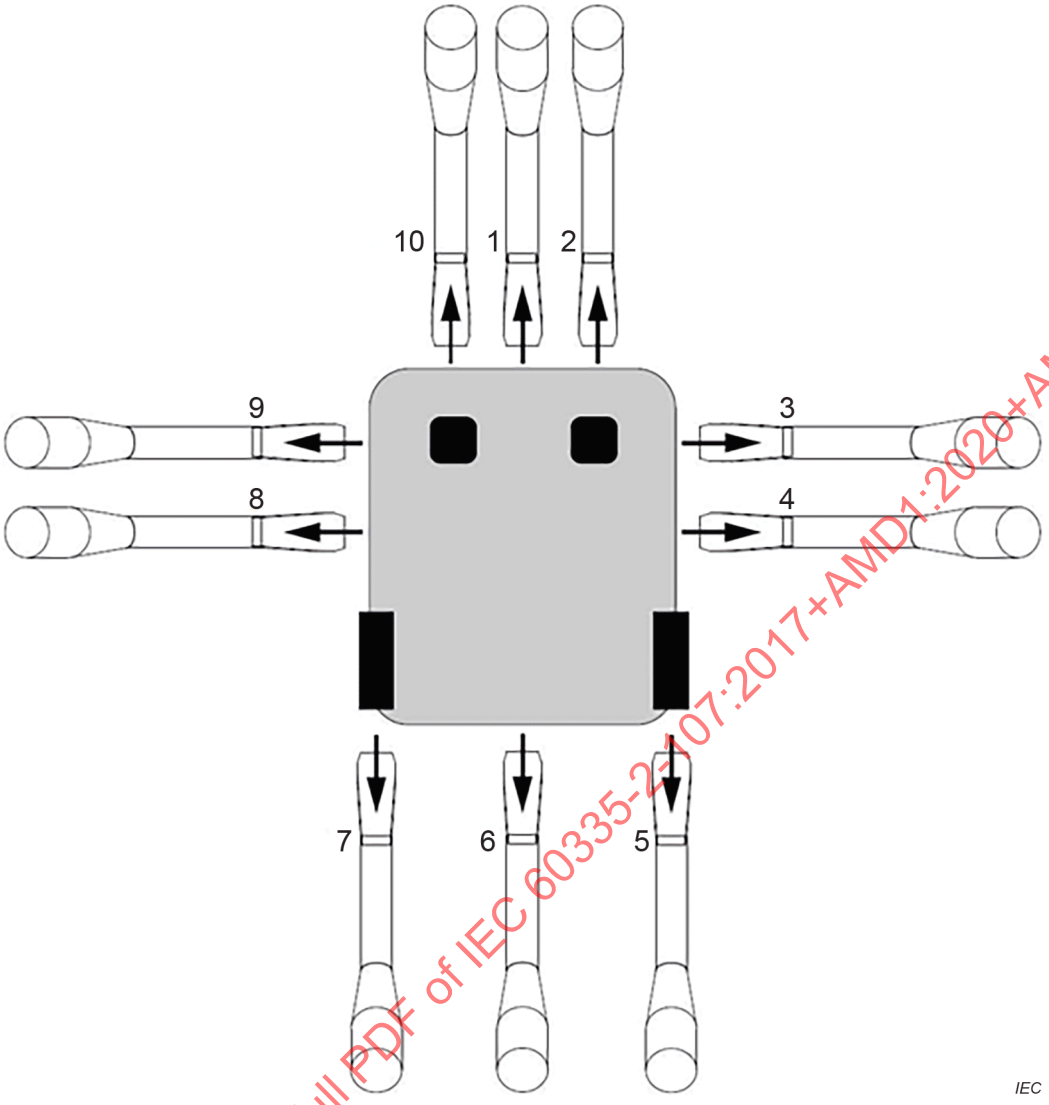
Dimensions in millimetres



Key

1 sole
2 toe

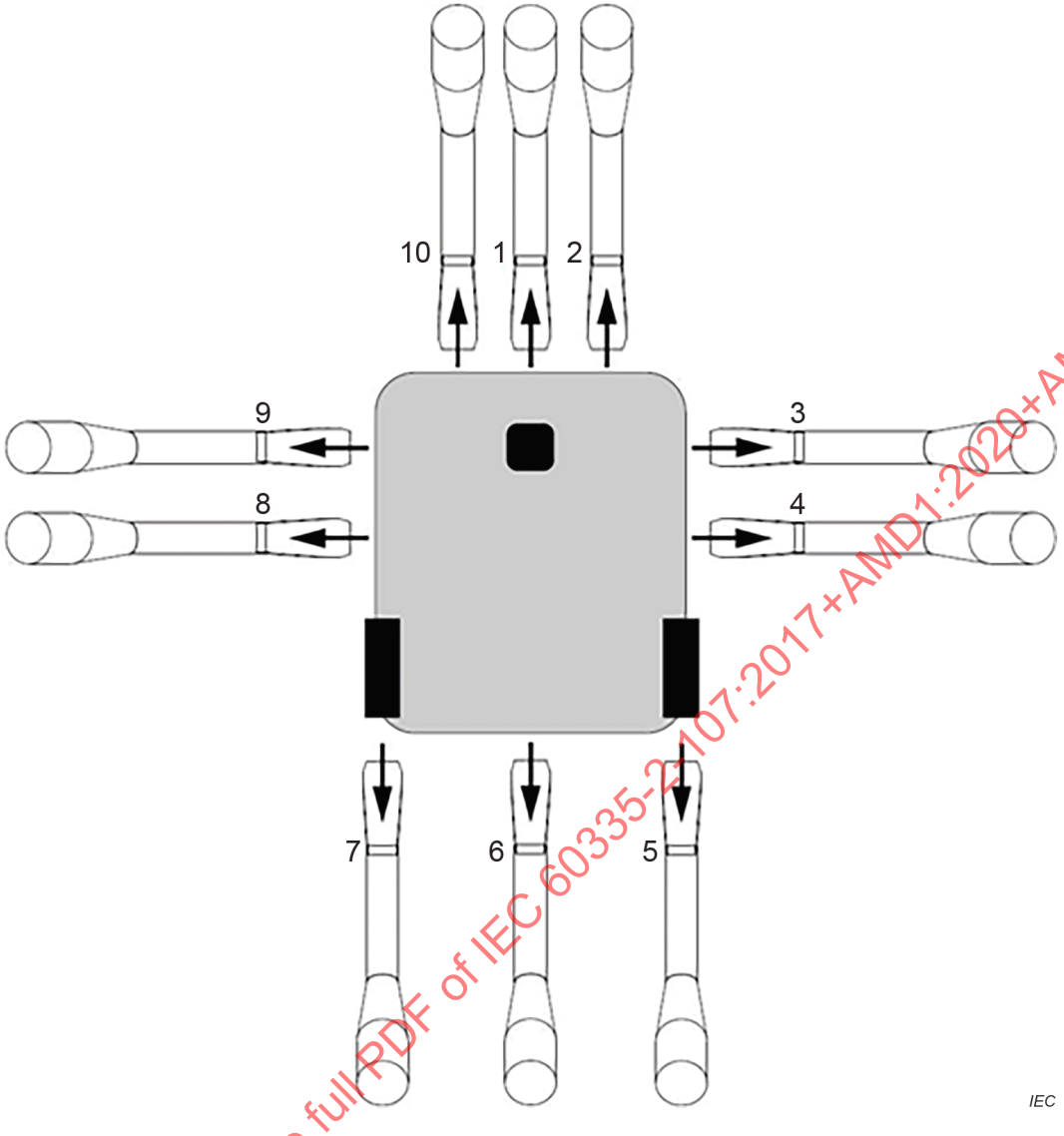
Figure 109 – Foot probe for kneeling child



Key

1 test position between undriven supports
2 test position aligned with undriven support
3 test position aligned with undriven support
4 test position between traction drive wheel and undriven support
5 test position aligned with traction drive wheel
6 test position between traction drive wheels
7 test position aligned with traction drive wheel
8 test position between traction drive wheel and undriven support
9 test position aligned with undriven support
10 test position aligned with undriven support

a) Example of foot probe for kneeling child test positions (two undriven supports)



Key

1 test position aligned with undriven support
2 test position aligned to the side of undriven support
3 test position aligned with undriven support
4 test position between traction drive wheel and undriven support
5 test position aligned with traction drive wheel
6 test position between traction drive wheels
7 test position aligned with traction drive wheel
8 test position between traction drive wheel and undriven support
9 test position aligned with undriven support
10 test position aligned to the side of undriven support

