IEC 60900

Edition 4.0 2018-06
REDLINE VERSION

INTERNATIONAL STANDARD

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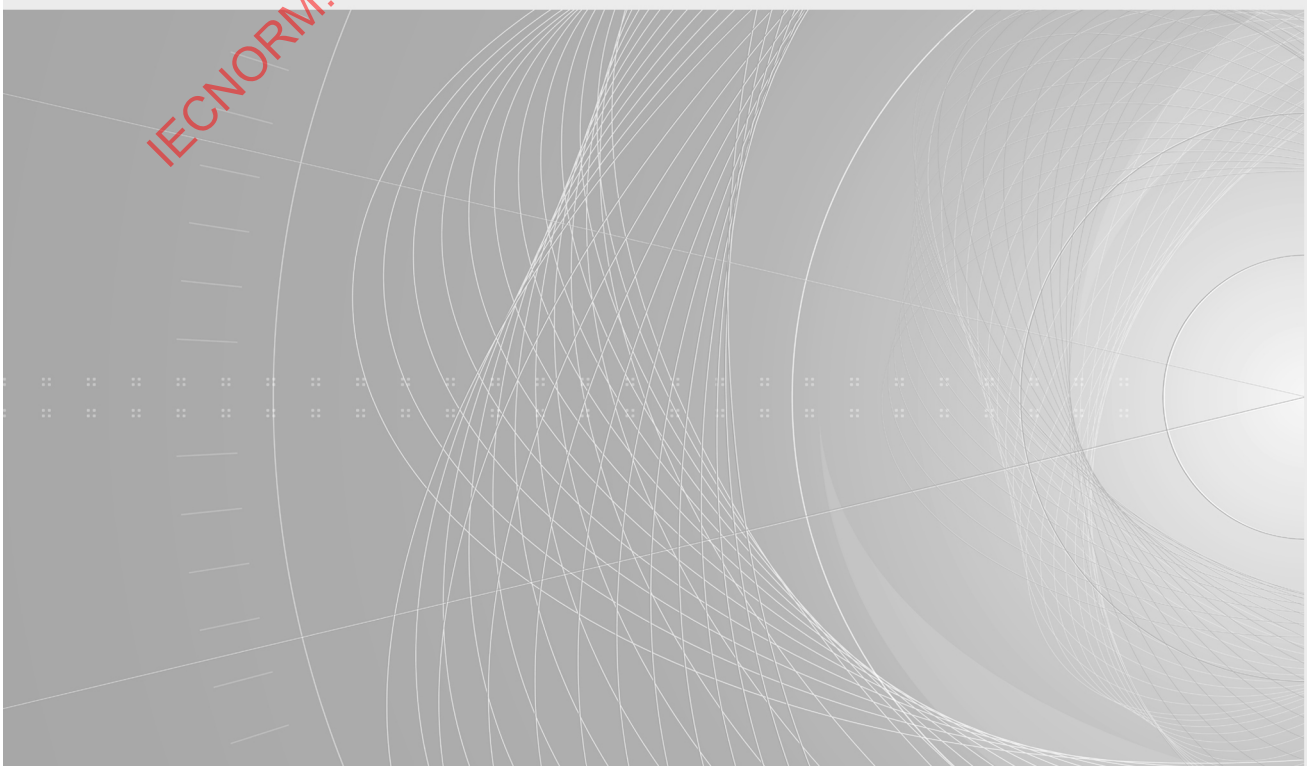
Live working –
Hand tools for use up to 1 000 V AC and 1 500 V DC



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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LIVE WORKING – HAND TOOLS FOR USE UP TO 1 000 V AC AND 1 500 V DC

FOREWORD

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International Standard IEC 60900 has been prepared by IEC technical committee 78: Live working.

This fourth edition cancels and replaces the third edition, published in 2012. This edition constitutes a technical revision.

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

a) addition of a third category of tools has been added, namely *hybrid hand tools*;
b) introduction of a new informative Annex A on examples of *insulated*, *insulating* and *hybrid hand tools*.

The text of this standard is based on the following documents:

FDIS	Report on voting
78/1221/FDIS	78/1229/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

Terms defined in Clause 3 are given in *italic* print throughout this document.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

The contents of the corrigenda of January 2019 and May 2020 have been included in this copy.

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

This document has been prepared in accordance with the requirements of IEC 61477 where applicable.

The products covered by this document may have an impact on the environment during some or all stages of its life cycle. These impacts can range from slight to significant, be of short-term or long-term duration, and occur at the global, regional or local level.

This document does not include requirements and test provisions for the manufacturers of the products, or recommendations to the users of the products for environmental improvement. However, all parties intervening in ~~its~~ their design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

LIVE WORKING – HAND TOOLS FOR USE UP TO 1 000 V AC AND 1 500 V DC

1 Scope

This document is applicable to *insulated*, *insulating* and *hybrid hand tools* used for working live or close to live parts at nominal voltages up to 1 000 V AC and 1 500 V DC.

The products designed and manufactured according to this document contribute to the safety of the users provided they are used by skilled persons, in accordance with safe methods of work and the instructions for use (where appropriate).

2 Normative references

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

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60417, *Graphical symbols for use on equipment* (available at: http://www.graphical-symbols.info/equipment)

IEC 61318, *Live working – Conformity assessment applicable to tools, devices and equipment*

IEC 61477, Live working – *Minimum requirements for the utilization of tools, devices and equipment*

ISO 1174-1, *Assembly tools for screw and nuts – Driving squares – Part 1: Driving squares for hand socket tools*

ISO 9654, *Pliers and nippers for electronics – Single-purpose nippers – Cutting nippers*

ISO 9655, *Pliers and nippers for electronics – Single-purpose pliers – Pliers for gripping and manipulating*

ISO 9656, *Pliers and nippers for electronics – Test methods*

ISO 9657, *Pliers and nippers for electronics – General technical requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61318 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE ~~For the definitions of general terms in this document, reference should be made to the IEC 60050 series or to special definitions laid down in IEC 60743. Nomenclature of hand tools are found in the relevant ISO standards such as ISO 1703, ISO 5742 and ISO 8979.~~ The definitions of general terms used in this document are given in IEC 60050 or in special definitions given in IEC 60743.

3.1
hand tool ~~(for live working)~~
hand held ~~insulated or insulating~~ tool

Note 1 to entry: *Hand tools* may be *insulated hand tools*, *insulating hand tools* or *hybrid hand tools* (see Annex A).

Note 2 to entry: *Hand tools* are normally tools such as screwdrivers, pliers, ~~wrenches~~ spanners or knives.

Note 3 to entry: *Hand tools* are designed to provide protection to the worker against electric shock.

[SOURCE: IEC 60050-651:~~1999~~ 2014, ~~651-01-27, modified – The scope of the definition has been enlarged~~ 651-21-19, modified – Note 1 to entry has been modified to refer to Annex A.]

3.1.1
hybrid hand tool
hand tool made from insulating material(s) with exposed conductive parts at the *working head*

Note 1 to entry: *Hybrid hand tools* may have some non-exposed conductive parts used for reinforcement.

[SOURCE: IEC 60050-651:2014, 651-21-22]

3.1.2
insulated hand tool
hand tool made of conductive material(s), fully or partially covered by insulating material(s)

[SOURCE: IEC 60050-651:~~1999~~ 2014, ~~651-01-25, modified – The definition has been changed to refer specifically to hand tools~~ 651-21-20.]

3.1.3
insulating hand tool
hand tool made totally or essentially from insulating material(s) except for inserts made from conductive material(s) used for reinforcement, but with no exposed conductive parts

[SOURCE: IEC 60050-651:~~1999~~ 2014, ~~651-01-26, modified - The definition has been changed to refer specifically to hand tools and its scope has been narrowed~~ 651-21-21.]

3.2
working head
part of the tool head that is limited to the working surface and the contact area

Note 1 to entry: See Figures 5 and 7.

4 Requirements

4.1 General requirements

4.1.1 Safety

Insulated, insulating and *hybrid hand tools* shall be manufactured and dimensioned in such a way that they protect the user from electric shock.

NOTE 1 *Insulating hand tools* minimize the risk of short-circuits between two parts at different potentials.

NOTE 2 *Hybrid hand tools* reduce the risk of short-circuits between two parts at different potentials.

NOTE 3 *Insulated hand tools*, completely covered by insulating materials and insulating tools minimize the risk of short circuits between two parts at different potentials when they are used in the correct manner, except the conductive part of the working surface, reduce the risk of short-circuits between two parts at different potentials.

The following requirements have been prepared in order that the *hand tools* covered by this document are designed and manufactured to contribute to the safety of the users, provided they are used by persons skilled for live working, in accordance with safe methods of work and the instructions for use (where appropriate).

4.1.2 Performance under load

The mechanical specifications for *insulated hand tools* shall comply with the corresponding ISO standards, or, where no ISO standard exists, with a standard specified by the manufacturer or the customer (for example a national standard). The mechanical specifications for the working parts of the *hand tools* shall be retained even after application of an insulating layer.

Insulating and *hybrid hand tools* specially designed for live working may have lower stress resistance than *insulated hand tools*, but they shall withstand the expected workloads without failing due to remaining deformation or breaking. These *hand tools* can be equipped with devices that limit the workloads that can be applied with them, for example by overload slipping clutches (see also Annex B).

4.1.3 Multiple-ended hand tools

Multiple-ended *hand tools*, such as box wrenches spanner, keys for hexagonal socket screws, double-ended socket-wrenches spanner, double-head open-end wrenches spanner, etc., are not allowed for *insulated hand tools* but are allowed for *insulating* or *hybrid hand tools* if the design assures that there is no conductive connection between two of the *working heads*.

4.1.4 Marking

The marking shall be clearly identifiable by persons with normal or corrected sight without further magnification.

Each *hand tool* and/or tool component shall be legibly and permanently marked with the following items of marking:

- on the insulating material or on the metal part:
  - marking of the origin (manufacturer's name or trade mark);
- on the insulating material:
  - model/type reference;
  - year of manufacture (at least the last two digits of the year);
  - symbol IEC 60417-5216:2002-10 – Suitable for live working; double triangle (see Annex C);

    NOTE For the symbol, the exact ratio of the height of the figure to the base of the triangle is 1,43:1. For the purpose of convenience, this ratio can be between the values of 1,4 and 1,5.
  - indication 1 000 V (i.e. the electrical working limit for alternating current), immediately adjacent to the double triangle symbol (see Figure 1 for an example);

Figure 1 – Marking of the electrical working limit adjacent to the double triangle symbol (IEC 60417-5216:2002-10)

- number of the relevant IEC standard immediately adjacent to the double triangle symbol (IEC 60900);
- for *hand tools* designed for use at extremely low temperature: letter "C" (see 4.2.2);
- additional marking for *hand tools* capable of being assembled and designed to be interchangeable between different manufacturers (see 4.4.1.3.2);
- additional marking where specified by the customer (for example ownership mark).

The *hand tools* shall bear no voltage marking apart from those described above.

NOTE For example, the indication of test voltage may lead to the assumption that the *hand tool* is suitable for work at that voltage.

Other characteristics or information not needed at the work location, like the year of publication of the standard and the type of *hand tool*, shall be associated to the product item by other means, such as coded information (bar codes, microchips, etc.), or shall be associated to its packaging.

The double triangle symbol shall be at least 3 mm high; the letter and the figures of the electrical working limit shall be at least 2 mm high (see Figure 1).

4.1.5 Separating of covers

If *hand tools* have conductive elements (for example: torque adjusting screws, operating direction switches, etc.) which are insulated with covers of insulating materials, these covers shall be ~~well~~ securely fastened, so that they do not ~~come off~~ become separated during normal use (see 5.9.1).

4.1.6 Instructions for correct adjustment and assembly

Where the manufacturer deems that instructions are necessary for correct adjustment or assembly, then the manufacturer shall provide these in accordance with the general provisions given in IEC 61477 (see also Annex D).

4.2 Requirements concerning insulating materials

4.2.1 General

The insulating material shall be selected according to the electrical, mechanical and thermal stresses to which it may be exposed during use. In addition, the insulating material shall have an adequate resistance to ageing and be flame retardant.

The insulating coating may consist of one or more layers. If two or more layers are adopted, contrasting colours may be used.

The design and construction of the handles shall provide a secure handhold and prevent unintentional hand slipping. The handle and guard dimensions given in different figures are applicable to all types of *hand tools* in order to define the handling zone.

4.2.2 Thermal stability

The service ability of the *hand tools* shall not be impaired within the temperature range –20 °C to +70 °C.

The insulating material applied on *hand tools* shall adhere securely to the conductive part from –20 °C to +70 °C.

Hand tools intended for use at extremely low temperatures (down to –40 °C) shall be designated “Category °C” and shall be designed for this purpose.

4.3 Requirement concerning exposed conductive parts of hybrid tools

Exposed conductive parts shall be securely fastened, so that they do not become separated during normal use (see 5.8).

4.4 Additional requirements

4.4.1 Hand tools capable of being assembled

4.4.1.1 Retaining devices for hand tools capable of being assembled

Hand tools capable of being assembled shall have suitable retaining devices to prevent unintentional separation of the assembly. The retaining forces shall be tested according to 5.9.5.

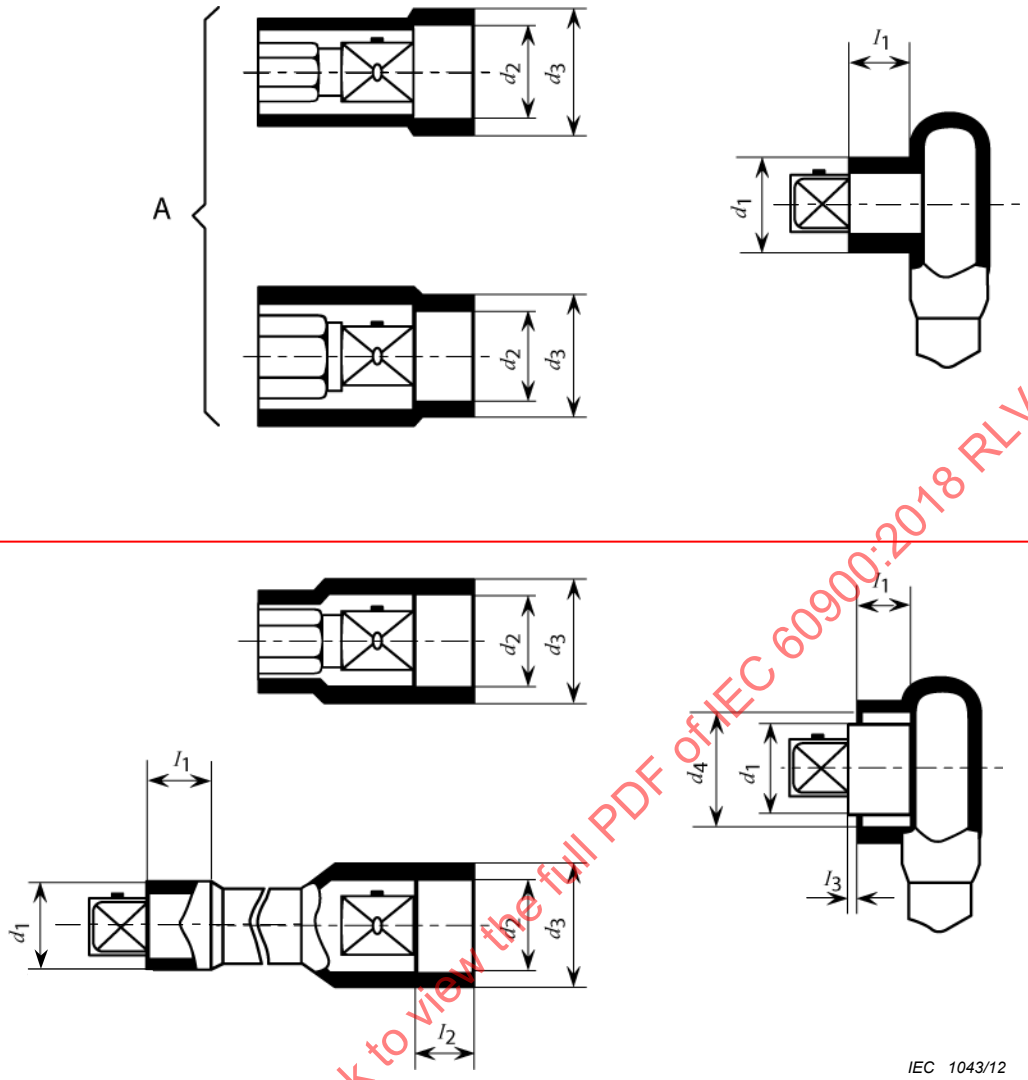
4.4.1.2 Insulation design for hand tools capable of being assembled

In the case of connecting parts of *hand tools* capable of being assembled, the insulation shall be applied in such a manner that if any part becomes detached during use by exceeding the retaining forces according to 5.9.5, no conductive part, which may still be live, can be inadvertently touched or cause a disruptive discharge.

4.4.1.3 Hand tools capable of being assembled with square drives

4.4.1.3.1 General

Hand tools capable of being assembled with square drives shall have square drives and square sockets in accordance with ISO 1174-1 (for separating forces, see 5.9.5.2). To ensure compatibility of insulation between different manufacturers, these *hand tools* shall be designed with overlapping elements described in Figure 2. Their dimensions and tolerances shall be in accordance with Table 1.



IEC 1043/12

~~**Key**~~

A ~~admitted shapes~~

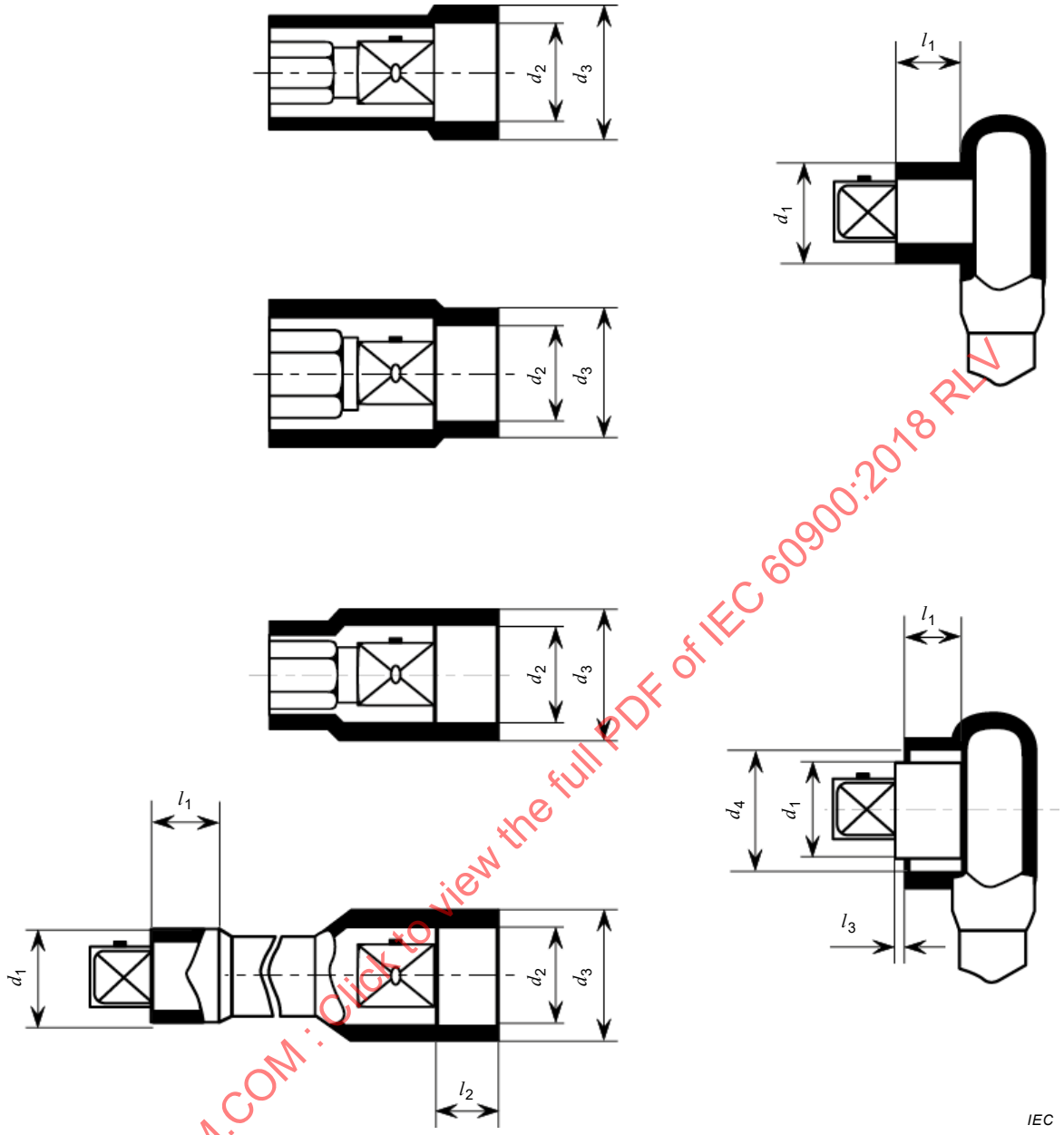


Figure 2 – Description of the insulating overlapping element and different assembly configurations for hand tools capable of being assembled with square drives

Table 1 – Dimensions and tolerances of the insulating overlapping element

Dimensions in millimetres

Nominal size of the square drive	l_1 min.	l_2 $^{+2}_{0}$	l_3 $^{+0,5}_{-0,5}$	d_1 $^{0}_{-1,5}$	d_2 $^{+1,5}_{0}$	d_3 $^{0}_{-1,5}$	d_4 $^{+1,5}_{0}$
6,3	19	16	2	12,5	13	18	19
10	19	16	2	17,5	18	23	24
12,5	19	16	2	21,5	22	27	28
20	19	16	2	32	33	38	39
l_1, l_2, l_3, d_1, d_2, d_3 and d_4 are described in Figure 2.							

4.4.1.3.2 Interchangeability of components made by different manufacturers

Hand tools capable of being assembled and designed to be interchangeable between different manufacturers shall be specifically marked as such.

The marking symbol and the dimensions are given in Figure 3. The dimension H shall be greater than or equal to 5 mm.

Dimensions in millimetres

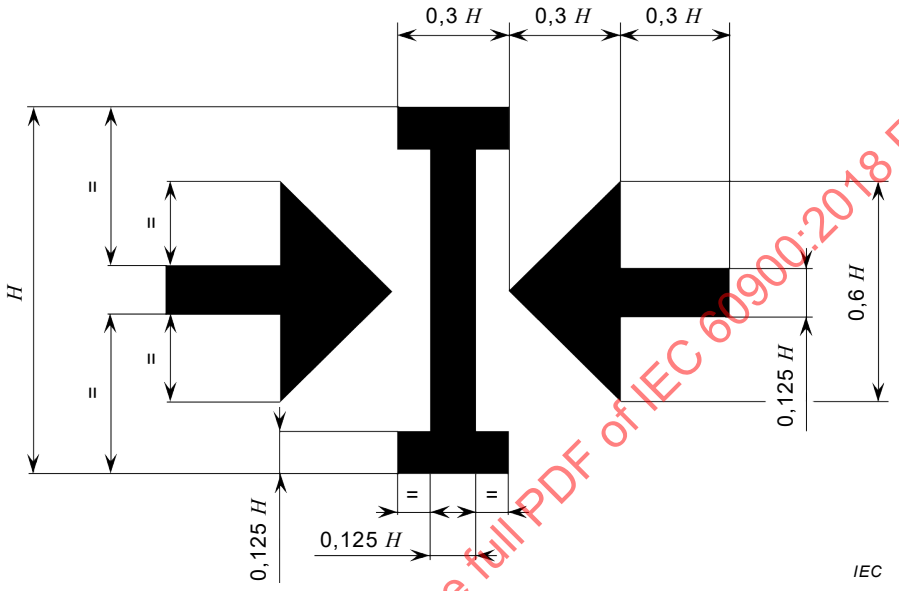


Figure 3 – Marking symbol for hand tools capable of being assembled and designed to be interchangeable between different manufacturers (IEC 60417-6168:2012-07)

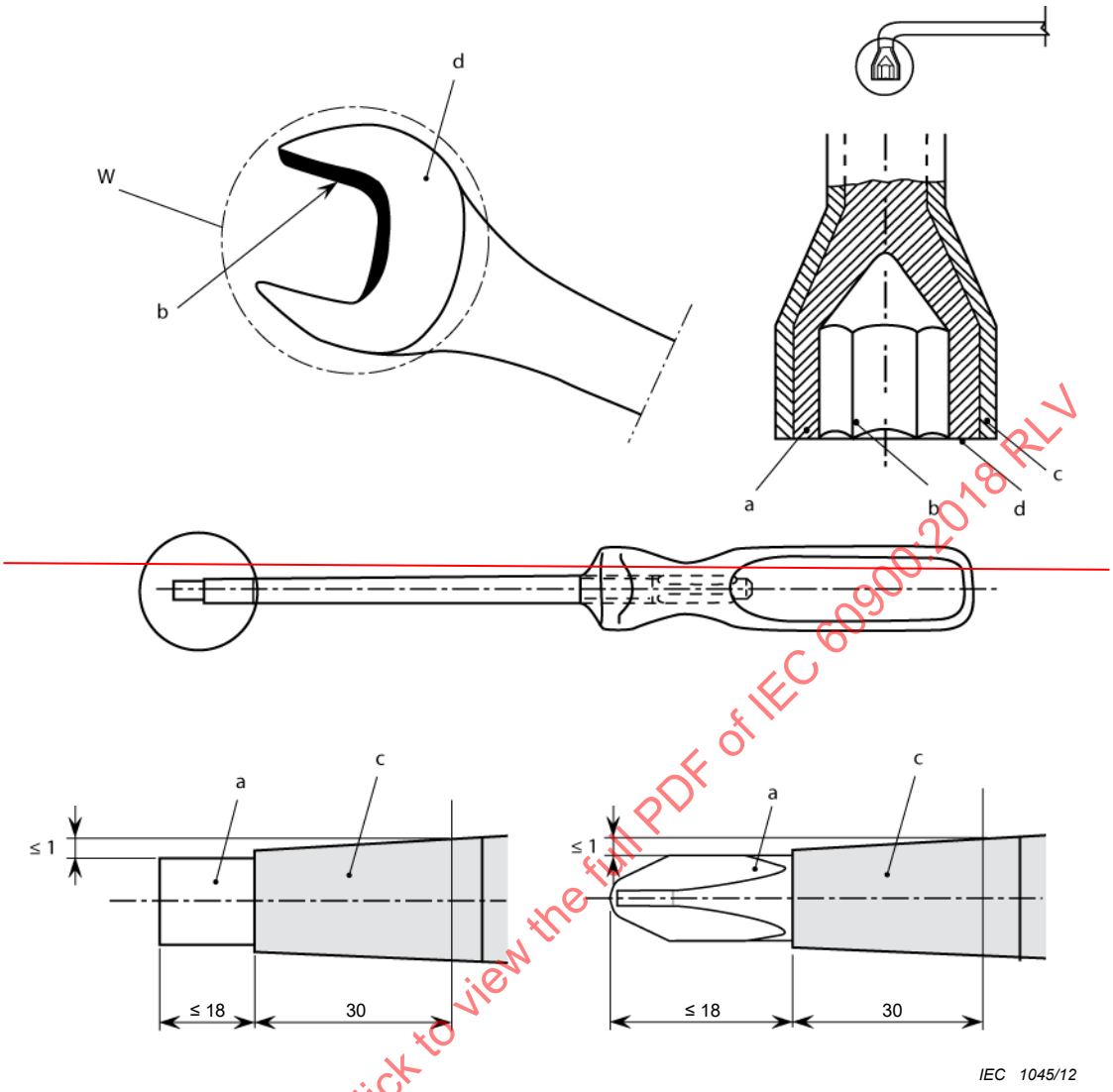
The reliable function of locking systems used for these *hand tools* shall be tested by applying a separation test in accordance with 5.9.5 with a corresponding dummy.

For this kind of *hand tools*, instructions for correct assembly are mandatory. The manufacturer shall include the following information: “To assure that the complete assembly of *insulated hand tool* components from different manufacturers will withstand separating forces that are expected during the intended use, prior to the use of any assembly the user shall assure, by pulling by hand in a separating direction, that the retaining devices of all used elements are working efficiently”.

4.4.2 Screwdrivers

4.4.2.1 Un-insulated areas

For insulated or hybrid screwdrivers, an un-insulated conductive area having a maximum length of 18 mm is permissible on the *working head* (see Figure 4).



~~Key~~

~~a conductive part~~

~~b working surface~~

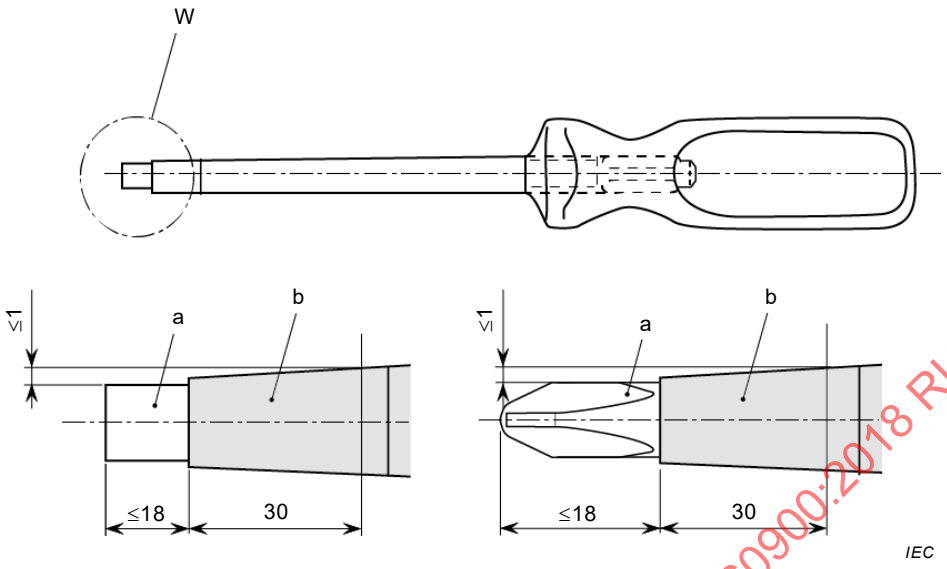
~~c insulation~~

~~d contact area~~

~~W working head~~

~~**Figure 4 – Illustration of insulation of typical hand tools**~~

Dimensions in millimetres



Key

a conductive part

b insulation

W working head

Figure 4 – Illustration of insulation of a typical screwdriver

4.4.2.2 Shape of shaft insulation

The shaft insulation of insulated screwdrivers shall be bonded to the handle.

The outer diameter of the insulation of insulated and hybrid screwdrivers, over a length of 30 mm, in area ~~c~~ "W" of Figure 4, shall not exceed by more than 2 mm the width of the shaft at the tip or the width of the tip, whatever is the larger dimension. This area may be parallel or tapered towards the tip.

This requirement does not apply to insulated bit sockets (or insulated socket drivers).

4.4.2.3 Screwdrivers with exchangeable working heads

Insulated or hybrid screwdrivers with exchangeable *working heads* are regarded as *hand tools* capable of being assembled. They shall meet the relevant requirements. The outer diameter of the insulation may exceed the dimensions of 4.4.2.2.

4.4.2.4 Screwdrivers with screw retaining devices

If an insulated or hybrid screwdriver has a screw retaining device, the screwdriver itself shall meet the requirements of this document. The outer diameter of the retaining device may exceed the dimensions of 4.4.2.2. The retaining device shall be made from insulating material.

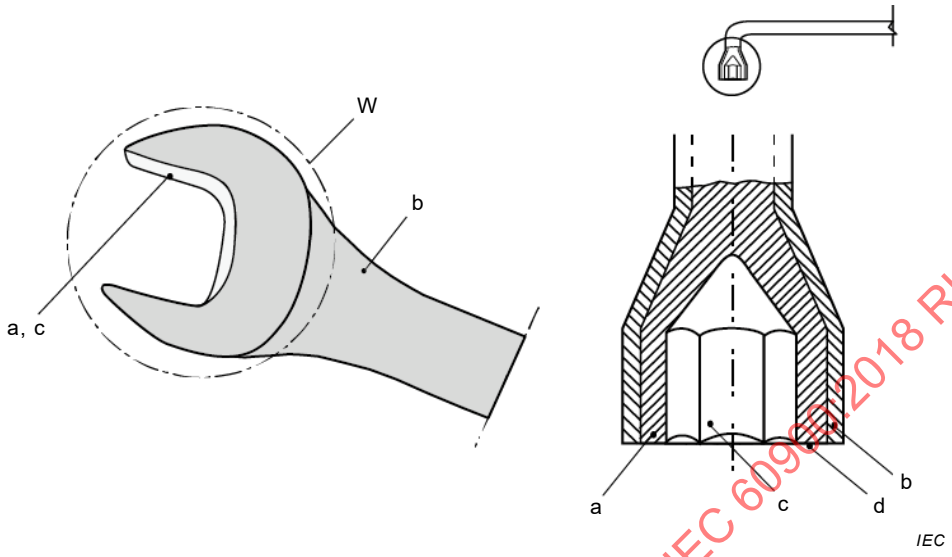
4.4.3 ~~Wrenches~~ Spanners – un-insulated areas

The following un-insulated areas ~~and lengths~~ on the *working head* of insulated and hybrid spanners are permissible (see Figure 5):

- ~~engineers' wrenches~~ single headed spanner: the working surface;

NOTE At the request of the customer, the un-insulated area ~~may~~ can be extended to the *working head*.

- ~~box wrenches, socket-wrenches, tee wrenches~~ ring spanner, socket-spanner, T spanner: the working surface and the contact area.



Key

a conductive part

b insulation

c working surface

d contact area

W *working head*

Figure 5 – Illustration of insulation of typical spanners

4.4.4 Adjustable ~~wrenches~~ spanners

The insulation of insulated adjustable ~~wrenches~~ spanners shall be applied as far as possible towards the *working head*. The un-insulated area may be extended to the *working head*. If the *working head* remains un-insulated, a guard shall be applied so that the hand is prevented from slipping towards the uncovered conductive parts of the head. For the minimum dimensions of the guards, see Figure 6.

In the case of hybrid adjustable spanners where there are more uncovered conductive parts than the working surface at the head, a guard shall be applied.

Dimensions in millimetres

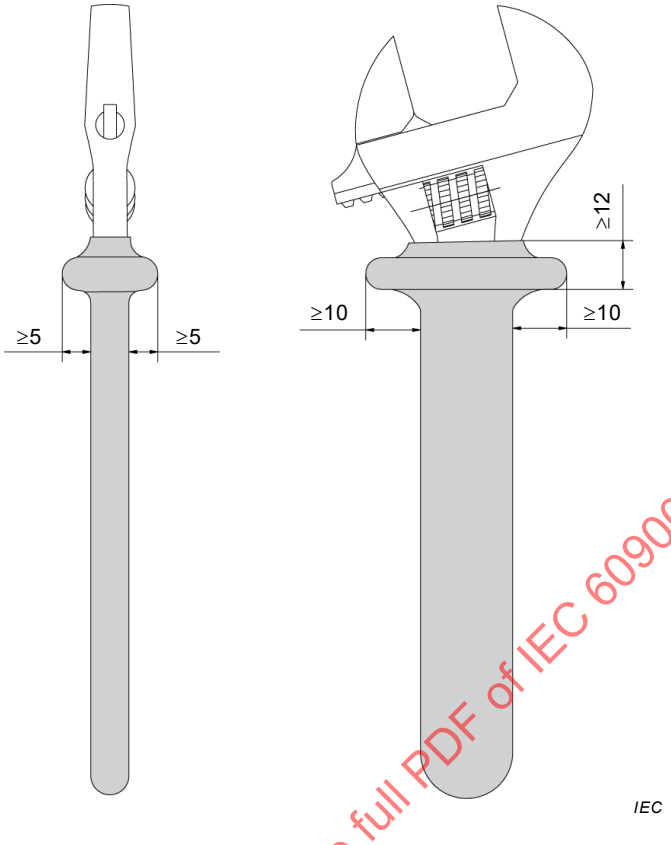
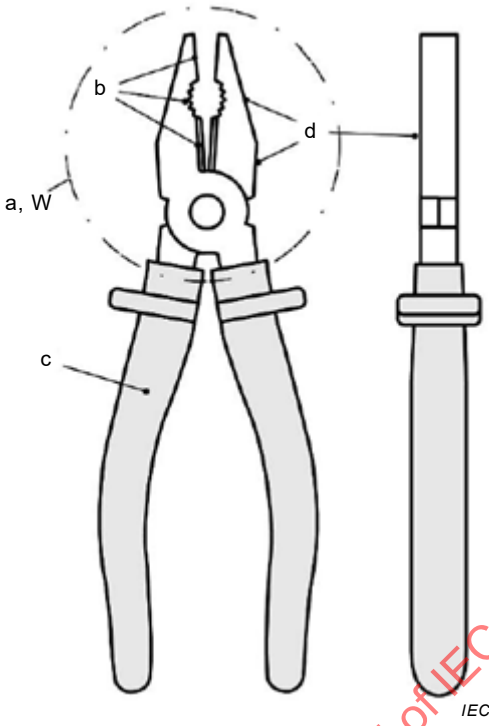


Figure 6 – Insulated or hybrid adjustable ~~wrench~~ spanner

4.4.5 Pliers, strippers, cable scissors, cable-cutting hand tools

The handle insulation of such *insulated* or *hybrid hand tools* shall have a guard so that the hand is prevented from slipping towards the uncovered conductive parts of the head (see Figure 7 as an example).



Key

a conductive part
b working surface
c insulation
d contact area
W *working head*

Figure 7 – Illustration of insulation of typical pliers

The height of the guard shall be sufficient to prevent the slipping of the fingers towards the uncovered conductive parts during the work.

For pliers, the minimum dimensions of the guard shall be (see Figures 8, 9 and 10 as an example):

- 10 mm on the left and on the right of the pliers held on a flat surface;
- 5 mm on the upper and lower part of the pliers held on a flat surface.

The minimum insulated distance between the inner edge of each guard and any non-insulated parts shall be 12 mm (see Figures 8, 9, 10 and 11). The insulation portion in front of the guard shall extend as far as possible towards the *working head*.

Dimensions in millimetres

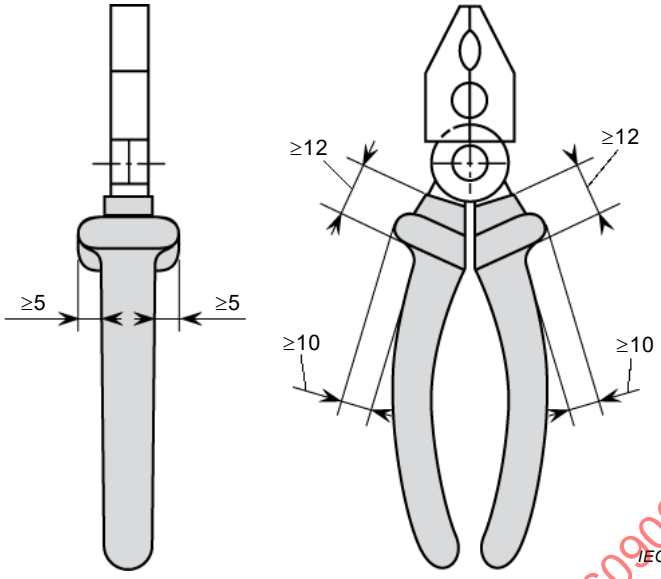


Figure 8 – Insulation of pliers

In the case of a slip joint, a guard of 5 mm shall be provided for the inner part of the handles. Refer to Figure 9 for further dimensioning.

Dimensions in millimetres

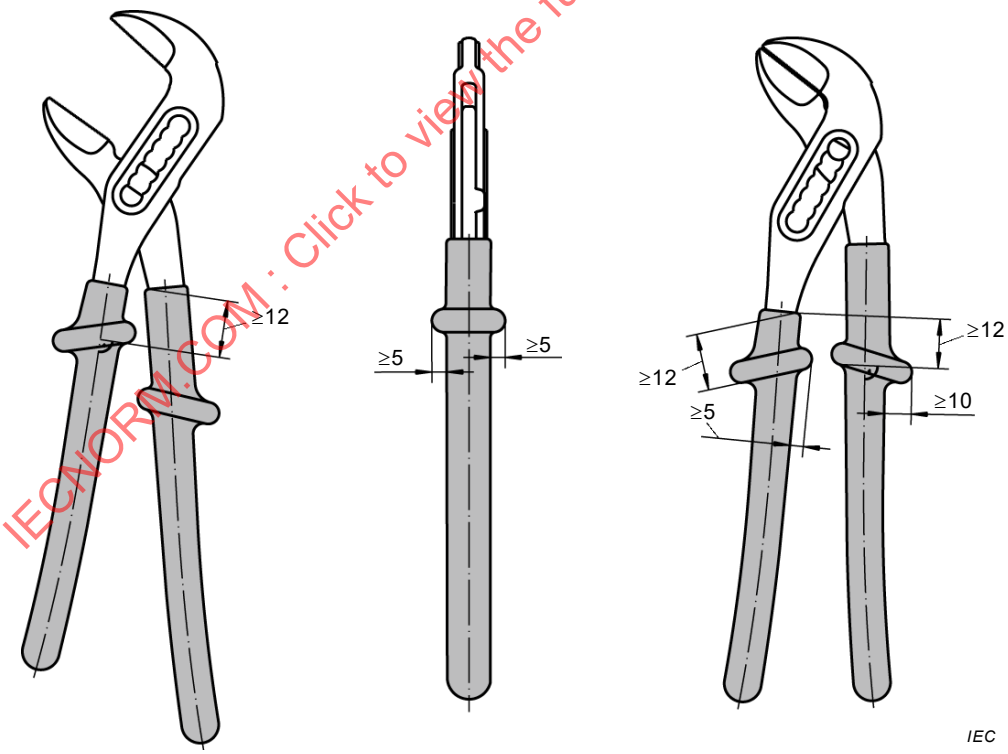


Figure 9 – Insulation of multiple slip joint pliers

Where there is a functional surface below the joint, an inner guard shall be provided (as used with multiple slip joint pliers). See Figure 10.

Dimensions in millimetres

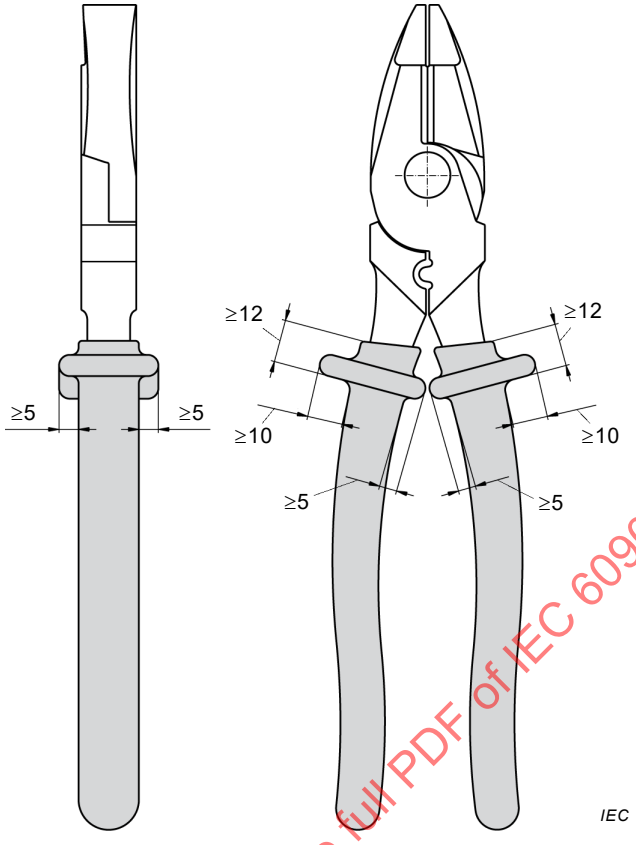


Figure 10 – Insulation of pliers with a functional area below the joint

Where the handles of the *hand tools* are longer than 400 mm, a guard is not required.

In the case of insulated pliers and nippers for electronics, the dimensions of the guard shall be at least:

- 5 mm on left and right of the pliers held on a flat surface;
- 3 mm on the upper part and the lower part of the pliers held on a flat surface.

The minimum insulated distance between the inner edge of the guard and the non-insulated part shall be 12 mm. The insulation portion in front of the guard shall extend as far as possible towards the *working head* (see Figure 11).

Insulated pliers and nippers for electronics shall be in accordance with ISO 9656 and ISO 9657 and, where relevant, with ISO 9654 or ISO 9655.

Dimensions in millimetres

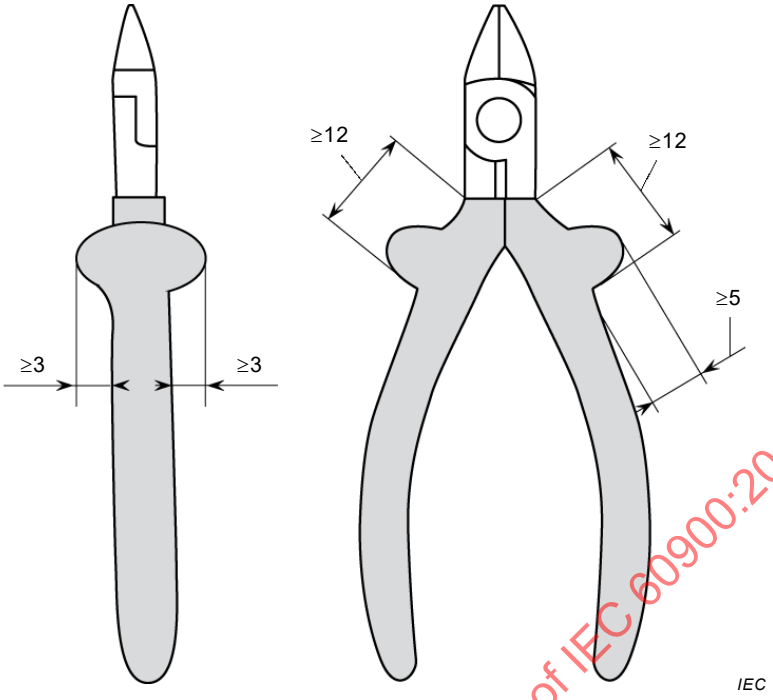


Figure 11 – Illustration of insulation of pliers and nippers for electronics

4.4.6 Scissors

A typical insulation of insulated scissors is shown in Figure 12.

The shackles of the scissors shall have ~~one of both designs~~ the design presented in Figure 12a or the design presented in Figure 12b.

The maximum length of the un-insulated parts of scissors shall not exceed 100 mm.

The insulation portion in front of the guard shall extend as far as possible towards the *working head*. If the insulated length in front of the shackle is less than 50 mm, at least one guard is required.

Dimensions in millimetres

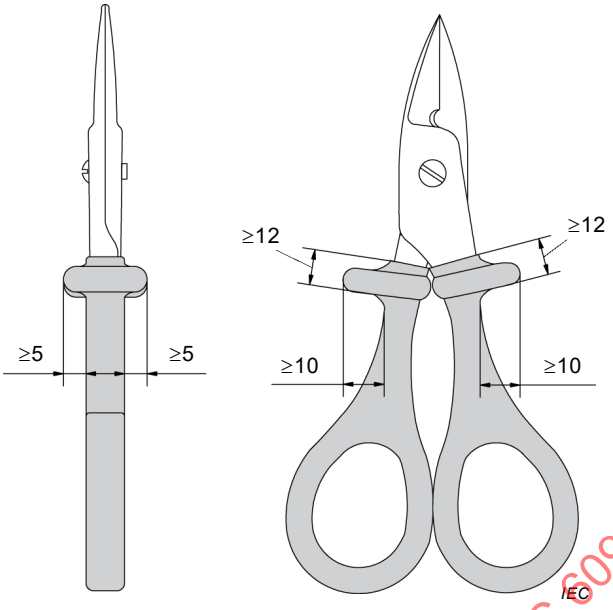


Figure 12a

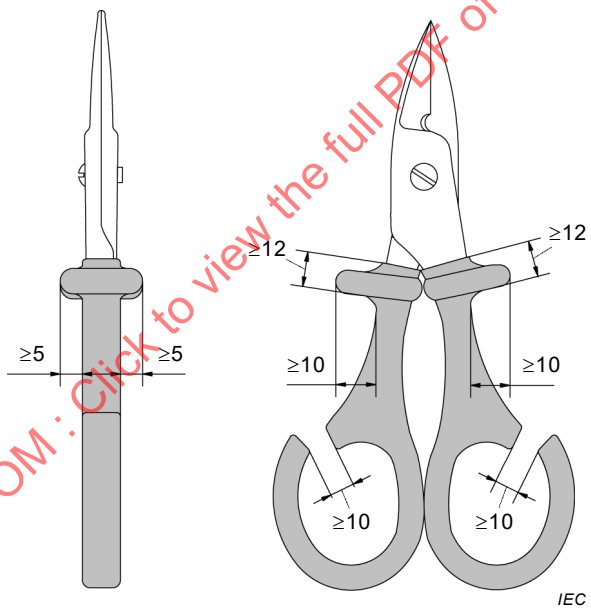


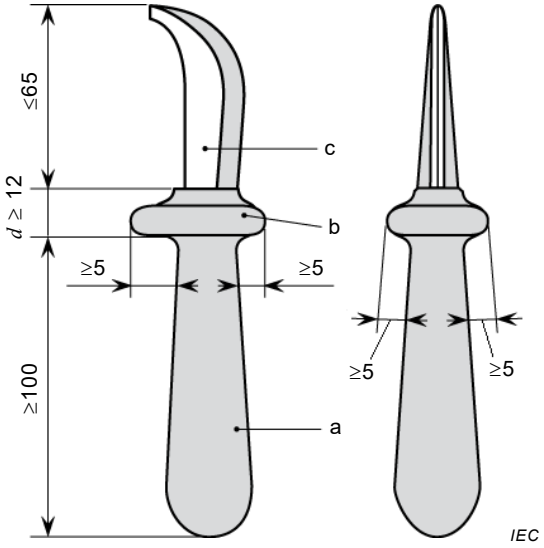
Figure 12b

Figure 12 – Insulation of scissors

4.4.7 Knives

Figure 13 shows an example for the application of the insulation of insulated or hybrid knives. The dimensions of insulated or hybrid knives shall be in accordance with Figure 13.

Dimensions in millimetres



Key

a insulation

b guard

c ~~working head~~ cutting blade (not insulated)

d distance between the inner edge of the guard and the non-insulated part

Figure 13 – Insulation of knives

4.4.8 Tweezers

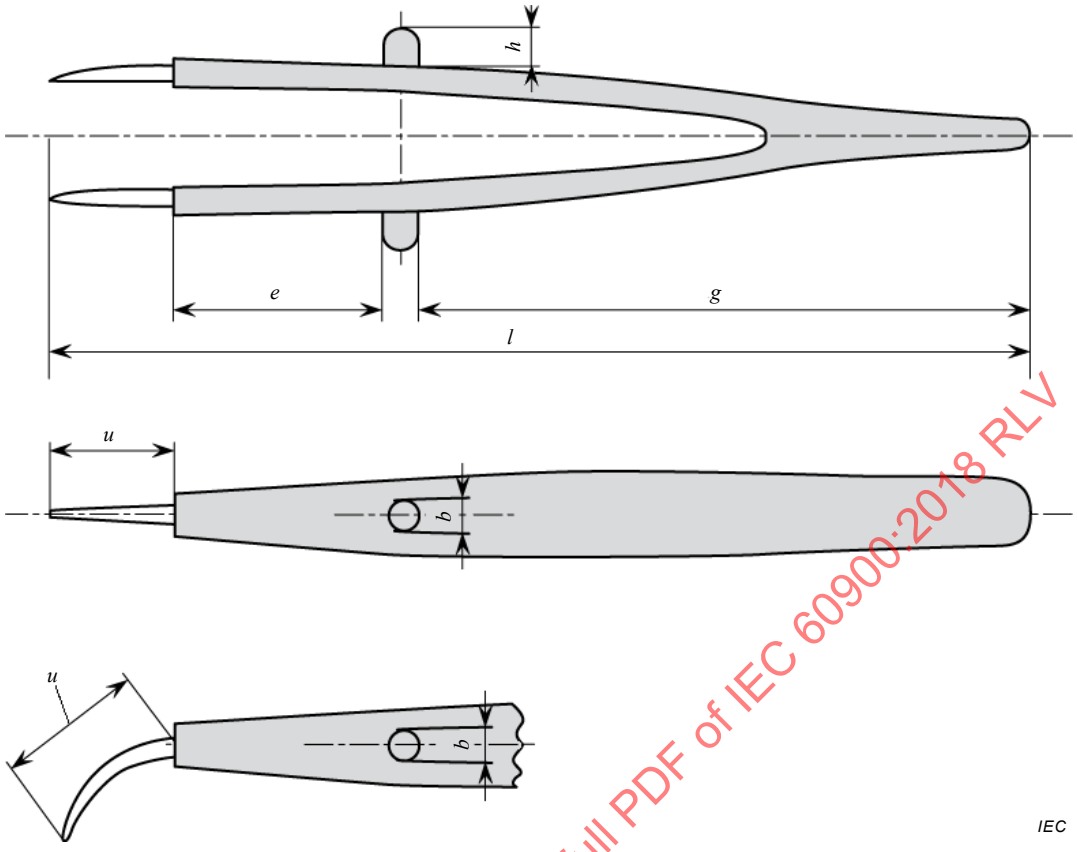
The total length *l* of tweezers shall be 130 mm minimum and 200 mm maximum. The length of the handles *g* shall be 80 mm minimum (see Figure 14).

Both handles of the tweezers shall have a guard towards the *working head*. The guard shall not be movable. Its height *h* and width *b* shall be sufficient (5 mm minimum) to prevent any slipping of the fingers during the work towards the un-insulated length *u* of the *working head*. On both handles, the insulated or insulating length *e* between the guard and the *working head* shall be 12 mm minimum and 35 mm maximum (see Figure 14).

The un-insulated length *u* of the *working head* shall not exceed 20 mm (see Figure 14).

In the case of tweezers with a metallic *working head*, the metallic part shall have a minimum hardness of 35 HRC at least from the *working head* up to the handles.

~~Insulating tweezers shall not have exposed conductive parts.~~



Key

l total length of the tweezers

g length of the handle (grip)

b width of the guard

h height of the guard

e insulated or insulating part of the handle between the guard and the *working head*

u ~~uninsulated part of the~~ *working head* (insulated or not)

Figure 14 – Example of insulation of the handles of tweezers

5 Tests

5.1 General

This document provides testing provisions to demonstrate compliance of the product to the requirements of Clause 4. These testing provisions are primarily intended to be used as type tests for validation of the design input. Where relevant, alternative means (calculation, examination, tests, etc.) are specified within the test subclauses for the purpose of *hand tools* having completed the production phase.

The type tests specified in 5.2 to 5.11 shall be carried out on at least three *hand tools* of the same design and in the sequence specified in Annex E.

Should a *hand tool* fail any part of the type test, the type test shall be repeated on at least six further *hand tools* of the same design. Should any one of these six *hand tools* fail any part of the type test, the whole test shall be regarded as having been failed.

All *hand tools* that have failed the type test shall be either destroyed or rendered unsuitable for use in live working.

Unless otherwise stated, the type tests shall be carried out after a minimum storage time of 16 h under IEC climatic conditions, 23 °C ± 5 °C, relative humidity 45 % to 75 % (see IEC 60212, "standard ambient").

Unless otherwise stated, tolerances of ± 5 % from any type test values required are permissible.

5.2 Visual check

The *hand tool* (in particular the insulation) shall be visually checked and shall be free from external defects.

The marking shall be checked for legibility and completeness in accordance with 4.1.4.

The compliance with the relevant complementary requirements of the following subclauses shall be checked by visual inspection:

- subclause 4.4.1.2, in the case of connecting parts of *hand tools* capable of being assembled;
- subclause 4.4.1.3.2 for instructions for use in the case of *hand tools* capable of being assembled and designed to be interchangeable between different manufacturers;
- subclause 4.4.2.4 for the type of material of the screw retaining devices of screwdrivers;
- subclause 4.4.3 for un-insulated areas of ~~wrenches~~ spanners.

5.3 Dimensional check

The dimensional requirements of 4.4 shall be checked. The dimensions of certain elements of marking shall be checked according to 4.1.4.

5.4 Impact tests

5.4.1 Type test

5.4.1.1 General

The test shall be carried out according to one of the two methods shown in Figures 15 and 16. In case of doubt, method "B" applies (see Figure 16).

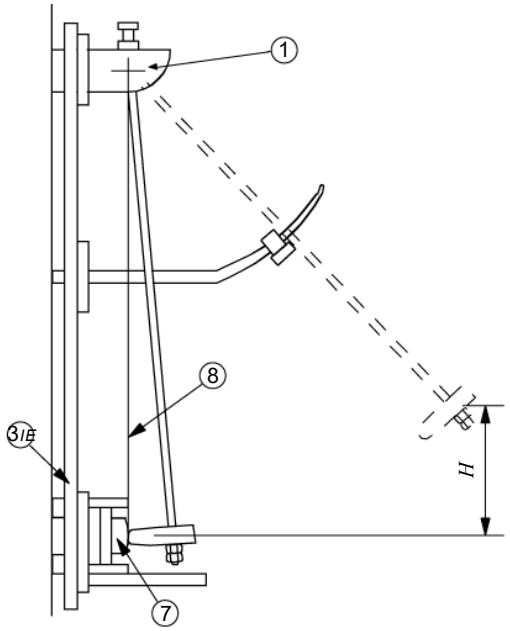
In the case of *hand tools* capable of being assembled, the tool components shall be tested separately.

The hammer used in the apparatus of Figure 15 and the hammer and intermediate piece used in the apparatus of Figure 16 shall be made of steel with hardness between 20 HRC and 46 HRC.

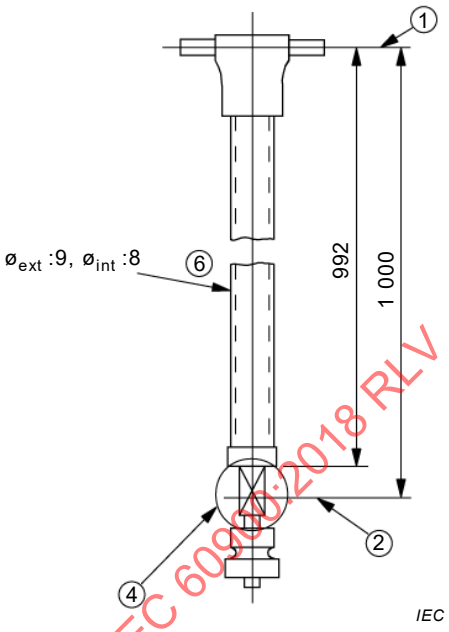
At least three points of the insulating material or insulating layer shall be selected as testing points, these being points which could be damaged when the *hand tool* drops on a flat surface.

The test shall be considered as passed if the insulating material shows no breaks, ~~exfoliations~~ peeling, or cracks ~~penetrating the insulating layer of the insulated hand tool or likely to reduce the solidity of the insulating hand tool~~. Any other visible or non-visible defects caused by the impact tests will be verified by the dielectric tests in 5.5.

Dimensions in millimetres

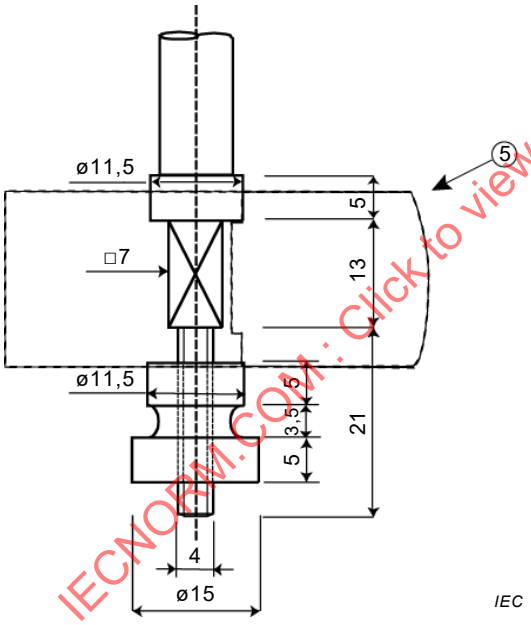


Side view

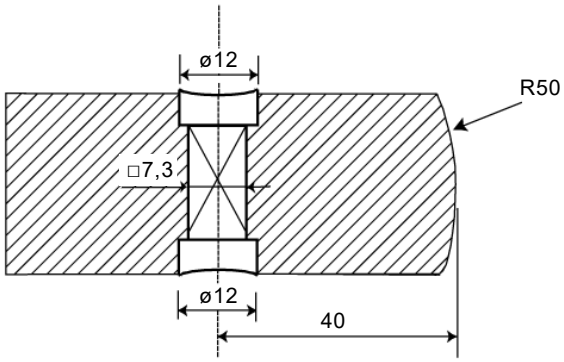


Front view

Dimensions in millimetres



Detail of the assembly of hammer



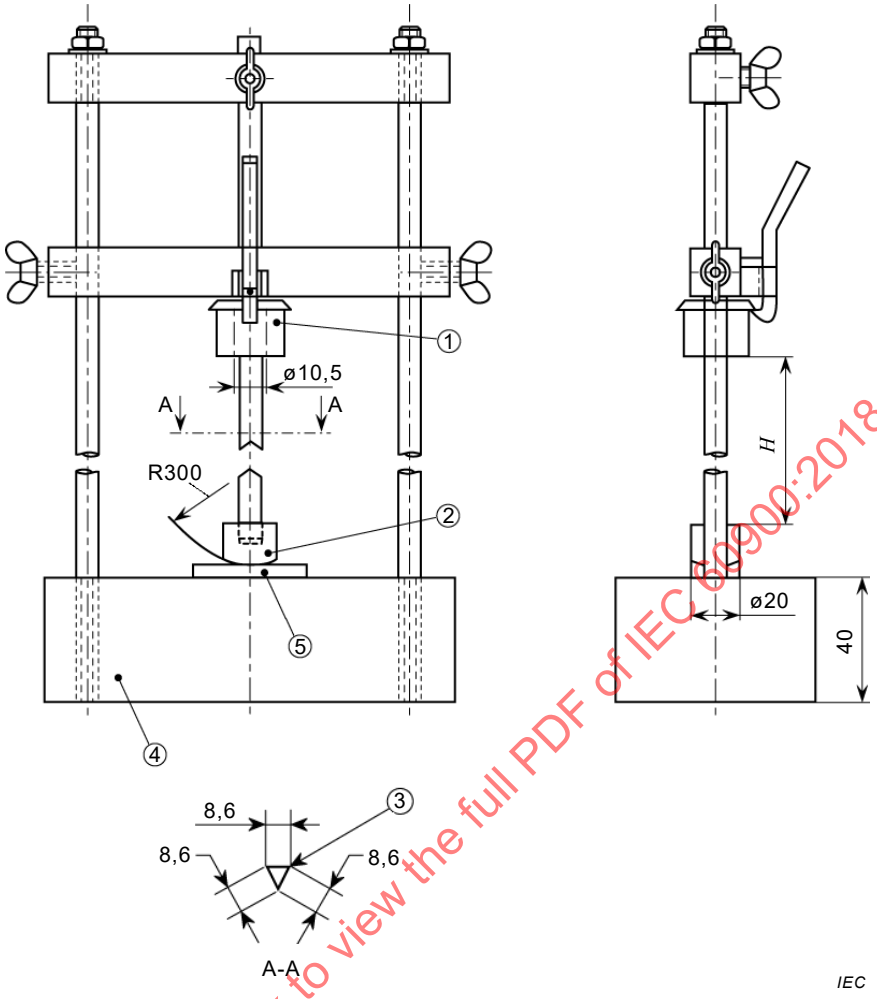
Detail of hammer head

Key

1	axis of swing adjustable	5	hammer head – Rockwell hardness of material between 20 HRC and 46 HRC
2	~~axe~~ neutral axis of hammer	6	steel tube
H	fall height	7	test piece
3	frame	8	vertical plane through axis of pendulum
4	hammer		

Figure 15 – Example of test arrangement for the impact test – Method A

Dimensions in millimetres



Key

H	fall height
1	hammer
2	steel intermediate piece 100 g
3	slightly rounded edges
4	steel part 10 kg
5	test piece

Figure 16 – Example of test arrangement for the impact test – Method B

5.4.1.2 Ambient temperature impact test

The *hand tool* shall be tested at the ambient temperature, 23 °C ± 5 °C, of the test room.

The height of fall H of the hammer shall be determined as a function of its weight P, so that the energy W of impact on the *hand tool* to be tested shall be equal to that of this tool falling on a hard surface from a height of 2 m:

$$H = \frac{W}{P} = \frac{2 \times F}{P}$$

where

H is the height of fall of the hammer, in metres;

F is the weight of the *hand tool* tested, in newtons;

P is the weight of the hammer, in newtons.

5.4.1.3 Low temperature impact test

Hand tools, excluding those of category "C", shall be conditioned in a cooling chamber for 2 h at –25 °C ± 3 °C. The impact test shall start 120 s after removal from the cooling chamber. The ambient temperature of the test room shall be 23 °C ± 5 °C.

The height of fall H of the hammer shall be determined as a function of its weight P, so that the energy W of impact on the *hand tool* to be tested shall be equal to that of this tool falling on a hard surface from a height of 0,6 m:

$$H = \frac{W}{P} = \frac{0{,}6 \times F}{P}$$

where

H is the height of fall of the hammer, in metres;

F is the weight of the *hand tool* tested, in newtons;

P is the weight of the hammer, in newtons.

5.4.1.4 Extreme low temperature impact test

Hand tools of category "C" shall be conditioned in a cooling chamber for 2 h at –40 °C ± 3 °C.

The impact test shall be carried out according to 5.4.1.3.

5.4.2 Alternative ~~means~~ methods in cases ~~of insulated and insulating~~ where hand tools have completed the production phase

For conformity evaluation of ~~insulated and insulating~~ *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the impact resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5 Dielectric tests

5.5.1 General requirements

For tests to be carried out according to IEC 60060-1, the test voltage shall be increased and reduced at a uniform rate of approximately 1 000 V/s.

The dielectric testing shall be started at the latest 5 min after conditioning is completed.

5.5.2 **Conditioning** (for type test only)

5.5.2.1 General

Before testing (according to 5.5.3 or 5.5.4), the *hand tools* shall be conditioned in accordance with one of the two possibilities described in 5.5.2.2 and 5.5.2.3.

5.5.2.2 Water bath

The *hand tools* shall be totally immersed in a bath of tap water at room temperature as specified in 5.1 (23 °C ± 5 °C) for 24 h ± 0,5 h. The water shall have a minimum conductivity of 100 µS/cm. After this conditioning, the *hand tools* shall be wiped dry and submitted to the dielectric test.

5.5.2.3 Wet chamber

The hand tools shall be stored at a relative humidity of (93 ± 2) % at a temperature of 23 °C ± 5 °C for 48 h. Hand tools capable of being assembled shall not be assembled prior to conditioning.

NOTE This humidity conditioning ~~may~~ can be obtained by storing the *hand tools* in a closed chamber which contains a saturated solution of sodium sulphate decahydrate $Na_2 SO_4 10H_2O$ (Glauber's salt) having a large exposed surface.

5.5.3 Dielectric testing of insulated and hybrid hand tools

5.5.3.1 Type test

5.5.3.1.1 General

The *hand tool* shall be immersed ~~with its insulated part~~ in a bath of tap water up to a level of 24 mm ± 2 mm from the nearest non-insulated part. The water shall have a minimum conductivity of 100 µS/cm. The accessible conductive part shall be above the water level (see Figure 17).

Pliers and similar *hand tools* shall be tested in such a position that the gap d between the two inner sides of the ~~insulated~~ handles is 2 mm to 3 mm, or the minimum possible by the tool's construction but not less than 2 mm (see Figure 17).

For *hand tools* capable of being assembled and for those tools where the design does not allow testing in a water bath, the water bath shall be replaced by a bath of nickel stainless steel balls 3 mm in diameter (measured with normal industrial tolerances).

A test voltage of 10 kV rms at 50 Hz or 60 Hz shall then be continuously applied between the accessible conductive parts and the water bath / steel ball bath for a test period of 3 min according to IEC 60060-1~~, and the leakage current is measured. This current shall be smaller than 1 mA for 200 mm of coated hand tool.~~ The current is measured during the test period, either continuously or at the end of the period.

For insulated tools this current shall be smaller than 1 mA rms for 200 mm of the insulation. This corresponds to a maximum value of the leakage current of:

$$I_M = 5\ L$$

where

I_M is the maximum leakage current (in milliamperes rms) rounded to the upper value in milliamperes;

L is the ~~unwinded~~ total linear length (in metres) of ~~coating~~ insulation rounded to the lower value in centimetres.

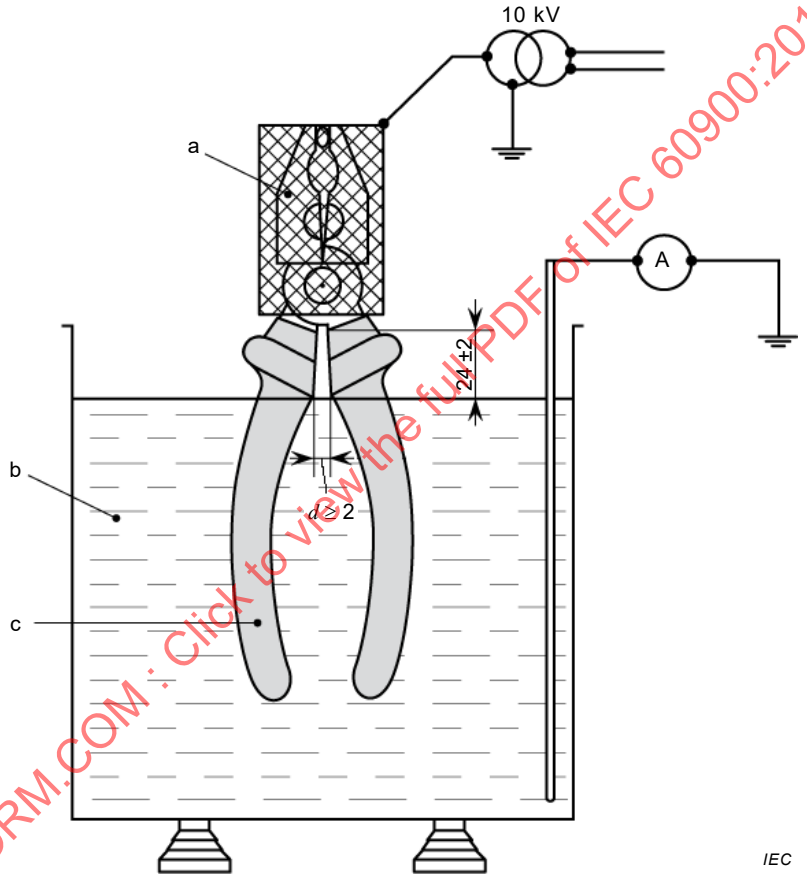
NOTE Annex F gives examples of calculation of the ~~unwinded~~ total linear length of ~~coating~~ insulation and the limits of acceptable leakage current.

For hybrid tools the current shall be smaller than 0,5 mA rms.

Hand tools capable of being assembled shall be tested in all variations of the assembly that are specified by the manufacturer. For tools capable of being assembled with square drives, dummies may be used for the electrical test (see 5.5.3.1.2). *Hand tools* with retaining devices shall be tested on both end positions, if applicable.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the limits of leakage current are not exceeded.

Dimensions in millimetres



Key

a conductive ~~working head~~ part

b tap water bath

c insulated or insulating part of the *hand tool*

d gap to be maintained between the two inner sides of the legs

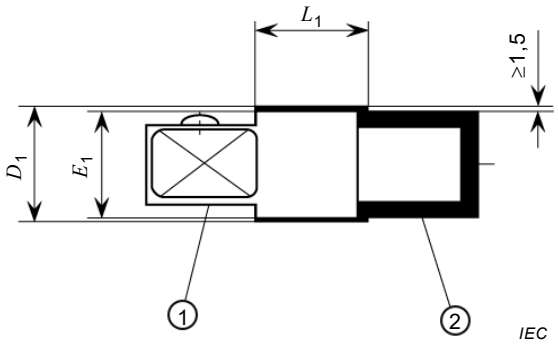
A ammeter

Figure 17 – Dielectric testing arrangement for insulated or hybrid hand tools

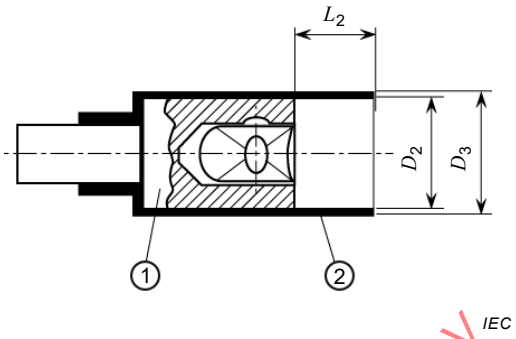
5.5.3.1.2 Tests of hand tools capable of being assembled with square drives

In the case of *hand tools* capable of being assembled with square drives (see 4.4.1.3.1), the tools can be tested in separate parts, if the parts are assembled with dummies described in Figure 18. The dimensions and tolerances of the dummies shall be in accordance with Table 2.

Dimensions in millimetres



Dummy part 1 to be used with female *hand tool* ends



Dummy part 2 to be used with male *hand tool* ends

Key

1 conductive part

2 insulation

Figure 18 – Description of dummies for dielectric tests for hand tools capable of being assembled with square drives

Table 2 – Dimensions and tolerances for dummies to be used for dielectric tests

Dimensions in millimetres

Nominal size	L_1 ± 0,1	L_2 ± 0,1	E_1 ± 0,05	D_1 ± 0,05	D_2 ± 0,05	D_3 ± 0,05
6,3	19	16	8,4	11	14,5	16,5
10	19	16	12,7	16	19,5	21,5
12,5	19	16	16,9	20	23,5	25,5
20	19	16	25,4	30,5	34,5	35,6
L_1, L_2, E_1, D_1, D_2 and D_3 are described in Figure 18.						

Dummy part 1 shall be assembled with female tool ends and dummy part 2 with male tool ends.

On all single parts tested with dummies, the dielectric testing on the complete assembly is not required.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the limits of leakage current are not exceeded.

5.5.3.2 Alternative ~~means~~ test in cases where insulated hand tools have completed the production phase

For conformity evaluation of *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the test of 5.5.3.1 which shall be performed but:

- conditioning as specified in 5.5.2 is not necessary;
- the period of test ~~time~~ shall be 10 s after reaching the specified voltage;
- the distance of the water level (or ball level) from the nearest exposed metal part shall be 24^{+4}_{-2} mm;

- the leakage current measurement is not carried out.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In any doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5.3.3 Alternative methods in cases where hybrid hand tools have completed the production phase

For conformity evaluation of *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In any doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5.4 Dielectric testing of insulating hand tools

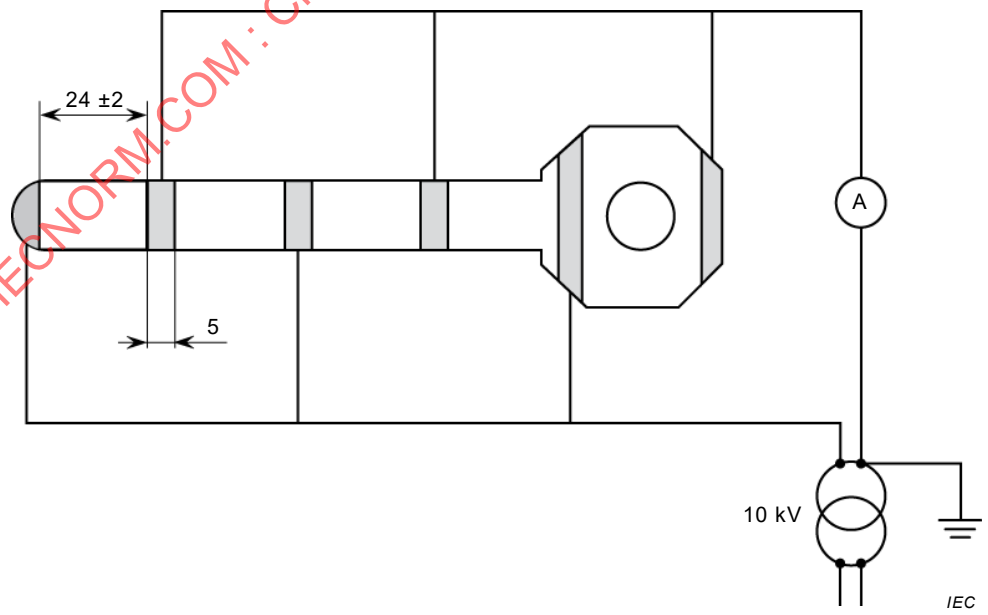
5.5.4.1 Type test

Tools having no exposed conductive parts shall be tested as follows.

NOTE The purpose of this test is to check the dielectric quality of the material used for the tool.

Electrodes of conductive tape or conductive paint, in 5 mm wide strips, shall be placed on the surface of the handle at intervals of 24 mm ± 2 mm (see Figure 19). In accordance with IEC 60060-1, a test voltage of 10 kV rms at 50 Hz or 60 Hz shall then be continuously applied for a test period of 3 min between each adjacent electrode.

Dimensions in millimetres



Key

A ammeter

Figure 19 – Dielectric testing arrangement for insulating hand tools

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the leakage current is less than 0,5 mA rms multiplied by the number of ~~inter-electrode spacings~~ spaces between adjacent electrodes.

5.5.4.2 Alternative ~~means~~ methods in cases where insulating hand tools have completed the production phase

For conformity evaluation of *insulating hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.6 Indentation test (for *insulated hand tools*)

5.6.1 Type test

All parts of the insulating coating of *insulated hand tools*, electrically tested as indicated in the relevant subclauses of 5.5 shall pass this test. The test shall be performed on the most vulnerable part(s) for screwdrivers with insulated shaft, and for other *hand tools* at the external middle part of the handle or legs.

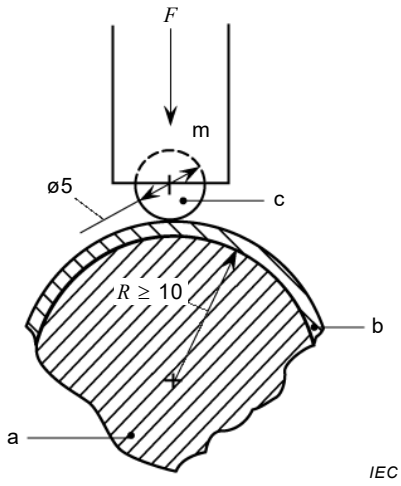
If the radius R at the test point is equal to or larger than 10 mm, the test shall be made with a test device according to Figure 20a. The part of the mass m in contact with the test piece shall be a stainless steel hemispheric nose-piece of 5 mm diameter. The applied force F shall be 20 N.

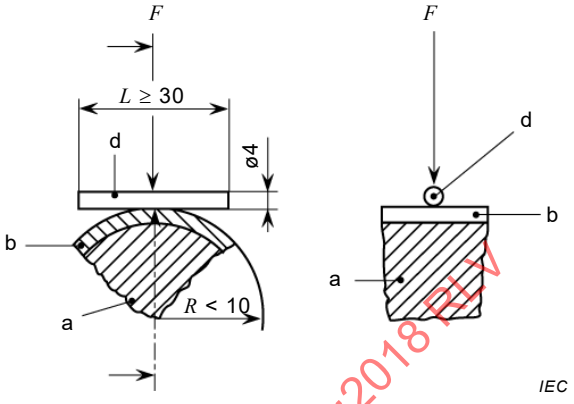
If the radius R at the test point is less than 10 mm, a rod of 4 mm diameter and at least 30 mm in length placed at right angles to the tool axis shall be used with the same force F of 20 N (see Figure 20b).

The *hand tool* shall be clamped in such a way that the insulating material coating at the test point is in a horizontal position. After setting up the testing device, the arrangement shall be held according to code 2 h/70 °C/<20 % of IEC 60212, in a heating chamber with ventilation. At the end of the heating time and after a cooling period outside the chamber of 5 min, a test voltage of 5 kV rms at 50 Hz or 60 Hz shall be applied continuously, in accordance with IEC 60060-1, between the testing device and the metal part of the *hand tool* for a test period of 3 min, using the code 18–28 °C/45–75 % of IEC 60212.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period.

Dimensions in millimetres





Key

a conductive part

b insulation (test point)

c hemispheric nose-piece

d rod

R radius at the test point of the *hand tool*

m testing mass

Figure 20a – Radius at the test point of the hand tool ≥ 10 mm

Figure 20b – Radius at the test point of the hand tool < 10 mm

Figure 20 – Indentation test

5.6.2 Alternative ~~means~~ methods in cases where insulated hand tools have completed the production phase

For conformity evaluation of *insulated hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the indentation resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.7 Test for adhesion of the insulating material coating of insulated hand tools

5.7.1 Conditioning

Before the test, the *insulated hand tools* shall be conditioned in a heating chamber with ventilation at a temperature of 70 °C ± 3 °C for 168 h.

The following tests shall be started at ambient temperature 3 min after removal from the heating chamber, using the code 18–28 °C/45–75 % of IEC 60212.

5.7.2 Type test

5.7.2.1 Test on the working head of insulated hand tools

The test shall be made on the following *insulated hand tools*:

- ~~wrenches~~ spanner;
- open-jaw holding ~~wrenches~~ spanner;
- *hand tools* capable of being assembled (except for pieces acting as screwdrivers).

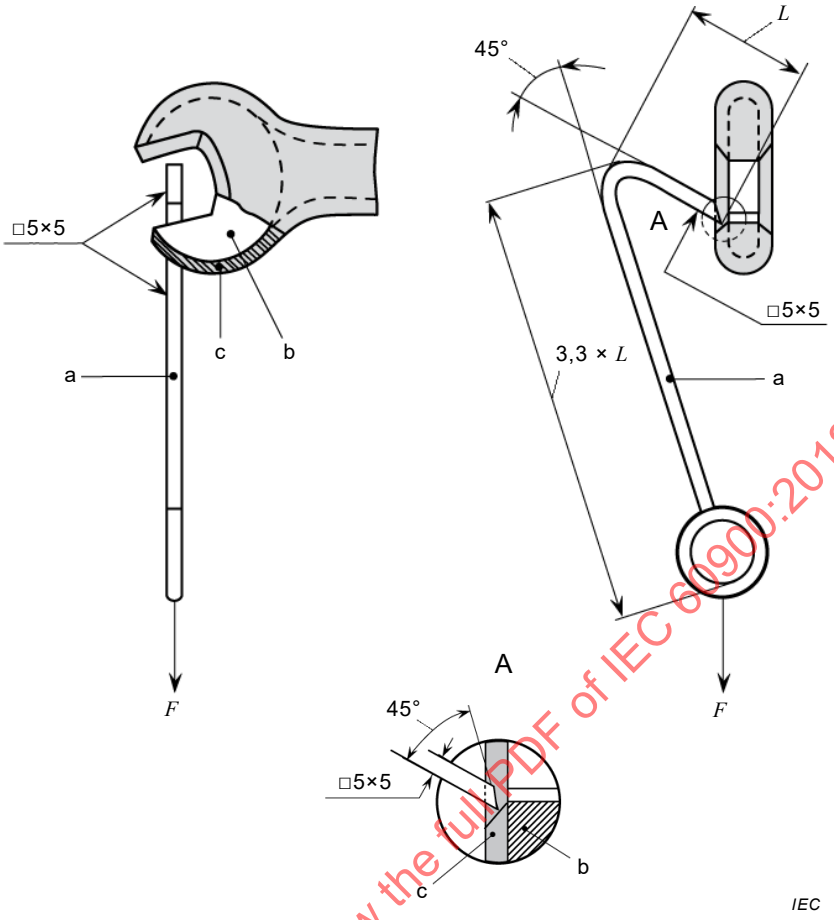
The test may be carried out using either method A or method B as shown in Figures 21 and 22, respectively. In case of doubt, method A shall apply.

Method A (see Figure 21):

A hook having a cutting edge of 5 mm width shall be placed on the *working head* in such a manner that it does not touch the conductive part.

A force F of 50 N shall be applied in the direction of the line dividing the insulating material coating from the conductive part for 3 min.

Dimensions in millimetres



Key

a hook (the length of the handle depends on the size of the *hand tool*)

b conductive part

c insulating material coating

L length of the short arm of the hook

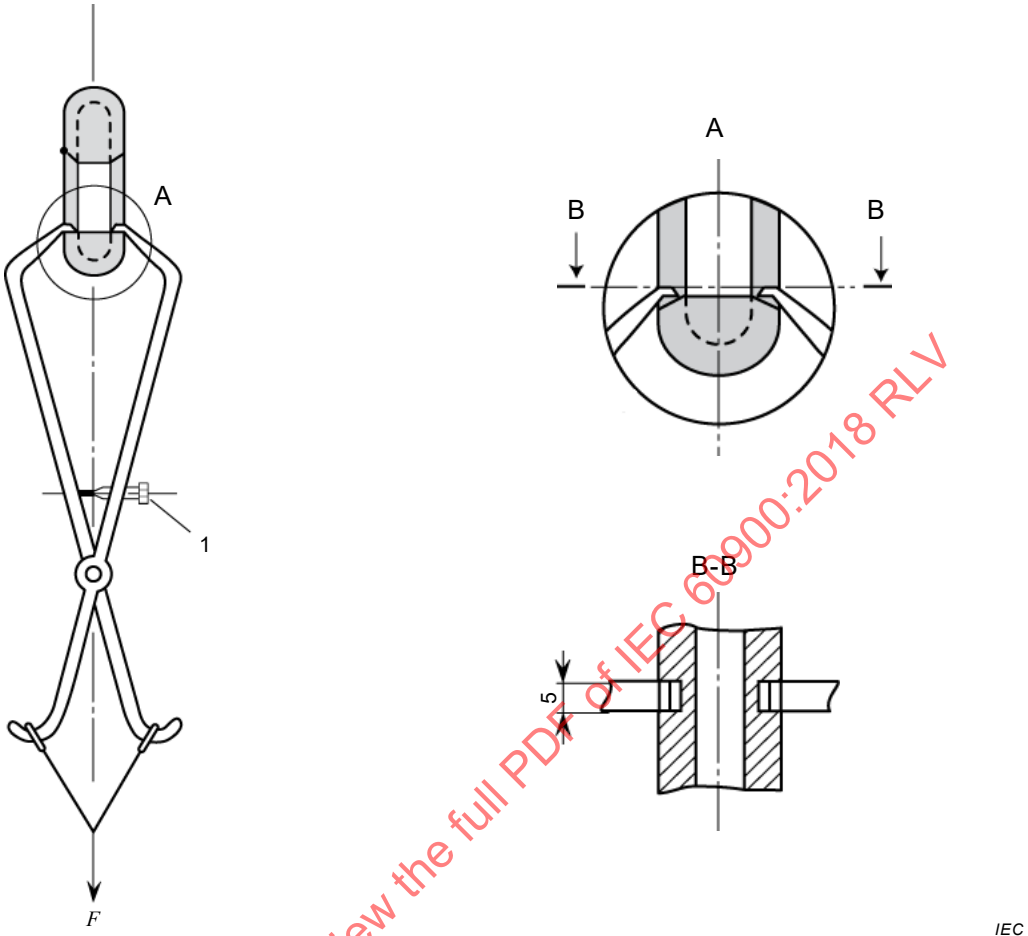
Figure 21 – Principle of the testing device for checking adhesion of the insulating coating on conductive parts of the insulated hand tool – Test on the working head – Method A

Method B (see Figure 22):

A device having two cutting edges, each of 5 mm width, shall be placed on the *working head* in such a manner that it does not touch the conductive part.

A force F of 100 N shall then be applied in the direction of the line dividing the insulating material coating from the conductive part for 3 min.

Dimensions in millimetres



Key

1 adjusting device

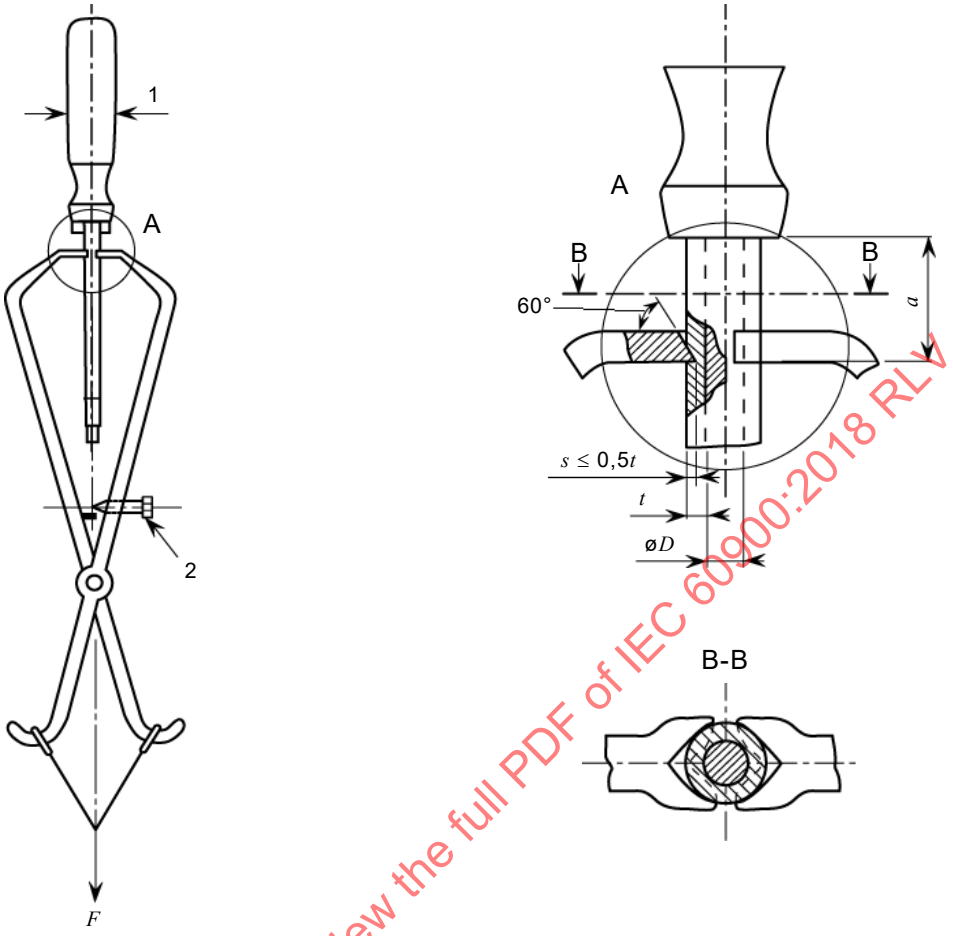
Figure 22 – Principle of the testing device for checking adhesion of the insulating coating on conductive parts of the insulated hand tools – Test on the working head – Method B

Either test shall be considered as passed if the insulating material coating does not move more than 3 mm from its initial location on the conductive part, and without any breakage of the insulating material.

5.7.2.2 Test on the insulation of the shafts of insulated screwdrivers

The test shall be carried out on insulated screwdrivers or on parts of *insulated hand tools* capable of being assembled acting as screwdrivers with the testing apparatus as shown in Figure 23.

Dimensions in millimetres



Key

1 suitable clamping device to hold the tested screwdriver in position with the shaft vertical downwards during the test

2 adjusting device

s depth of penetration ($s \leq 0{,}5\,t$)

t thickness of the insulating material coating

F testing force

a spacing of 10 mm to 15 mm between the point where the shaft comes out of the handle and the cutting edge of the testing appliance

D shaft diameter

Figure 23 – Testing device for checking adhesion of the insulating coating of insulated screwdrivers on conductive parts and the handle

The penetration depth of the cutting edges s of the testing apparatus shall not exceed 50 % of the thickness t of the insulating material coating. The cutting edges shall be placed on the shaft insulation at a distance a of 10 mm to 15 mm from the point where the shaft emerges from the handle or from the body of the *hand tools* capable of being assembled acting as screwdrivers.

If the cutting edges slide on the insulation, it is permissible to cut a groove in the shaft insulation of up to 50 % of its thickness, to prevent movement.

The force F in newtons shall be equal to 35 times the shaft diameter or 35 times the greatest dimension of the shaft cross-section in millimetres. The maximum force to be applied is 200 N. It shall be applied in the axial direction of the shaft for 1 min.

The test shall be considered as passed if the insulating coating does not move more than 3 mm from its initial location on the conductive part and if there is no breakage of the insulating material.

5.7.2.3 Test of adhesion of the insulation of the entire insulated hand tool

The test shall be made on pliers, strippers, cable-cutting *hand tools*, cable scissors and knives with the testing apparatus according to Figure 24.

The force F of 500 N shall be applied for 3 min.

The test shall be considered as passed

- if the handle remains firmly attached to the conducting part, and
- if the guard(s) remain firmly attached to the handles.

~~NOTE~~ Deformation of the insulating coating is not considered as a failure.

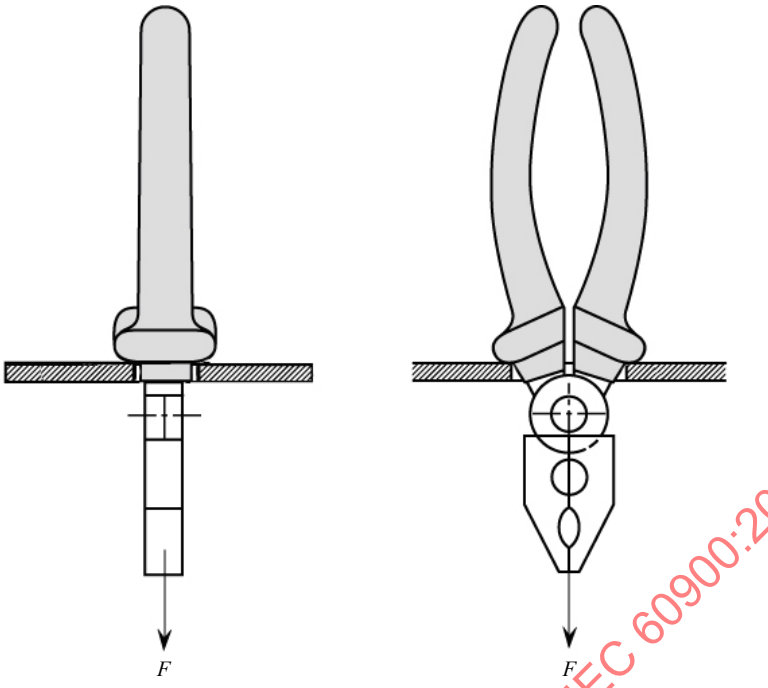


Figure 24a

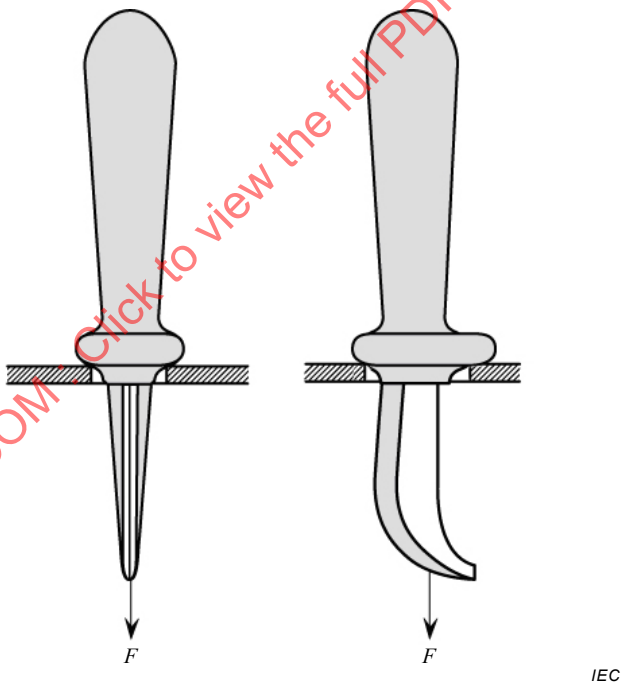


Figure 24b

Figure 24 – Example of mountings for checking stability of adhesion of the insulation of the entire insulated hand tool

5.7.3 Alternative ~~means~~ methods in cases where insulated hand tools have completed the production phase

In the case where *insulated hand tools* have completed the production phase, the conditioning time can be reduced to 2 h.

If the test devices shown in Figures 24a and/or 24b leave marks on the tested *hand tools*, ~~it is up to~~ the manufacturer ~~to~~ can shape the contact areas between tool and test devices with a customized fit to the tested tools.

The manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the adhesion resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.8 Test of adhesion of exposed conductive parts at the working head of hybrid hand tools

5.8.1 Type test

A separating force of 100 N shall be applied to the exposed conductive part in a possible separating direction by a suitable device for 3 min.

The test shall be considered as passed if the exposed conductive parts or inserts are not separated from the supporting insulating material at the *working head*. If there is any movement between the conductive parts or inserts and the supporting material the test is deemed to have failed.

5.8.2 Alternative methods in cases where hybrid hand tools have completed the production phase

For conformity evaluation of *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the retaining process.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9 Mechanical tests

5.9.1 Test of adhesion of insulating covers of conductive adjusting or switching elements

5.9.1.1 Type test

A separating force of 50 N shall be applied to the cover in a possible separating direction by a suitable device for 3 min.

The test shall be considered as passed if the covers do not come off the elements they are insulating, if the function of the elements they are insulating is still ~~given~~ in good working condition and if the dielectric test of 5.5.3.1 is passed after this test.

Deformation of the covers due to this test is not considered to be a failure.

If covers are used in areas that are not touched during work, this test need not be performed. Also, the test need not be performed where the design of the sealing elements does not allow application of a separating force.

5.9.1.2 Alternative ~~means~~ methods in cases where hand tools have completed the production phase

In the case where *hand tools* have completed the production phase, the test of 5.9.1.1 shall be performed but the time for the application of the separating force shall be limited to 10 s and the test of 5.5.3.1 shall be performed with a conditioning time of 2 h.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.2 Insulated hand tools

5.9.2.1 Type test

~~The hand tools shall comply with all the specific mechanical requirements of ISO standards corresponding to the different types of hand tools. If no ISO standard exists, the hand tools shall comply with a standard specified by the manufacturer or the customer (for example: a national standard).The manufacturer shall provide the reports of these tests at the request of the customer.~~

Type tests are described in the ISO standards corresponding to the different types of *hand tools*. The manufacturer shall provide the reports of these tests at the request of the customer.

5.9.2.2 Alternative ~~means~~ methods in cases where insulated hand tools have completed the production phase

For conformity evaluation of *insulated hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the mechanical stability of the *hand tool*. This includes documentation concerning the basic *hand tools* that have been insulated.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.3 Insulating and hybrid hand tools

5.9.3.1 Type test

Insulating and *hybrid hand tools* specially designed for live working may have lower stress resistance than *insulated hand tools*, but they shall withstand the expected workloads without failing due to remaining deformation or breaking (see Annex B).

The manufacturer shall provide the reports of the type tests performed on the *insulating* or *hybrid hand tools*, at the request of the customer.

5.9.3.2 Alternative ~~means~~ methods in cases where insulating and hybrid hand tools have completed the production phase

For conformity evaluation of *insulating* and *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the mechanical stability of the *hand tool*.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.4 Tweezers

A clamping force of 10 N shall be applied 10 mm behind the guard, clamping a test piece with a thickness of 2 mm, a width and length of 10 mm and a hardness of not less than 35 HRC. This stress shall not cause any permanent deformation.

5.9.5 Retaining force test for tools capable of being assembled

5.9.5.1 General procedure

The ~~hand~~ tool assembly shall be maintained in such position that the dismantling direction of the detachable part is vertical and downwards.

The load shall be gradually applied ~~along~~ in the dismantling direction to reach the value given in 5.9.5.2 or 5.9.5.3 within 2 s; it shall then be held for 1 min.

In the case of interchangeable components made by different manufacturers (see 4.4.1.3.2), the reliable function of locking systems used for those *hand tools* shall be tested with a corresponding dummy. These dummies can be shaped to the needs of the measuring devices used for the test, but the dimensions of the female square drive part shall be in accordance with Figures 25 and 26. To assure that the intended function is given with all possible combinations of tolerances according to ISO 1174, always a “MIN” and a “MAX” dummy shall be used.

Due to a lack of information concerning relevant dimensions, the design of the dummies has been limited to the nominal dimensions 10 mm and 12,5 mm.

The test shall be considered as passed if the assembly does not come apart.

Dimensions in millimetres

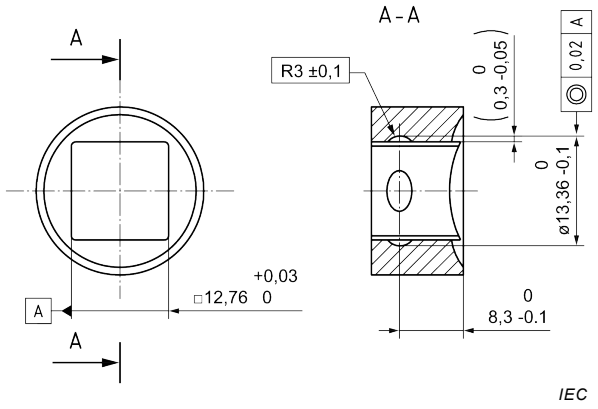


Figure 25a – Dummy "MIN"

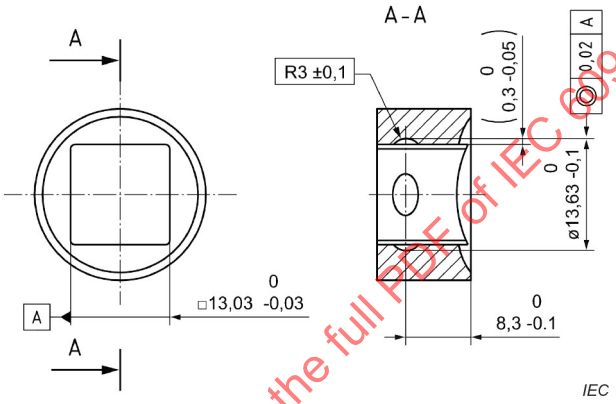


Figure 25b – Dummy "MAX"

Figure 25 – Dummies for testing locking systems used with square drives of nominal size 12,5 mm of ISO 1174

Dimensions in millimetres

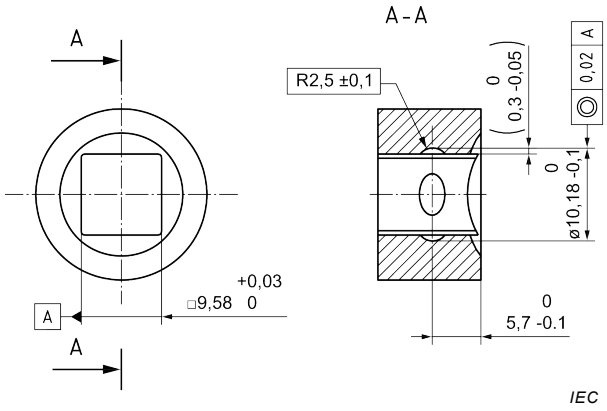


Figure 26a – Dummy "MIN"

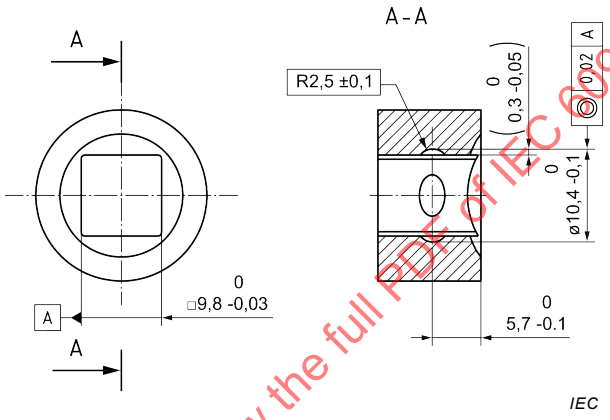


Figure 26b – Dummy "MAX"

Figure 26 – Dummies for testing locking systems used with square drives of nominal size 10 mm of ISO 1174

5.9.5.2 Not mechanically locked retaining systems

For *hand tools* capable of being assembled with retaining systems without mechanical lock, which means that no locking element has to be activated before elements of the assembly can be exchanged (for example retaining systems acting based on magnetic retaining forces or systems acting by a spring loaded element only), the following values shall be used for evaluation:

- 4 N for drives up to 6,50 mm;
- 11 N for drives from 6,51 mm to 10,00 mm;
- 30 N for drives from 10,01 mm to 13,50 mm;
- 80 N when drives exceed 13,50 mm.

~~NOTE~~ The nominal size of the drives is measured across flats. If there are no parallel flats (triangular drive, pentagon drive, etc.), the nominal size should be specified in a comparable manner.

5.9.5.3 Mechanically locked retaining systems

In the case of mechanically locked retaining systems, which means that a locking element (screwed fitting, lever, ring, etc.) has to be activated before elements of the assembly can be exchanged, a load of 500 N shall be used.

5.10 Durability of marking

The items of marking shall be rubbed for 15 s with a rag soaked in water, and then for 15 s with a rag soaked in isopropanol (CH_3-CH(OH)-CH_3).

After this rubbing, the marking shall still be legible.

NOTE 1 It is ~~the employer's duty~~ not part of this document to ensure that any relevant legislation and any specific safety instructions regarding the use of isopropanol are fully observed.

NOTE 2 For special service requirements, the customer ~~may~~ can specify extra tests for the durability of marking.

5.11 Flame retardancy test

5.11.1 Type test

The test shall be carried out in a draught-free room. The *hand tool* to be tested shall be clamped in a horizontal position. A small burner shall be arranged in such a way that the axis of the burner nozzle and the axis of the handle of the *hand tool* are at right angles and form a vertical plane.

The gas supply shall be technical grade methane gas with a suitable regulator and meter to produce a uniform gas flow.

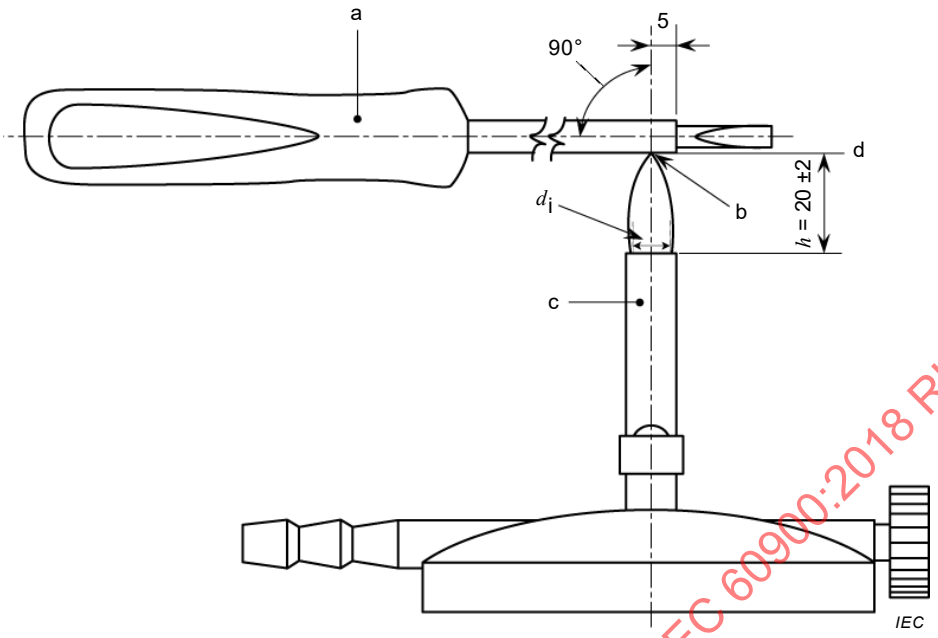
~~NOTE~~ If natural gas is used as an alternative to methane, its heat content should be approximately 37 MJ/m^3, which has been found to provide similar results.

The nozzle of the burner shall have a diameter of 9,5 mm ± 0,5 mm to produce a 20 mm ± 2 mm high blue flame.

The burner is placed remote from the *hand tool*, ignited and adjusted in the vertical position to produce a blue flame 20 mm ± 2 mm high. The flame is then obtained by adjusting the gas supply and the air ports of the burner until a 20 mm ± 2 mm yellow-tipped blue flame is produced. The air supply is then increased until the yellow tip disappears. The height of the flame is measured again, and corrected if necessary.

The burner shall then be placed in the test position as shown in Figure 27, with the axis of the flame at right angles to that of the *hand tool*.

Dimensions in millimetres



Key

a test piece

b tip of the flame

c burner

d horizontal reference line

d_i inner diameter of burner tube 9,5 mm ± 0,5 mm

h height of the flame of the gas burner

Figure 27 – Example of a flame retardancy test arrangement

At the start of the test, the tip of the testing flame shall touch the insulating material at the lower part of the *working head* facing the *hand tool* to be tested (see Figure 27).

The horizontal reference line d of Figure 27 at the level of the lower end of the insulating material is the datum for measuring the flame height.

If different types of insulating material are used for the same *hand tool*, the test shall be made on each individual type of insulating material.

The testing flame shall act upon the *hand tool* to be tested for 10 s. After this period, the flame shall be withdrawn. It shall be ensured that no air draught interferes with the test. The propagation of the flame on the *hand tool* shall be observed for 20 s after the withdrawal of the testing flame.

The test shall be considered as passed if the flame height on the *hand tool* does not exceed 120 mm during the 20 s of the observation period.

5.11.2 Alternative ~~means~~ methods in cases where hand tools have completed the production phase

For conformity evaluation of ~~insulating and insulated~~ *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the flame retardancy of the insulation.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

6 Conformity assessment of hand tools having completed the production phase

For conducting the conformity assessment during the production phase, IEC 61318 shall be used in conjunction with this document.

Annex G, developed from a risk analysis on the performance of the *hand tools*, provides the classification of defects and identifies the associated tests applicable in the case of production follow-up.

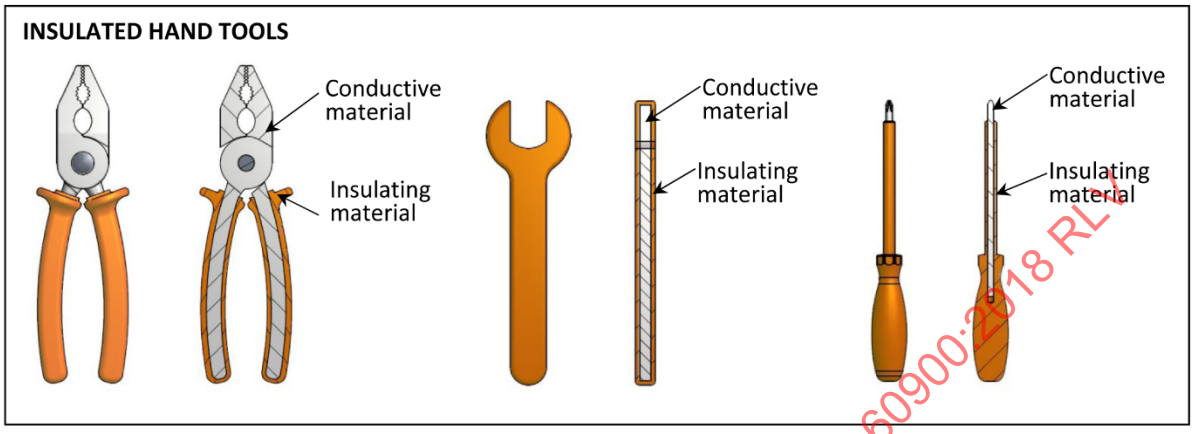
The rationale for the classification of defects specified in Annex G is provided in Annex H.

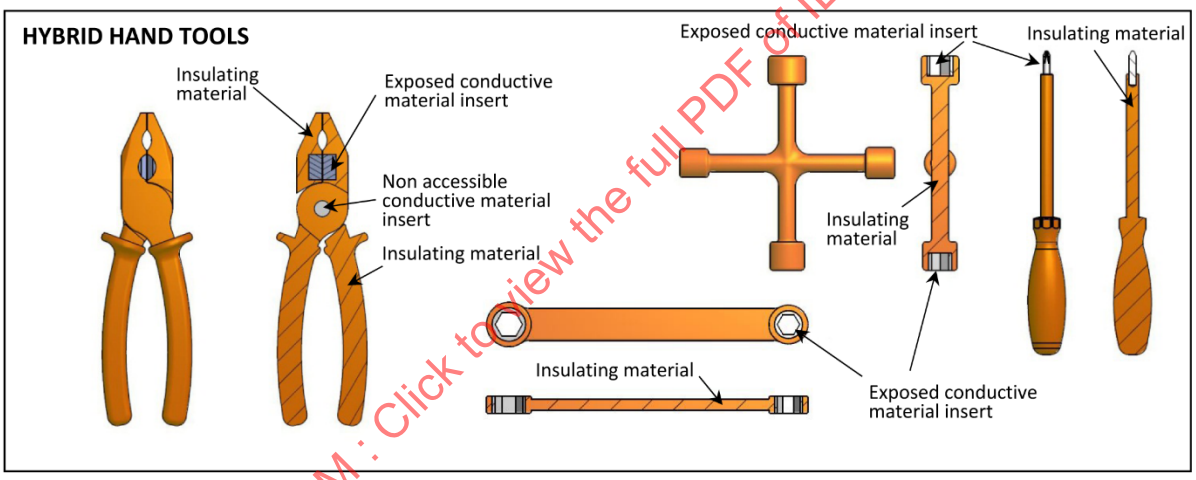
7 Modifications

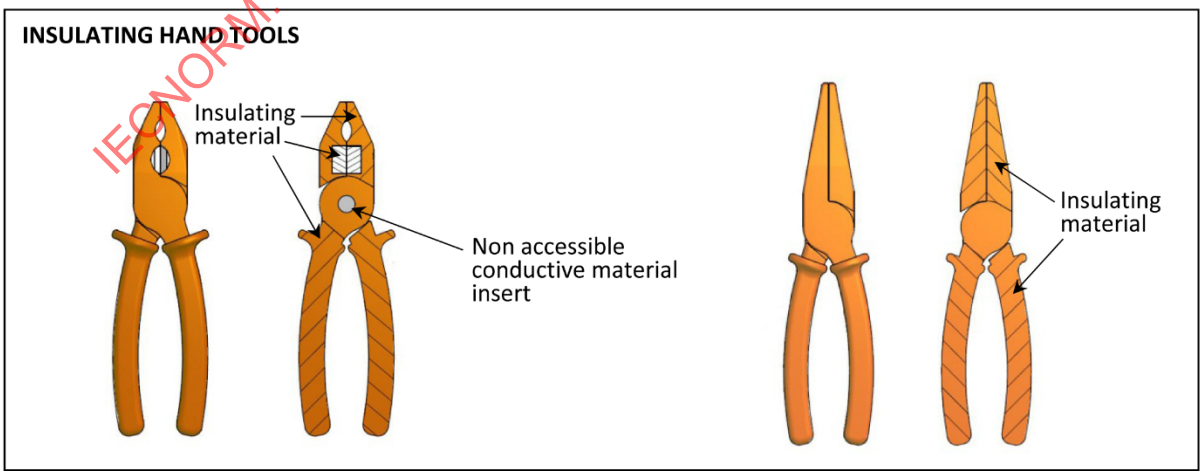
Any modification of the *hand tools* shall require the type tests to be repeated, in whole or in part (if the degree of modification so justifies), as well as a change in *hand tool* reference literature.

Annex A
(informative)

Description and examples for insulated, hybrid and insulating hand tools







Annex B
(informative)

Mechanical strength of insulating and hybrid hand tools

B.1 Context

Hand tools complying with ISO standards are often tested with test loads far beyond loads that can really be applied by hand. Among the reasons for this are

- that the application of these universal *hand tools* is not always known in detail, and
- that such *hand tools* are required to resist various improper uses that are to be expected, without failing and endangering the user.

For live working, the workers have to have a much better training level and the applications of some *hand tools* are very well defined. The following informative proposals are based on loads that can be applied by hand only and under regular conditions.

Insulating and *hybrid hand tools* specially designed for live working applications may have lower stress resistance than *insulated hand tools*, if they withstand the expected workloads without failing due to permanent deformation or breaking.

B.2 General

To check the ability of *insulating* and *hybrid hand tools* to withstand the expected maximum workloads specified in Clauses B.3 to B.6, tests should be carried out in accordance with the test procedures defined in ISO standards for similar *insulated hand tools*. If such ISO standards do not exist, tests may be specified by the manufacturer or by the customer. For those tests the IEC climatic conditions and tolerances of 5.1 apply.

If *insulating hand tools* are equipped with devices that limit the workloads that can be applied with them, for example overload slipping clutches, these limiting devices are activated before these tools reach the test loads specified hereafter.

B.3 Insulating and hybrid screwdrivers

Torque values for insulating and hybrid screwdrivers are given in Table B.1.

Table B.1 – Torque values for insulating and hybrid screwdrivers

Blade diameter mm	Test torque N·m
More than 8,0	10
6,5 to 7,9	8,0
5,5 to 6,4	5,5
4,5 to 5,4	4,5
4,0 to 4,4	2,5
3,5 to 3,9	1,3
3,0 to 3,4	0,7
2,5 to 2,9	0,4
Up to 2,4	0,3

B.4 Insulating and hybrid ~~wrenches~~ spanners and ratchets

~~Wrenches~~ Spanners and ratchets: maximum hand force = 500 N.

The force is applied 35 mm away from the outer extremities of the handles right angled to the axle of the work piece to be turned.

B.5 Insulating and hybrid T-~~wrenches~~ spanners

T-~~wrenches~~ spanners: maximum hand force = 250 N.

The force is applied simultaneously on both handles in opposite directions, 35 mm away from the outer extremities of the handles right angled to the axle of the work piece to be turned.

B.6 Insulating and hybrid pliers and cable shears

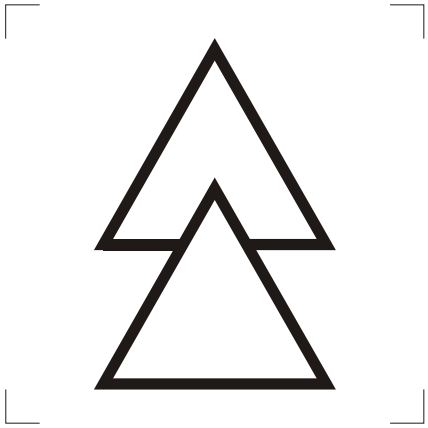
A hand load test in accordance with ISO 5744 should be carried out with a load of 500 N.

The load is applied 35 mm away from the outer extremities of the handles squeezing the handles.

A torsion test in accordance with ISO 5744 should be carried out for gripping pliers with a flat nose. The force for clamping is 350 N, applied 35 mm away from the outer extremities of the handle. The torque applied is 4 N·m. The maximum permissible twist angle at this torque is 20°.

Annex C
(normative)

Suitable for live working; double triangle (IEC 60417-5216:2002-10)



Annex D
(informative)

Recommendation for use and in-service care

D.1 General

Annex D is for guidance only concerning the maintenance, inspection, retest and use of *hand tools* after purchase.

D.2 Storage

~~Insulated or insulating~~ *Hand tools* should be properly stored to minimize the risk of damage to the insulation due to storage or transportation. These *hand tools* should be stored generally separated from other tools to avoid mechanical damage or confusion. Furthermore, these *hand tools* should be ~~prevented~~ protected from excessive heat (for example heating or steam pipes) as well as UV radiation.

D.3 Inspection before use

Each time before use, each *hand tool* should be visually inspected by the user.

If there is any doubt concerning the safety of the *hand tool*, it should either be scrapped or subjected to examination by a competent person and retested, if necessary.

D.4 Temperature

According to their capability, *hand tools* should be used only in areas having temperatures between –20 °C and +70 °C and, for tools marked “C”, between –40 °C and +70 °C.

D.5 Periodic examination and electrical retesting

An annual visual examination by a suitably trained person is recommended to determine the suitability of the *hand tool* for further service. If an electrical retest is required by national regulation or by customer specifications or in the case of doubt after visual examination, the dielectric test in 5.5.3.2 for *insulated hand tools*, 5.5.3.3 for *hybrid hand tools* and the test in 5.5.4.1 for *insulating hand tools* should be performed.

Annex E
(normative)

General type test procedure

See Table E.1.

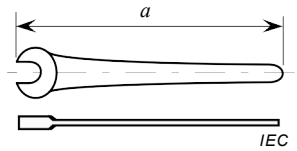
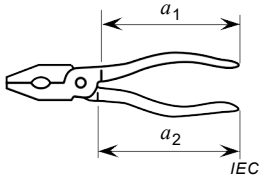
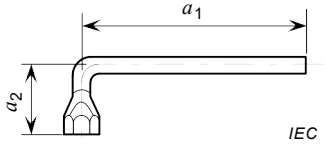
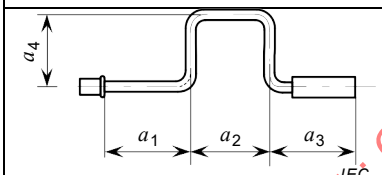
Table E.1 – Sequential order for performing type tests [a]

Sequential order[a]	Type test	Subclause	Requirements
1	Visual check	5.2	4.1.1, 4.1.4, 4.1.6, 4.4.1.2, 4.4.1.3.2, 4.4.2.4, 4.4.3
1	Dimensional check	5.3	4.1.4, 4.4
2	Impact test	5.4.1	4.2.1 and 4.2.2
	– at ambient temperature (for all *hand tools*)	5.4.1.2	
3	Impact test	5.4.1	
	– at low temperature (all *hand tools* except category "C")	5.4.1.3	
	– at extremely low temperature (*hand tools* of category "C")	5.4.1.4	
4	Dielectric testing (*insulated* or *hybrid hand tools*)	5.5.1, 5.5.2 and 5.5.3.1	4.2.1
4	Dielectric testing (*insulating hand tools*)	5.5.1, 5.5.2 and 5.5.4.1	4.2.1
5	Indentation test (*insulated hand tools*)	5.6.1	4.2.1 and 4.2.2
6	Test for adhesion of the insulating material coating (*insulated hand tools*)	5.7.1 and 5.7.2	4.2.1 and 4.2.2
	– test on the *working head* (5.7.2.1)		
	– test on the insulation of the shaft of screwdrivers (5.7.2.2)		
	– test of the insulation of the entire *hand tool* (5.7.2.3)	5.7.2.1	4.1.5
7	Test of adhesion of exposed conductive parts at the working head of *hybrid hand tools*	5.8.1	4.3
8	Mechanical tests	5.9	
	– test of insulating covers of conductive adjusting or switching elements	5.9.1.1	4.1.5
	– performance under load (*insulated hand tools*)	5.9.2.1	4.1.2
	– performance under load (*insulating* or *hybrid hand tools*)	5.9.3.1	4.1.2
	– tweezers	5.9.4	4.1.2
	– retaining force test	5.9.5	4.4.1.1
9	Durability of marking	5.10	4.1.4
10	Flame retardancy test	5.11.1	4.2.1

[a] Type tests with the same sequential number can be performed in the more convenient order.

Annex F
(normative)

Examples of calculation of the ~~unwinded~~ total linear length of ~~coating~~ insulation and acceptable leakage current (see 5.5.3.1.1)

Designations	~~Unwinded~~ Total linear length of ~~coating~~ insulation L	Limits of acceptable leakage current $I_M = 5\ L$
 Engineers' ~~wrench~~ spanner single head	$L = a$ Example: $L = a$ = 0,20 m	5 L = 1 I_M = 1 mA
 All-purpose pliers	$L = a_1 + a_2 = 2a_1$ Example: $a_1 = a_2$ = 0,14 m L = 0,28 m	5 L = 1,4 rounded to I_M = 2 mA
 Socket ~~wrench~~ spanner, single head	$L = a_1 + a_2$ Example: a_1 = 0,30 m a_2 = 0,10 m L = 0,40 m	5 L = 2 I_M = 2 mA
 Speed brace	$L = a_1 + a_2 + a_3 + 2a_4$ Example: a_1 = 0,30 m a_2 = 0,15 m a_3 = 0,15 m a_4 = 0,25 m L = 1,10 m	5 L = 5,50 rounded to I_M = 6 mA

Annex G
(normative)

Classification of defects and tests to be allocated

Annex G was developed to address the type of defects of a manufactured *hand tool* (critical, major or minor) in a consistent manner (see IEC 61318). For each requirement identified in Table G.1, both the type of defect and the associated test are specified.

Table G.1 – Classification of defects and associated requirements and tests

Requirements		Type of defects			Tests
		Critical	Major	Minor	
General (4.1)					
4.1.1	General integrity	X			5.2, 5.3
4.1.2	Performance under load				
	– *Insulated hand tools*		X		5.9.2.2
	– *Insulating* or *hybrid hand tools*		X		5.9.3.2
	– Tweezers		X		5.9.4
4.1.4	Marking				
	– Correctness			X	5.2, 5.3
	– Durability			X	5.10
4.1.5	Separating of covers	X			5.9.1.2
4.1.6	Instructions for use			X	5.2
General requirements concerning insulating materials (4.2)					
4.2.1	Resistance to electrical stress				5.5
	– *Insulated hand tools*	X			5.5.3.2
	– *Hybrid hand tools*	X			5.5.3.3
	– *Insulating hand tools*	X			5.5.4.2
4.2.1 and 4.2.2	Resistance to mechanical stress				
	– Impact resistance		X		5.4.2
	– *Insulated hand tools* – resistance to indentation		X		5.6.2
4.3	– *Insulated hand tools* – adhesion of the insulating materials		X		5.7.3
	– *Hybrid hand tools* – adhesion of conductive parts		X		5.8.2
4.2.1	Flame retardancy			X	5.11.2
Additional requirements – *Hand tools* capable of being assembled (4.4.1)					
4.4.1.1	Retaining devices			X	5.9.5
4.4.1.2	Insulation design	X			5.2
	Hand tools capable of being assembled with square drives				
4.4.1.3.1	– General requirements		X		5.3
4.4.1.3.2	– Interchangeability of components made by different manufacturers		X		5.2, 5.3, 5.9.5
4.4.1.3.2	– Instructions for use	X			5.2
Additional requirements – Screwdrivers (4.4.2)					
4.4.2.1	Un-insulated areas	X			5.3
4.4.2.2	Shape of shaft insulation	X			
4.4.2.3	Bit screwdrivers	X			5.2, 5.3
4.4.2.4	Screwdrivers with screw retaining devices	X			
Additional requirements – ~~Wrenches~~ Spanner – un-insulated areas (4.4.3)		X			5.2
Additional requirements – Adjustable ~~wrenches~~ spanner (4.4.4)		X			5.2, 5.3
Additional requirements – Pliers, strippers, cable scissors, cable-cutting hand tools (4.4.5)		X			5.2, 5.3
Additional requirements – Scissors (4.4.6)		X			5.2, 5.3
Additional requirements – Knives (4.4.7)		X			5.3

Requirements	Type of defects			Tests
	Critical	Major	Minor	
Additional requirements – Tweezers (4.4.8)	X			5.2, 5.3

Annex H
(informative)

Rationale for the classification of defects

Annex H provides the rationale for the classification of defects specified in Annex G. For brand new hand tools, Table H.1 presents the justification for the type of defect associated with a lack of compliance with each of the requirements included in this document. This analysis takes into consideration that the hand tools are used by skilled persons and in accordance with safe methods of work.

Table H.1 – Justification for the type of defect

Requirement	Justification for the associated defect specified in Annex G
Critical defects	
General integrity	Electrical hazard in the case of defects (for example lack of insulating material, significant inclusions in the insulation coating).
Separating of covers	In case of separation of covers this will result in an electrical hazard for the user.
Resistance to electrical stress – *Insulated hand tools* – *Hybrid hand tools* – *Insulating hand tools*	The good dielectric performance of the insulating material guarantees the protection of the worker during each use of the *hand tools*. Lack of dielectric properties makes the *hand tool* an electrical hazard for the worker.
Insulation design for *hand tools* capable of being assembled	Separation of parts during use of a *hand tool* may result in electrical hazards for the user.
Instructions for use for *hand tools* capable of being assembled with square drives	If no information or wrong information is provided, incorrect assembly may result, leading to hazardous conditions for the user.
Additional requirements – Screwdrivers (4.4.2) – Un-insulated areas – Shape of shaft insulation – Bit screwdrivers – Screwdrivers with screw retaining devices	Electrical hazard for the user.
Additional requirements – Spanner – un-insulated areas (4.4.3)	A too wide un-insulated area can increase electrical hazards to the user.
Additional requirements – Adjustable spanner (4.4.4)	A too wide un-insulated area can increase electrical hazards to the user. The absence of guard can lead to a hazardous situation.
Additional requirements – Pliers, strippers, cable scissors, cable-cutting *hand tools* (4.4.5)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Scissors (4.4.6)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Knives (4.4.7)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Tweezers (4.4.8)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.

Requirement	Justification for the associated defect specified in Annex G
Major defects	
Performance under load	The deformation or breaking of the *hand tools* under load makes them unusable.
Resistance to mechanical stress – *Insulated hand tools* – adhesion of the insulating materials – *Hybrid hand tools* – adhesion of conductive parts	Defect is likely to be detected by the user – the worker will stop using the *hand tool*.
For hand tools capable of being assembled with square drives – General requirements – Interchangeability of components made by different suppliers	Defect is likely to be detected by the user – the worker will stop using the *hand tool*.
Resistance to mechanical stress – Impact resistance – *Insulated hand tools* – resistance to indentation	Defect is likely to be detected by the user during the visual inspection before use – the worker will not use the *hand tool*.
Minor defects	
Flame retardancy	The effect of flames on insulated tools already results from an accident at work (electric arc) and is not a normal working condition of live working. The flame retardancy of insulating materials is only to minimize the effects of otherwise created hazards.
Correctness of marking	Wrong information will not result in a hazardous situation for the user.
Durability of marking	As long as the worker can read the marking, the *hand tools* can be used.
Instructions for use (availability)	Without information the skilled worker can use the *hand tools*.
Retaining devices for tools capable of being assembled	In case of separation of the assembly, the worker can use it again after being re-assembled.

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at http://www.electropedia.org)

IEC 60743, *Live working – Terminology for tools, devices and equipment*

ISO 1703, *Assembly tools for screws and nuts – Designation and nomenclature*

ISO 5742, *Pliers and nippers – Nomenclature*

ISO 5744, *Pliers and nippers – Methods of test*

ISO 8979, *Pliers and nippers for electronics – Nomenclature*

IEC 60900

Edition 4.0 2018-06

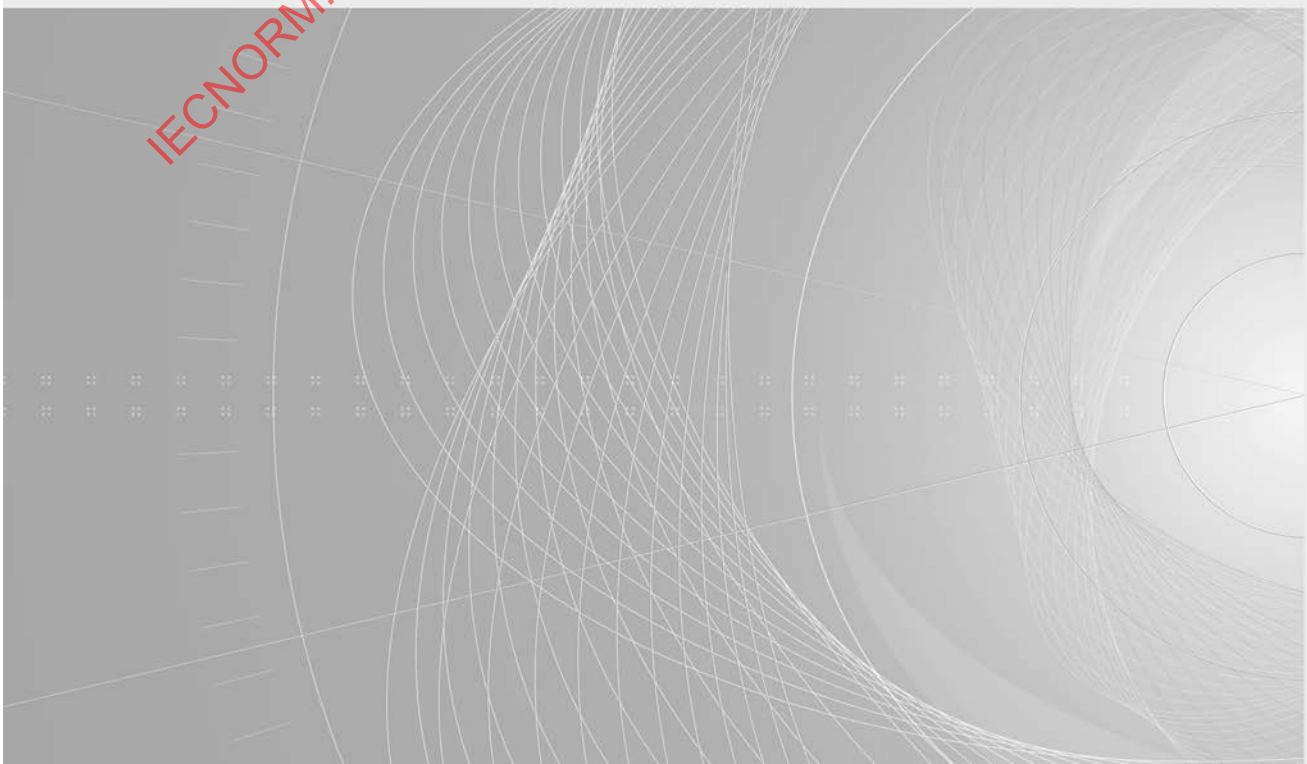
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Live working –
Hand tools for use up to 1 000 V AC and 1 500 V DC

Travaux sous tension –
Outils à main pour usage jusqu'à 1 000 V en courant alternatif et 1 500 V en courant continu



IEC 60900:2018-06(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LIVE WORKING – HAND TOOLS FOR USE UP TO 1 000 V AC AND 1 500 V DC

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International Standard IEC 60900 has been prepared by IEC technical committee 78: Live working.

This fourth edition cancels and replaces the third edition, published in 2012. This edition constitutes a technical revision.

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

a) addition of a third category of tools has been added, namely *hybrid hand tools*;
b) introduction of a new informative Annex A on examples of *insulated*, *insulating* and *hybrid hand tools*.

The text of this standard is based on the following documents:

FDIS	Report on voting
78/1221/FDIS	78/1229/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

Terms defined in Clause 3 are given in *italic* print throughout this document.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

The contents of the corrigenda of January 2019 and May 2020 have been included in this copy.

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

This document has been prepared in accordance with the requirements of IEC 61477 where applicable.

The products covered by this document may have an impact on the environment during some or all stages of its life cycle. These impacts can range from slight to significant, be of short-term or long-term duration, and occur at the global, regional or local level.

This document does not include requirements and test provisions for the manufacturers of the products, or recommendations to the users of the products for environmental improvement. However, all parties intervening in their design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

LIVE WORKING – HAND TOOLS FOR USE UP TO 1 000 V AC AND 1 500 V DC

1 Scope

This document is applicable to *insulated*, *insulating* and *hybrid hand tools* used for working live or close to live parts at nominal voltages up to 1 000 V AC and 1 500 V DC.

The products designed and manufactured according to this document contribute to the safety of the users provided they are used by skilled persons, in accordance with safe methods of work and the instructions for use (where appropriate).

2 Normative references

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

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60417, *Graphical symbols for use on equipment* (available at: http://www.graphical-symbols.info/equipment)

IEC 61318, *Live working – Conformity assessment applicable to tools, devices and equipment*

IEC 61477, Live working – *Minimum requirements for the utilization of tools, devices and equipment*

ISO 1174-1, *Assembly tools for screw and nuts – Driving squares – Part 1: Driving squares for hand socket tools*

ISO 9654, *Pliers and nippers for electronics – Single-purpose nippers – Cutting nippers*

ISO 9655, *Pliers and nippers for electronics – Single-purpose pliers – Pliers for gripping and manipulating*

ISO 9656, *Pliers and nippers for electronics – Test methods*

ISO 9657, *Pliers and nippers for electronics – General technical requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61318 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE The definitions of general terms used in this document are given in IEC 60050 or in special definitions given in IEC 60743.

3.1
hand tool
hand held tool

Note 1 to entry: *Hand tools* may be *insulated hand tools*, *insulating hand tools* or *hybrid hand tools* (see Annex A).

Note 2 to entry: *Hand tools* are normally tools such as screwdrivers, pliers, spanners or knives.

Note 3 to entry: *Hand tools* are designed to provide protection to the worker against electric shock.

[SOURCE: IEC 60050-651:2014, 651-21-19, modified – Note 1 to entry has been modified to refer to Annex A.]

3.1.1
hybrid hand tool
hand tool made from insulating material(s) with exposed conductive parts at the *working head*

Note 1 to entry: *Hybrid hand tools* may have some non-exposed conductive parts used for reinforcement.

[SOURCE: IEC 60050-651:2014, 651-21-22]

3.1.2
insulated hand tool
hand tool made of conductive material(s), fully or partially covered by insulating material(s)

[SOURCE: IEC 60050-651:2014, 651-21-20]

3.1.3
insulating hand tool
hand tool made totally or essentially from insulating material(s) except for inserts made from conductive material(s) used for reinforcement, but with no exposed conductive parts

[SOURCE: IEC 60050-651: 2014, 651-21-21,]

3.2
working head
part of the tool head that is limited to the working surface and the contact area

Note 1 to entry: See Figures 5 and 7.

4 Requirements

4.1 General requirements

4.1.1 Safety

Insulated, insulating and *hybrid hand tools* shall be manufactured and dimensioned in such a way that they protect the user from electric shock.

NOTE 1 *Insulating hand tools* minimize the risk of short-circuits between two parts at different potentials.

NOTE 2 *Hybrid hand tools* reduce the risk of short-circuits between two parts at different potentials.

NOTE 3 *Insulated hand tools*, completely covered by insulating material, except the conductive part of the working surface, reduce the risk of short-circuits between two parts at different potentials.

The following requirements have been prepared in order that the *hand tools* covered by this document are designed and manufactured to contribute to the safety of the users, provided they are used by persons skilled for live working, in accordance with safe methods of work and the instructions for use (where appropriate).

4.1.2 Performance under load

The mechanical specifications for *insulated hand tools* shall comply with the corresponding ISO standards, or, where no ISO standard exists, with a standard specified by the manufacturer or the customer (for example a national standard). The mechanical specifications for the working parts of the *hand tools* shall be retained even after application of an insulating layer.

Insulating and *hybrid hand tools* specially designed for live working may have lower stress resistance than *insulated hand tools*, but they shall withstand the expected workloads without failing due to remaining deformation or breaking. These *hand tools* can be equipped with devices that limit the workloads that can be applied with them, for example by overload slipping clutches (see also Annex B).

4.1.3 Multiple-ended hand tools

Multiple-ended *hand tools*, such as box spanner, keys for hexagonal socket screws, double-ended socket-spanner, double-head open-end spanner, etc., are not allowed for *insulated hand tools* but are allowed for *insulating* or *hybrid hand tools* if the design assures that there is no conductive connection between two of the *working head*s.

4.1.4 Marking

The marking shall be clearly identifiable by persons with normal or corrected sight without further magnification.

Each *hand tool* and/or tool component shall be legibly and permanently marked with the following items of marking:

- on the insulating material or on the metal part:
  - marking of the origin (manufacturer's name or trade mark);
- on the insulating material:
  - model/type reference;
  - year of manufacture (at least the last two digits of the year);
  - symbol IEC 60417-5216:2002-10 – Suitable for live working; double triangle (see Annex C);

    NOTE For the symbol, the exact ratio of the height of the figure to the base of the triangle is 1,43:1. For the purpose of convenience, this ratio can be between the values of 1,4 and 1,5.
  - indication 1 000 V (i.e. the electrical working limit for alternating current), immediately adjacent to the double triangle symbol (see Figure 1 for an example);

IEC

Figure 1 – Marking of the electrical working limit adjacent to the double triangle symbol (IEC 60417-5216:2002-10)

- number of the relevant IEC standard immediately adjacent to the double triangle symbol (IEC 60900);
- for *hand tools* designed for use at extremely low temperature: letter “C” (see 4.2.2);
- additional marking for *hand tools* capable of being assembled and designed to be interchangeable between different manufacturers (see 4.4.1.3.2);
- additional marking where specified by the customer (for example ownership mark).

The *hand tools* shall bear no voltage marking apart from those described above.

NOTE For example, the indication of test voltage may lead to the assumption that the *hand tool* is suitable for work at that voltage.

Other characteristics or information not needed at the work location, like the year of publication of the standard and the type of *hand tool*, shall be associated to the product item by other means, such as coded information (bar codes, microchips, etc.), or shall be associated to its packaging.

The double triangle symbol shall be at least 3 mm high; the letter and the figures of the electrical working limit shall be at least 2 mm high (see Figure 1).

4.1.5 Separating of covers

If *hand tools* have conductive elements (for example: torque adjusting screws, operating direction switches, etc.) which are insulated with covers of insulating materials, these covers shall be securely fastened, so that they do not become separated during normal use (see 5.9.1).

4.1.6 Instructions for correct adjustment and assembly

Where the manufacturer deems that instructions are necessary for correct adjustment or assembly, then the manufacturer shall provide these in accordance with the general provisions given in IEC 61477 (see also Annex D).

4.2 Requirements concerning insulating materials

4.2.1 General

The insulating material shall be selected according to the electrical, mechanical and thermal stresses to which it may be exposed during use. In addition, the insulating material shall have an adequate resistance to ageing and be flame retardant.

The insulating coating may consist of one or more layers. If two or more layers are adopted, contrasting colours may be used.

The design and construction of the handles shall provide a secure handhold and prevent unintentional hand slipping. The handle and guard dimensions given in different figures are applicable to all types of *hand tools* in order to define the handling zone.

4.2.2 Thermal stability

The service ability of the *hand tools* shall not be impaired within the temperature range −20 °C to +70 °C.

The insulating material applied on *hand tools* shall adhere securely to the conductive part from −20 °C to +70 °C.

Hand tools intended for use at extremely low temperatures (down to −40 °C) shall be designated “Category °C” and shall be designed for this purpose.

4.3 Requirement concerning exposed conductive parts of hybrid tools

Exposed conductive parts shall be securely fastened, so that they do not become separated during normal use (see 5.8).

4.4 Additional requirements

4.4.1 Hand tools capable of being assembled

4.4.1.1 Retaining devices for hand tools capable of being assembled

Hand tools capable of being assembled shall have suitable retaining devices to prevent unintentional separation of the assembly. The retaining forces shall be tested according to 5.9.5.

4.4.1.2 Insulation design for hand tools capable of being assembled

In the case of connecting parts of *hand tools* capable of being assembled, the insulation shall be applied in such a manner that if any part becomes detached during use by exceeding the retaining forces according to 5.9.5, no conductive part, which may still be live, can be inadvertently touched or cause a disruptive discharge.

4.4.1.3 Hand tools capable of being assembled with square drives

4.4.1.3.1 General

Hand tools capable of being assembled with square drives shall have square drives and square sockets in accordance with ISO 1174-1 (for separating forces, see 5.9.5.2). To ensure compatibility of insulation between different manufacturers, these *hand tools* shall be designed with overlapping elements described in Figure 2. Their dimensions and tolerances shall be in accordance with Table 1.

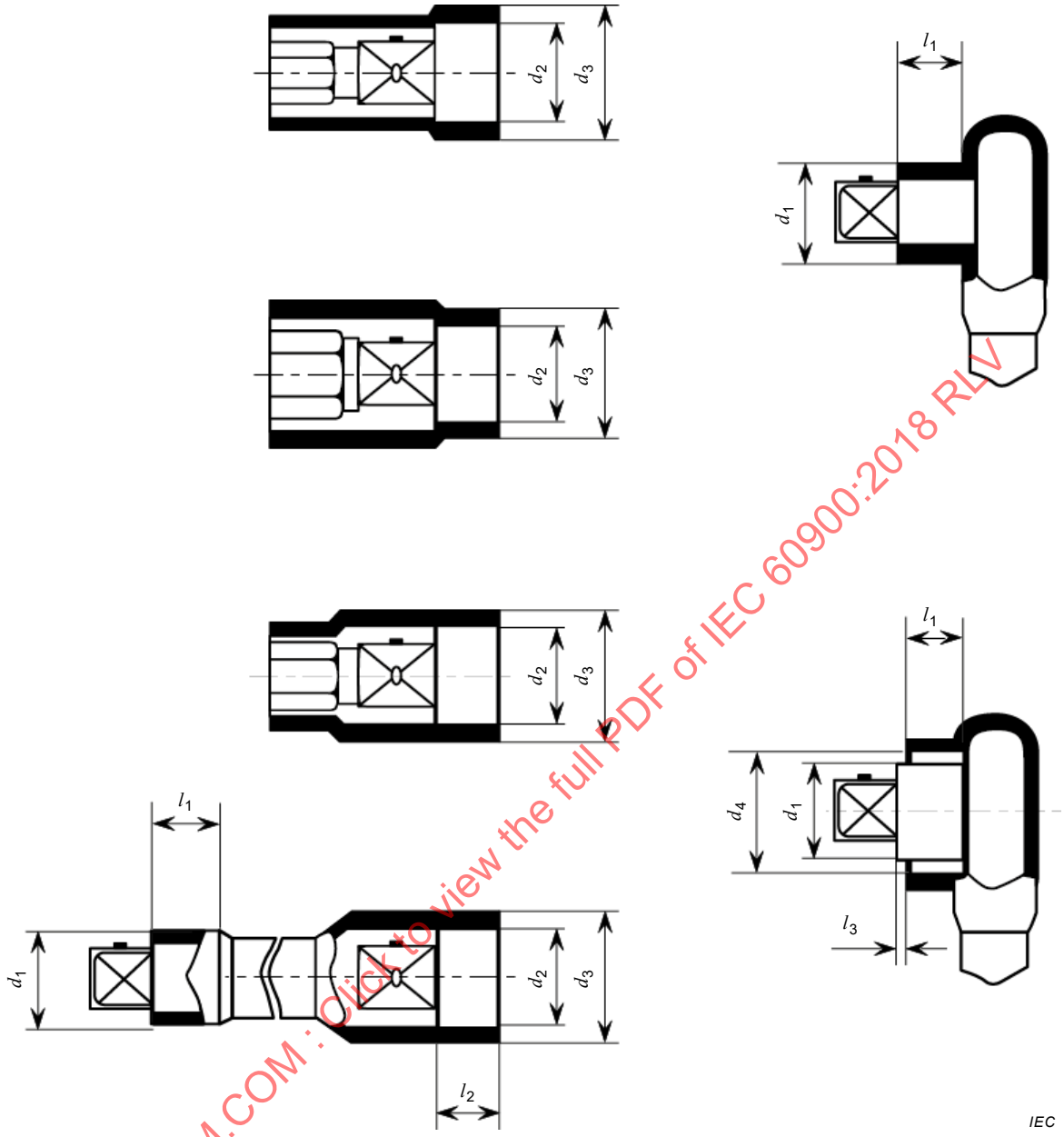


Figure 2 – Description of the insulating overlapping element and different assembly configurations for hand tools capable of being assembled with square drives

Table 1 – Dimensions and tolerances of the insulating overlapping element

Dimensions in millimetres

Nominal size of the square drive	l_1 min.	l_2 $^{+2}_{0}$	l_3 $^{+0,5}_{-0,5}$	d_1 $^{0}_{-1,5}$	d_2 $^{+1,5}_{0}$	d_3 $^{0}_{-1,5}$	d_4 $^{+1,5}_{0}$
6,3	19	16	2	12,5	13	18	19
10	19	16	2	17,5	18	23	24
12,5	19	16	2	21,5	22	27	28
20	19	16	2	32	33	38	39
l_1, l_2, l_3, d_1, d_2, d_3 and d_4 are described in Figure 2.							

4.4.1.3.2 Interchangeability of components made by different manufacturers

Hand tools capable of being assembled and designed to be interchangeable between different manufacturers shall be specifically marked as such.

The marking symbol and the dimensions are given in Figure 3. The dimension H shall be greater than or equal to 5 mm.

Dimensions in millimetres

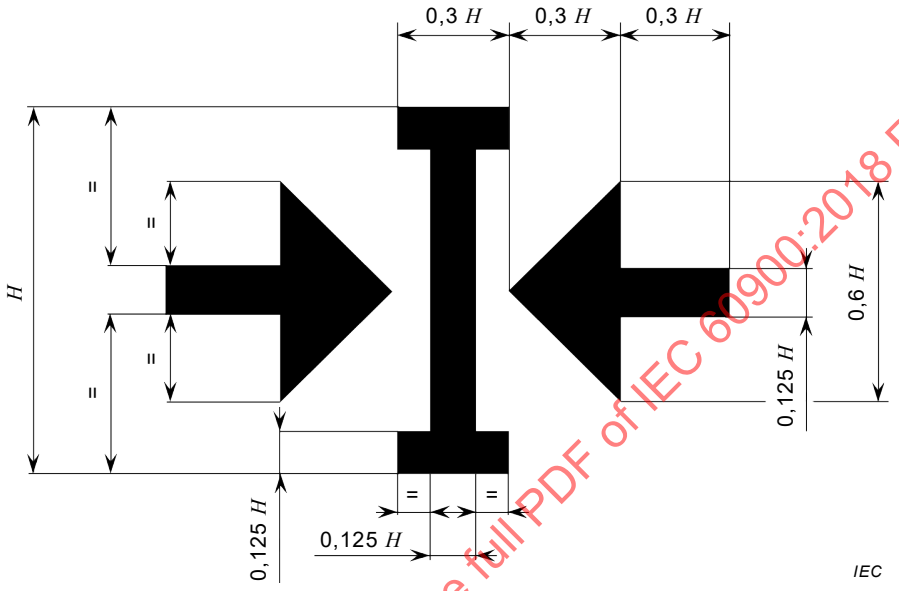


Figure 3 – Marking symbol for hand tools capable of being assembled and designed to be interchangeable between different manufacturers (IEC 60417-6168:2012-07)

The reliable function of locking systems used for these *hand tools* shall be tested by applying a separation test in accordance with 5.9.5 with a corresponding dummy.

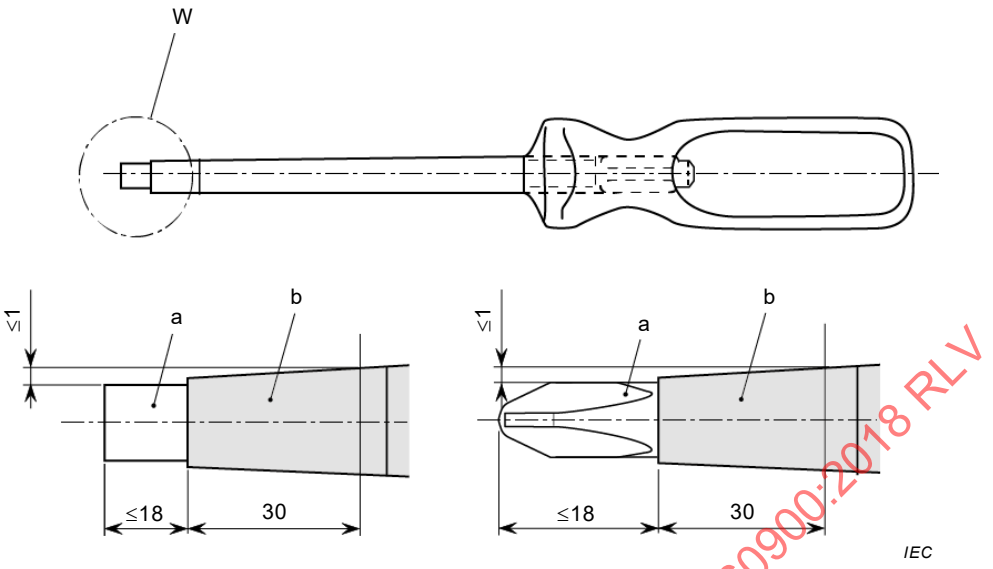
For this kind of *hand tools*, instructions for correct assembly are mandatory. The manufacturer shall include the following information: “To assure that the complete assembly of *insulated hand tool* components from different manufacturers will withstand separating forces that are expected during the intended use, prior to the use of any assembly the user shall assure, by pulling by hand in a separating direction, that the retaining devices of all used elements are working efficiently”.

4.4.2 Screwdrivers

4.4.2.1 Un-insulated areas

For insulated or hybrid screwdrivers, an un-insulated conductive area having a maximum length of 18 mm is permissible on the *working head* (see Figure 4).

Dimensions in millimetres



Key

a conductive part

b insulation

W *working head*

Figure 4 – Illustration of insulation of a typical screwdriver

4.4.2.2 Shape of shaft insulation

The shaft insulation of insulated screwdrivers shall be bonded to the handle.

The outer diameter of the insulation of insulated and hybrid screwdrivers, over a length of 30 mm, in area "W" of Figure 4, shall not exceed by more than 2 mm the width of the shaft at the tip or the width of the tip, whatever is the larger dimension. This area may be parallel or tapered towards the tip.

This requirement does not apply to insulated bit sockets (or insulated socket drivers).

4.4.2.3 Screwdrivers with exchangeable working heads

Insulated or hybrid screwdrivers with exchangeable *working head*s are regarded as *hand tools* capable of being assembled. They shall meet the relevant requirements. The outer diameter of the insulation may exceed the dimensions of 4.4.2.2.

4.4.2.4 Screwdrivers with screw retaining devices

If an insulated or hybrid screwdriver has a screw retaining device, the screwdriver itself shall meet the requirements of this document. The outer diameter of the retaining device may exceed the dimensions of 4.4.2.2. The retaining device shall be made from insulating material.

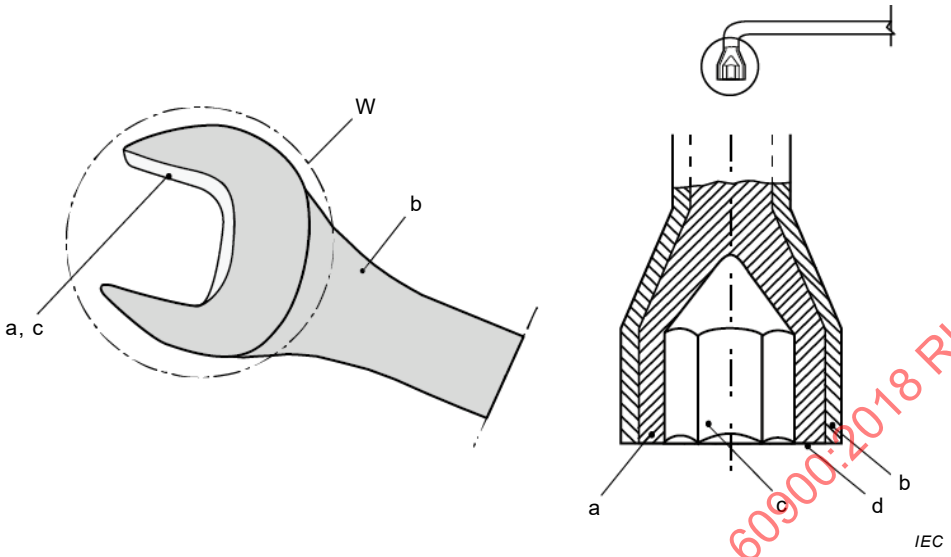
4.4.3 Spanners – un-insulated areas

The following un-insulated areas on the *working head* of insulated and hybrid spanners are permissible (see Figure 5):

- single headed spanner: the working surface;

NOTE At the request of the customer, the un-insulated area can be extended to the *working head*.

- ring spanner, socket-spanner, T spanner: the working surface and the contact area.



Key

a conductive part
b insulation
c working surface
d contact area
W *working head*

Figure 5 – Illustration of insulation of typical spanners

4.4.4 Adjustable spanners

The insulation of insulated adjustable spanners shall be applied as far as possible towards the *working head*. The un-insulated area may be extended to the *working head*. If the *working head* remains un-insulated, a guard shall be applied so that the hand is prevented from slipping towards the uncovered conductive parts of the head. For the minimum dimensions of the guards, see Figure 6.

In the case of hybrid adjustable spanners where there are more uncovered conductive parts than the working surface at the head, a guard shall be applied.

Dimensions in millimetres

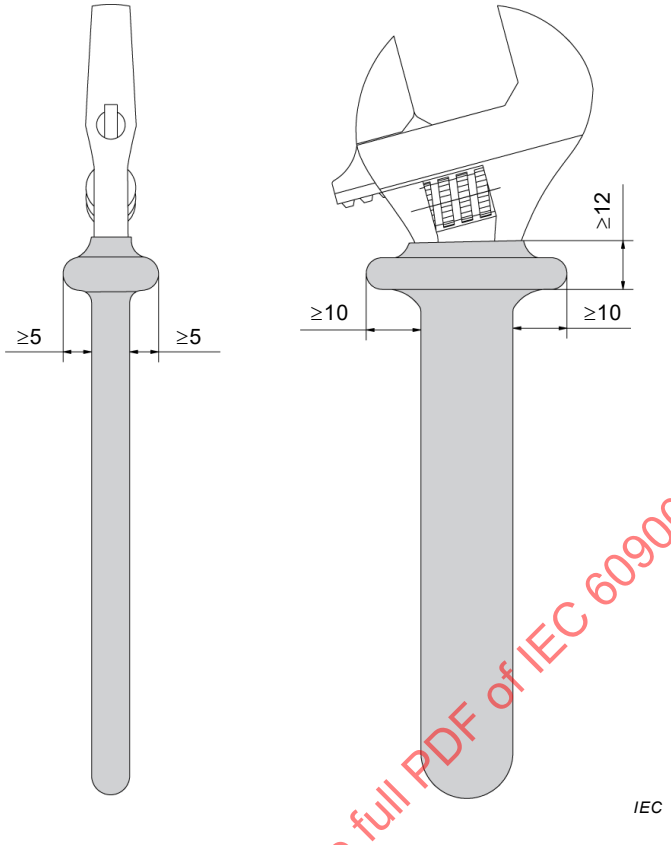
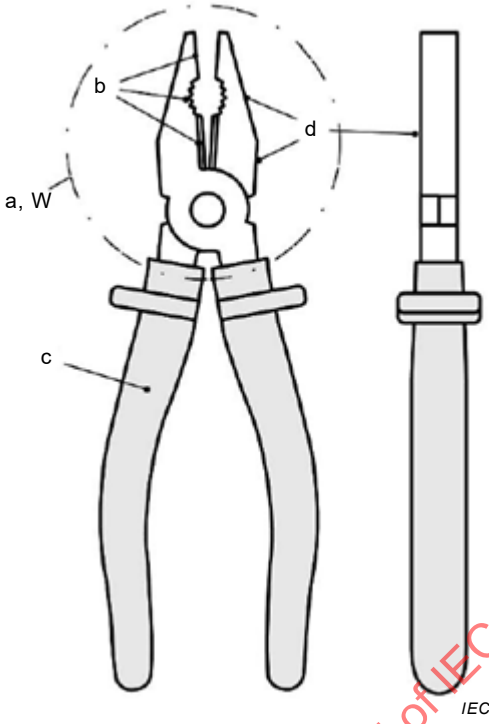


Figure 6 – Insulated or hybrid adjustable spanner

4.4.5 Pliers, strippers, cable scissors, cable-cutting hand tools

The handle insulation of such *insulated* or *hybrid hand tools* shall have a guard so that the hand is prevented from slipping towards the uncovered conductive parts of the head (see Figure 7 as an example).



Key

a conductive part

b working surface

c insulation

d contact area

W *working head*

Figure 7 – Illustration of insulation of typical pliers

The height of the guard shall be sufficient to prevent the slipping of the fingers towards the uncovered conductive parts during the work.

For pliers, the minimum dimensions of the guard shall be (see Figures 8, 9 and 10 as an example):

- 10 mm on the left and on the right of the pliers held on a flat surface;
- 5 mm on the upper and lower part of the pliers held on a flat surface.

The minimum insulated distance between the inner edge of each guard and any non-insulated parts shall be 12 mm (see Figures 8, 9, 10 and 11). The insulation portion in front of the guard shall extend as far as possible towards the *working head*.

Dimensions in millimetres

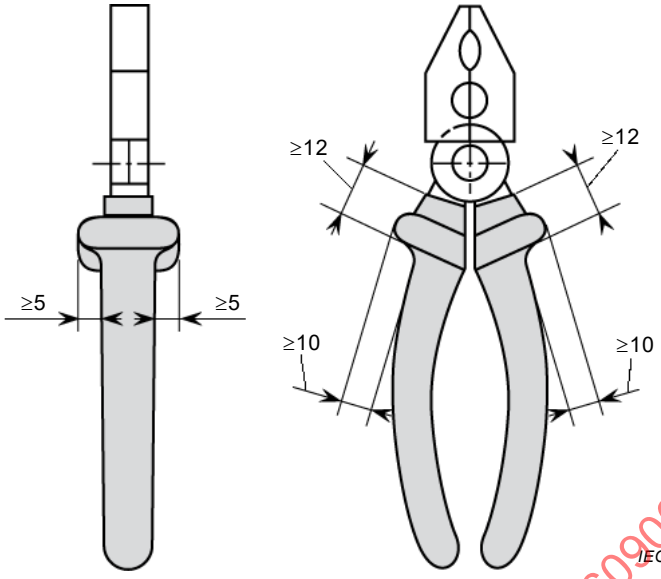


Figure 8 – Insulation of pliers

In the case of a slip joint, a guard of 5 mm shall be provided for the inner part of the handles. Refer to Figure 9 for further dimensioning.

Dimensions in millimetres

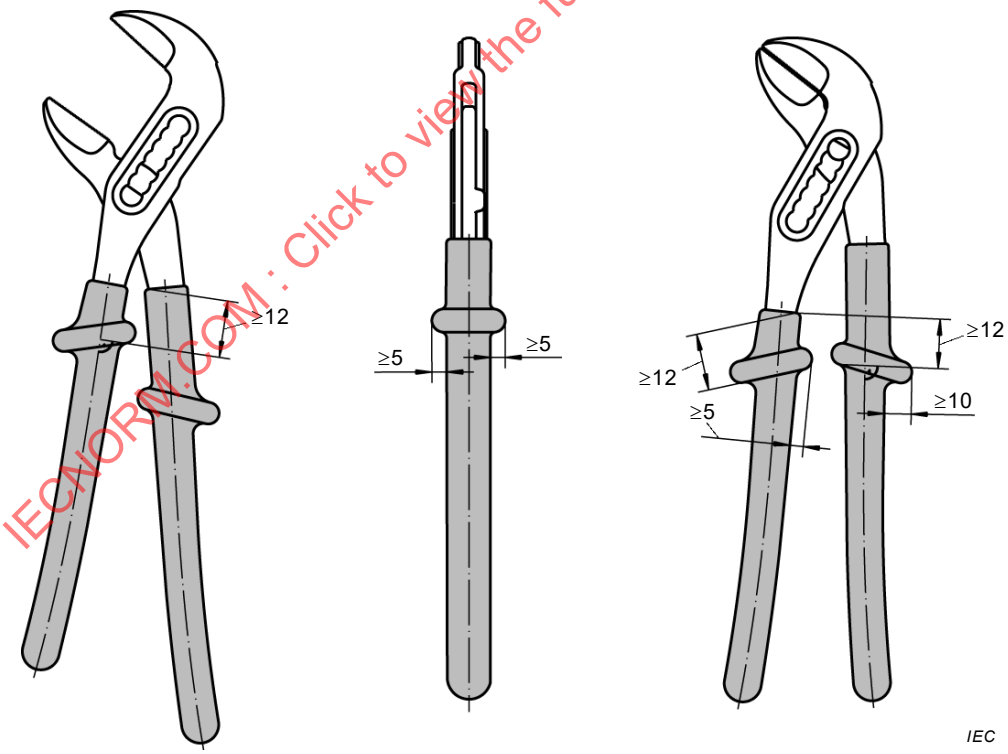


Figure 9 – Insulation of multiple slip joint pliers

Where there is a functional surface below the joint, an inner guard shall be provided (as used with multiple slip joint pliers). See Figure 10.

Dimensions in millimetres

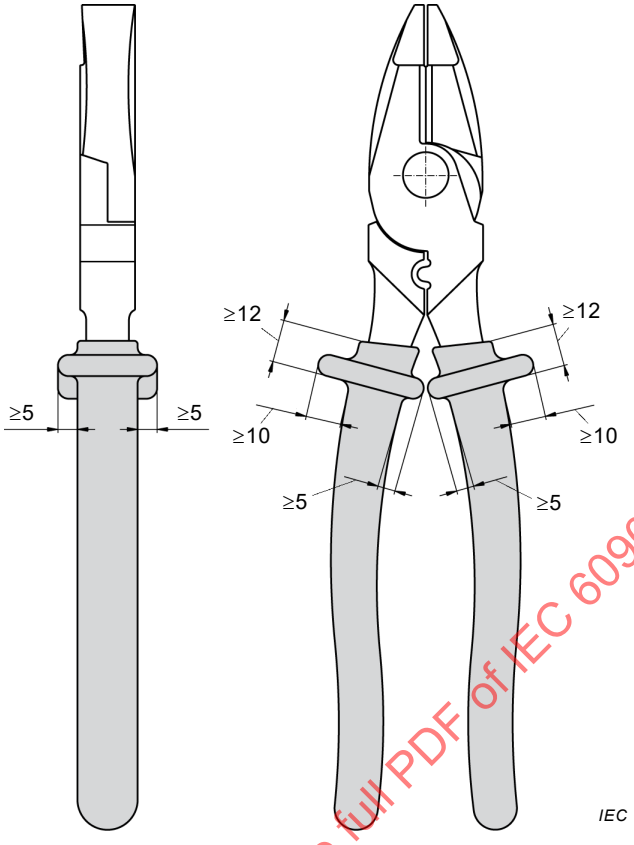


Figure 10 – Insulation of pliers with a functional area below the joint

Where the handles of the *hand tools* are longer than 400 mm, a guard is not required.

In the case of insulated pliers and nippers for electronics, the dimensions of the guard shall be at least:

- 5 mm on left and right of the pliers held on a flat surface;
- 3 mm on the upper part and the lower part of the pliers held on a flat surface.

The minimum insulated distance between the inner edge of the guard and the non-insulated part shall be 12 mm. The insulation portion in front of the guard shall extend as far as possible towards the *working head* (see Figure 11).

Insulated pliers and nippers for electronics shall be in accordance with ISO 9656 and ISO 9657 and, where relevant, with ISO 9654 or ISO 9655

Dimensions in millimetres

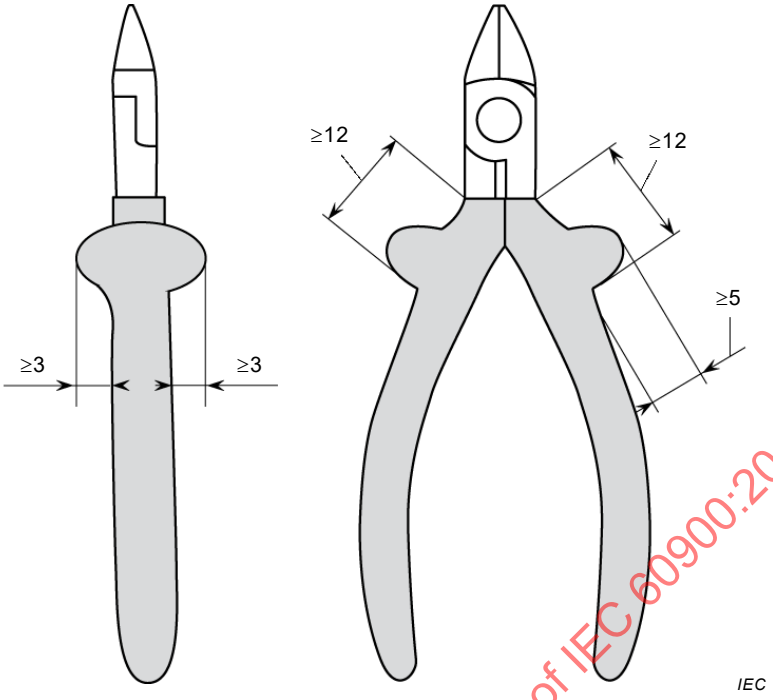


Figure 11 – Illustration of insulation of pliers and nippers for electronics

4.4.6 Scissors

A typical insulation of insulated scissors is shown in Figure 12.

The shackles of the scissors shall have the design presented in Figure 12a or the design presented in Figure 12b.

The maximum length of the un-insulated parts of scissors shall not exceed 100 mm.

The insulation portion in front of the guard shall extend as far as possible towards the *working head*. If the insulated length in front of the shackle is less than 50 mm, at least one guard is required.

Dimensions in millimetres

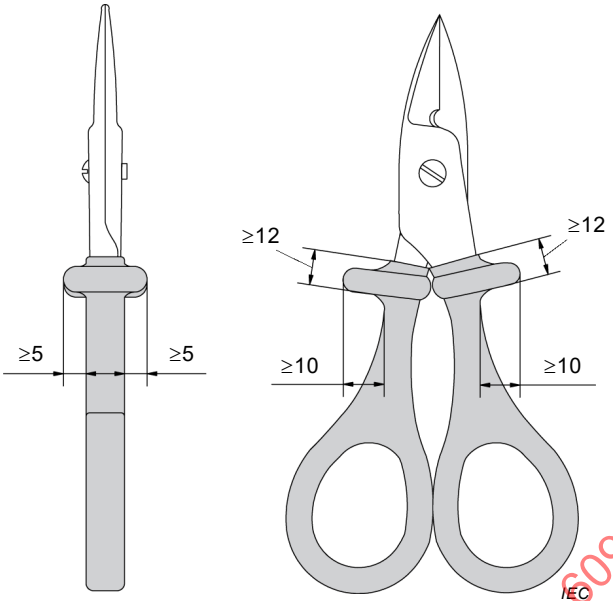


Figure 12a

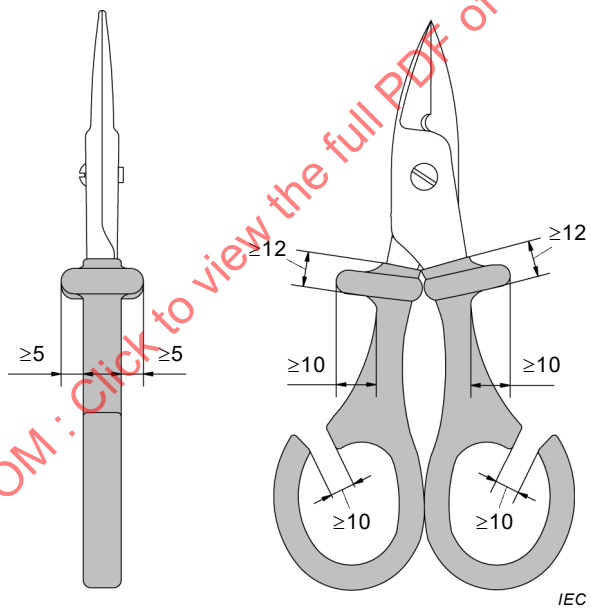


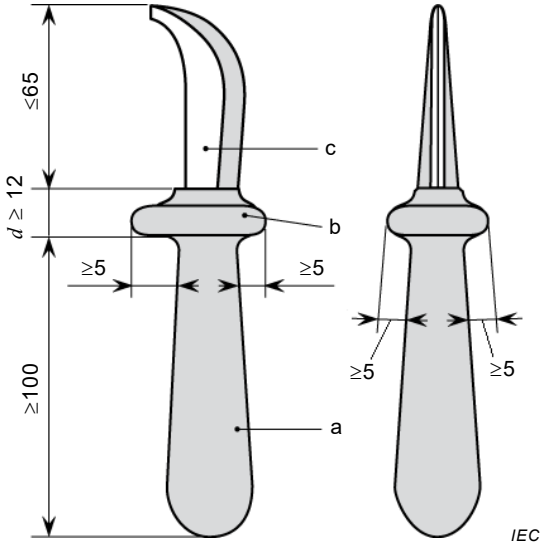
Figure 12b

Figure 12 – Insulation of scissors

4.4.7 Knives

Figure 13 shows an example for the application of the insulation of insulated or hybrid knives. The dimensions of insulated or hybrid knives shall be in accordance with Figure 13.

Dimensions in millimetres



Key

a insulation

b guard

c cutting blade (not insulated)

d distance between the inner edge of the guard and the non-insulated part

Figure 13 – Insulation of knives

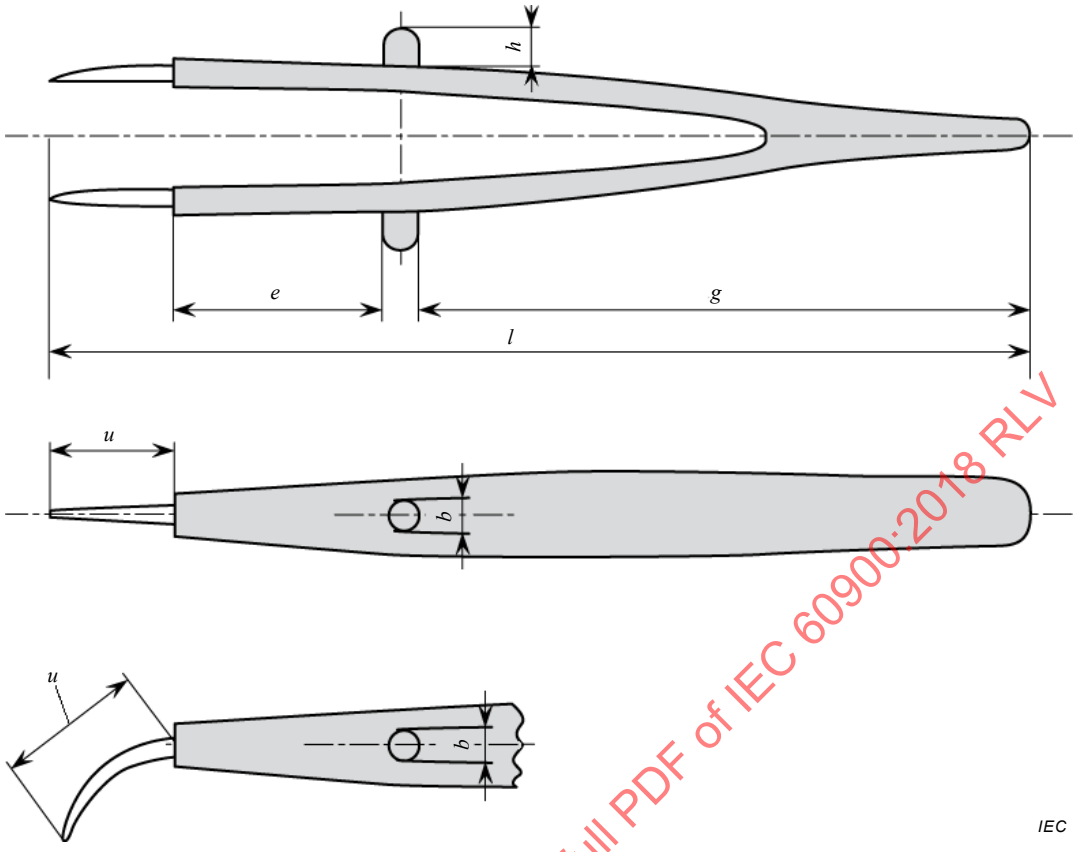
4.4.8 Tweezers

The total length l of tweezers shall be 130 mm minimum and 200 mm maximum. The length of the handles g shall be 80 mm minimum (see Figure 14).

Both handles of the tweezers shall have a guard towards the *working head*. The guard shall not be movable. Its height h and width b shall be sufficient (5 mm minimum) to prevent any slipping of the fingers during the work towards the un-insulated length u of the *working head*. On both handles, the insulated or insulating length e between the guard and the *working head* shall be 12 mm minimum and 35 mm maximum (see Figure 14).

The un-insulated length u of the *working head* shall not exceed 20 mm (see Figure 14).

In the case of tweezers with a metallic *working head*, the metallic part shall have a minimum hardness of 35 HRC at least from the *working head* up to the handles.



Key

l total length of the tweezers

g length of the handle (grip)

b width of the guard

h height of the guard

e insulated or insulating part of the handle between the guard and the *working head*

u *working head* (insulated or not)

Figure 14 – Example of insulation of the handles of tweezers

5 Tests

5.1 General

This document provides testing provisions to demonstrate compliance of the product to the requirements of Clause 4. These testing provisions are primarily intended to be used as type tests for validation of the design input. Where relevant, alternative means (calculation, examination, tests, etc.) are specified within the test subclauses for the purpose of *hand tools* having completed the production phase.

The type tests specified in 5.2 to 5.11 shall be carried out on at least three *hand tools* of the same design and in the sequence specified in Annex E.

Should a *hand tool* fail any part of the type test, the type test shall be repeated on at least six further *hand tools* of the same design. Should any one of these six *hand tools* fail any part of the type test, the whole test shall be regarded as having been failed.

All *hand tools* that have failed the type test shall be either destroyed or rendered unsuitable for use in live working.

Unless otherwise stated, the type tests shall be carried out after a minimum storage time of 16 h under IEC climatic conditions, 23 °C ± 5 °C, relative humidity 45 % to 75 % (see IEC 60212, "standard ambient").

Unless otherwise stated, tolerances of ± 5 % from any type test values required are permissible.

5.2 Visual check

The *hand tool* (in particular the insulation) shall be visually checked and shall be free from external defects.

The marking shall be checked for legibility and completeness in accordance with 4.1.4.

The compliance with the relevant complementary requirements of the following subclauses shall be checked by visual inspection:

- subclause 4.4.1.2, in the case of connecting parts of *hand tools* capable of being assembled;
- subclause 4.4.1.3.2 for instructions for use in the case of *hand tools* capable of being assembled and designed to be interchangeable between different manufacturers;
- subclause 4.4.2.4 for the type of material of the screw retaining devices of screwdrivers;
- subclause 4.4.3 for un-insulated areas of spanners.

5.3 Dimensional check

The dimensional requirements of 4.4 shall be checked. The dimensions of certain elements of marking shall be checked according to 4.1.4.

5.4 Impact tests

5.4.1 Type test

5.4.1.1 General

The test shall be carried out according to one of the two methods shown in Figures 15 and 16. In case of doubt, method "B" applies (see Figure 16).

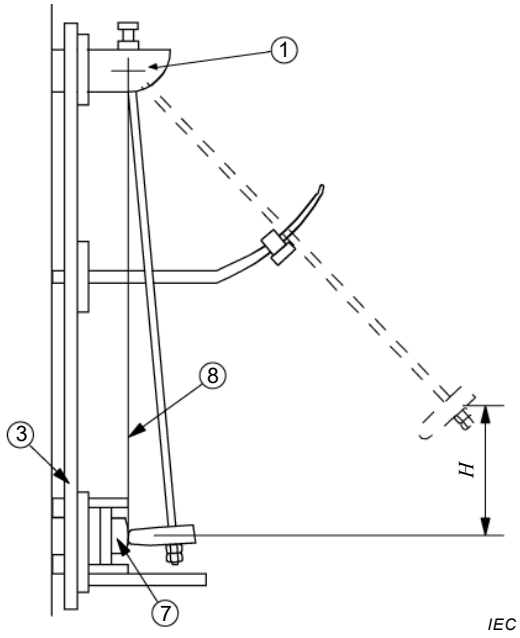
In the case of *hand tools* capable of being assembled, the tool components shall be tested separately.

The hammer used in the apparatus of Figure 15 and the hammer and intermediate piece used in the apparatus of Figure 16 shall be made of steel with hardness between 20 HRC and 46 HRC.

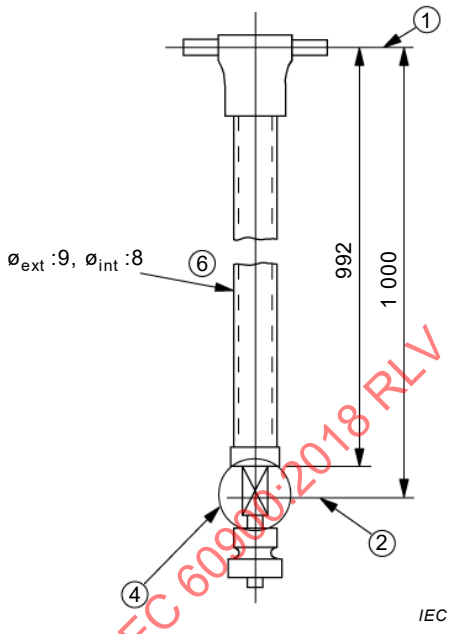
At least three points of the insulating material or insulating layer shall be selected as testing points, these being points which could be damaged when the *hand tool* drops on a flat surface.

The test shall be considered as passed if the insulating material shows no breaks, peeling, or cracks. Any other visible or non-visible defects caused by the impact tests will be verified by the dielectric tests in 5.5.

Dimensions in millimetres

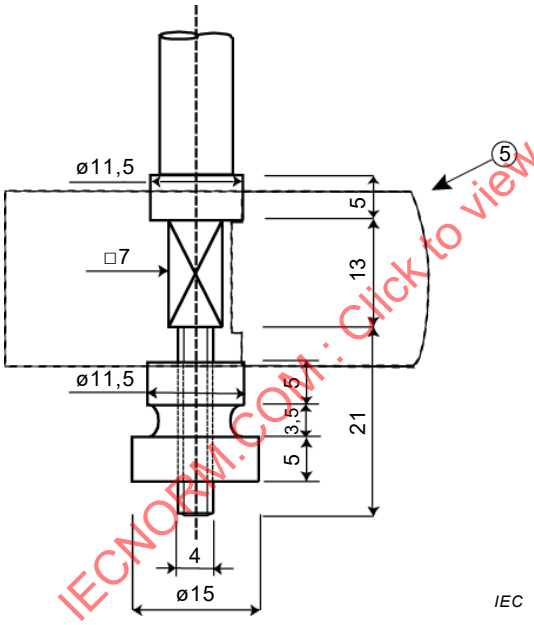


Side view

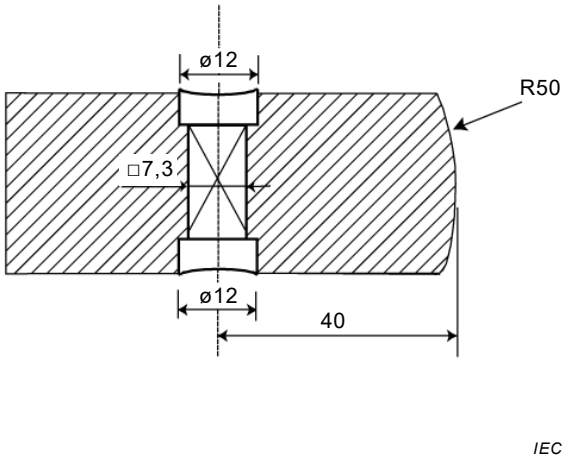


Front view

Dimensions in millimetres



Detail of the assembly of hammer



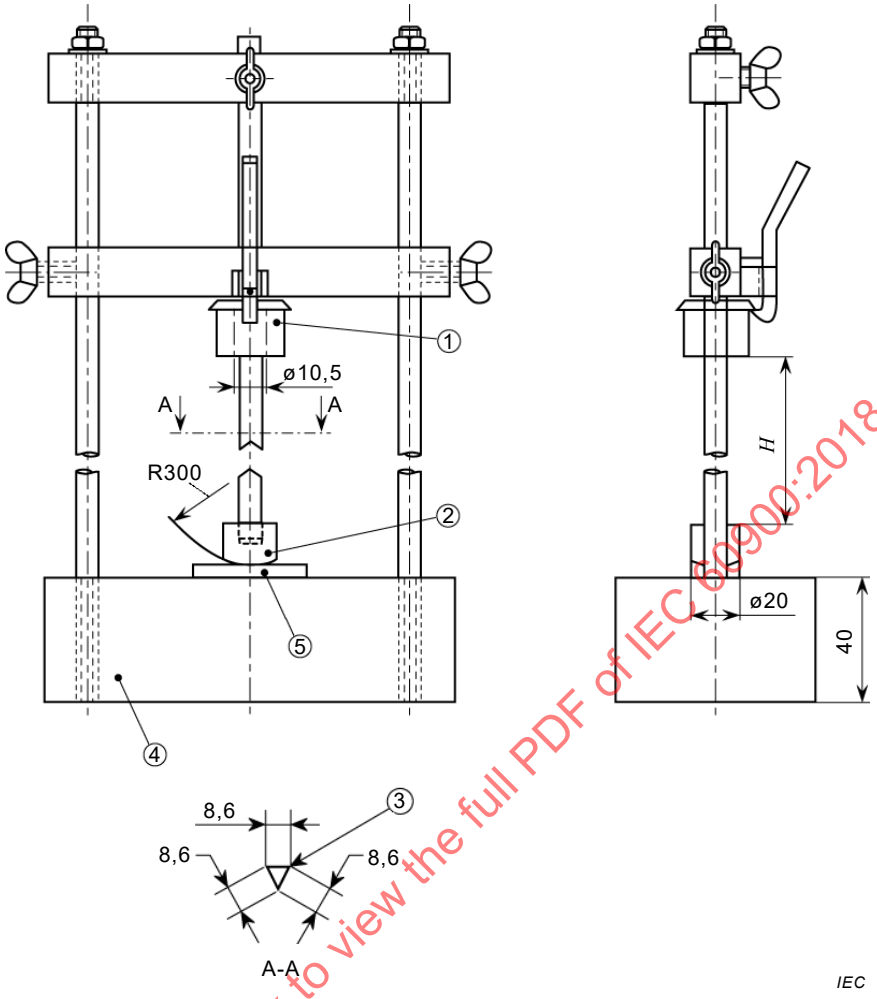
Detail of hammer head

Key

1	axis of swing adjustable	5	hammer head – Rockwell hardness of material between 20 HRC and 46 HRC
2	neutral axis of hammer	6	steel tube
H	fall height	7	test piece
3	frame	8	vertical plane through axis of pendulum
4	hammer		

Figure 15 – Example of test arrangement for the impact test – Method A

Dimensions in millimetres



Key

H	fall height
1	hammer
2	steel intermediate piece 100 g
3	slightly rounded edges
4	steel part 10 kg
5	test piece

Figure 16 – Example of test arrangement for the impact test – Method B

5.4.1.2 Ambient temperature impact test

The *hand tool* shall be tested at the ambient temperature, 23 °C ± 5 °C, of the test room.

The height of fall H of the hammer shall be determined as a function of its weight P, so that the energy W of impact on the *hand tool* to be tested shall be equal to that of this tool falling on a hard surface from a height of 2 m:

$$H = \frac{W}{P} = \frac{2 \times F}{P}$$

where

H is the height of fall of the hammer, in metres;

F is the weight of the *hand tool* tested, in newtons;

P is the weight of the hammer, in newtons.

5.4.1.3 Low temperature impact test

Hand tools, excluding those of category "C", shall be conditioned in a cooling chamber for 2 h at –25 °C ± 3 °C. The impact test shall start 120 s after removal from the cooling chamber. The ambient temperature of the test room shall be 23 °C ± 5 °C.

The height of fall H of the hammer shall be determined as a function of its weight P, so that the energy W of impact on the *hand tool* to be tested shall be equal to that of this tool falling on a hard surface from a height of 0,6 m:

$$H = \frac{W}{P} = \frac{0{,}6 \times F}{P}$$

where

H is the height of fall of the hammer, in metres;

F is the weight of the *hand tool* tested, in newtons;

P is the weight of the hammer, in newtons.

5.4.1.4 Extreme low temperature impact test

Hand tools of category "C" shall be conditioned in a cooling chamber for 2 h at –40 °C ± 3 °C.

The impact test shall be carried out according to 5.4.1.3.

5.4.2 Alternative methods in cases where hand tools have completed the production phase

For conformity evaluation of *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the impact resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5 Dielectric tests

5.5.1 General requirements

For tests to be carried out according to IEC 60060-1, the test voltage shall be increased and reduced at a uniform rate of approximately 1 000 V/s.

The dielectric testing shall be started at the latest 5 min after conditioning is completed.

5.5.2 **Conditioning** (for type test only)

5.5.2.1 General

Before testing (according to 5.5.3 or 5.5.4), the *hand tools* shall be conditioned in accordance with one of the two possibilities described in 5.5.2.2 and 5.5.2.3.

5.5.2.2 Water bath

The *hand tools* shall be totally immersed in a bath of tap water at room temperature as specified in 5.1 (23 °C ± 5 °C) for 24 h ± 0,5 h. The water shall have a minimum conductivity of 100 µS/cm. After this conditioning, the *hand tools* shall be wiped dry and submitted to the dielectric test.

5.5.2.3 Wet chamber

The hand tools shall be stored at a relative humidity of (93 ± 2) % at a temperature of 23 °C ± 5 °C for 48 h. Hand tools capable of being assembled shall not be assembled prior to conditioning.

NOTE This humidity conditioning can be obtained by storing the *hand tools* in a closed chamber which contains a saturated solution of sodium sulphate decahydrate $Na_2 SO_4 10H_2O$ (Glauber's salt) having a large exposed surface.

5.5.3 Dielectric testing of insulated and hybrid hand tools

5.5.3.1 Type test

5.5.3.1.1 General

The *hand tool* shall be immersed in a bath of tap water up to a level of 24 mm ± 2 mm from the nearest non-insulated part. The water shall have a minimum conductivity of 100 µS/cm. The accessible conductive part shall be above the water level (see Figure 17).

Pliers and similar *hand tools* shall be tested in such a position that the gap d between the two inner sides of the handles is 2 mm to 3 mm, or the minimum possible by the tool's construction but not less than 2 mm (see Figure 17).

For *hand tools* capable of being assembled and for those tools where the design does not allow testing in a water bath, the water bath shall be replaced by a bath of nickel stainless steel balls 3 mm in diameter (measured with normal industrial tolerances).

A test voltage of 10 kV rms at 50 Hz or 60 Hz shall then be continuously applied between the accessible conductive parts and the water bath / steel ball bath for a test period of 3 min according to IEC 60060-1. The current is measured during the test period, either continuously or at the end of the period.

For insulated tools this current shall be smaller than 1 mA rms for 200 mm of the insulation. This corresponds to a maximum value of the leakage current of:

$$I_M = 5\ L$$

where

I_M is the maximum leakage current (in milliamperes rms) rounded to the upper value in milliamperes;

L is the total linear length (in metres) of insulation rounded to the lower value in centimetres.

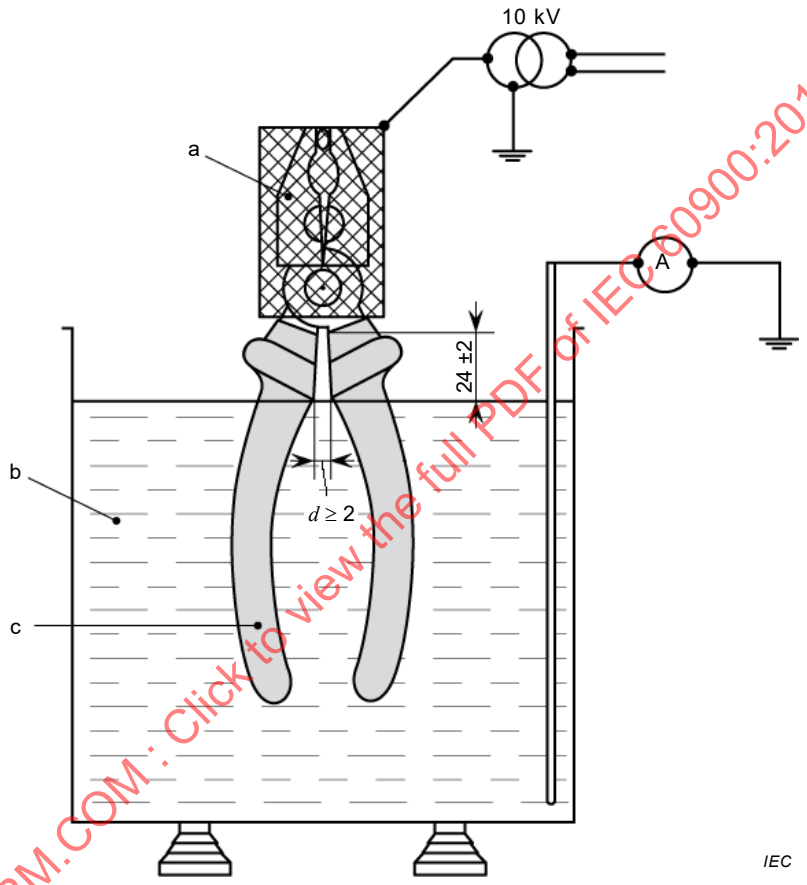
NOTE Annex F gives examples of calculation of the total linear length of insulation and the limits of acceptable leakage current.

For hybrid tools the current shall be smaller than 0,5 mA rms.

Hand tools capable of being assembled shall be tested in all variations of the assembly that are specified by the manufacturer. For tools capable of being assembled with square drives, dummies may be used for the electrical test (see 5.5.3.1.2). *Hand tools* with retaining devices shall be tested on both end positions, if applicable.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the limits of leakage current are not exceeded.

Dimensions in millimetres



Key

a conductive part

b tap water bath

c insulated or insulating part of the *hand tool*

d gap to be maintained between the two inner sides of the legs

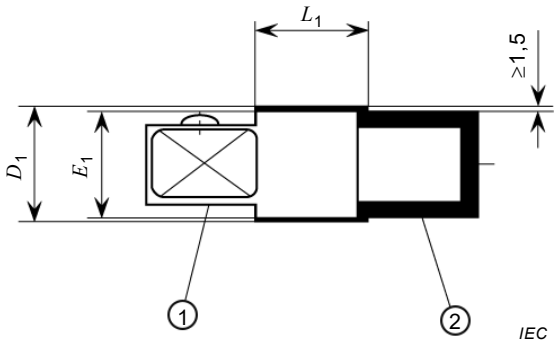
A ammeter

Figure 17 – Dielectric testing arrangement for insulated or hybrid hand tools

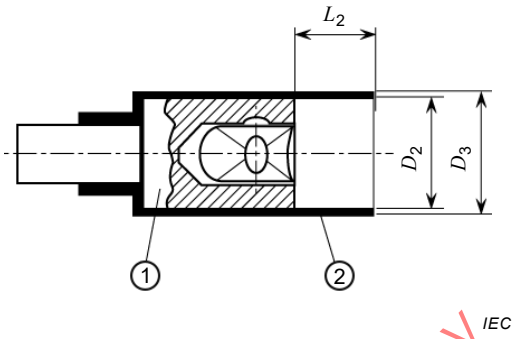
5.5.3.1.2 Tests of hand tools capable of being assembled with square drives

In the case of *hand tools* capable of being assembled with square drives (see 4.4.1.3.1), the tools can be tested in separate parts, if the parts are assembled with dummies described in Figure 18. The dimensions and tolerances of the dummies shall be in accordance with Table 2.

Dimensions in millimetres



Dummy part 1 to be used with female *hand tool* ends



Dummy part 2 to be used with male *hand tool* ends

Key

1 conductive part

2 insulation

Figure 18 – Description of dummies for dielectric tests for hand tools capable of being assembled with square drives

Table 2 – Dimensions and tolerances for dummies to be used for dielectric tests

Dimensions in millimetres

Nominal size	L_1 ± 0,1	L_2 ± 0,1	E_1 ± 0,05	D_1 ± 0,05	D_2 ± 0,05	D_3 ± 0,05
6,3	19	16	8,4	11	14,5	16,5
10	19	16	12,7	16	19,5	21,5
12,5	19	16	16,9	20	23,5	25,5
20	19	16	25,4	30,5	34,5	35,6
L_1, L_2, E_1, D_1, D_2 and D_3 are described in Figure 18.						

Dummy part 1 shall be assembled with female tool ends and dummy part 2 with male tool ends.

On all single parts tested with dummies, the dielectric testing on the complete assembly is not required.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the limits of leakage current are not exceeded.

5.5.3.2 Alternative test in cases where insulated hand tools have completed the production phase

For conformity evaluation of *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the test of 5.5.3.1 which shall be performed but:

- conditioning as specified in 5.5.2 is not necessary;
- the period of test shall be 10 s after reaching the specified voltage;
- the distance of the water level (or ball level) from the nearest exposed metal part shall be 24^{+4}_{-2} mm;

- the leakage current measurement is not carried out.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In any doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5.3.3 Alternative methods in cases where hybrid hand tools have completed the production phase

For conformity evaluation of *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In any doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.5.4 Dielectric testing of insulating hand tools

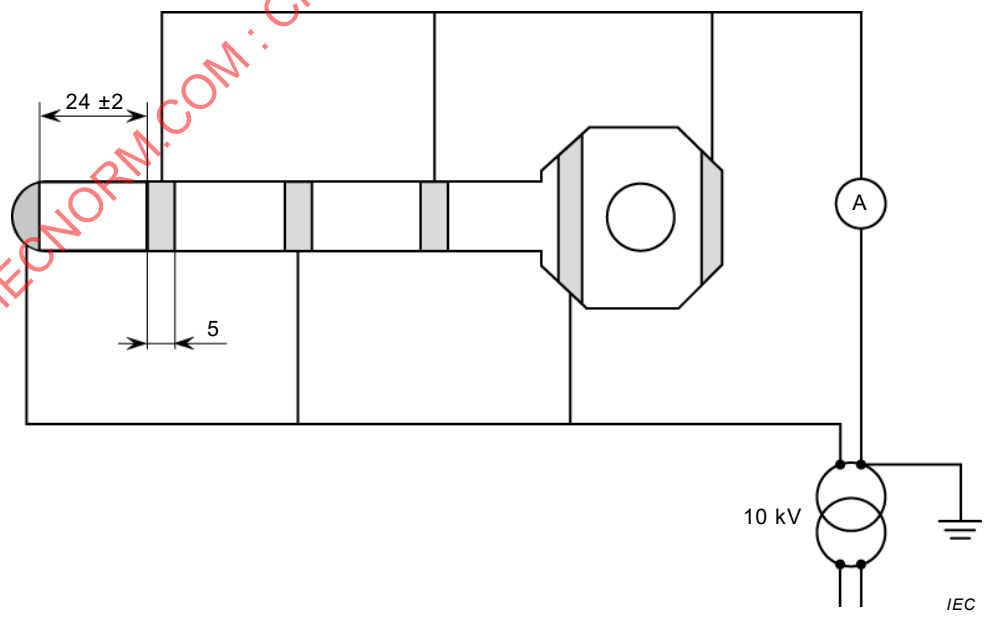
5.5.4.1 Type test

Tools having no exposed conductive parts shall be tested as follows.

NOTE The purpose of this test is to check the dielectric quality of the material used for the tool.

Electrodes of conductive tape or conductive paint, in 5 mm wide strips, shall be placed on the surface of the handle at intervals of 24 mm ± 2 mm (see Figure 19). In accordance with IEC 60060-1, a test voltage of 10 kV rms at 50 Hz or 60 Hz shall then be continuously applied for a test period of 3 min between each adjacent electrode.

Dimensions in millimetres



Key

A ammeter

Figure 19 – Dielectric testing arrangement for insulating hand tools

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period, and if the leakage current is less than 0,5 mA rms multiplied by the number of spaces between adjacent electrodes.

5.5.4.2 Alternative methods in cases where insulating hand tools have completed the production phase

For conformity evaluation of *insulating hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the dielectric performance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.6 Indentation test (for *insulated hand tools*)

5.6.1 Type test

All parts of the insulating coating of *insulated hand tools*, electrically tested as indicated in the relevant subclauses of 5.5 shall pass this test. The test shall be performed on the most vulnerable part(s) for screwdrivers with insulated shaft, and for other *hand tools* at the external middle part of the handle or legs.

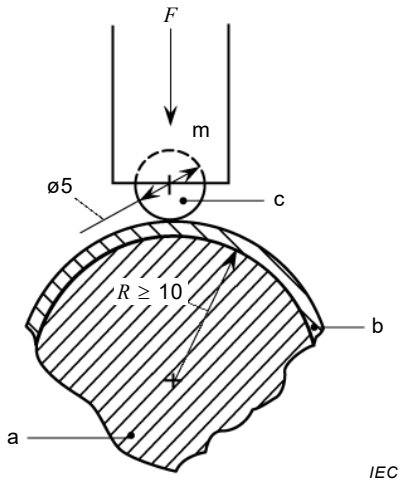
If the radius R at the test point is equal to or larger than 10 mm, the test shall be made with a test device according to Figure 20a. The part of the mass m in contact with the test piece shall be a stainless steel hemispheric nose-piece of 5 mm diameter. The applied force F shall be 20 N.

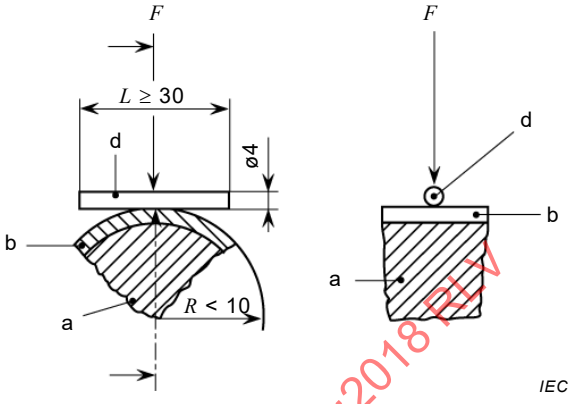
If the radius R at the test point is less than 10 mm, a rod of 4 mm diameter and at least 30 mm in length placed at right angles to the tool axis shall be used with the same force F of 20 N (see Figure 20b).

The *hand tool* shall be clamped in such a way that the insulating material coating at the test point is in a horizontal position. After setting up the testing device, the arrangement shall be held according to code 2 h/70 °C/<20 % of IEC 60212, in a heating chamber with ventilation. At the end of the heating time and after a cooling period outside the chamber of 5 min, a test voltage of 5 kV rms at 50 Hz or 60 Hz shall be applied continuously, in accordance with IEC 60060-1, between the testing device and the metal part of the *hand tool* for a test period of 3 min, using the code 18–28 °C/45–75 % of IEC 60212.

The test shall be considered as passed if no electrical puncture, sparkover or flashover occurs during the test period.

Dimensions in millimetres





Key

a conductive part

b insulation (test point)

c hemispheric nose-piece

d rod

R radius at the test point of the *hand tool*

m testing mass

Figure 20a – Radius at the test point of the hand tool ≥ 10 mm

Figure 20b – Radius at the test point of the hand tool < 10 mm

Figure 20 – Indentation test

5.6.2 Alternative methods in cases where insulated hand tools have completed the production phase

For conformity evaluation of *insulated hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the indentation resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.7 Test for adhesion of the insulating material coating of insulated hand tools

5.7.1 Conditioning

Before the test, the *insulated hand tools* shall be conditioned in a heating chamber with ventilation at a temperature of 70 °C ± 3 °C for 168 h.

The following tests shall be started at ambient temperature 3 min after removal from the heating chamber, using the code 18–28 °C/45–75 % of IEC 60212.

5.7.2 Type test

5.7.2.1 Test on the working head of insulated hand tools

The test shall be made on the following *insulated hand tools*:

- spanner;
- open-jaw holding spanner;
- *hand tools* capable of being assembled (except for pieces acting as screwdrivers).

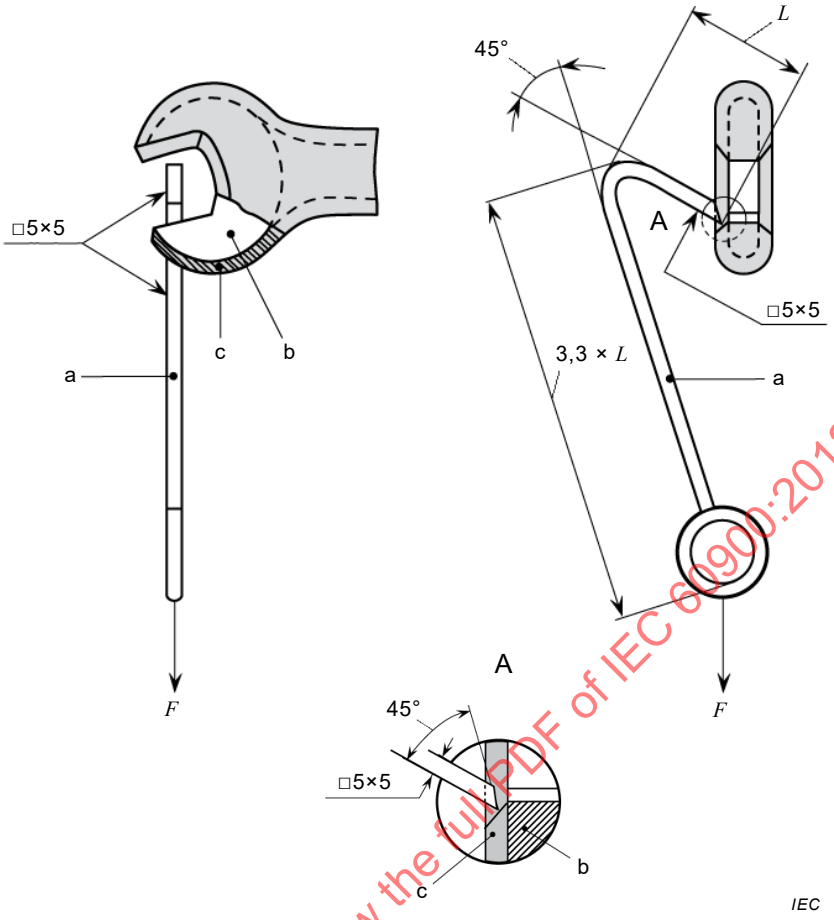
The test may be carried out using either method A or method B as shown in Figures 21 and 22, respectively. In case of doubt, method A shall apply.

Method A (see Figure 21):

A hook having a cutting edge of 5 mm width shall be placed on the *working head* in such a manner that it does not touch the conductive part.

A force F of 50 N shall be applied in the direction of the line dividing the insulating material coating from the conductive part for 3 min.

Dimensions in millimetres



Key

a hook (the length of the handle depends on the size of the *hand tool*)

b conductive part

c insulating material coating

L length of the short arm of the hook

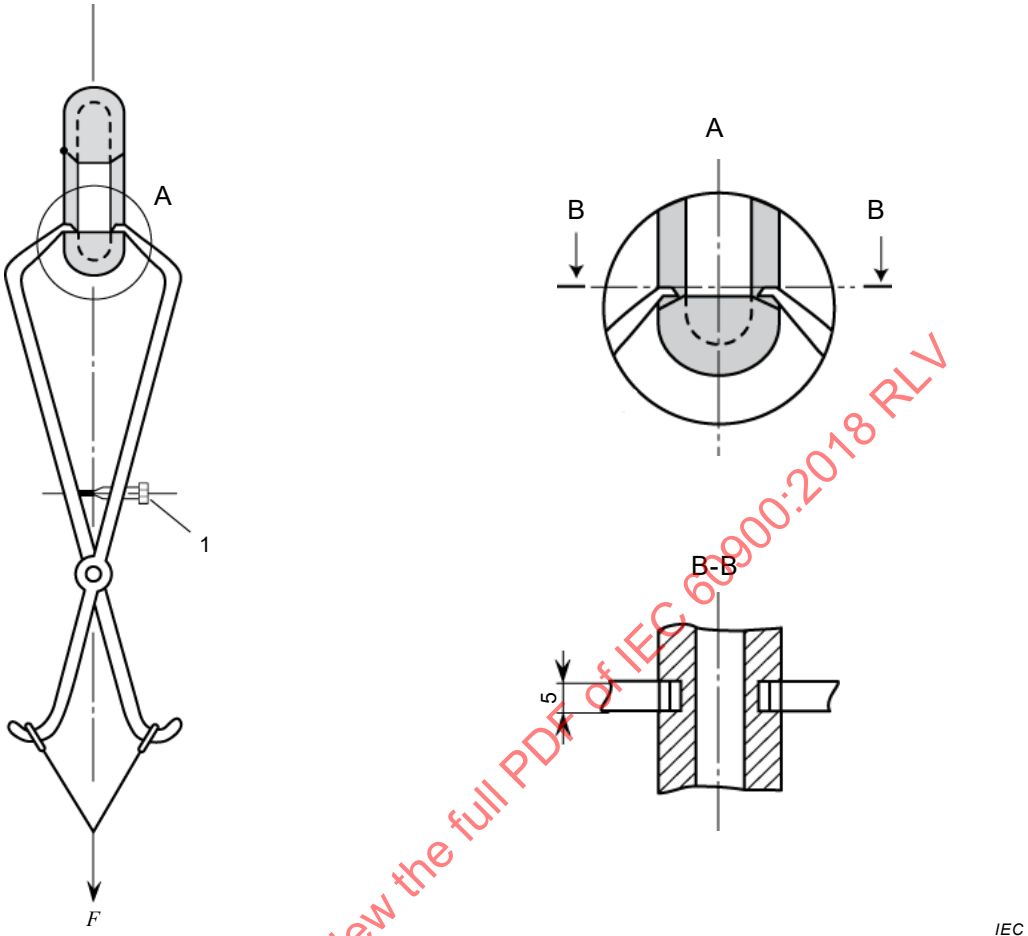
Figure 21 – Principle of the testing device for checking adhesion of the insulating coating on conductive parts of the insulated hand tool – Test on the working head – Method A

Method B (see Figure 22):

A device having two cutting edges, each of 5 mm width, shall be placed on the *working head* in such a manner that it does not touch the conductive part.

A force F of 100 N shall then be applied in the direction of the line dividing the insulating material coating from the conductive part for 3 min.

Dimensions in millimetres



Key

1 adjusting device

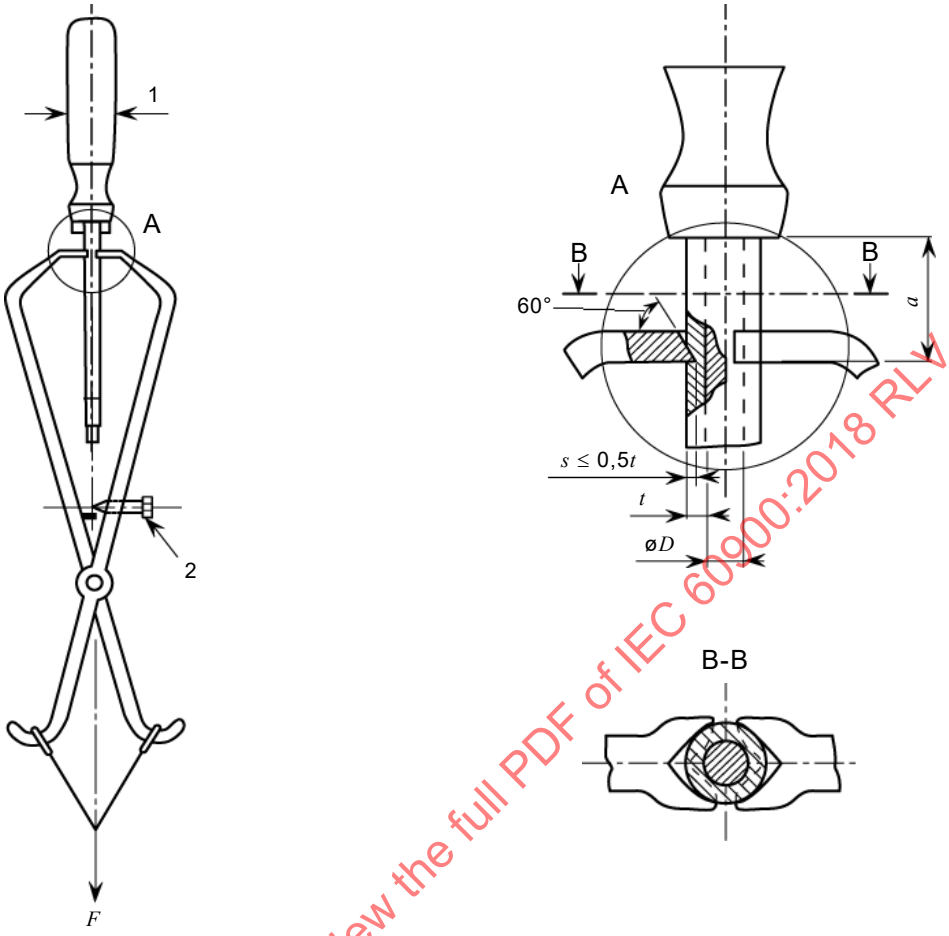
Figure 22 – Principle of the testing device for checking adhesion of the insulating coating on conductive parts of the insulated hand tools – Test on the working head – Method B

Either test shall be considered as passed if the insulating material coating does not move more than 3 mm from its initial location on the conductive part, and without any breakage of the insulating material.

5.7.2.2 Test on the insulation of the shafts of insulated screwdrivers

The test shall be carried out on insulated screwdrivers or on parts of *insulated hand tools* capable of being assembled acting as screwdrivers with the testing apparatus as shown in Figure 23.

Dimensions in millimetres



Key

1 suitable clamping device to hold the tested screwdriver in position with the shaft vertical downwards during the test

2 adjusting device

s depth of penetration ($s \leq 0{,}5\,t$)

t thickness of the insulating material coating

F testing force

a spacing of 10 mm to 15 mm between the point where the shaft comes out of the handle and the cutting edge of the testing appliance

D shaft diameter

Figure 23 – Testing device for checking adhesion of the insulating coating of insulated screwdrivers on conductive parts and the handle

The penetration depth of the cutting edges s of the testing apparatus shall not exceed 50 % of the thickness t of the insulating material coating. The cutting edges shall be placed on the shaft insulation at a distance a of 10 mm to 15 mm from the point where the shaft emerges from the handle or from the body of the *hand tools* capable of being assembled acting as screwdrivers.

If the cutting edges slide on the insulation, it is permissible to cut a groove in the shaft insulation of up to 50 % of its thickness, to prevent movement.

The force F in newtons shall be equal to 35 times the shaft diameter or 35 times the greatest dimension of the shaft cross-section in millimetres. The maximum force to be applied is 200 N. It shall be applied in the axial direction of the shaft for 1 min.

The test shall be considered as passed if the insulating coating does not move more than 3 mm from its initial location on the conductive part and if there is no breakage of the insulating material.

5.7.2.3 Test of adhesion of the insulation of the entire insulated hand tool

The test shall be made on pliers, strippers, cable-cutting *hand tools*, cable scissors and knives with the testing apparatus according to Figure 24.

The force F of 500 N shall be applied for 3 min.

The test shall be considered as passed

- if the handle remains firmly attached to the conducting part, and
- if the guard(s) remain firmly attached to the handles.

Deformation of the insulating coating is not considered as a failure.

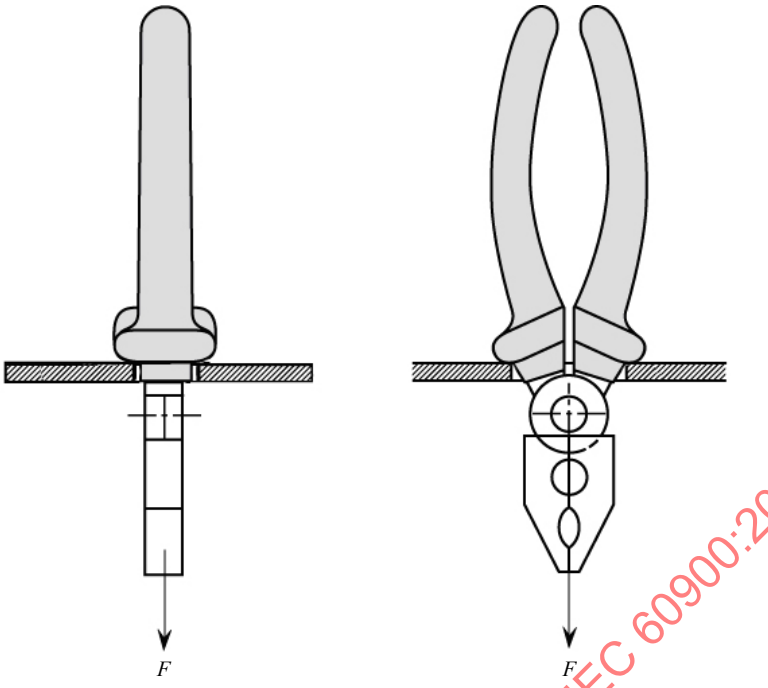


Figure 24a

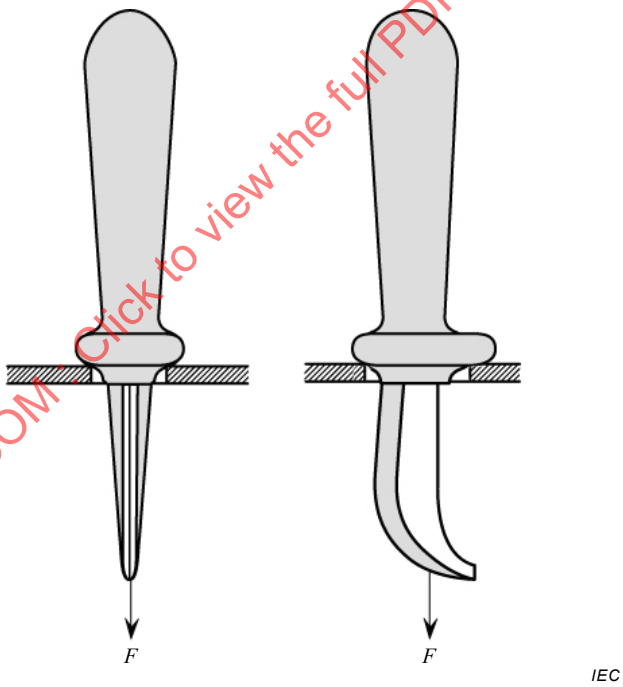


Figure 24b

Figure 24 – Example of mountings for checking stability of adhesion of the insulation of the entire insulated hand tool

5.7.3 Alternative methods in cases where insulated hand tools have completed the production phase

In the case where *insulated hand tools* have completed the production phase, the conditioning time can be reduced to 2 h.

If the test devices shown in Figures 24a and/or 24b leave marks on the tested *hand tools*, the manufacturer can shape the contact areas between tool and test devices with a customized fit to the tested tools.

The manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the adhesion resistance.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.8 Test of adhesion of exposed conductive parts at the working head of hybrid hand tools

5.8.1 Type test

A separating force of 100 N shall be applied to the exposed conductive part in a possible separating direction by a suitable device for 3 min.

The test shall be considered as passed if the exposed conductive parts or inserts are not separated from the supporting insulating material at the *working head*. If there is any movement between the conductive parts or inserts and the supporting material the test is deemed to have failed.

5.8.2 Alternative methods in cases where hybrid hand tools have completed the production phase

For conformity evaluation of *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented manufacturing procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the retaining process.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9 Mechanical tests

5.9.1 Test of adhesion of insulating covers of conductive adjusting or switching elements

5.9.1.1 Type test

A separating force of 50 N shall be applied to the cover in a possible separating direction by a suitable device for 3 min.

The test shall be considered as passed if the covers do not come off the elements they are insulating, if the function of the elements they are insulating is still in good working condition and if the dielectric test of 5.5.3.1 is passed after this test.

Deformation of the covers due to this test is not considered to be a failure.

If covers are used in areas that are not touched during work, this test need not be performed. Also, the test need not be performed where the design of the sealing elements does not allow application of a separating force.

5.9.1.2 Alternative methods in cases where hand tools have completed the production phase

In the case where *hand tools* have completed the production phase, the test of 5.9.1.1 shall be performed but the time for the application of the separating force shall be limited to 10 s and the test of 5.5.3.1 shall be performed with a conditioning time of 2 h.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.2 Insulated hand tools

5.9.2.1 Type test

Type tests are described in the ISO standards corresponding to the different types of *hand tools.* The manufacturer shall provide the reports of these tests at the request of the customer.

5.9.2.2 Alternative methods in cases where insulated hand tools have completed the production phase

For conformity evaluation of *insulated hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the mechanical stability of the *hand tool*. This includes documentation concerning the basic *hand tools* that have been insulated.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.3 Insulating and hybrid hand tools

5.9.3.1 Type test

Insulating and *hybrid hand tools* specially designed for live working may have lower stress resistance than *insulated hand tools*, but they shall withstand the expected workloads without failing due to remaining deformation or breaking (see Annex B).

The manufacturer shall provide the reports of the type tests performed on the *insulating* or *hybrid hand tools*, at the request of the customer.

5.9.3.2 Alternative methods in cases where insulating and hybrid hand tools have completed the production phase

For conformity evaluation of *insulating* and *hybrid hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the mechanical stability of the *hand tool*.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

5.9.4 Tweezers

A clamping force of 10 N shall be applied 10 mm behind the guard, clamping a test piece with a thickness of 2 mm, a width and length of 10 mm and a hardness of not less than 35 HRC. This stress shall not cause any permanent deformation.

5.9.5 Retaining force test for tools capable of being assembled

5.9.5.1 General procedure

The tool assembly shall be maintained in such position that the dismantling direction of the detachable part is vertical and downwards.

The load shall be gradually applied in the dismantling direction to reach the value given in 5.9.5.2 or 5.9.5.3 within 2 s; it shall then be held for 1 min.

In the case of interchangeable components made by different manufacturers (see 4.4.1.3.2), the reliable function of locking systems used for those *hand tools* shall be tested with a corresponding dummy. These dummies can be shaped to the needs of the measuring devices used for the test, but the dimensions of the female square drive part shall be in accordance with Figures 25 and 26. To assure that the intended function is given with all possible combinations of tolerances according to ISO 1174, always a “MIN” and a “MAX” dummy shall be used.

Due to a lack of information concerning relevant dimensions, the design of the dummies has been limited to the nominal dimensions 10 mm and 12,5 mm.

The test shall be considered as passed if the assembly does not come apart.

Dimensions in millimetres

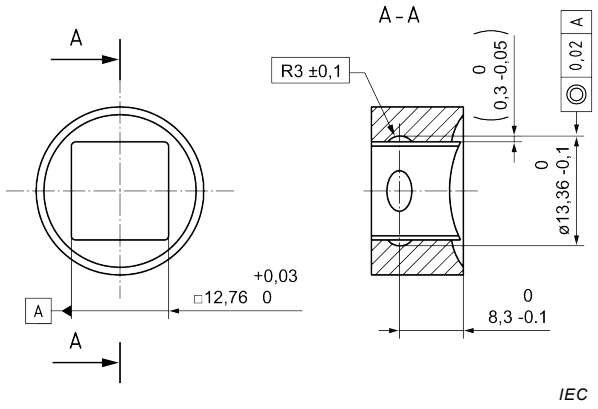


Figure 25a – Dummy "MIN"

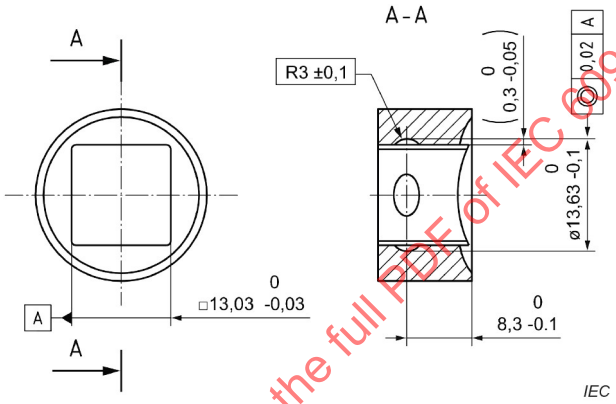


Figure 25b – Dummy "MAX"

Figure 25 – Dummies for testing locking systems used with square drives of nominal size 12,5 mm of ISO 1174

Dimensions in millimetres

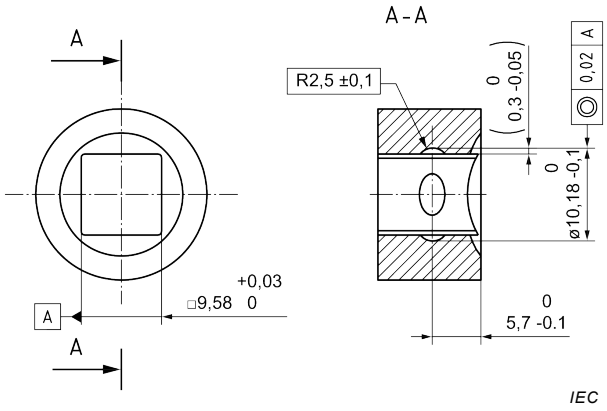


Figure 26a – Dummy "MIN"

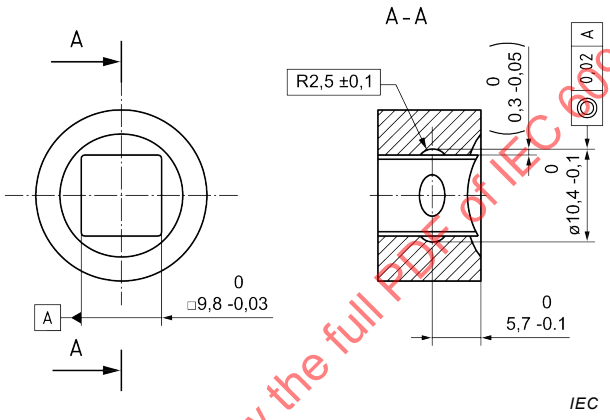


Figure 26b – Dummy "MAX"

Figure 26 – Dummies for testing locking systems used with square drives of nominal size 10 mm of ISO 1174

5.9.5.2 Not mechanically locked retaining systems

For *hand tools* capable of being assembled with retaining systems without mechanical lock, which means that no locking element has to be activated before elements of the assembly can be exchanged (for example retaining systems acting based on magnetic retaining forces or systems acting by a spring loaded element only), the following values shall be used for evaluation:

- 4 N for drives up to 6,50 mm;
- 11 N for drives from 6,51 mm to 10,00 mm;
- 30 N for drives from 10,01 mm to 13,50 mm;
- 80 N when drives exceed 13,50 mm.

The nominal size of the drives is measured across flats. If there are no parallel flats (triangular drive, pentagon drive, etc.), the nominal size should be specified in a comparable manner.

5.9.5.3 Mechanically locked retaining systems

In the case of mechanically locked retaining systems, which means that a locking element (screwed fitting, lever, ring, etc.) has to be activated before elements of the assembly can be exchanged, a load of 500 N shall be used.

5.10 Durability of marking

The items of marking shall be rubbed for 15 s with a rag soaked in water, and then for 15 s with a rag soaked in isopropanol (CH_3-CH(OH)-CH_3).

After this rubbing, the marking shall still be legible.

NOTE 1 It is not part of this document to ensure that any relevant legislation and any specific safety instructions regarding the use of isopropanol are fully observed.

NOTE 2 For special service requirements, the customer can specify extra tests for the durability of marking.

5.11 Flame retardancy test

5.11.1 Type test

The test shall be carried out in a draught-free room. The *hand tool* to be tested shall be clamped in a horizontal position. A small burner shall be arranged in such a way that the axis of the burner nozzle and the axis of the handle of the *hand tool* are at right angles and form a vertical plane.

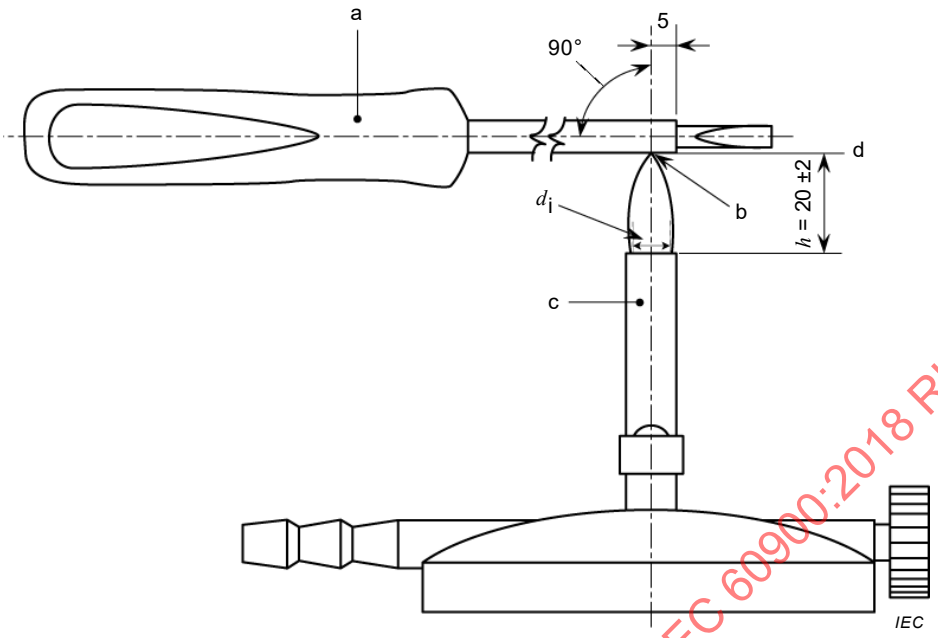
The gas supply shall be technical grade methane gas with a suitable regulator and meter to produce a uniform gas flow. If natural gas is used as an alternative to methane, its heat content should be approximately 37 MJ/m^3, which has been found to provide similar results.

The nozzle of the burner shall have a diameter of 9,5 mm ± 0,5 mm to produce a 20 mm ± 2 mm high blue flame.

The burner is placed remote from the *hand tool*, ignited and adjusted in the vertical position to produce a blue flame 20 mm ± 2 mm high. The flame is then obtained by adjusting the gas supply and the air ports of the burner until a 20 mm ± 2 mm yellow-tipped blue flame is produced. The air supply is then increased until the yellow tip disappears. The height of the flame is measured again, and corrected if necessary.

The burner shall then be placed in the test position as shown in Figure 27, with the axis of the flame at right angles to that of the *hand tool*.

Dimensions in millimetres



Key

a test piece

b tip of the flame

c burner

d horizontal reference line

d_i inner diameter of burner tube 9,5 mm ± 0,5 mm

h height of the flame of the gas burner

Figure 27 – Example of a flame retardancy test arrangement

At the start of the test, the tip of the testing flame shall touch the insulating material at the lower part of the *working head* facing the *hand tool* to be tested (see Figure 27).

The horizontal reference line d of Figure 27 at the level of the lower end of the insulating material is the datum for measuring the flame height.

If different types of insulating material are used for the same *hand tool*, the test shall be made on each individual type of insulating material.

The testing flame shall act upon the *hand tool* to be tested for 10 s. After this period, the flame shall be withdrawn. It shall be ensured that no air draught interferes with the test. The propagation of the flame on the *hand tool* shall be observed for 20 s after the withdrawal of the testing flame.

The test shall be considered as passed if the flame height on the *hand tool* does not exceed 120 mm during the 20 s of the observation period.

5.11.2 Alternative methods in cases where hand tools have completed the production phase

For conformity evaluation of *hand tools* having completed the production phase, the manufacturer shall prove that he has followed the same documented production procedure as per the type tested device.

The manufacturer shall document components and procedures that could affect the flame retardancy of the insulation.

In case of doubt, a sampling test in accordance with IEC 61318, using the test method defined for the type test, applies.

6 Conformity assessment of hand tools having completed the production phase

For conducting the conformity assessment during the production phase, IEC 61318 shall be used in conjunction with this document.

Annex G, developed from a risk analysis on the performance of the *hand tools*, provides the classification of defects and identifies the associated tests applicable in the case of production follow-up.

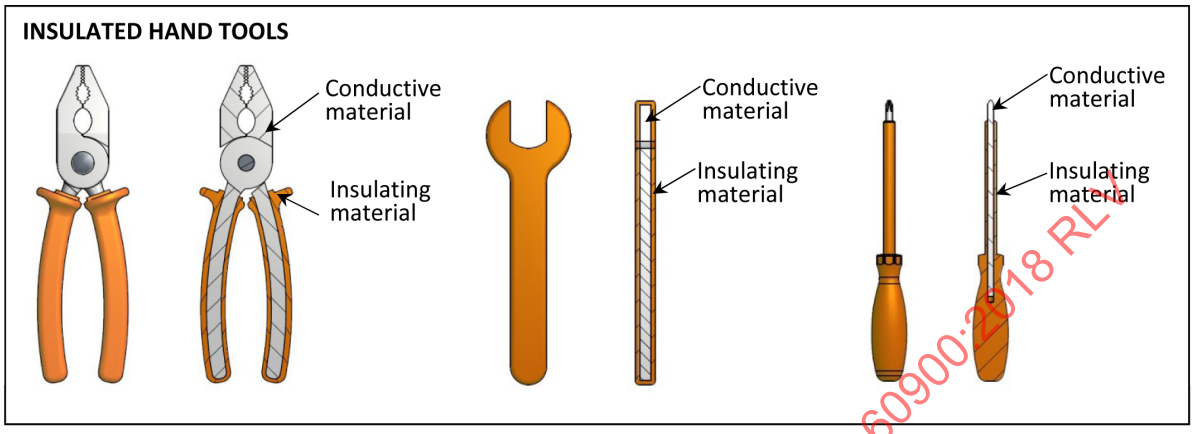
The rationale for the classification of defects specified in Annex G is provided in Annex H.

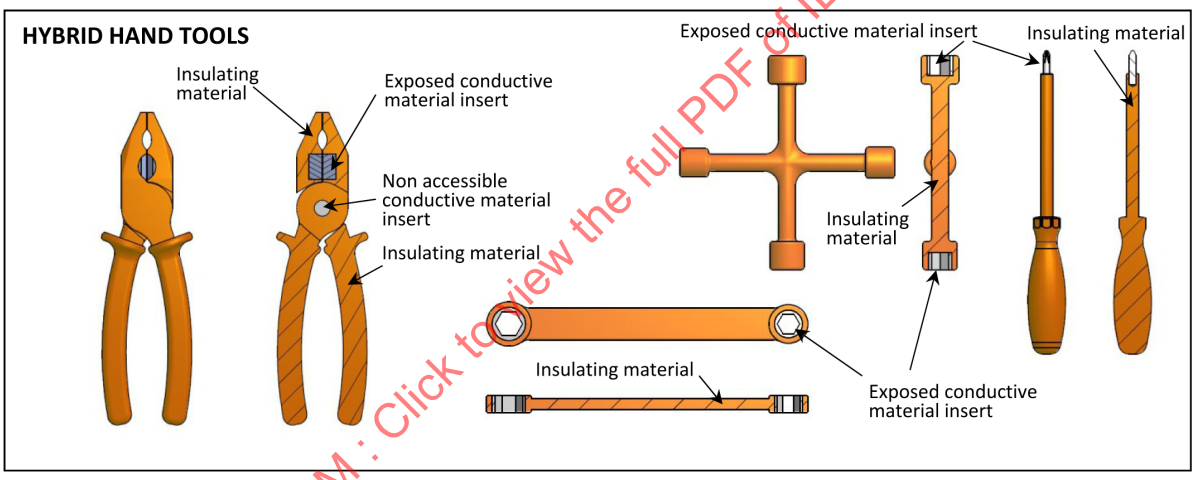
7 Modifications

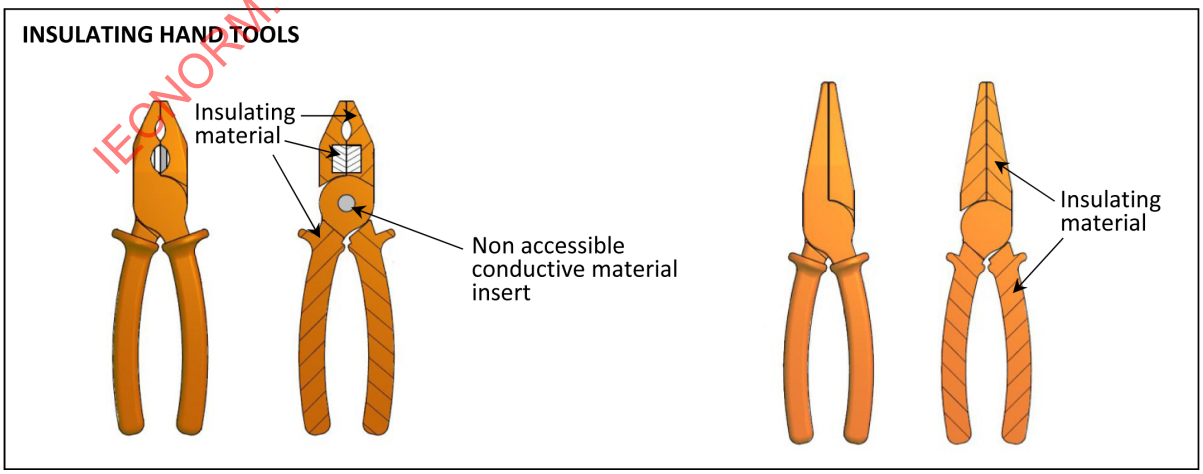
Any modification of the *hand tools* shall require the type tests to be repeated, in whole or in part (if the degree of modification so justifies), as well as a change in *hand tool* reference literature.

Annex A
(informative)

Description and examples for insulated, hybrid and insulating hand tools







Annex B
(informative)

Mechanical strength of insulating and hybrid hand tools

B.1 Context

Hand tools complying with ISO standards are often tested with test loads far beyond loads that can really be applied by hand. Among the reasons for this are

- that the application of these universal *hand tools* is not always known in detail, and
- that such *hand tools* are required to resist various improper uses that are to be expected, without failing and endangering the user.

For live working, the workers have to have a much better training level and the applications of some *hand tools* are very well defined. The following informative proposals are based on loads that can be applied by hand only and under regular conditions.

Insulating and *hybrid hand tools* specially designed for live working applications may have lower stress resistance than *insulated hand tools*, if they withstand the expected workloads without failing due to permanent deformation or breaking.

B.2 General

To check the ability of *insulating* and *hybrid hand tools* to withstand the expected maximum workloads specified in Clauses B.3 to B.6, tests should be carried out in accordance with the test procedures defined in ISO standards for similar *insulated hand tools*. If such ISO standards do not exist, tests may be specified by the manufacturer or by the customer. For those tests the IEC climatic conditions and tolerances of 5.1 apply.

If *insulating hand tools* are equipped with devices that limit the workloads that can be applied with them, for example overload slipping clutches, these limiting devices are activated before these tools reach the test loads specified hereafter.

B.3 Insulating and hybrid screwdrivers

Torque values for insulating and hybrid screwdrivers are given in Table B.1.

Table B.1 – Torque values for insulating and hybrid screwdrivers

Blade diameter mm	Test torque N·m
More than 8,0	10
6,5 to 7,9	8,0
5,5 to 6,4	5,5
4,5 to 5,4	4,5
4,0 to 4,4	2,5
3,5 to 3,9	1,3
3,0 to 3,4	0,7
2,5 to 2,9	0,4
Up to 2,4	0,3

B.4 Insulating and hybrid spanners and ratchets

Spanners and ratchets: maximum hand force = 500 N.

The force is applied 35 mm away from the outer extremities of the handles right angled to the axle of the work piece to be turned.

B.5 Insulating and hybrid T-spanners

T-spanners: maximum hand force = 250 N.

The force is applied simultaneously on both handles in opposite directions, 35 mm away from the outer extremities of the handles right angled to the axle of the work piece to be turned.

B.6 Insulating and hybrid pliers and cable shears

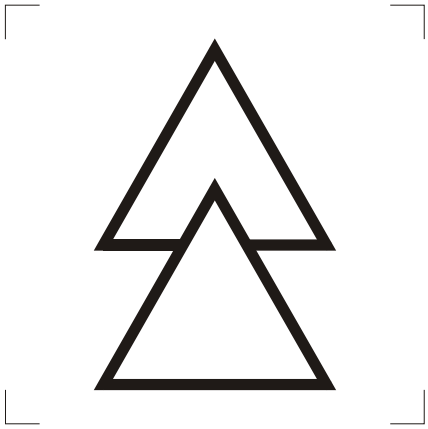
A hand load test in accordance with ISO 5744 should be carried out with a load of 500 N.

The load is applied 35 mm away from the outer extremities of the handles squeezing the handles.

A torsion test in accordance with ISO 5744 should be carried out for gripping pliers with a flat nose. The force for clamping is 350 N, applied 35 mm away from the outer extremities of the handle. The torque applied is 4 N·m. The maximum permissible twist angle at this torque is 20°.

Annex C
(normative)

Suitable for live working; double triangle (IEC 60417-5216:2002-10)



Annex D
(informative)

Recommendation for use and in-service care

D.1 General

Annex D is for guidance only concerning the maintenance, inspection, retest and use of *hand tools* after purchase.

D.2 Storage

Hand tools should be properly stored to minimize the risk of damage to the insulation due to storage or transportation. These *hand tools* should be stored generally separated from other tools to avoid mechanical damage or confusion. Furthermore, these *hand tools* should be protected from excessive heat (for example heating or steam pipes) as well as UV radiation.

D.3 Inspection before use

Each time before use, each *hand tool* should be visually inspected by the user.

If there is any doubt concerning the safety of the *hand tool*, it should either be scrapped or subjected to examination by a competent person and retested, if necessary.

D.4 Temperature

According to their capability, *hand tools* should be used only in areas having temperatures between –20 °C and +70 °C and, for tools marked “C”, between –40 °C and +70 °C.

D.5 Periodic examination and electrical retesting

An annual visual examination by a suitably trained person is recommended to determine the suitability of the *hand tool* for further service. If an electrical retest is required by national regulation or by customer specifications or in the case of doubt after visual examination, the dielectric test in 5.5.3.2 for *insulated hand tools*, 5.5.3.3 for *hybrid hand tools* and the test in 5.5.4.1 for *insulating hand tools* should be performed.

Annex E
(normative)

General type test procedure

See Table E.1.

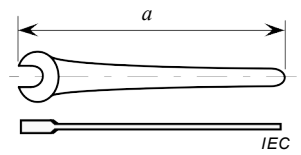
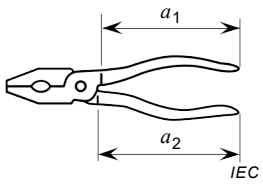
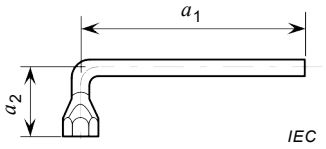
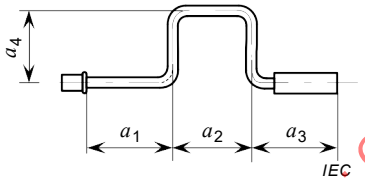
Table E.1 – Sequential order for performing type tests

Sequential order[a]	Type test	Subclause	Requirements
1	Visual check	5.2	4.1.1, 4.1.4, 4.1.6, 4.4.1.2, 4.4.1.3.2, 4.4.2.4, 4.4.3
1	Dimensional check	5.3	4.1.4, 4.4
2	Impact test	5.4.1	4.2.1 and 4.2.2
	– at ambient temperature (for all *hand tools*)	5.4.1.2	
3	Impact test	5.4.1	
	– at low temperature (all *hand tools* except category “C”)	5.4.1.3	
	– at extremely low temperature (*hand tools* of category “C”)	5.4.1.4	
4	Dielectric testing (*insulated* or *hybrid hand tools*)	5.5.1, 5.5.2 and 5.5.3.1	4.2.1
4	Dielectric testing (*insulating hand tools*)	5.5.1, 5.5.2 and 5.5.4.1	4.2.1
5	Indentation test (*insulated hand tools*)	5.6.1	4.2.1 and 4.2.2
6	Test for adhesion of the insulating material coating (*insulated hand tools*)	5.7.1 and 5.7.2	4.2.1 and 4.2.2
	– test on the *working head* (5.7.2.1)		
	– test on the insulation of the shaft of screwdrivers (5.7.2.2)		
	– test of the insulation of the entire *hand tool* (5.7.2.3)	5.7.2.1	4.1.5
7	Test of adhesion of exposed conductive parts at the working head of *hybrid hand tools*	5.8.1	4.3
8	Mechanical tests	5.9	
	– test of insulating covers of conductive adjusting or switching elements	5.9.1.1	4.1.5
	– performance under load (*insulated hand tools*)	5.9.2.1	4.1.2
	– performance under load (*insulating* or *hybrid hand tools*)	5.9.3.1	4.1.2
	– tweezers	5.9.4	4.1.2
	– retaining force test	5.9.5	4.4.1.1
9	Durability of marking	5.10	4.1.4
10	Flame retardancy test	5.11.1	4.2.1

[a] Type tests with the same sequential number can be performed in the more convenient order.

Annex F
(normative)

Examples of calculation of the total linear length of insulation and acceptable leakage current (see 5.5.3.1.1)

Designations	Total linear length of insulation L	Limits of acceptable leakage current $I_M = 5\ L$
 Engineers' spanner single head	$L = a$ Example: $L = a$ = 0,20 m	5 L = 1 I_M = 1 mA
 All-purpose pliers	$L = a_1 + a_2 = 2a_1$ Example: $a_1 = a_2$ = 0,14 m L = 0,28 m	5 L = 1,4 rounded to I_M = 2 mA
 Socket spanner, single head	$L = a_1 + a_2$ Example: a_1 = 0,30 m a_2 = 0,10 m L = 0,40 m	5 L = 2 I_M = 2 mA
 Speed brace	$L = a_1 + a_2 + a_3 + 2a_4$ Example: a_1 = 0,30 m a_2 = 0,15 m a_3 = 0,15 m a_4 = 0,25 m L = 1,10 m	5 L = 5,50 rounded to I_M = 6 mA

Annex G
(normative)

Classification of defects and tests to be allocated

Annex G was developed to address the type of defects of a manufactured *hand tool* (critical, major or minor) in a consistent manner (see IEC 61318). For each requirement identified in Table G.1, both the type of defect and the associated test are specified.

Table G.1 – Classification of defects and associated requirements and tests

Requirements		Type of defects			Tests
		Critical	Major	Minor	
General (4.1)					
4.1.1	General integrity	X			5.2, 5.3
4.1.2	Performance under load				
	– *Insulated hand tools*		X		5.9.2.2
	– *Insulating* or *hybrid hand tools*		X		5.9.3.2
	– Tweezers		X		5.9.4
4.1.4	Marking				
	– Correctness			X	5.2, 5.3
	– Durability			X	5.10
4.1.5	Separating of covers	X			5.9.1.2
4.1.6	Instructions for use			X	5.2
General requirements concerning insulating materials (4.2)					
4.2.1	Resistance to electrical stress				5.5
	– *Insulated hand tools*	X			5.5.3.2
	– *Hybrid hand tools*	X			5.5.3.3
	– *Insulating hand tools*	X			5.5.4.2
4.2.1 and 4.2.2	Resistance to mechanical stress				
	– Impact resistance		X		5.4.2
	– *Insulated hand tools* – resistance to indentation		X		5.6.2
4.3	– *Insulated hand tools* – adhesion of the insulating materials		X		5.7.3
	– *Hybrid hand tools* – adhesion of conductive parts		X		5.8.2
4.2.1	Flame retardancy			X	5.11.2
Additional requirements – *Hand tools* capable of being assembled (4.4.1)					
4.4.1.1	Retaining devices			X	5.9.5
4.4.1.2	Insulation design	X			5.2
	Hand tools capable of being assembled with square drives				
4.4.1.3.1	– General requirements		X		5.3
4.4.1.3.2	– Interchangeability of components made by different manufacturers		X		5.2, 5.3, 5.9.5
4.4.1.3.2	– Instructions for use	X			5.2
Additional requirements – Screwdrivers (4.4.2)					
4.4.2.1	Un-insulated areas	X			5.3
4.4.2.2	Shape of shaft insulation	X			
4.4.2.3	Bit screwdrivers	X			5.2, 5.3
4.4.2.4	Screwdrivers with screw retaining devices	X			
Additional requirements – Spanner – un-insulated areas (4.4.3)		X			5.2
Additional requirements – Adjustable spanner (4.4.4)		X			5.2, 5.3
Additional requirements – Pliers, strippers, cable scissors, cable-cutting hand tools (4.4.5)		X			5.2, 5.3
Additional requirements – Scissors (4.4.6)		X			5.2, 5.3
Additional requirements – Knives (4.4.7)		X			5.3
Additional requirements – Tweezers (4.4.8)		X			5.2, 5.3

Annex H
(informative)

Rationale for the classification of defects

Annex H provides the rationale for the classification of defects specified in Annex G. For brand new hand tools, Table H.1 presents the justification for the type of defect associated with a lack of compliance with each of the requirements included in this document. This analysis takes into consideration that the hand tools are used by skilled persons and in accordance with safe methods of work.

Table H.1 – Justification for the type of defect

Requirement	Justification for the associated defect specified in Annex G
Critical defects	
General integrity	Electrical hazard in the case of defects (for example lack of insulating material, significant inclusions in the insulation coating).
Separating of covers	In case of separation of covers this will result in an electrical hazard for the user.
Resistance to electrical stress – *Insulated hand tools* – *Hybrid hand tools* – *Insulating hand tools*	The good dielectric performance of the insulating material guarantees the protection of the worker during each use of the *hand tools*. Lack of dielectric properties makes the *hand tool* an electrical hazard for the worker.
Insulation design for *hand tools* capable of being assembled	Separation of parts during use of a *hand tool* may result in electrical hazards for the user.
Instructions for use for *hand tools* capable of being assembled with square drives	If no information or wrong information is provided, incorrect assembly may result, leading to hazardous conditions for the user.
Additional requirements – Screwdrivers (4.4.2) – Un-insulated areas – Shape of shaft insulation – Bit screwdrivers – Screwdrivers with screw retaining devices	Electrical hazard for the user.
Additional requirements – Spanner – un-insulated areas (4.4.3)	A too wide un-insulated area can increase electrical hazards to the user.
Additional requirements – Adjustable spanner (4.4.4)	A too wide un-insulated area can increase electrical hazards to the user. The absence of guard can lead to a hazardous situation.
Additional requirements – Pliers, strippers, cable scissors, cable-cutting *hand tools* (4.4.5)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Scissors (4.4.6)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Knives (4.4.7)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.
Additional requirements – Tweezers (4.4.8)	A too wide un-insulated area can increase electrical hazards to the user. The absence of a guard can lead to a hazardous situation.

Requirement	Justification for the associated defect specified in Annex G
Major defects	
Performance under load	The deformation or breaking of the *hand tools* under load makes them unusable.
Resistance to mechanical stress – *Insulated hand tools* – adhesion of the insulating materials – *Hybrid hand tools* – adhesion of conductive parts	Defect is likely to be detected by the user – the worker will stop using the *hand tool*.
For hand tools capable of being assembled with square drives – General requirements – Interchangeability of components made by different suppliers	Defect is likely to be detected by the user – the worker will stop using the *hand tool*.
Resistance to mechanical stress – Impact resistance – *Insulated hand tools* – resistance to indentation	Defect is likely to be detected by the user during the visual inspection before use – the worker will not use the *hand tool*.
Minor defects	
Flame retardancy	The effect of flames on insulated tools already results from an accident at work (electric arc) and is not a normal working condition of live working. The flame retardancy of insulating materials is only to minimize the effects of otherwise created hazards.
Correctness of marking	Wrong information will not result in a hazardous situation for the user.
Durability of marking	As long as the worker can read the marking, the *hand tools* can be used.
Instructions for use (availability)	Without information the skilled worker can use the *hand tools*.
Retaining devices for tools capable of being assembled	In case of separation of the assembly, the worker can use it again after being re-assembled.

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at http://www.electropedia.org)

IEC 60743, *Live working – Terminology for tools, devices and equipment*

ISO 1703, *Assembly tools for screws and nuts – Designation and nomenclature*

ISO 5742, *Pliers and nippers – Nomenclature*

ISO 5744, *Pliers and nippers – Methods of test*

ISO 8979, *Pliers and nippers for electronics – Nomenclature*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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TRAVAUX SOUS TENSION – OUTILS À MAIN POUR USAGE JUSQU'À 1 000 V EN COURANT ALTERNATIF ET 1 500 V EN COURANT CONTINU

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La Norme internationale IEC 60900 a été établie par le comité d'études 78 de l'IEC: Travaux sous tension.

Cette quatrième édition annule et remplace la troisième édition, parue en 2012. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) ajout d'une troisième catégorie d'outils: les *outils à main hybrides*;
b) introduction d'une nouvelle Annexe A informative sur des exemples des différents types d'*outils à main: isolés, isolants et hybrides*.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
78/1221/FDIS	78/1229/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Les termes définis à l'Article 3 sont rédigés en *italique* tout au long du présent document.

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INTRODUCTION

Le présent document a été préparé conformément aux exigences de l'IEC 61477 lorsque cela s'applique.

Pendant certaines ou pendant toutes les étapes de son cycle de vie, les produits couverts par le présent document peuvent avoir un impact sur l'environnement. Ces impacts peuvent être de légers à importants, de court ou de long terme, et se produire à un niveau local, régional ou global.

Le présent document ne contient pas d'exigences et de dispositions d'essai s'adressant aux fabricants, ou de recommandations aux utilisateurs des produits ayant pour but d'améliorer l'environnement. Cependant, tous les intervenants à la conception, la fabrication, l'emballage, la distribution, l'utilisation, l'entretien, la réparation, la réutilisation, la récupération et la mise au rebut sont invités à prendre en compte les éléments environnementaux.

TRAVAUX SOUS TENSION – OUTILS À MAIN POUR USAGE JUSQU'À 1 000 V EN COURANT ALTERNATIF ET 1 500 V EN COURANT CONTINU

1 Domaine d'application

Le présent document est applicable aux *outils à main isolés, isolants* et *hybrides* utilisés sous tension ou à proximité de parties actives, à des tensions nominales jusqu'à 1 000 V en courant alternatif et 1 500 V en courant continu.

Les produits conçus et fabriqués en conformité avec le présent document contribuent à la sécurité des utilisateurs, à condition qu'ils soient utilisés par des personnes qualifiées, conformément à des méthodes de travail en toute sécurité et aux instructions d'emploi (le cas échéant).

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60060-1, *Technique des essais à haute tension – Partie 1: Définitions et exigences générales*

IEC 60212, *Conditions normales à observer avant et pendant les essais de matériaux isolants électriques solides*

IEC 60417, *Symboles graphiques utilisables sur le matériel* (disponible sous: http://www.graphical-symbols.info/equipment)

IEC 61318, *Travaux sous tension – Évaluation de la conformité applicable à l'outillage, au matériel et aux dispositifs*

IEC 61477, Travaux sous tension – *Exigences minimales pour l'utilisation des outils, dispositifs et équipements*

ISO 1174-1, *Outils de manœuvre pour vis et écrous – Carrés d'entraînement – Partie 1: Carrés d'entraînement pour outils à main*

ISO 9654, *Pinces pour l'électronique – Pinces unifonction – Pinces coupantes*

ISO 9655, *Pinces pour l'électronique – Pinces unifonction – Pinces de serrage et de manipulation*

ISO 9656, *Pinces pour l'électronique – Méthodes d'essai*

ISO 9657, *Pinces pour l'électronique – Spécifications techniques générales*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 61318, ainsi que les suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

NOTE Les définitions des termes généraux utilisés dans le présent document sont données dans l'IEC 60050 ou pour les définitions spécifiques données dans l'IEC 60743.

3.1
outil à main
outil tenu à la main

Note 1 à l'article: Les *outils à main* peuvent être des *outils à main isolés*, des *outils à main isolants* ou des *outils à main hybrides* (voir l'Annexe A).

Note 2 à l'article: Les *outils à main* sont normalement des outils tels que tournevis, pinces, clés ou couteaux.

Note 3 à l'article: Les *outils à main* sont conçus pour fournir au travailleur une protection contre le choc électrique.

[SOURCE: IEC 60050-651:2014, 651-21-19, modifiée – La Note 1 à l'article a été modifiée afin de faire référence à l'Annexe A.]

3.1.1
outil à main hybride
outil à main réalisé en matériau(x) isolant(s) comportant des parties conductrices accessibles dans *la tête de travail*

Note 1 à l'article: Les *outils à main hybrides* peuvent comporter des parties conductrices non accessibles utilisées pour les renforcer.

[SOURCE: IEC 60050-651:2014, 651-21-22]

3.1.2
outil à main isolé
outil à main réalisé en matériau(x) conducteur(s), recouvert totalement ou partiellement de matériau(x) isolant(s)

[SOURCE: IEC 60050-651:2014, 651-21-20]

3.1.3
outil à main isolant
outil à main fabriqué essentiellement ou totalement en matériau(x) isolant(s), à l'exception d'inserts en matériau(x) conducteur(s), qui sont utilisés pour le renforcer, mais sans partie conductrice accessible

[SOURCE: IEC 60050-651:2014, 651-21-21]

3.2
tête de travail
partie de la tête de l'outil limitée à la surface de travail et la surface de contact

Note 1 à l'article: Voir les Figures 5 et 7.

4 Exigences

4.1 Exigences générales

4.1.1 Sécurité

Les *outils à main isolés, isolants* et *hybrides* doivent être fabriqués et dimensionnés de façon à protéger l'utilisateur contre tout choc électrique.

NOTE 1 Les *outils à main isolants* réduisent le plus possible le risque de court-circuit entre deux pièces portées à des potentiels différents.

NOTE 2 Les *outils à main hybrides* réduisent le risque de court-circuit entre deux pièces portées à des potentiels différents.

NOTE 3 Les *outils à main isolés* complètement recouverts de matériaux isolants à l'exception des parties conductrices situées sur la surface de travail réduisent le risque de court-circuit entre deux pièces portées à des potentiels différents.

Les exigences qui suivent ont été rédigées afin que les *outils à main* couverts par le présent document soient conçus et fabriqués de façon à contribuer à la sécurité des utilisateurs, à condition qu'ils soient utilisés par des personnes qualifiées pour réaliser des travaux sous tension, conformément à des méthodes de travail en toute sécurité et aux instructions d'emploi (le cas échéant).

4.1.2 Performance sous charge

Les spécifications mécaniques des *outils à main isolés* doivent être conformes aux normes ISO correspondantes ou, en l'absence de norme ISO, à une norme spécifiée par le fabricant ou le client (par exemple une norme nationale). Les spécifications mécaniques des parties actives des *outils à main* doivent être maintenues même après la mise en place de la couche isolante.

Les *outils à main isolants* et *hybrides* spécialement conçus pour les travaux sous tension peuvent avoir une résistance mécanique inférieure à celle des *outils à main isolés*, mais ils doivent supporter les charges de travail attendues sans subir de déformation permanente ou de rupture. Ces *outils à main* peuvent être équipés de dispositifs limitant les charges de travail qu'ils peuvent appliquer, par exemple des systèmes de débrayage par surcharge (voir aussi l'Annexe B).

4.1.3 Outils à main ayant plusieurs extrémités de travail

Les *outils à main* ayant plusieurs extrémités de travail, tels que les clés polygonales, les clés pour écrous à six pans creux, les clés à douilles à deux têtes, les clés à fourche double, etc., peuvent être des *outils à main isolants* ou *hybrides* si leur conception assure l'absence de connexion conductrice entre deux *têtes de travail*, mais ne peuvent pas être des *outils à main isolés*.

4.1.4 Marquage

Le marquage doit pouvoir être clairement identifié par toute personne ayant une vue normale ou corrigée sans autre moyen de grossissement.

Chaque *outil à main* et/ou élément d'outil doit être marqué clairement et de façon permanente des éléments de marquage suivants:

- sur le matériau isolant ou sur la partie métallique:
  - l'origine (nom du fabricant ou marque de fabrique);
- sur le matériau isolant:
  - le modèle/référence du type;

– l'année de fabrication (au moins les deux derniers chiffres de l'année);

– le symbole IEC 60417-5216:2002-10 – Approprié aux travaux sous tension; double triangle (voir l'Annexe C);

NOTE Pour le symbole, la proportion exacte de la hauteur de la figure à la base du triangle est de 1,43:1. Dans un souci pratique, la proportion peut se situer entre les valeurs de 1,4 et 1,5.

– l'indication 1 000 V (c'est-à-dire la limite électrique de travail en courant alternatif), immédiatement adjacent au symbole double triangle (voir l'exemple à la Figure 1);

Figure 1 – Marquage de la limite électrique de travail adjacent au symbole double triangle (IEC 60417-5216:2002-10)

– le numéro de la norme IEC applicable immédiatement adjacent au symbole double triangle (IEC 60900);

– pour les *outils à main* conçus pour être utilisés à très basse température: la lettre «C» (voir 4.2.2);

– le marquage additionnel pour les *outils à main* pouvant être assemblés et conçus pour être interchangeables entre différents fabricants (voir 4.4.1.3.2);

– un marquage additionnel lorsqu'il est spécifié par le client (par exemple, marque du propriétaire).

Les *outils à main* ne doivent porter aucune indication de tension autre que celles décrites ci-dessus.

NOTE L'indication, par exemple, d'une tension d'essai peut conduire à l'hypothèse que l'*outil à main* est prévu pour être utilisé à cette tension.

D'autres caractéristiques ou informations non nécessaires sur le lieu de travail, comme l'année de publication de la norme ou le type d'*outil à main*, doivent être associées à chaque produit par d'autres moyens, tels que le codage d'information (code-barres, puces électroniques, etc.), ou doivent être associées à l'emballage.

Le symbole double triangle doit avoir une hauteur d'au moins 3 mm; la lettre et les chiffres indiquant la limite électrique de travail doivent avoir une hauteur d'au moins 2 mm (voir la Figure 1).

4.1.5 Tenue des capots

Si les *outils à main* ont des éléments conducteurs (tels que vis de réglage de couple, bouton inverseur de sens, etc.) isolés par des capots en matériau isolant, ces derniers doivent être fixés de façon sûre pour éviter qu'ils se séparent pendant leur utilisation normale (voir 5.9.1).

4.1.6 Instructions d'assemblage ou de réglage

Dans le cas où le fabricant juge que des instructions sont nécessaires afin de permettre un assemblage ou un réglage correct, il doit alors les fournir conformément aux dispositions générales données dans l'IEC 61477 (voir aussi l'Annexe D).

4.2 Exigences relatives aux matériaux isolants

4.2.1 Généralités

Le matériau isolant doit être choisi en fonction des contraintes électriques, mécaniques et thermiques auxquelles il peut être exposé pendant le travail. De plus, le matériau isolant doit avoir une résistance adéquate au vieillissement et ne doit pas propager la flamme.

Le revêtement isolant peut comporter une ou plusieurs couches. S'il existe plus d'une couche, celles-ci peuvent être de couleurs différentes.

La conception et la construction des manches doivent permettre une prise sûre et éviter que la main ne puisse glisser inopinément. Les dimensions du manche et de la garde données dans les différentes figures sont applicables à tous les types d'*outils à main* dans le but de définir la zone de prise en main.

4.2.2 Stabilité thermique

Les *outils à main* doivent pouvoir être utilisés sans restriction entre –20 °C et +70 °C.

Le revêtement isolant appliqué sur les *outils à main* doit adhérer solidement à la partie conductrice entre –20 °C et +70 °C.

Les *outils à main* conçus pour usage à des températures extrêmement basses (jusqu'à –40 °C) doivent être dénommés «Catégorie C» et doivent être conçus à cet effet.

4.3 Exigence relative aux parties conductrices accessibles des outils hybrides

Les parties conductrices accessibles doivent être fixées de façon sûre pour éviter qu'elles se séparent pendant leur utilisation normale (voir 5.8).

4.4 Exigences complémentaires

4.4.1 Outils à main pouvant être assemblés

4.4.1.1 Dispositifs de retenue des outils à main pouvant être assemblés

Les *outils à main* pouvant être assemblés doivent avoir un dispositif de retenue approprié pour éviter une séparation inopinée de l'assemblage. Les forces de retenue doivent être soumises à l'essai conformément au 5.9.5.

4.4.1.2 Conception de l'isolation des outils à main pouvant être assemblés

Dans le cas d'éléments de liaison pour des *outils à main* pouvant être assemblés, le recouvrement isolant doit être appliqué de façon telle que si une pièce quelconque se désaccouple en cours d'opération par suite de l'application d'une charge dépassant les forces de retenue conformes à 5.9.5, aucune pièce conductrice pouvant être sous tension ne puisse être touchée par inadvertance ni ne puisse causer un amorçage.

4.4.1.3 Outils à main pouvant être assemblés avec des carrés conducteurs

4.4.1.3.1 Généralités

Les *outils à main* pouvant être assemblés avec des carrés conducteurs doivent avoir des carrés mâles et femelles conformes à l'ISO 1174-1 (pour les efforts de désassemblage, voir 5.9.5.2). Pour assurer la compatibilité de l'isolation entre différents fabricants, ces *outils à main* doivent présenter des éléments de chevauchement, tels que décrits à la Figure 2. Leurs dimensions et tolérances doivent être conformes à celles données dans le Tableau 1.

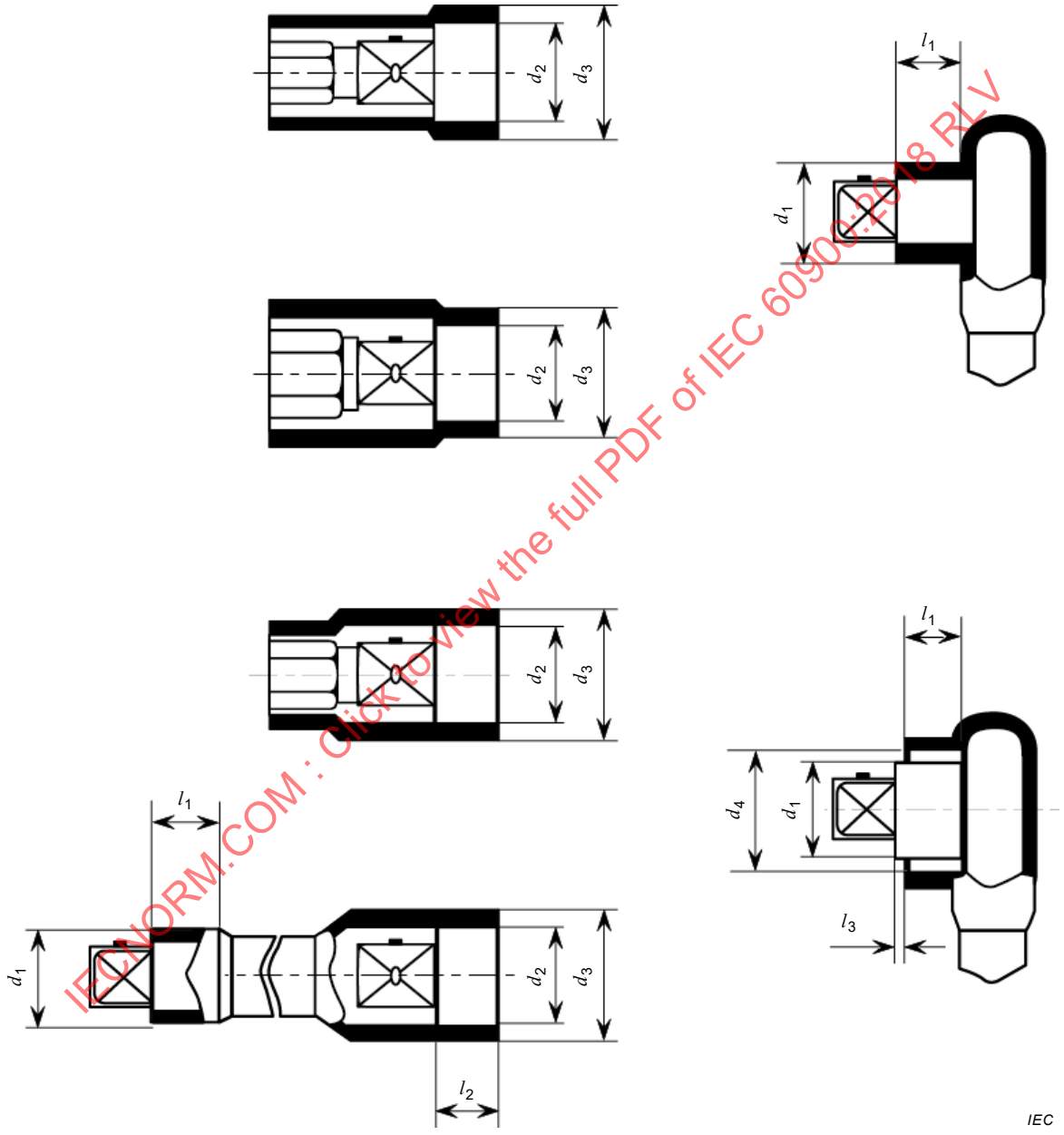


Figure 2 – Description de l'élément de chevauchement isolant et de différentes configurations d'assemblage d'outils à main pouvant être assemblés avec des carrés conducteurs

Tableau 1 – Dimensions et tolérances de l'élément de chevauchement isolant

Dimensions en millimètres

Taille nominale du carré conducteur	l_1 min.	l_2 $^{+2}_{0}$	l_3 $^{+0,5}_{-0,5}$	d_1 $^{0}_{-1,5}$	d_2 $^{+1,5}_{0}$	d_3 $^{0}_{-1,5}$	d_4 $^{+1,5}_{0}$
6,3	19	16	2	12,5	13	18	19
10	19	16	2	17,5	18	23	24
12,5	19	16	2	21,5	22	27	28
20	19	16	2	32	33	38	39
l_1, l_2, l_3, d_1, d_2, d_3 et d_4 sont décrites à la Figure 2.							

4.4.1.3.2 Interchangeabilité des composants provenant de différents fabricants

Les *outils à main* pouvant être assemblés et conçus pour être interchangeables entre différents fabricants doivent être spécialement marqués à cet effet.

Le symbole de marquage et ses dimensions sont indiqués à la Figure 3. La dimension H doit être supérieure ou égale à 5 mm.

Dimensions en millimètres

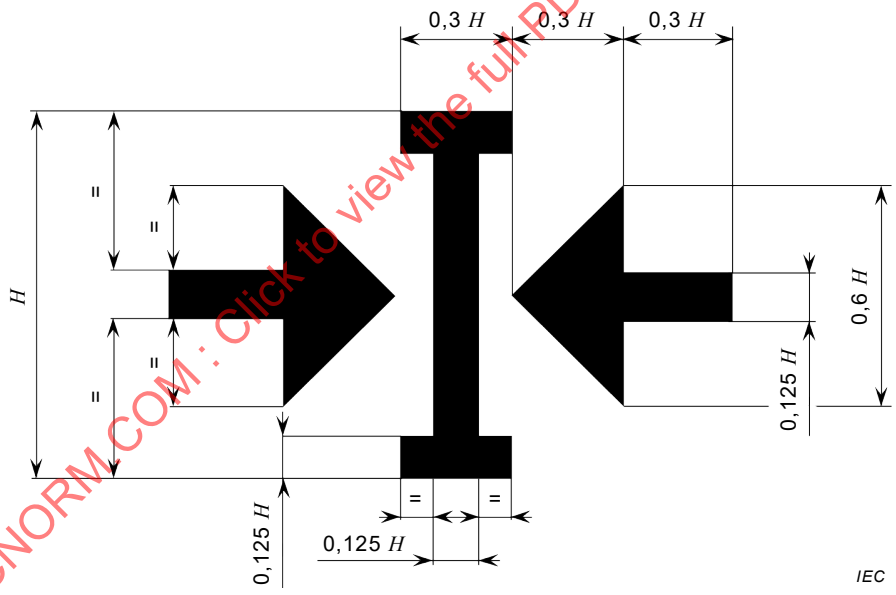


Figure 3 – Symbole de marquage des outils à main pouvant être assemblés et conçus pour être interchangeables entre différents fabricants (IEC 60417-6168:2012-07)

Le fonctionnement fiable des mécanismes de verrouillage utilisés par ces *outils à main* doit être soumis à l'essai en réalisant un essai de retenue conformément au 5.9.5 à l'aide d'un gabarit approprié.

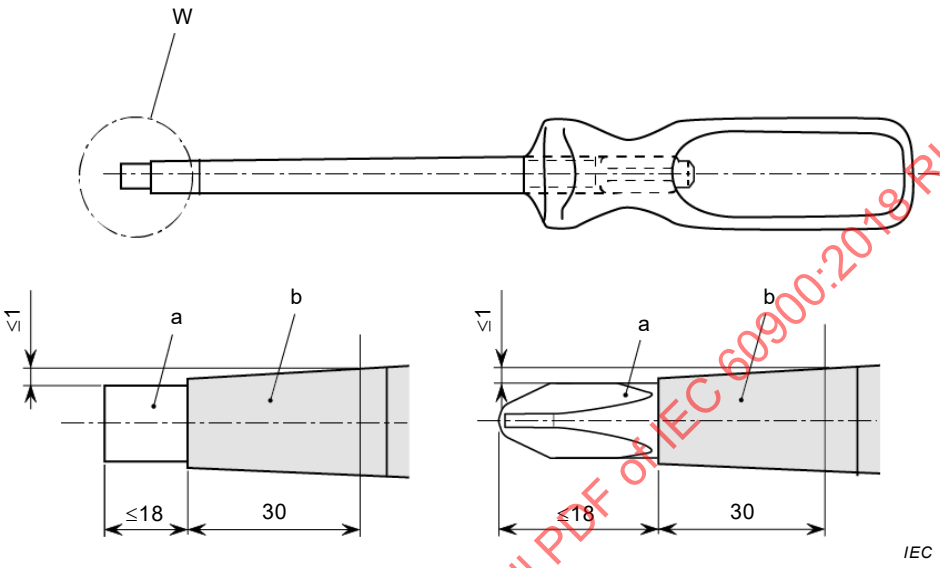
Pour ce genre d'*outils à main*, les instructions pour un assemblage correct sont obligatoires. Le fabricant doit inclure l'information suivante: «Afin d'être sûr que l'assemblage complet de tous les éléments d'*outils à main isolés* issus de différents fabricants résisteront aux efforts de désassemblage qui pourraient intervenir pendant l'utilisation, l'utilisateur doit vérifier, avant l'utilisation de tout assemblage, en tirant manuellement dans une direction tendant à séparer les éléments, que tous les dispositifs de retenue des éléments utilisés restent efficaces».

4.4.2 Tournevis

4.4.2.1 Surfaces non isolées

Pour les tournevis isolés ou hybrides, une surface conductrice non isolée d'une longueur maximale de 18 mm est autorisée sur la *tête de travail* (voir la Figure 4).

Dimensions en millimètres



Légende

a partie conductrice

b isolation

W *tête de travail*

Figure 4 – Représentation de l'isolation d'un tournevis typique

4.4.2.2 Forme de l'isolation de la lame

L'isolation de la lame des tournevis isolés doit être reliée au manche.

Dans la zone «W» de la Figure 4, le diamètre extérieur de l'isolation, des tournevis isolés et hybrides sur une longueur de 30 mm, ne doit pas dépasser de plus de 2 mm la largeur la plus grande, que ce soit la largeur de la lame à l'extrémité ou la largeur de l'extrémité. Cette partie peut être parallèle ou conique vers l'extrémité.

Cette exigence ne s'applique pas aux embouts à douilles isolés (ou aux pièces de commande des douilles isolées).

4.4.2.3 Tournevis avec des têtes de travail interchangeables

Les tournevis isolés ou hybrides avec des *têtes de travail* interchangeables sont considérés comme des *outils à main* pouvant être assemblés. Ils doivent répondre aux exigences appropriées. Le diamètre extérieur de l'isolation peut excéder les dimensions données en 4.4.2.2.

4.4.2.4 Tournevis avec dispositifs de maintien de la vis

Si un tournevis isolé ou hybride a un système de maintien de la vis, le tournevis doit lui-même répondre aux exigences du présent document. Le diamètre extérieur du système de maintien

peut excéder les dimensions données en 4.4.2.2. Le système de maintien doit être réalisé en matériau isolant.

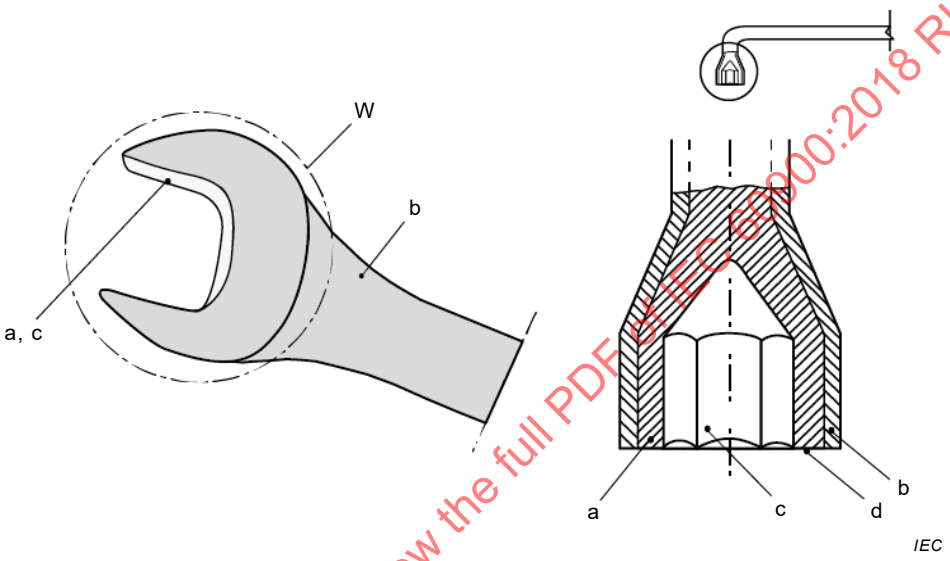
4.4.3 Clés – surfaces non isolées

Les surfaces non isolées autorisées sur la *tête de travail* des clés isolées ou hybrides sont les suivantes (voir la Figure 5):

- clés à une tête: la surface de travail;

  NOTE À la demande du client, la partie non isolée peut être étendue à la *tête de travail.*

- clé polygonale, clé à douilles, clé en T: la surface de travail et la zone de contact.



Légende

a partie conductrice
b Isolation
c surface de travail
d zone de contact
W *tête de travail*

Figure 5 – Représentation de l'isolation d'une clé typique

4.4.4 Clés à molette

L'isolation des clés à molette isolées doit être prolongée aussi loin que possible vers *la tête de travail*. La zone non isolée peut s'étendre à *la tête de travail*. Si la *tête de travail* reste non isolée, une garde doit être installée afin d'éviter que la main glisse vers les parties conductrices découvertes de la tête. Pour les dimensions minimales des gardes, voir la Figure 6.

Dans le cas des clés à molette hybrides, une garde doit être installée si les parties conductrices découvertes sont plus importantes que la surface de travail.

Dimensions en millimètres

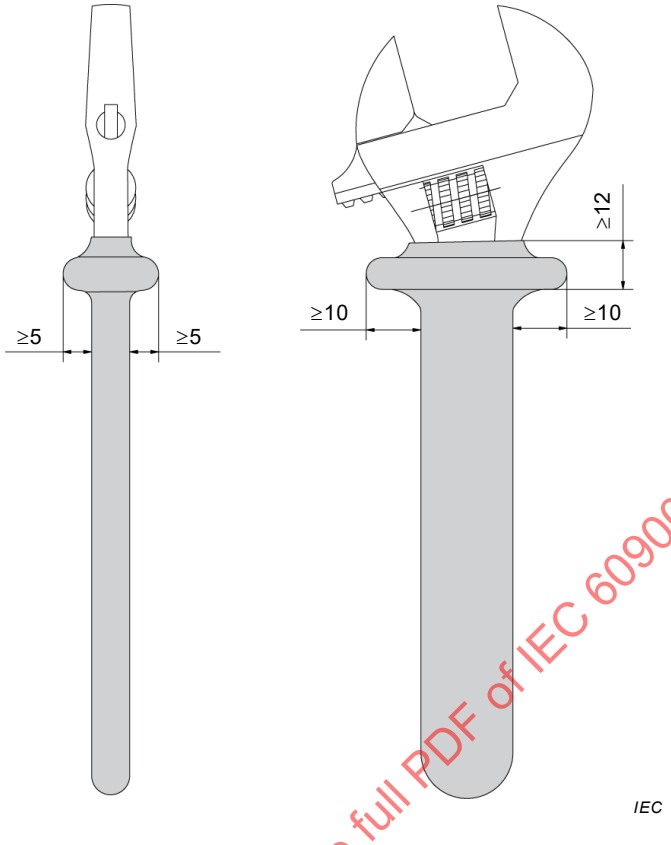
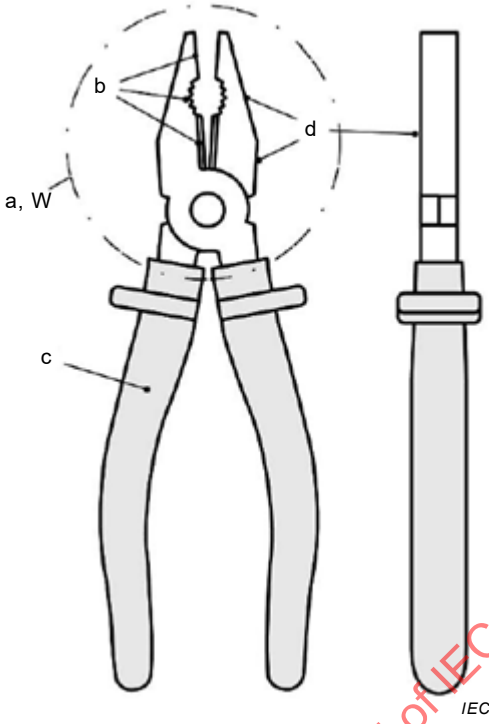


Figure 6 – Clé à molette isolée ou hybride

4.4.5 Pinces, pinces à dénuder, coupe-câbles, pinces coupantes

L'isolation des branches de tels *outils à main isolés* ou *hybrides* doit comporter une garde afin que la main ne puisse pas glisser vers les parties conductrices découvertes de la tête (voir la Figure 7 à titre d'exemple).



Légende

a partie conductrice

b surface de travail

c isolation

d zone de contact

W *tête de travail*

Figure 7 – Représentation de l'isolation d'une pince typique

La hauteur de la garde doit être suffisante pour éviter tout glissement des doigts vers les parties conductrices découvertes au cours du travail.

Pour les pinces, les dimensions de cette garde doivent être d'au moins (voir les Figures 8, 9 et 10 à titre d'exemple):

- 10 mm sur la gauche et la droite de la pince posée sur une surface plane;
- 5 mm sur les parties supérieure et inférieure de la pince posée sur une surface plane.

La distance minimale isolée entre la partie interne de chaque garde et toute partie non isolée doit être de 12 mm (voir les Figures 8, 9, 10 et 11). La partie de l'isolation au-delà de la garde doit être prolongée aussi loin que possible vers la *tête de travail*.

Dimensions en millimètres

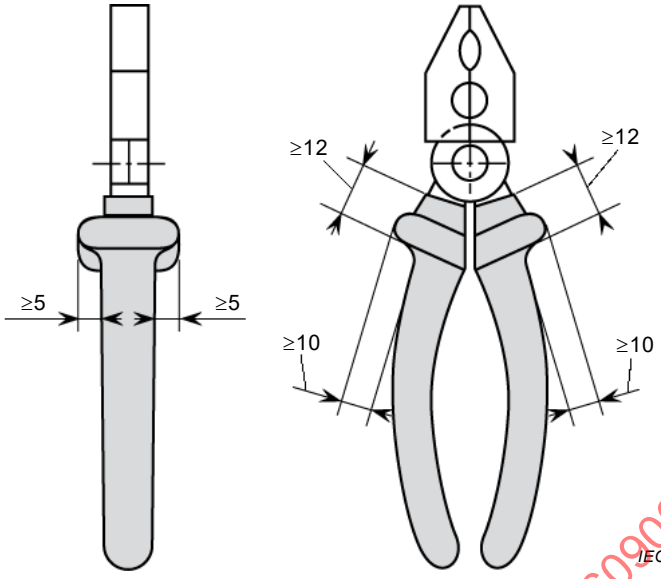


Figure 8 – Isolation des pinces

Dans le cas d'une articulation coulissante, une garde de 5 mm doit être prévue sur la partie interne des branches. Se référer à la Figure 9 pour des dimensions additionnelles.

Dimensions en millimètres

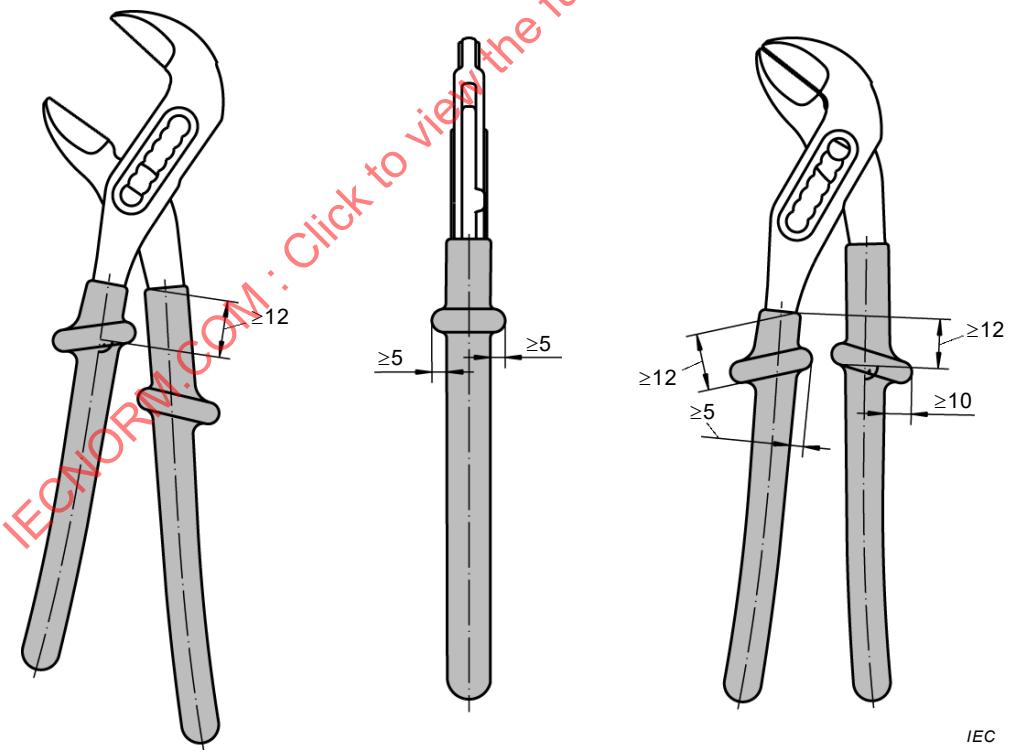


Figure 9 – Isolation de pinces multiprises

Lorsqu'il existe une surface fonctionnelle sous l'articulation, une garde intérieure doit être disponible (comme utilisée dans le cas des pinces multiprises). Voir la Figure 10.

Dimensions en millimètres

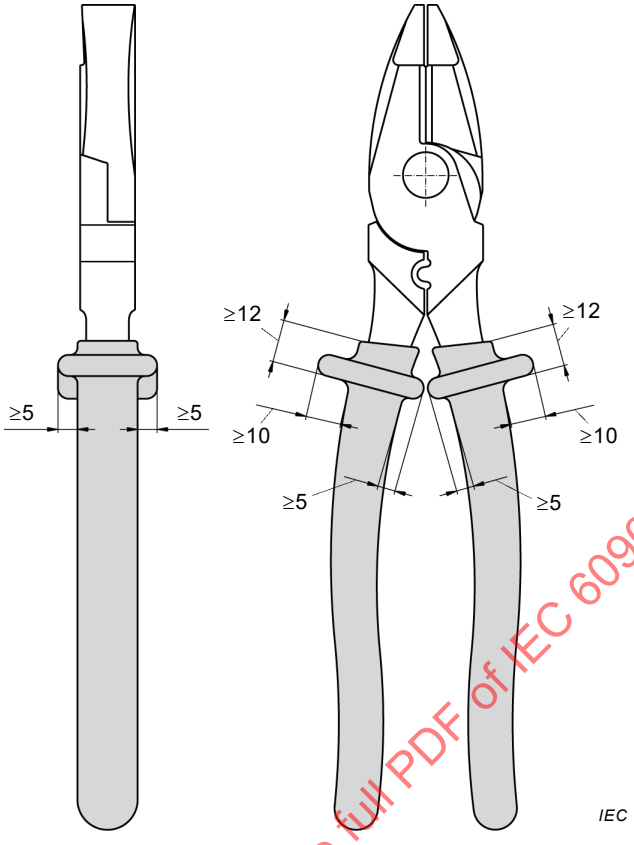


Figure 10 – Isolation des pinces comportant une surface fonctionnelle sous l'articulation

Dans le cas où les branches des *outils à main* ont une longueur supérieure à 400 mm, une garde n'est pas exigée.

Dans le cas de pinces et de tenailles isolées pour l'électronique, les dimensions de la garde doivent être d'au moins:

- 5 mm sur la gauche et sur la droite de la pince posée sur une surface plane;
- 3 mm sur les parties supérieure et inférieure de la pince posée sur une surface plane.

La distance minimale isolée entre la partie interne de la garde et la partie non isolée doit être de 12 mm. La partie de l'isolation au-delà de la garde doit être prolongée aussi loin que possible vers la *tête de travail* (voir la Figure 11).

Les pinces et les tenailles isolées pour l'électronique doivent être conformes à l'ISO 9656 et l'ISO 9657, et le cas échéant à l'ISO 9654 ou l'ISO 9655.

Dimensions en millimètres

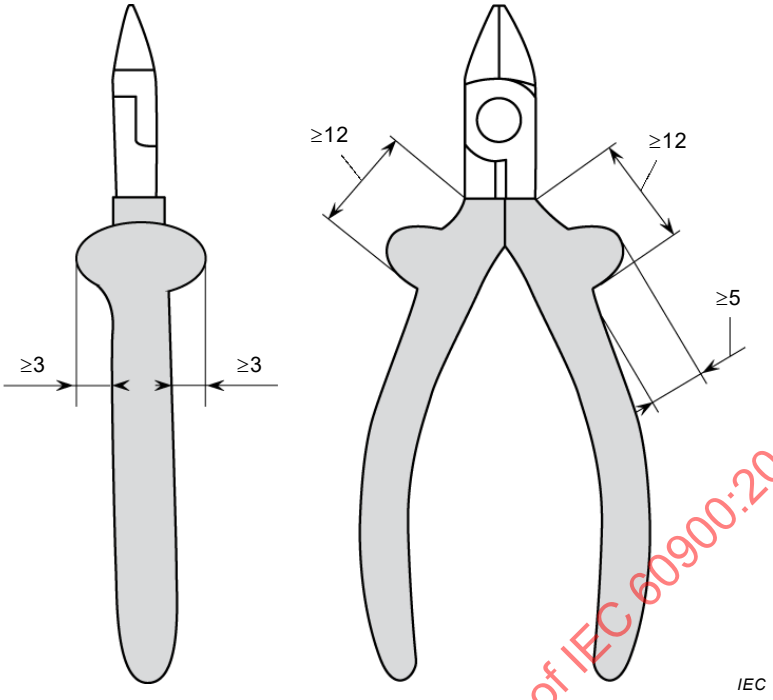


Figure 11 – Représentation de l'isolation des pinces et des tenailles pour l'électronique

4.4.6 Ciseaux

L'isolation typique de ciseaux isolés est représentée à la Figure 12.

Les arceaux des ciseaux doivent être de la conception représentée à la Figure 12a ou de la conception représentée à la Figure 12b.

La longueur maximale des parties non isolées des ciseaux ne doit pas dépasser 100 mm.

La partie de l'isolation au-delà de la garde doit être prolongée aussi loin que possible vers la *tête de travail*. Lorsque la longueur isolée au-delà de l'arceau est inférieure à 50 mm, au moins une garde est exigée.

Dimensions en millimètres

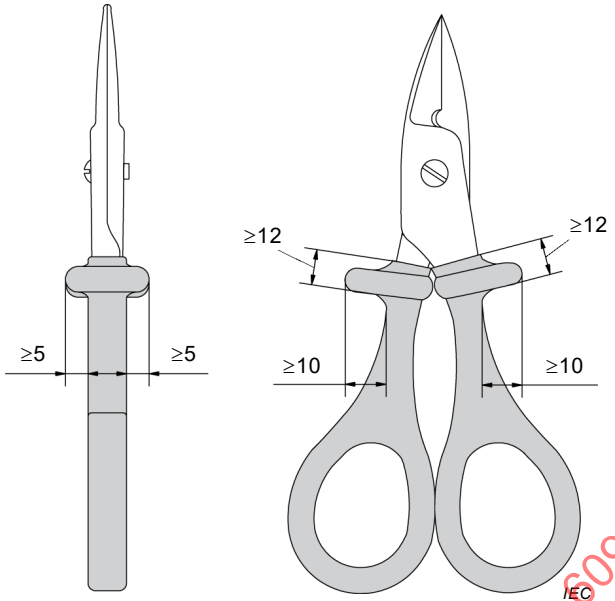


Figure 12a

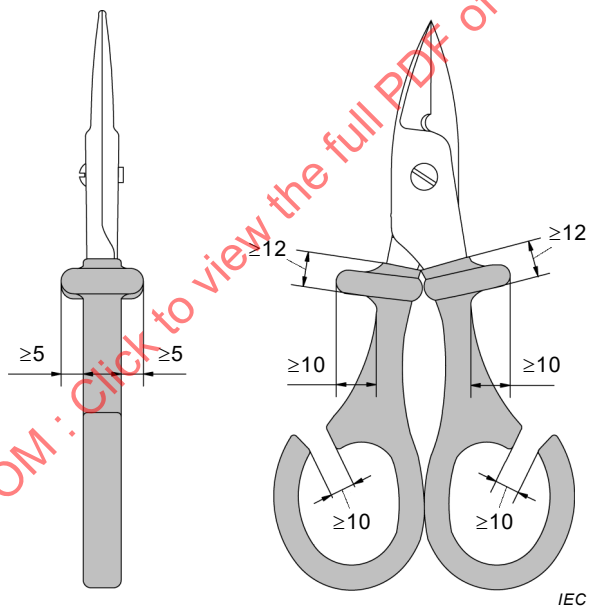


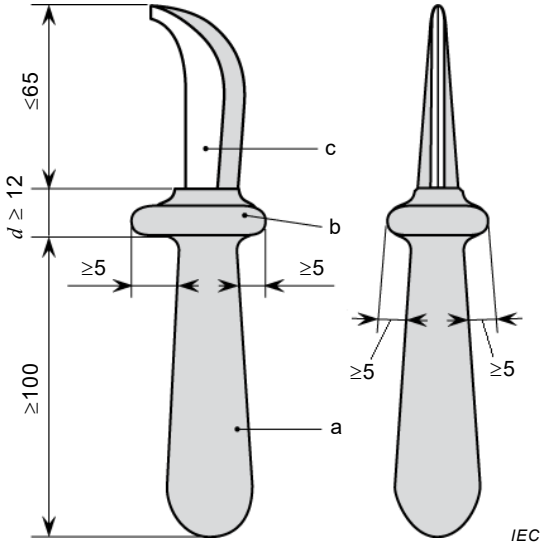
Figure 12b

Figure 12 – Isolation des ciseaux

4.4.7 Couteaux

La Figure 13 présente un exemple de l'application de l'isolation des couteaux isolés ou hybrides. Les dimensions des couteaux isolés ou hybrides doivent se conformer à la Figure 13.

Dimensions en millimètres



Légende

a isolation

b garde

c lame (non isolée)

d distance entre le bord intérieur de la garde et la partie non isolée

Figure 13 – Isolation des couteaux

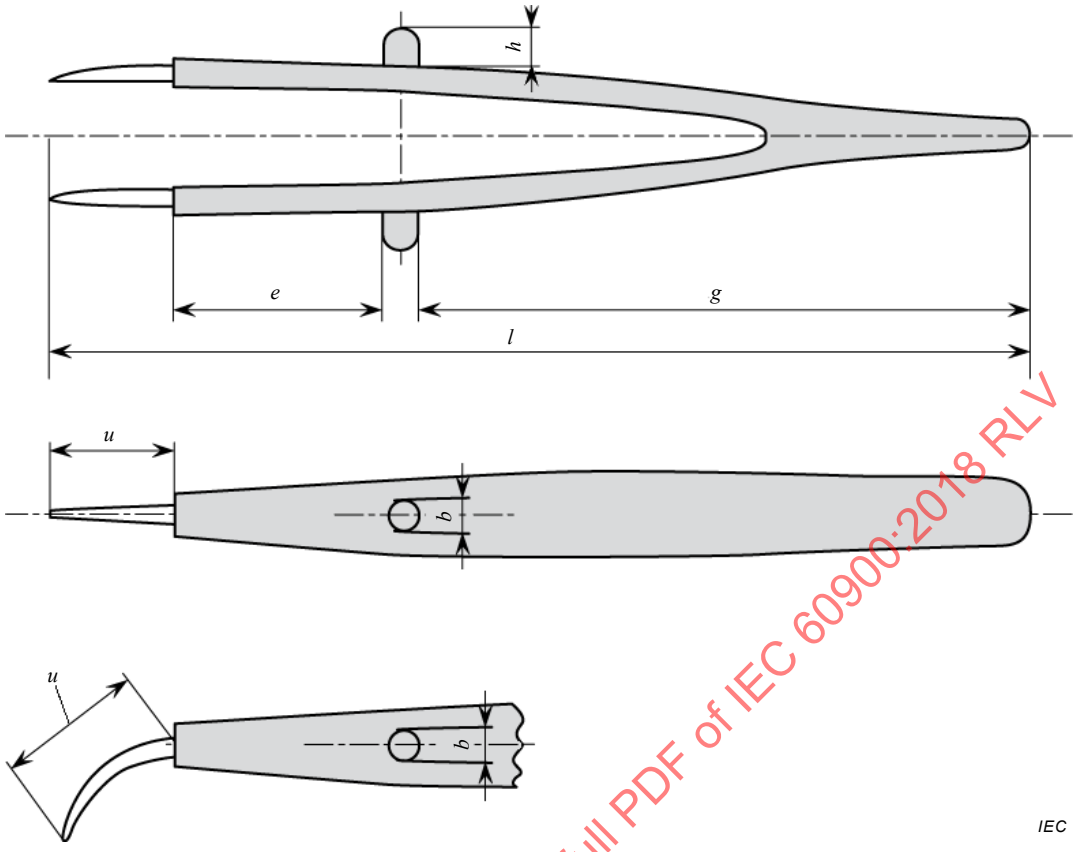
4.4.8 Brucelles

La longueur totale l des brucelles doit être comprise entre 130 mm minimum et 200 mm maximum. La longueur des branches g doit être au minimum de 80 mm (voir la Figure 14).

Les deux branches des brucelles doivent avoir une garde en direction de la *tête de travail*. La garde ne doit pas pouvoir se déplacer. Sa hauteur h et sa largeur b doivent être suffisantes (5 mm au minimum) pour éviter, durant le travail, tout glissement des doigts vers la longueur non isolée u de la *tête de travail.* Sur chaque branche, la longueur isolée ou en matière isolante e entre la garde et la *tête de travail* doit être comprise entre 12 mm au minimum et 35 mm au maximum (voir la Figure 14).

La longueur non isolée u de la *tête de travail* ne doit pas dépasser 20 mm (voir la Figure 14).

Dans le cas de brucelles ayant une *tête de travail* métallique, la partie métallique doit avoir une dureté minimale de 35 HRC, au moins de la *tête de travail* aux branches.



Légende

l longueur totale des brucelles

g longueur de la branche (préhension)

b largeur de la garde

h hauteur de la garde

e partie isolée ou isolante de la branche entre la garde et la *tête de travail*

u *tête de travail* (isolée ou non)

Figure 14 – Exemple de l'isolation des branches des brucelles

5 Essais

5.1 Généralités

Le présent document fournit les dispositions d'essai qui permettent de démontrer que le produit satisfait aux exigences de l'Article 4. Ces dispositions d'essai sont principalement destinées à être utilisées comme essais de type permettant de valider la conception. Lorsque cela est approprié, des moyens alternatifs (calcul, examen, essais, etc.) sont spécifiés dans les paragraphes consacrés aux essais et sont destinés aux *outils à main* issus de la production.

Les essais de type spécifiés de 5.2 à 5.11 doivent être effectués sur au moins trois *outils à main* de même conception et conformément à la séquence spécifiée à l'Annexe E.

Si un *outil à main* ne passe pas une partie quelconque de l'essai de type, l'essai de type doit être répété sur au moins six autres *outils à main* de même conception. Si n'importe lequel de ces six *outils à main* ne passe une partie quelconque de l'essai de type, alors l'essai complet doit être considéré comme ayant échoué.

Tous les *outils à main* qui n'ont pas satisfait à l'essai de type doivent être soit détruits, soit rendus inutilisables pour des travaux sous tension.

Sauf indication contraire, les essais de type doivent être effectués après un entreposage d'une durée minimale de 16 h conformément aux conditions climatiques IEC, 23 °C ± 5 °C, avec une humidité relative de 45 % à 75 % (voir l'IEC 60212 «ambiante normale»).

Sauf indication contraire, des tolérances de ± 5 % sont admises sur les valeurs d'essai de type exigées.

5.2 Contrôle visuel

L'*outil à main* (en particulier son isolation) doit être vérifié visuellement et doit être sans défauts apparents.

La lisibilité et la conformité du marquage doivent être vérifiées conformément à 4.1.4.

La conformité aux exigences complémentaires qui s'appliquent et présentées dans les paragraphes suivants doit être vérifiée par examen visuel:

- le 4.4.1.2, dans le cas d'éléments de liaison pour des *outils à main* pouvant être assemblés;
- le 4.4.1.3.2 concernant les instructions d'emploi, dans le cas d'*outils à main* pouvant être assemblés et conçus pour être interchangeables entre différents fabricants;
- le 4.4.2.4 concernant le type de matériau du système de maintien de la vis des tournevis;
- le 4.4.3 concernant les surfaces non isolées des clés.

5.3 Contrôle dimensionnel

Les exigences dimensionnelles spécifiées en 4.4 doivent être vérifiées. Les dimensions de certains éléments de marquage telles que spécifiées en 4.1.4 doivent être vérifiées.

5.4 Essais de chocs

5.4.1 Essai de type

5.4.1.1 Généralités

L'essai doit être réalisé conformément à l'une des deux méthodes représentées aux Figures 15 et 16. En cas de doute, la méthode «B» s'applique (voir la Figure 16).

Dans le cas d'*outils à main* pouvant être assemblés, les composants d'un outil doivent être vérifiés par essai séparément.

L'acier du marteau utilisé dans l'appareil de la Figure 15 et du marteau et de la pièce intermédiaire utilisés dans l'appareil de la Figure 16 doit avoir une dureté comprise entre 20 HRC et 46 HRC.

Au minimum trois points de la couche isolante ou du matériau isolant doivent être choisis comme points d'essai, ces points étant ceux qui sont les plus susceptibles d'être endommagés lorsque l'*outil à main* tombe sur une surface plane.

L'essai doit être considéré comme satisfait si le matériau isolant ne présente ni rupture, ni desquamation, ni fissure. Tous les autres défauts visibles ou non visibles causés par l'essai de choc sont vérifiés par les essais diélectriques en 5.5.