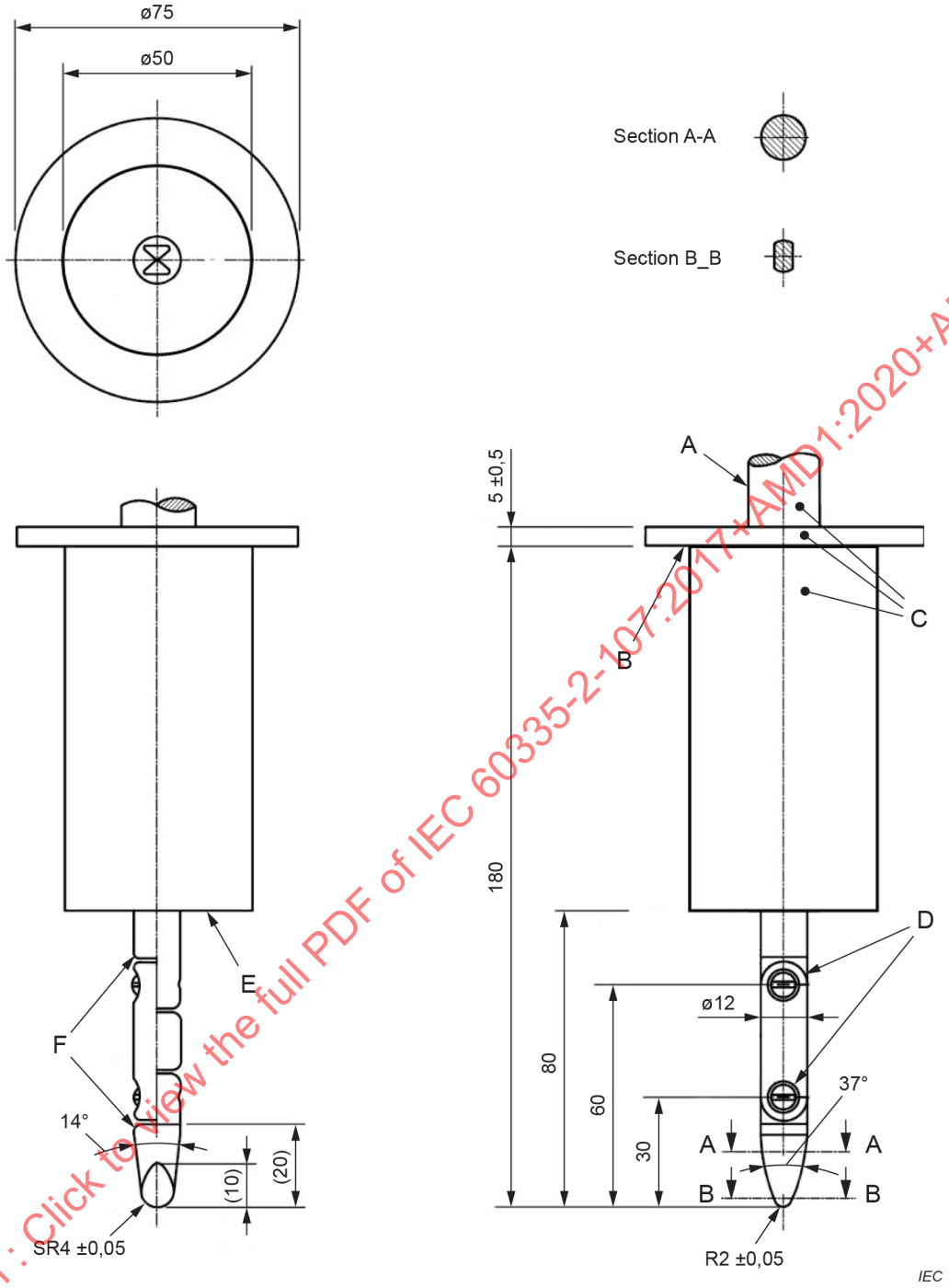
b) Example of foot probe for kneeling child test positions (one front support)

NOTE 1 The arrows in the above examples represent the direction of machine movement.

NOTE 2 The above examples can be used as a guide for other machine configurations.

Figure 110 – Foot probe for kneeling child test positions

Linear dimensions in millimetres



Key

A handle
B guard
C insulating material
D joints
E stop face
F chamfer all edges

Material: Metal, except where otherwise specified

Both joints shall permit movement in the same plane and the same direction through an angle of 90° with a 0° to +10° tolerance.

Tolerances except where otherwise specified: