BS EN 60832-1:2010

BSI Standards Publication

Live working — Insulating sticks and attachable devices

Part 1: Insulating sticks

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National foreword

This British Standard is the UK implementation of EN 60832-1:2010. It is identical to IEC 60832-1:2010. Together with BS EN 60832-2:2010, it supersedes BS EN 60832:1997, which will be withdrawn on 1 March 2013.

The UK participation in its preparation was entrusted to Technical Committee PEL/78, Tools for live working.

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

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Supersedes EN 60832:1996 (partially)

English version

Live working - Insulating sticks and attachable devices - Part 1: Insulating sticks

(IEC 60832-1:2010)

Travaux sous tension -
Perches isolantes et outils adaptables -
Partie 1: Perches isolantes
(CEI 60832-1:2010)

Arbeiten unter Spannung -
Isolierende Stangen und auswechselbare Adapter/Arbeitsköpfe -
Teil 1: Isolierende Stangen
(IEC 60832-1:2010)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 78/838/FDIS, future edition 1 of IEC 60832-1, prepared by IEC TC 78, Live working, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60832-1 on 2010-03-01.

This EN 60832-1, together with EN 60832-2, supersedes EN 60832:1996. The two parts have been created to clearly separate the requirements and testing of insulating sticks from those of attachable devices.

Compared to EN 60832:1996, the major changes included in EN 60832-1:2010 are:

- integration of a cold impact test on the end fitting;
- creation of an electrical category of end fittings;
- integration of a test of the dielectric strength of internal insulation;
- modification of the dye penetration test (disappearance of fuchsine);
- application of conformity assessment for products having completed the production phase, according to IEC 61318:2007 (Edition 3), focusing on the classification of defects and the introduction of alternative testing in case of production follow-up.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2010-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60832-1:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60743:2001	NOTE Harmonized as EN 60743:2001 (not modified).
IEC 61472:2004	NOTE Harmonized as EN 61472:2004 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60060-1	-	High-voltage test techniques - Part 1: General definitions and test requirements	HD 588.1 S1	-
IEC 60212	1971	Standard conditions for use prior to and during the testing of solid electrical insulating materials	HD 437 S1	1984
IEC 60417	-	Graphical symbols for use on equipment	-	-
IEC 60855-1	-	Live working - Insulating foam-filled tubes and solid rods - Part 1: Tubes and rods of a circular cross-section	FprEN 60855-1	-
IEC 61318	2007	Live working - Conformity assessment applicable to tools, devices and equipment	EN 61318	2008
IEC 61477	-	Live working - Minimum requirements for the utilization of tools, devices and equipment	EN 61477	-
ISO 8486-1	1996	Bonded abrasives - Determination and designation of grain size distribution - Part 1: Macrogrits F4 to F220	-	-

CONTENTS

INTRODUCTION

The purpose of this standard is to provide essential requirements. Each user may supplement it with their own requirements. For example, the user may add requirements regarding the use of insulating sticks on d.c. electrical installations or the mechanical performance or compatibility and interchangeability with tools already in service. In such cases, caution should be taken to maintain or improve the performance of the products.

This publication has been prepared in accordance with the requirements of IEC 61477.

The products designed and manufactured according to this standard 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.

The product covered by this standard 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, and occur at the global, regional or local level.

Except for a disposal statement in the instructions for use, and special considerations for the selection of a dye (see 5.6), this standard does not include requirements and test provisions for the manufacturers of the product, or recommendations to the users of the product for environmental improvement. However, all parties intervening in its design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

LIVE WORKING – INSULATING STICKS AND ATTACHABLE DEVICES –

Part 1: Insulating sticks

1 Scope

This part of IEC 60832 gives the essential requirements for insulating sticks for live working for use on a.c. electrical installations.

Part 2 of IEC 60832 covers devices that can be attached onto and removed from the fitting of the insulating sticks.

The products designed and manufactured according to this standard 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.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this international standard. 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 60212:1971, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60855-1, *Live working – Insulating foam-filled tubes and solid rods – Part 1: Tubes and rods of a circular cross-section*

IEC 61318:2007, *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 8486-1:1996, *Bonded abrasives – Determination and designation of grain size distribution – Part 1: Macrogrits F4 to F220*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
insulating stick
insulating tool essentially made of insulating tube and/or rod with end fitting(s)

[Definition 2.5.1 of IEC 60743 and IEV 651-02-01, modified]

3.1.2
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment or system

[IEV 151-16-08]

3.1.3
end fitting
part permanently fitted to the end of the insulating tube or rod

[Definition 2.4.1 of IEC 60743 and IEV 651-02-02 modified]

3.1.4
type of tool
family of tools which are of the same design and application

3.1.5
rated voltage
U_r
maximum r.m.s. voltage for using the stick, which corresponds to the phase-to-phase voltage of three-phase networks

3.2 Symbols

T_N	rated torque given by the manufacturer for a given tool and for testing purposes
F_{TN}	rated tensile force given by the manufacturer for a given tool and for testing purposes
F_{CN}	rated compression force given by the manufacturer for a given tool and for testing purposes
F_{BN}	rated bending force given by the manufacturer for a given tool and for testing purposes

4 Requirements

4.1 General

The following requirements have been prepared in order that the products covered by this standard 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 method of work and the instructions for use.

It shall be ensured that all appropriate measures have been taken to minimize size and weight of the insulating sticks so as to facilitate their handling.

4.2 Electrical insulation

The tools covered by this standard shall only use foam-filled tube and/or solid rod with a circular cross-section that are in accordance with IEC 60855-1.

NOTE 1 Appropriate value of insulation should be achieved by using an appropriate length of tube or rod according to the method of work and taking into account the minimum approach distances (see IEC 61472) and the flashover characteristics of the stick.

NOTE 2 The electrical insulating characteristics of raw material used for insulating stick with non circular cross section will be covered by a future publication in the IEC 60855 series of standards.

The end fitting(s) shall be designed such as to avoid any internal insulation failure.

4.3 Electrical category of end fittings

End fittings shall be categorized according to their maximum use voltage:

- category A for use where U_r is lower than or equal to 550 kV;
- category B for use where U_r is larger than 550 kV but lower than or equal to 800 kV.

4.4 Dimensional and mechanical requirements

4.4.1 Dimensional requirements

For each type of tool complying with this part of the standard, the manufacturer shall provide in writing the dimensions or operating ranges relating to the specific functions of the tool.

4.4.2 Mechanical requirements

For each type of tool listed in Tables 1 and 2 and complying with this part of the standard, the manufacturer shall provide in writing the rated values corresponding to the characteristics specified in Tables 1 and 2.

The clip-on ammeter stick does not require mechanical tests to be performed on it, only visual inspection (see 5.2) and dimensional check (see 5.3) shall be carried out.

In case of tools equipped with wing screw(s), the wing screw(s) shall withstand the torsion stress of normal use.

Table 1 – Mechanical characteristics of hand sticks (to be supplied by the manufacturer)

Characteristics	Type of tools									
	Tie stick	Hook stick	Hook stick extension	Universal hand stick	Wire holding stick	Pliers stick	Wire cutter stick Binding-wire cutter stick	All-angle cog spanner stick	Flexible insulated spanner stick	Extensible universal hand stick
F_{BN}		X	X			X				X
F_{TN}	X (*)	X		X	X	X				X
T_N		X	X	X	X			X	X	X
Specific characteristics	(*) Tension strength of the rotary blade and hook		Tension strength of the connecting clamp		Tightening capability F_c	Tightening capability F_c Torsion strength of the support handle Torsion strength of the control handle	Cutting capability (maximum diameter and type of conductors)			

Table 2 – Mechanical characteristics of support sticks (to be supplied by the manufacturer)

Characteristics	Type of tools		
	Conductor support stick	Tension stick [a]	Tension puller (dead-end tool)
F_{TN}	X	X	X
F_{CN}	X		

[a] Tension stick: this term includes clevis/tongue stick, tension link stick, roller link stick, swivel link stick, spiral link stick.

4.5 Insulating sticks end fittings

4.5.1 Mechanical protection

When necessary, the ends of each stick shall be fitted with a suitable device providing mechanical protection, such as an end fitting or an end cap.

When metal end fittings are used, they shall be designed so that their edges, in proximity to the joint with the insulating tube or rod are rounded off.

The end fitting(s) of each stick shall be designed to prevent water or other polluting agents from penetrating inside the end fitting(s) of the tool or inside the insulating tube.

The end fitting(s) shall resist to shock even at low temperature.

NOTE 1 A cold impact test on the end fitting is included in 5.5.1. For tools intended to be used at temperatures lower than –25 °C, the client should discuss with the manufacturer the relevance of defining a more restricting test.

NOTE 2 In general, for tools intended to be used in unusual atmospheric conditions (very high or very low temperature or relative humidity), the client should discuss with the manufacturer the relevance of defining more restricting mechanical tests in appropriate conditions.

4.5.2 Protection against corrosion

Metal parts shall be protected against corrosion, either by their composition or by the use of a suitable surface treatment.

4.5.3 Conductive parts

All conductive parts attached to tubes or rods shall be clearly identified.

When this is not technically feasible, the outside of the tube or rod shall be clearly marked with a durable strip indicating the positions of internal metal parts.

All conductive parts attached to tubes or rods shall be designed and manufactured so as to reduce the danger of short-circuits.

4.6 Multiple-tube or multiple-rod tools

All tools comprising several tubes or rods shall be designed so that they can be taken apart for the purposes of maintenance.

4.7 Marking

Each tool shall be marked with the following permanent items of marking:

– manufacturer’s name or trademark,
– type reference,
– year and month of manufacture,
– marking showing the electrical category of the end fitting(s) (see 4.3),
– symbol IEC 60417-5216:2002-10 – Suitable for live working; double triangle (see Annex A);

  NOTE The exact ratio of the height of the figure to the base of the triangle is 1,43. For the purpose of convenience, this ratio can be between the values of 1,4 and 1,5.

– number of the relevant IEC standard immediately adjacent to the symbol, (IEC 60832-1).

The marking shall be durable, clearly visible and legible to a person with normal or corrected vision without additional magnification. The marking shall be placed in a position remote from the strip indicating the positions of internal metal parts.

Other characteristics or information not needed at the work location, like the year of publication of the standard, 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.

No marking shall adversely affect performance of insulating parts. Where a removable marking (e.g. a stick-on label) is used, the electrical performance of the tool shall remain unaffected when the marking is removed.

4.8 Instructions for use

Each tool shall be supplied with the manufacturer's written instructions for use and care.

These instructions shall be prepared in accordance with the general provisions given in IEC 61477.

These instructions shall include, as a minimum, recommendations for maximum mechanical load (see 4.4.2), cleaning, storage and transportation, periodic testing, possible repair and disposal of the tool.

5 Tests

5.1 General

The present standard 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 insulating sticks having completed the production phase.

To show compliance with this standard, the manufacturer shall prove that the type tests referred to in Tables B.1 and B.2 have been successfully carried out on at least three tools of each type of assembly.

However, when differences between various types of tools are limited in number, tests that are unaffected by the differing characteristics of the tools can be carried out on a single type of tool and the results can be used for the other tool types.

Tensile force tests need not be repeated when tool types only differ in the length of the insulating foam-filled tube or solid rod.

The tests referred to in Tables B.1 and B.2 shall be performed in the specified numbered order.

The required values of mechanical forces specified in Clause 5 shall be reached using a rate of increase between 1 % and 10 % of the rated force per second. The forces shall be applied with an accuracy of ±5 %.

NOTE For example, if the rated tensile force stated by the manufacturer for a given tool is F_{TN} = 100 N, the rate of increase will be between 1 N/s and 10 N/s and the applied force to the tool will be between 95 N and 105 N.

The dimensions specified in mm in Clause 5 shall be verified with an accuracy of ±2 %.

Unless otherwise specified, room temperature shall be (25 ± 10) °C.

When visual inspection is specified, it shall be understood to be visual inspection by a person with normal or corrected vision without additional magnification.

5.2 Visual inspection

Each tool shall be visually inspected to detect manufacturing defaults and to check proper functioning and compliance with requirements included in 4.2, 4.5, 4.6, 4.7 and 4.8 where applicable.

5.3 Dimensional check

Each tool shall be measured to ensure that its dimensions match the manufacturer's rated dimensions.

5.4 Durability of marking

The durability of the marking shall be verified by thoroughly cleaning the marking for at least 1 min with a piece of lint-free cloth dampened with water and then rubbing it vigorously for a further minimum of 1 min with a piece of lint-free cloth dampened with isopropanol (CH_3-CH(OH)-CH_3).

NOTE 1 It is the employer's duty to ensure that any relevant legislation and any specific safety instructions regarding the use of isopropanol are fully observed.

The test shall be considered as passed if the marking remains legible and the letters do not smear.

The surface of the tool may change. No signs of loosening shall be present for labels.

NOTE 2 Marking made by moulding or engraving need not be subjected to this test.

5.5 Mechanical tests

5.5.1 Cold impact test on the end fitting

If the tool has more than one end fitting, each different type of end fitting shall be tested.

The end fitting of the tool shall be left in a chamber at a temperature of (–25 ± 3) °C for at least 2 h. The impact test shall be performed at a time interval not greater than 120 s after removing the end fitting from the chamber.

NOTE Depending on the relative dimensions of the test chamber and of the tool under test, it is permitted to have only the tested extremity of the tool inserted in the test chamber by a porthole.

The height (H) of fall of the hammer shall be calculated in relation to its weight (P), so that the impact force (W) on the end fitting shall be equal to that of the complete tool falling from a height of 0,6 m on a hard surface:

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

where

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

F is the weight of the complete tool to be tested, in newton,

P is the weight of the hammer, in newton.

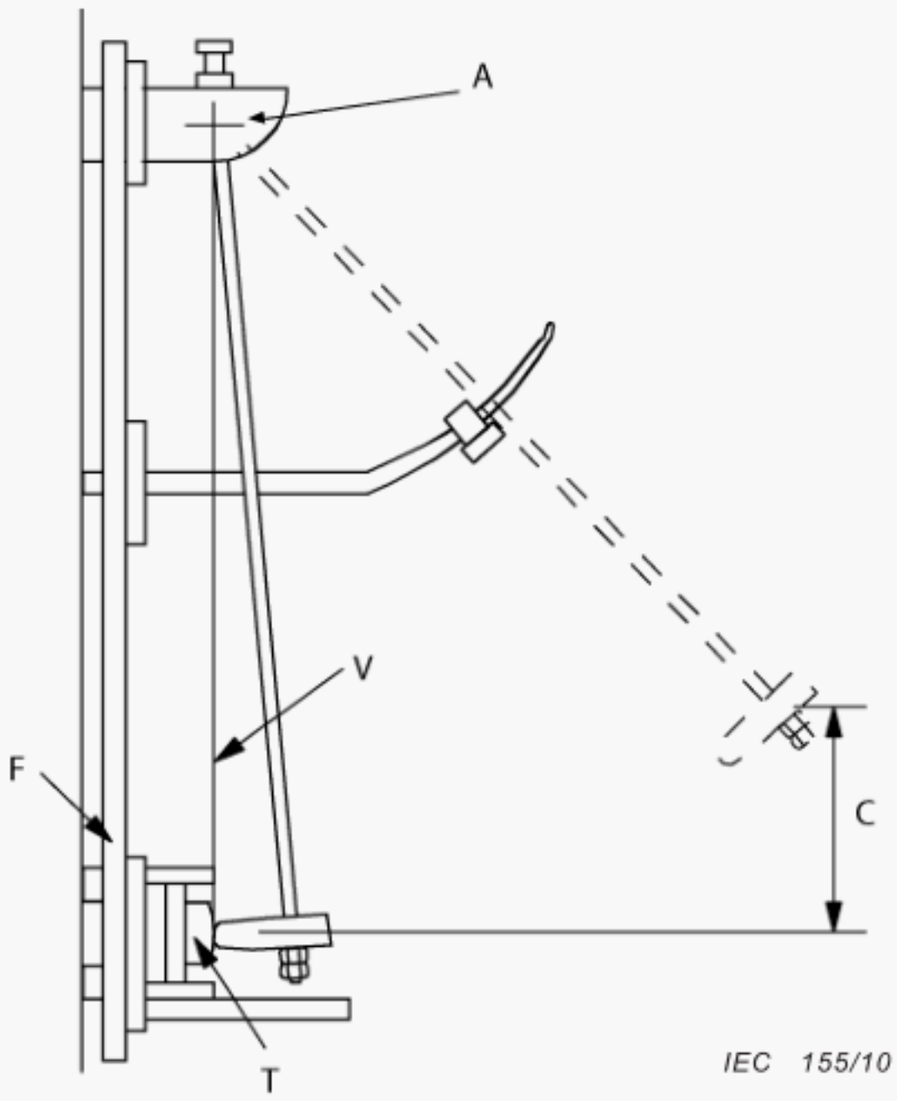
The test shall be conducted in accordance with one of the two methods shown in Figures 1a and 1b. The hammer of method A and the hammer and intermediate piece of method B shall have a minimum hardness of 20 HRC.

Three separate points of impact shall be located on the end fitting (not on the tube or rod). They shall be selected as being points that are likely to be damaged when the tool falls on a flat surface. The same location shall be tested only once.

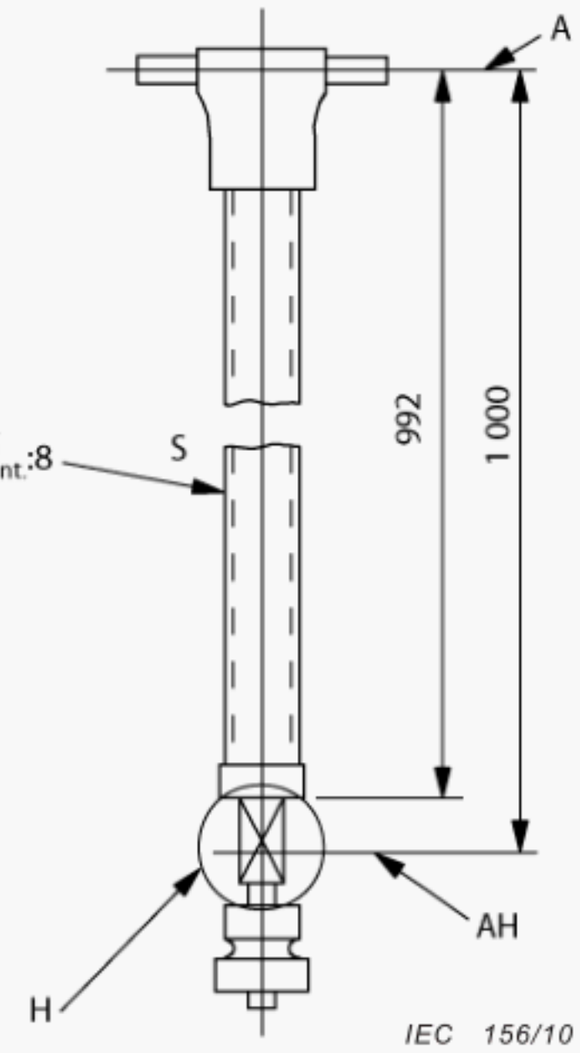
The test shall be considered as passed if there are no signs of rupture or cracks on any of the end fittings.

In case of dispute, method A (Figure 1a) shall be used.

Dimensions in millimetres

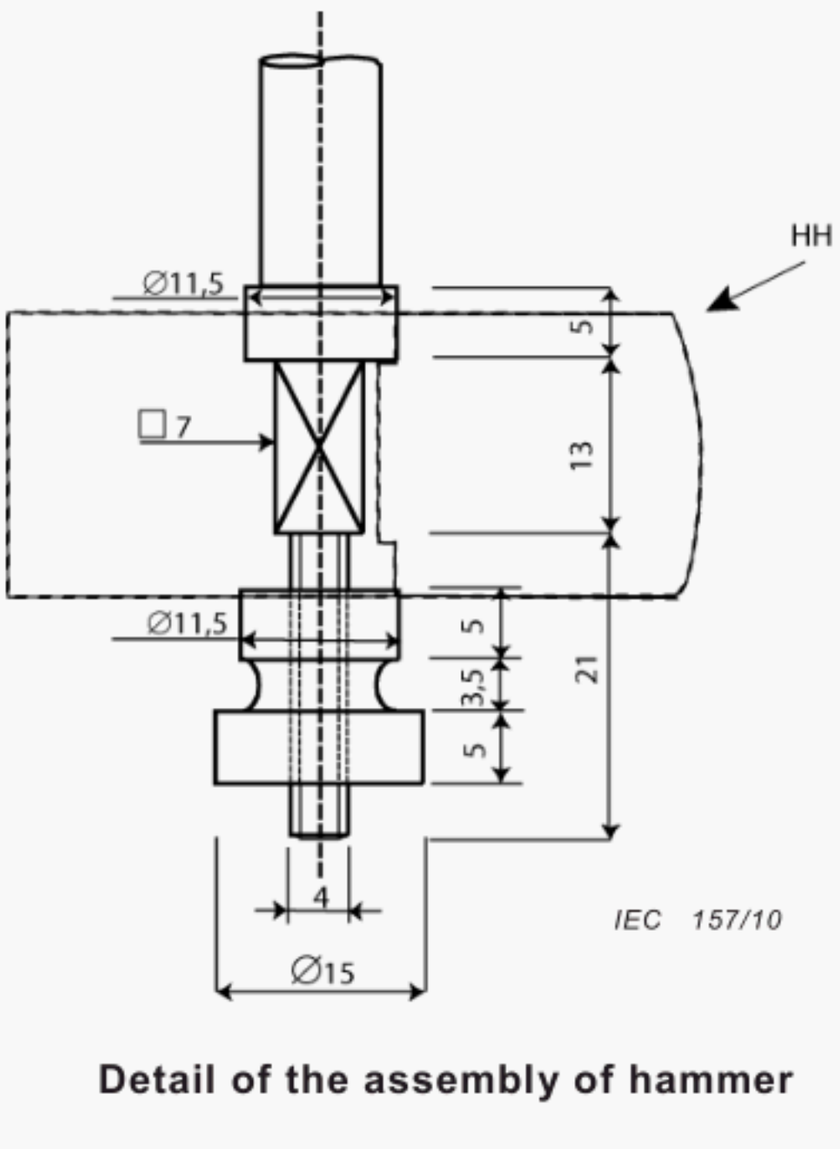


Side view

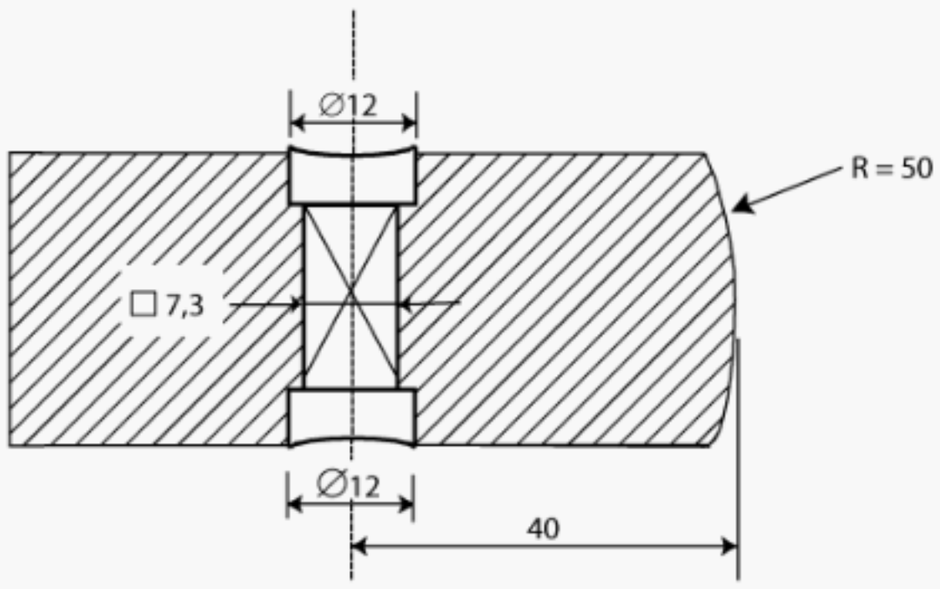


Front view

Dimensions in millimetres



Detail of the assembly of hammer



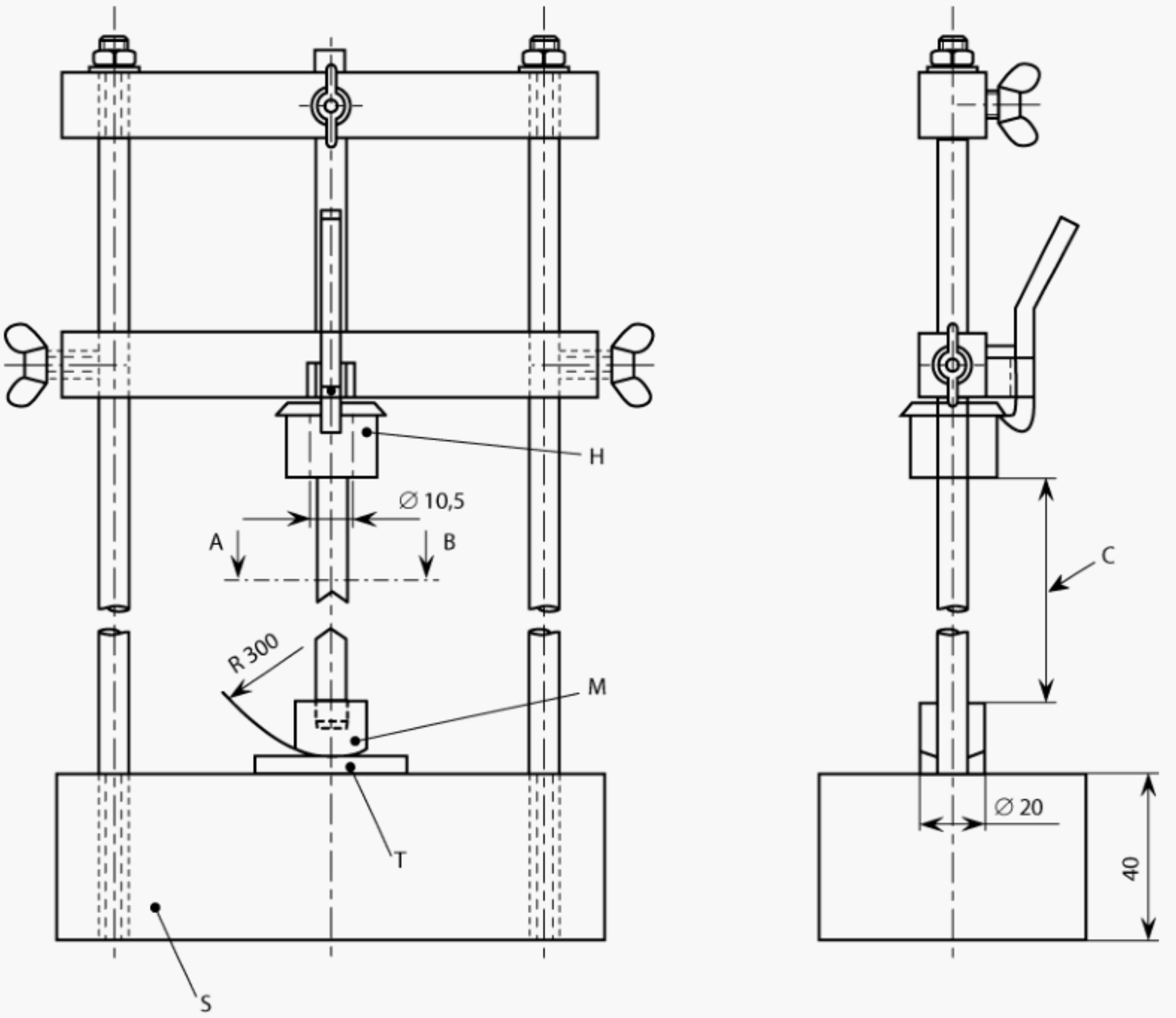
Detail of hammer head

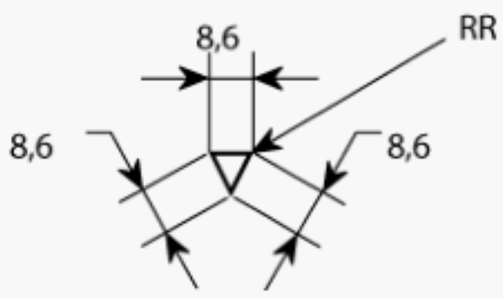
Key

A	axis of swing adjustable	HH	hammer head – Rockwell hardness of material ≥ 20 HRC
AH	axe of hammer	S	metal tube
C	fall height	T	test piece
F	frame	V	vertical plane through axis of pendulum
H	hammer		

Figure 1a – Cold impact test on the end fitting – Method A

Dimensions in millimetres





Section A-B

IEC 159/10

Key

C fall height

H hammer

M metal intermediate piece 100 g

RR slightly rounded edges

S metal part 10 kg

T test piece

Figure 1b – Cold impact test on the end fitting – Method B

Figure 1 – Cold impact test on the end fitting

5.5.2 Torsion

The prescribed values of torque given in Table 3 shall be maintained for a period of not less than 1 min before the results are recorded and the visual inspection is carried out.

The torque shall be applied to the ends of the tool.

Table 3 – Torque values and pass criteria of the torsion test

Torque	Pass criteria
1,25 T_N	No visible sign of damage shall be observed on the tool
2,5 T_N	No permanent deformation or breakage shall be observed on the tool

5.5.3 Tension

The tensile forces given in Table 4 shall be maintained for a period of not less than 1 min before the results are recorded and the visual inspection is carried out.

The tensile force shall be applied to the ends of the tool.

Table 4 – Tensile forces and pass criteria of the tension test

Tensile force	Pass criteria
1,25 F_{TN}	No visible sign of damage shall be observed on the tool
2,5 F_{TN}	No permanent deformation or breakage shall be observed on the tool

5.5.4 Compression

The compression forces given in Table 5 shall be maintained for a period of not less than 1 min before the results are recorded and the visual inspection is carried out.

The compression force shall be applied to the ends of the tool.

Table 5 – Compression forces and pass criteria of the compression test

Compression force	Pass criteria
1,25 F_{CN}	No visible sign of damage shall be observed on the tool
2,5 F_{CN}	No permanent deformation or breakage shall be observed on the tool

5.5.5 Bending

The tool shall be placed horizontally between two supports located on opposite sides of the tool as shown in Figure 2. These two supports shall be placed 500 mm and 1 000 mm from a fixed surface. The bending force shall be applied to the head of the tool which is located remote to the fixed surface.

When the tool being tested is a stick extension or part of an extendable stick, the force shall be applied to the head of the tool and the other end of the tool shall be firmly attached to a base simulating the point of connection when the tool is in service.

The bending forces given in Table 6 shall be maintained for a period of not less than 1 min before results are recorded and the visual inspection is carried out.

Table 6 – Bending forces and pass criteria of the bending test

Bending force	Pass criteria
1,25 F_{BN}	No visible sign of damage shall be observed on the tool
2,5 F_{BN}	No permanent deformation or breakage shall be observed on the tool

Dimensions in millimetres

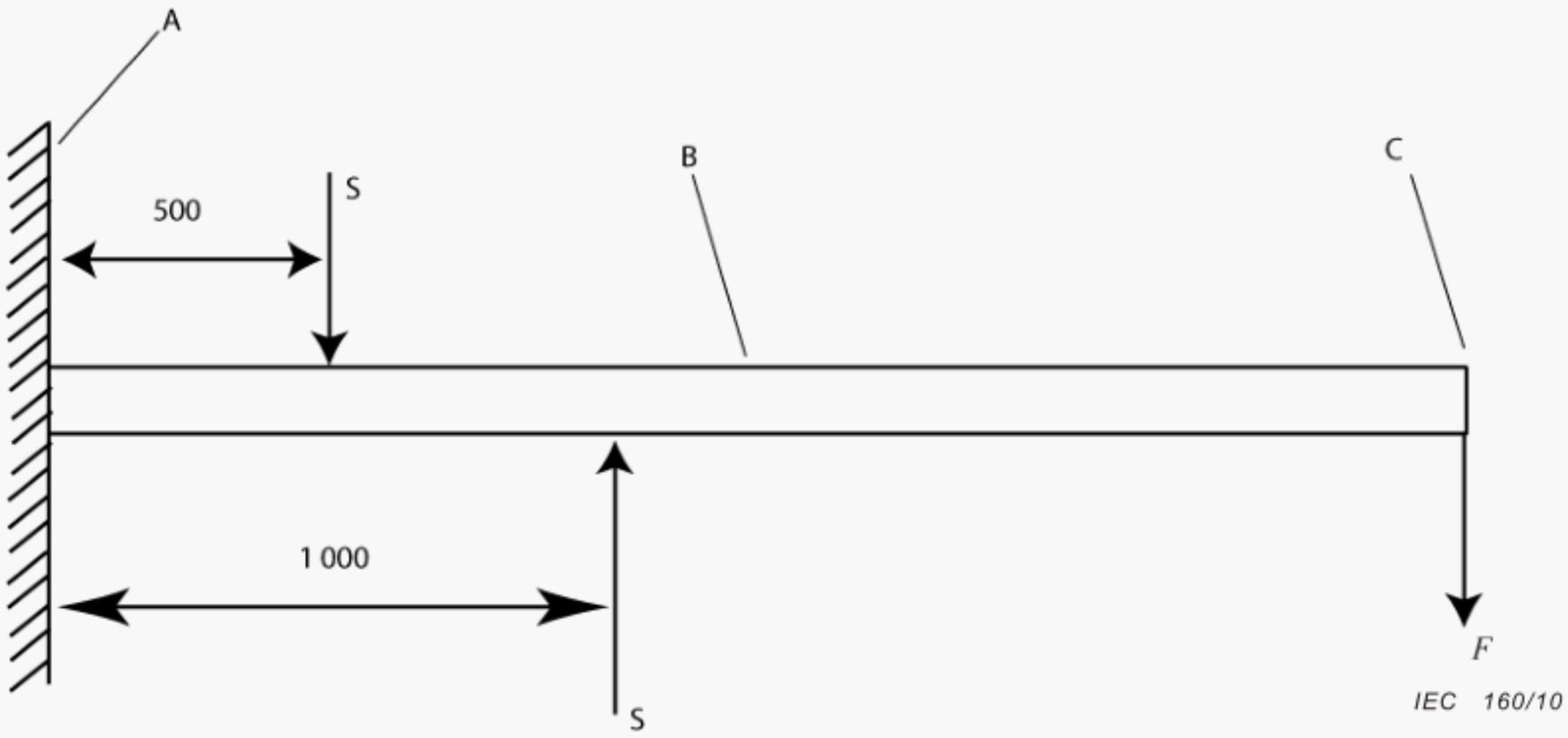
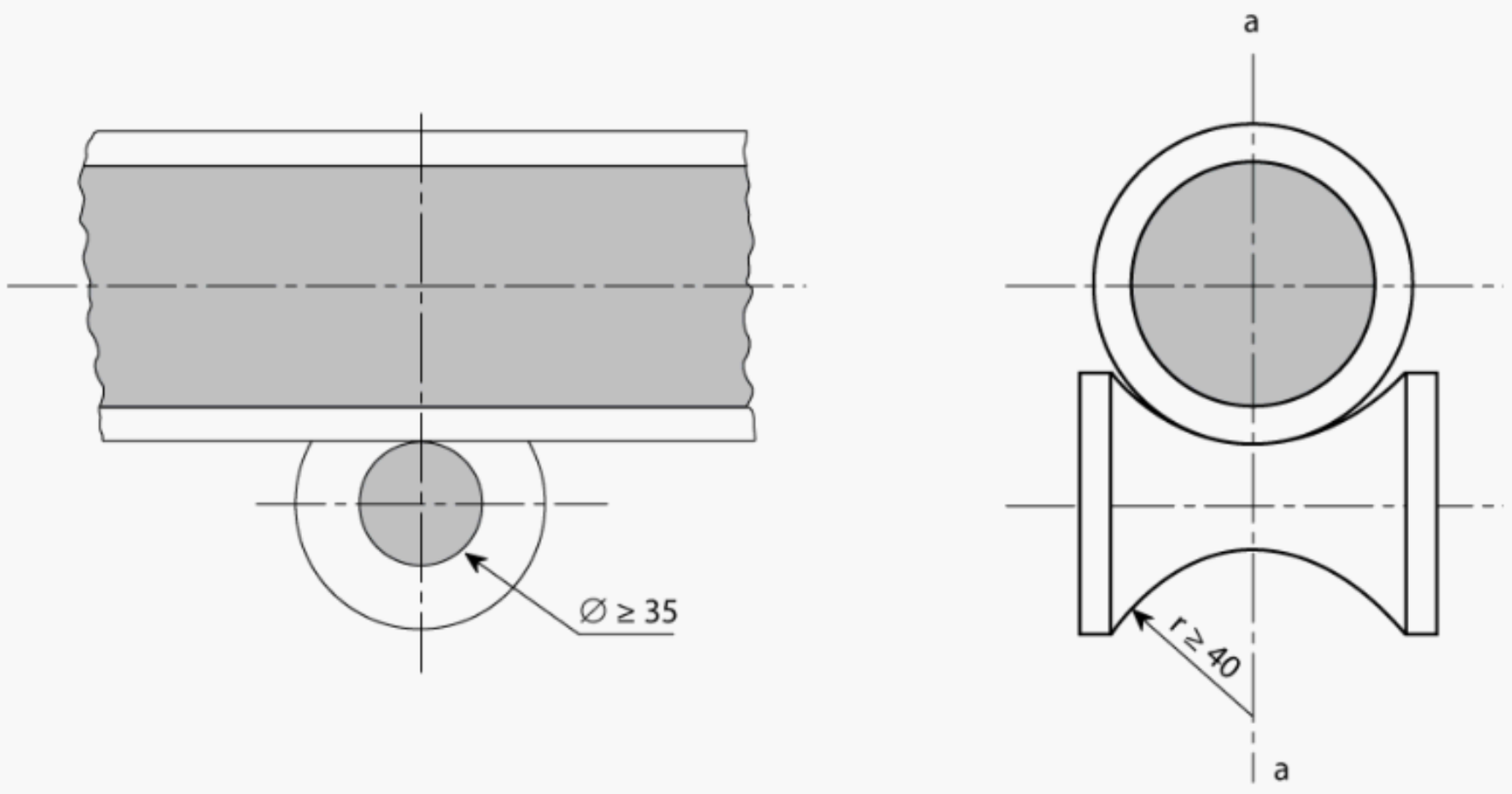


Figure 2a – Test assembly

Dimensions in millimetres



a-a section

Figure 2b –Detail of supports

Key

A fixed surface

B insulating stick

C operating head

S support

Figure 2 – Bending test

5.5.6 Torsion test of wing screw(s)

For tools equipped with wing screw(s), a torque shall be applied to the wing screw up to a value of 1,25 times the rated torque of 3 N·m and then maintained at this value for a period of not less than 1 min.

The test shall be considered as passed if no visible sign of damage is observed after the test.

The torque shall be applied again in the same manner as above using a maximum value of torque of 2,5 times the rated torque of 3 N·m and then maintained at this value for a period of not less than 1 min.

The test shall be considered as passed if no permanent deformation or breakage is observed after the test.

5.6 Dye penetration test

The dye penetration test shall only be carried out on test pieces cut from complete tools whose insulating tube has been pierced with holes for inserts (made of metal or other material). Three test pieces shall be cut from three complete tools.

Each test piece shall be 100 mm long and shall include at least one pierced hole such that the hole is more than 10 mm from either end of the test piece. Each test piece shall be entirely immersed in a container filled with an aqueous dye solution. The dye shall be selected in accordance with occupational health and environmental requirements.

NOTE 1 Comparative dye penetration tests have been carried out, using various dyes. These tests indicate that the choice of the dye does not affect significantly the characterisation of tubes and rods. In practice however, eosine ($C_{60}H_6Br_4Na_2O_5$) proves to be particularly convenient.

NOTE 2 IEC 60832 was specifying a fuchsine/distilled water solution for the dye penetration test. In the context of occupational health and environmental considerations it has been agreed that TC78 will no longer specify fuchsine. In making this decision TC78 has taken into account that fuchsine is an aniline substance with suspected health hazards and its use should be avoided.

The container with the immersed test pieces shall be placed in a vacuum chamber at a pressure of less than 6 500 Pa (about 50 Torr). After not less than 1 h, the pressure shall be released and the test pieces shall be removed from the solution.

To avoid any dye spreading at the cut surfaces, the test pieces shall be dried for a period of not less than 24 h at room temperature (code >24h/18-28C/45-75 % of IEC 60212).

After being dried, the test pieces shall be cut through at a distance of 10 mm from each end. The resulting parts (each now 80 mm long) shall then be cut lengthwise.

The test shall be considered as passed if no penetration of dye solution is observed when visually inspected.

5.7 Electrical tests

5.7.1 Electrical test after water conditioning

5.7.1.1 Type test

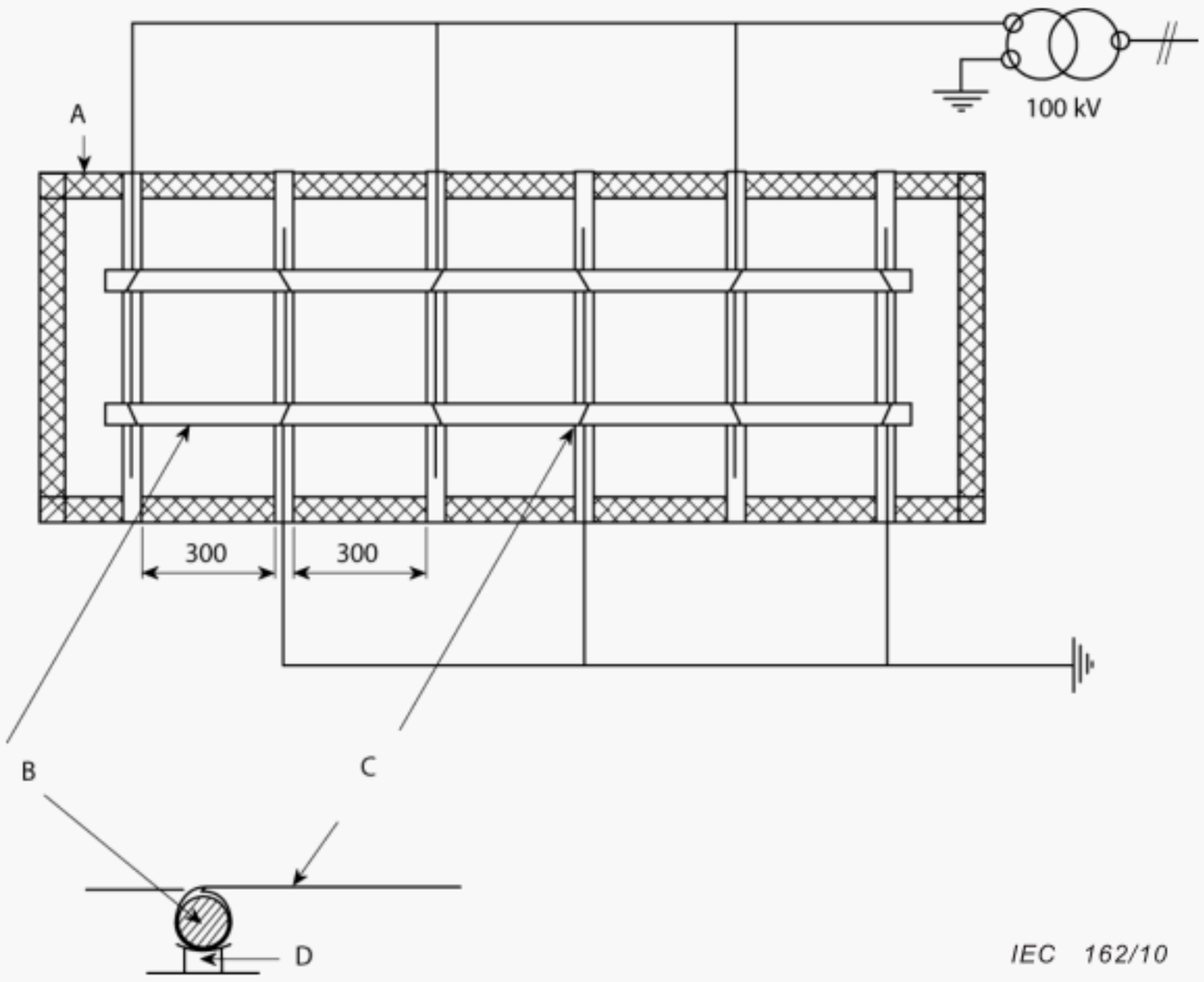
5.7.1.1.1 General test conditions

The test location shall be at standard atmospheric conditions in accordance with code 18-28C/45-75 % of IEC 60212. The temperature of the water used for the test shall be within the same limits as the ambient air temperature that is between 18°C and 28°C.

A test voltage of not less than 100 kV r.m.s. at power frequency shall be applied between the electrodes that are placed 300 mm apart, for a period of not less than 1 min, as specified in IEC 60060-1. Connections for the test may be as shown in Figure 3.

NOTE The distance between the tools in Figure 3 should be at least twice the distance which separates the electrodes.

Dimensions in millimetres



Key

A insulating table

B insulating tool

C stranded wire electrodes > 5 mm width

D metal support

Figure 3 – Electrical test after water conditioning

5.7.1.1.2 Conditioning in water

Tools shall be completely immersed in water having a resistivity of $(100 \pm 15)\ \Omega{\cdot}m$ (IEC 60060-1) and shall be subjected to a conditioning of 24 h/23C/water, according to IEC 60212. Then the tools shall be taken out of the water and the liquid film shall be removed by wiping with a clean fibre-free absorbent cloth.

The test voltage shall be applied within a period of not more than 5 min following the wiping of the tool.

5.7.1.1.3 Pass criteria

The test shall be considered as passed if no total or partial insulation failure is observed on any of the three tools:

- the first requirement (no total failure) is met when each of the tools withstands the entire test sequence without the voltage source tripping,

- the second requirement (no partial failure) is verified by a visual inspection within 1 min after the test. There shall be no signs of flashover, sparkover, or puncture of the insulating tube or rod, or any signs of tracking or of surface erosion.

5.7.1.2 Alternative means for insulating sticks having completed the production phase

The manufacturer or end assembler shall prove that he has followed the same documented assembly procedure with identical components as per the type-tested device and shall pass these requirements on to his subcontractor.

NOTE At the present time, there is no alternative test associated with the electrical performance of the tools. The rationale being that this performance is based on the one of tubes or rods covered by IEC 60855-1 which includes a dielectric routine test. However, if in the future experience from the field indicates differently, the addition of a routine test could be considered.

5.7.2 Dielectric strength of internal insulation

5.7.2.1 Type test

This test shall be carried out on three test pieces taken from three identical insulating sticks with the following length of the insulating tube L_{type} (in metre):

L_{type} = 4,20 m (tolerance ± 0,05 m) when the tool is made of an end fitting of category A,

L_{type} = 8,30 m (tolerance ± 0,05 m) when the tool is made of an end fitting of category B.

NOTE This test is limited to sticks made of foam filled tube since there is no evidence of any internal failure on sticks made of solid rod.

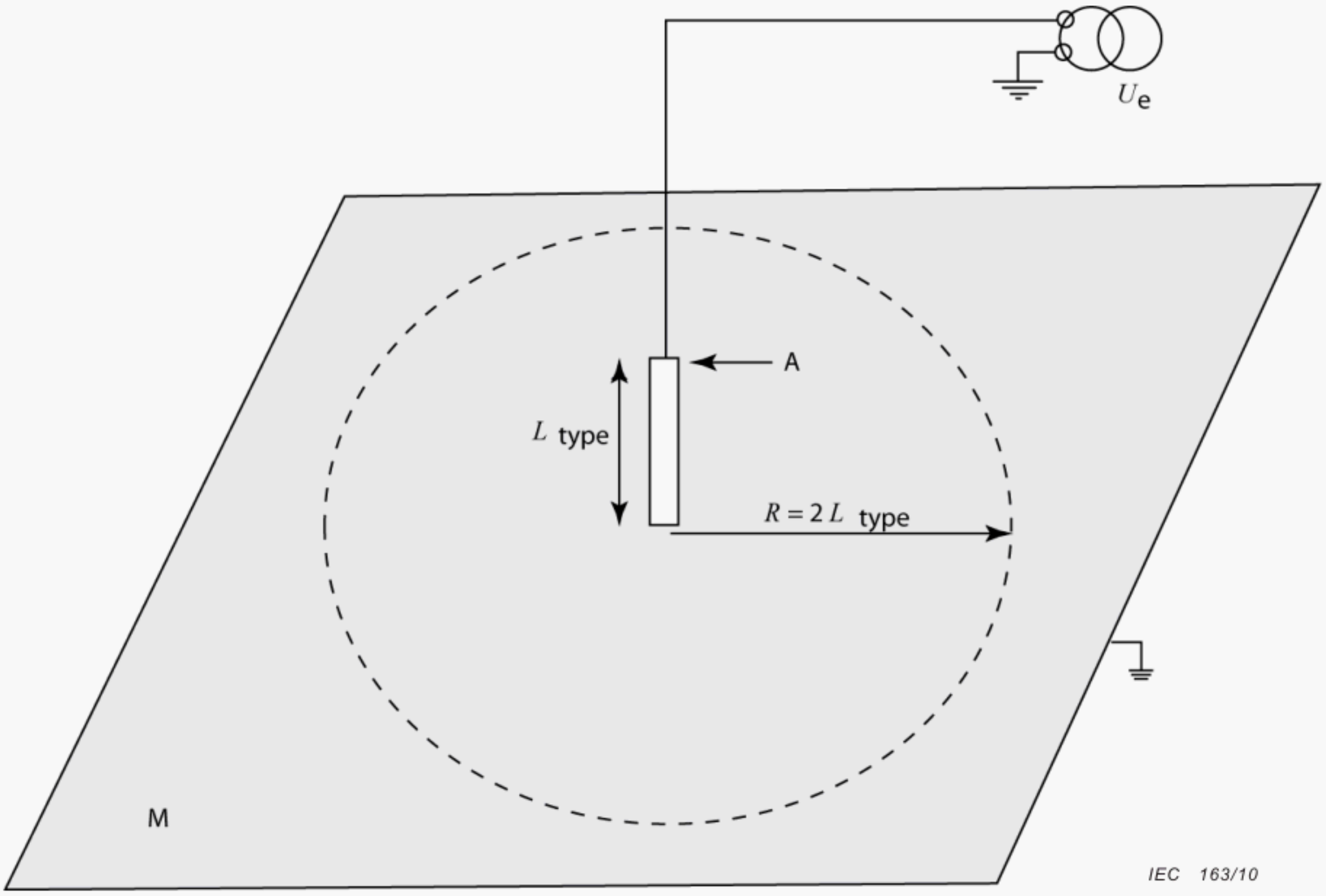
5.7.2.1.1 General testing conditions

The test location shall be at standard atmospheric conditions in accordance with code 18-28C/45-75 % of IEC 60212, i.e. ambient temperature 18 °C to 28 °C, and relative humidity 45 % to 75 %.

This test shall be performed within 1 h after the water conditioning.

5.7.2.1.2 Test circuit

The test piece shall be positioned vertically, with the end fitting extremity connected to an a.c. voltage source and the other extremity placed on an earthed conductive matting (see Figure 4).



Key

A end-fitting extremity of the test piece

M exposed conductive matting

U_e see 5.7.2.1.3

Figure 4 – Dielectric strength of internal insulation

The conductive matting shall be flat and larger in area than that of a circle with a radius R of $2L_{type}$, measured from the vertical axis of the test piece.

The test piece shall be located at a distance of not less than $2L_{type}$ from any walls of the test chamber and from any laboratory equipment.

The high voltage connection to the test piece shall be aligned with the vertical axis of the test piece and shall be supported at a height greater than L_{type}. The diameter of the test connection shall not exceed that of the end fitting of the test piece.

The end fitting shall not be fitted with any corona ring (or any other device) during the test.

The short-circuit output test current of the voltage source shall be greater than or equal to 0,1 A in accordance with IEC 60060-1. Any overcurrent protection for this voltage source shall be set to a sufficiently high value so as to prevent any untimely tripping during the test procedure.

5.7.2.1.3 Test procedure

The test consists of applying a series of test voltages U_e at power frequency to each of the three identical test pieces, in the following order:

- $U_{e1} = \frac{2 \times Ur}{\sqrt{3}}$ for 1 min;
- $U_{e2} = \frac{2{,}5 \times Ur}{\sqrt{3}}$ for 1 min;
- $U_{e3} = \frac{1{,}5 \times Ur}{\sqrt{3}}$ for 1 h,

where U_r is fixed to:

– 550 kV r.m.s. for the electrical category A of end fitting;

– 800 kV r.m.s. for the electrical category B of end fitting.

NOTE In accordance with IEC 60060-1, increase in voltage should be fairly slow to allow time for taking readings from instruments, but not so slow as to unnecessarily prolong the exposure of the test piece to stress near the test voltage U_e. These requirements are usually met when the speed of increase in voltage over 75 % of U_e is about 2 % of U_e per second. This voltage U_e should be maintained for the specified time then lowered by discharging capacitance charge of the test circuit, including that of the test piece, using a suitable resistor.

5.7.2.1.4 Pass criteria

The test shall be considered as passed if no total or partial insulation failure is observed on any of the three test pieces:

– the first requirement (no total failure) is met when each of the test pieces withstands the entire test sequence without the voltage source tripping;

– the second requirement (no partial failure) is verified by visual inspection, after cutting the insulating tube lengthwise over a length of not less than 0,50 m from the end fitting that was connected to the voltage source, and progressively removing the foam: there shall be no visible tracking in the foam or on the tube's inner surface.

5.7.2.2 Alternative means for insulating sticks having completed the production phase

There is no alternative test for checking the conformity to the associated requirement (for instance, some tests could be destructive). Nevertheless, the manufacturer or end assembler shall prove that he has followed the same documented assembly procedure with identical components as per the type-tested device and shall pass these requirements on to his subcontractor.

5.8 Specific tests

5.8.1 Tie stick – Tension test of the rotary blade and hook

The tie stick shall be fixed firmly in place. A tensile force shall be applied to the rotary blade parallel to the axis of the stick (see Figure 5), up to a value of 1,25 times the tension strength of the rotary blade supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

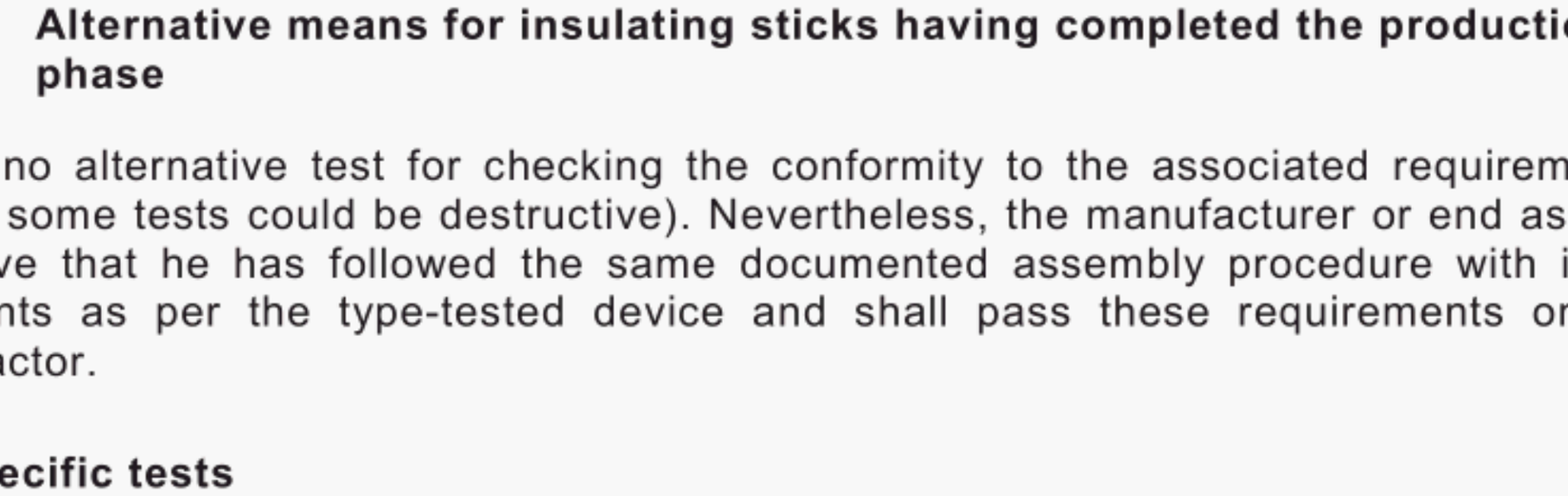


Figure 5 – Tie stick – Tension of the rotary blade

This test shall be considered as passed if, after the test, the blade rotates easily and smoothly and there is no visible deformation of the blade or break in the glued joint.

The tensile force shall be applied again in the same manner as above using a maximum value of tensile force of 2,5 times the tension strength of the rotary blade supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

This test shall be considered as passed if, after the test, the blade rotates easily and smoothly and there is no permanent deformation or breakage seen during a visual inspection after the test.

The tests shall be carried out on the rotary hook, under the same test conditions specified above (see Figure 6).

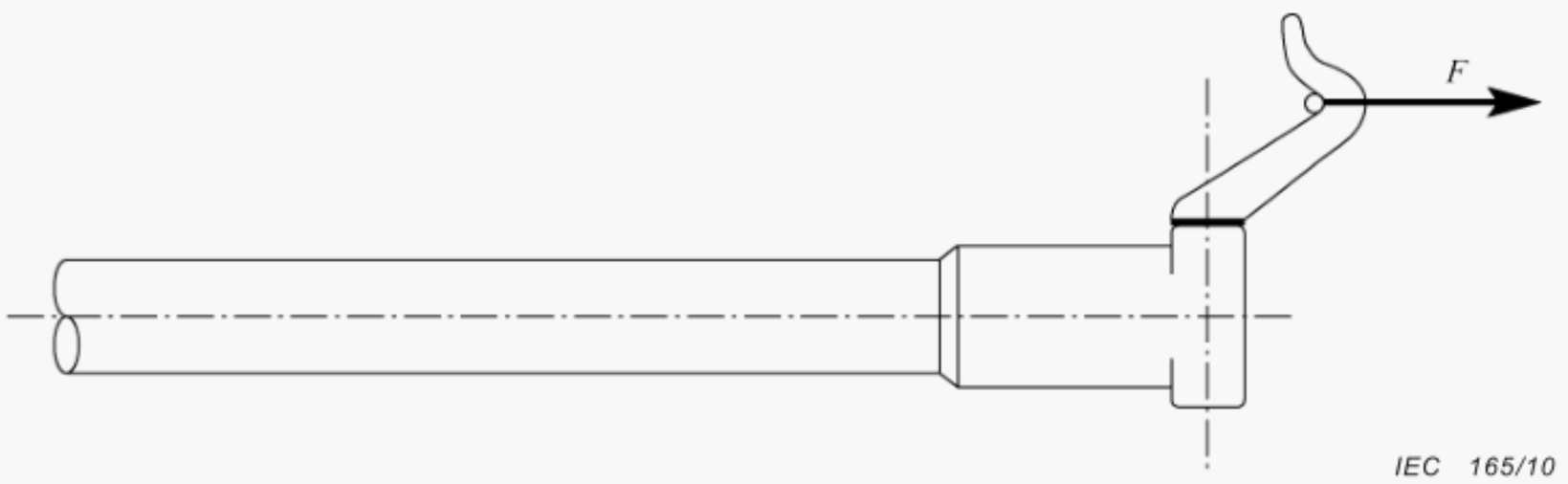


Figure 6 – Tie stick – Tension of the rotary hook

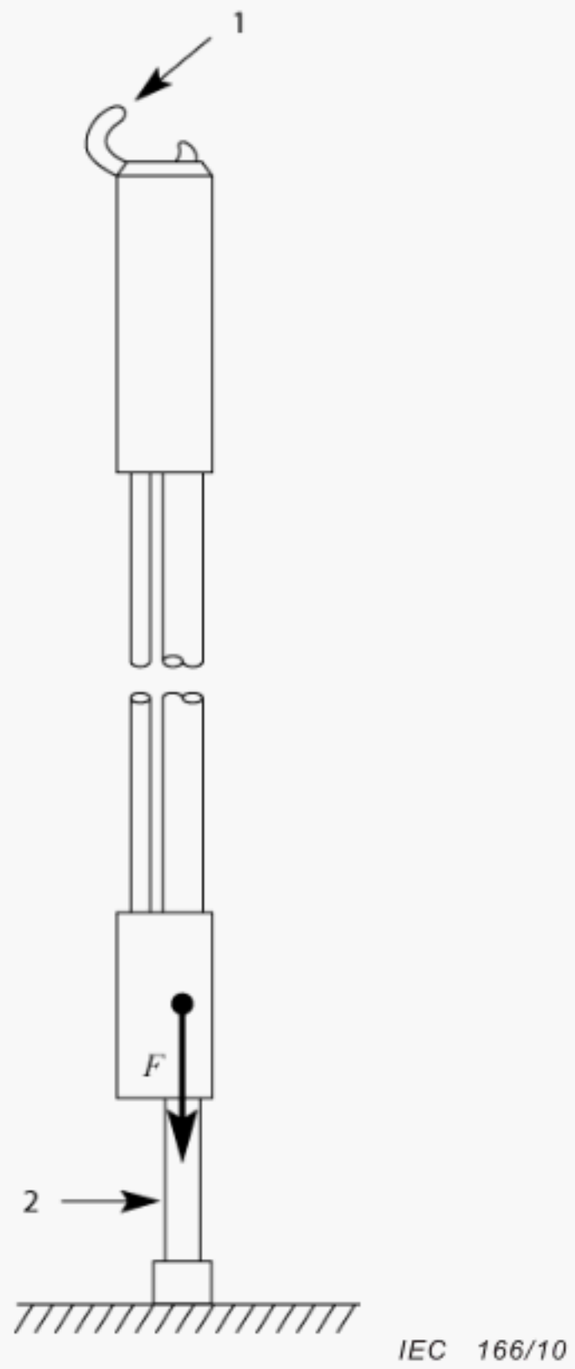
It is permissible for the two tests described above (test of the rotary blade and test of the rotary hook) to be carried out simultaneously.

5.8.2 Hook stick – Operating rod functioning

The hook stick shall be securely fixed in the vertical position with the hook in the “open” position. A progressively increasing force shall be applied to the operating handle until it unlocks (see Figure 7).

The test shall be considered as passed if the unlocking takes place at a value of force between 15 N and 50 N.

The same test shall be repeated under the same conditions and with the same requirements, with the hook in the “median” position (closed, but not entirely retracted).



Key

1 opened hook

2 stick in vertical position on the ground

Figure 7 – Hook stick – Operating rod functioning

5.8.3 Hook stick extension – Tension strength of the connecting clamp

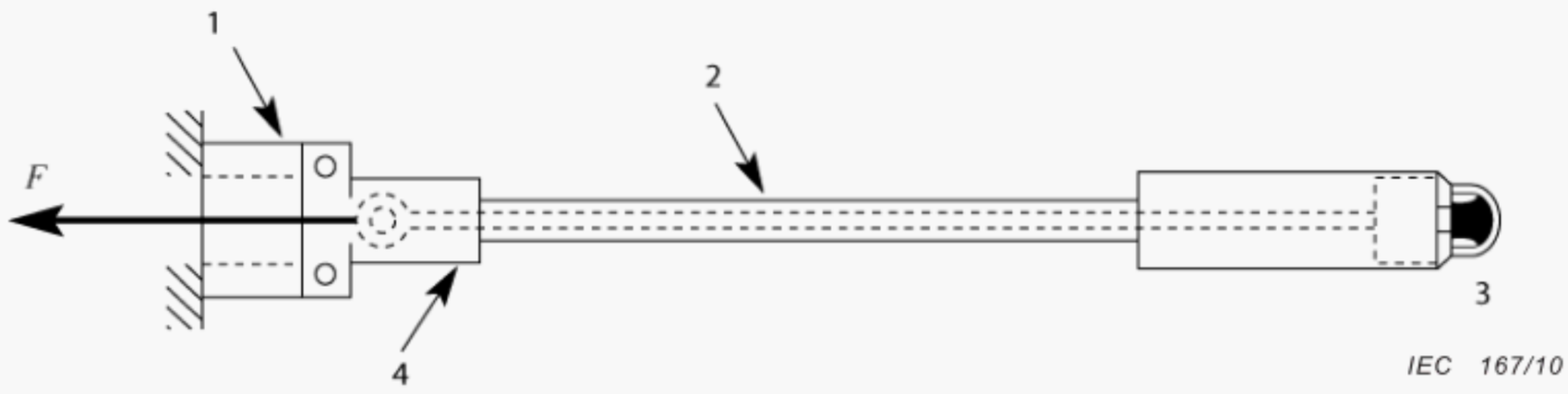
The open hook shall be hooked tightly onto a metal rod 10 mm in diameter. The hook stick extension is attached to a test arrangement simulating the head of a hook stick. The screws shall be tightened using a coupling torque of 5 N·m (see Figure 8).

A tensile force F shall then be applied to the eye through the test arrangement up to a value of 1,25 times the tension strength of the connecting clamp supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

When the tensile force is removed, no deformation shall be visible on any part of the hook stick extension.

The tensile force shall be applied again in the same manner as above using a maximum value of tensile force of 2,5 times the tension strength of the connecting clamp supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

When the tensile force is removed, no permanent deformation or breakage shall be visible on any part of the hook stick extension.



Key

1 test arrangement

2 hook stick extension

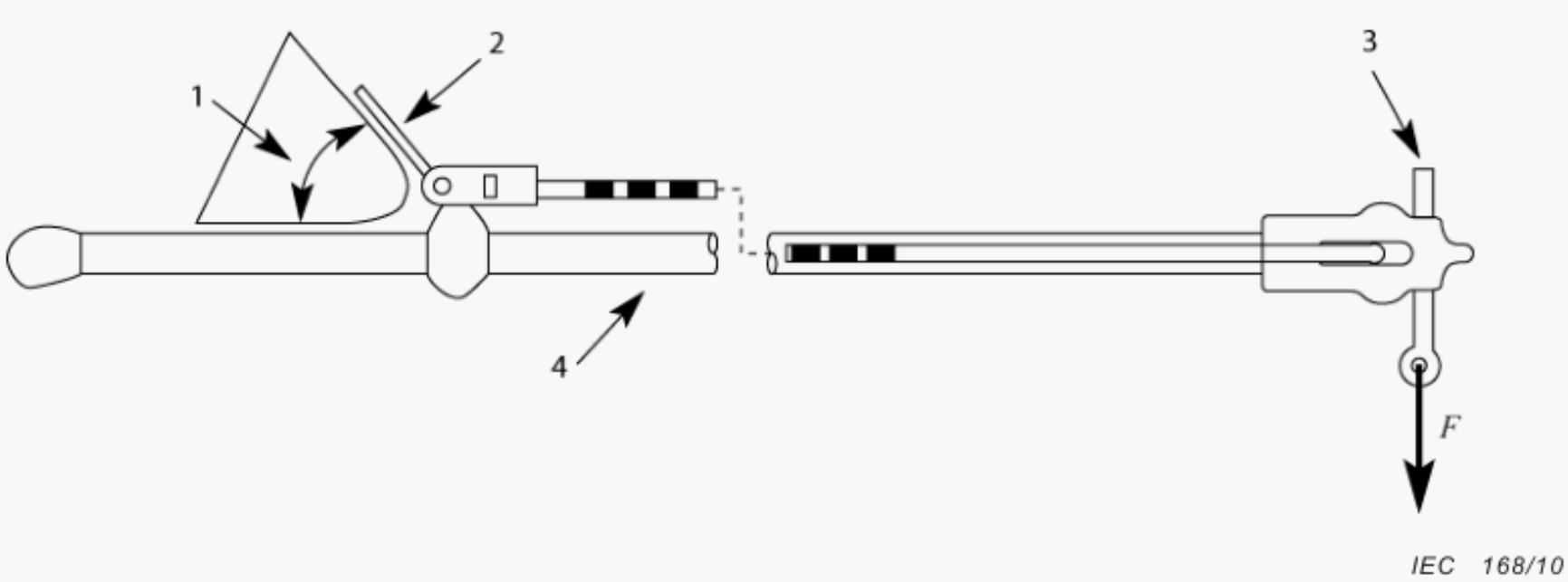
3 hook closed on a metal rod 10 mm diameter

4 connecting clamp

Figure 8 – Hook stick extension – Tensile strength test for the connecting clamp

5.8.4 Wire holding stick – Tightening capability

A smooth metal test rod of 20 mm ± 1 mm in diameter shall be firmly secured by a clamping arrangement. With the operating lever at a 50° angle to the longitudinal axis of the stick holding the rod (see Figure 9), the mobile jaw shall be brought into contact with the test rod using the fine screw adjusting knurled nut. The test rod shall be then clamped in the wire holding stick by operating the lever to the locking position; the head of the stick shall be held firmly in place.



Key

1 50 degrees gauge

2 operating lever

3 metal test rod 20 mm ± 1 mm in diameter

4 stick fixed horizontally

Figure 9 – Wire holding stick – Tightening capability

A tensile force F shall be applied straight along the longitudinal axis of the metal test rod until the rod slips.

The test shall be considered as passed when this slipping only occurs for a value of the tensile force greater than F_C, where F_C is the manufacturer's rated value for tightening capability.

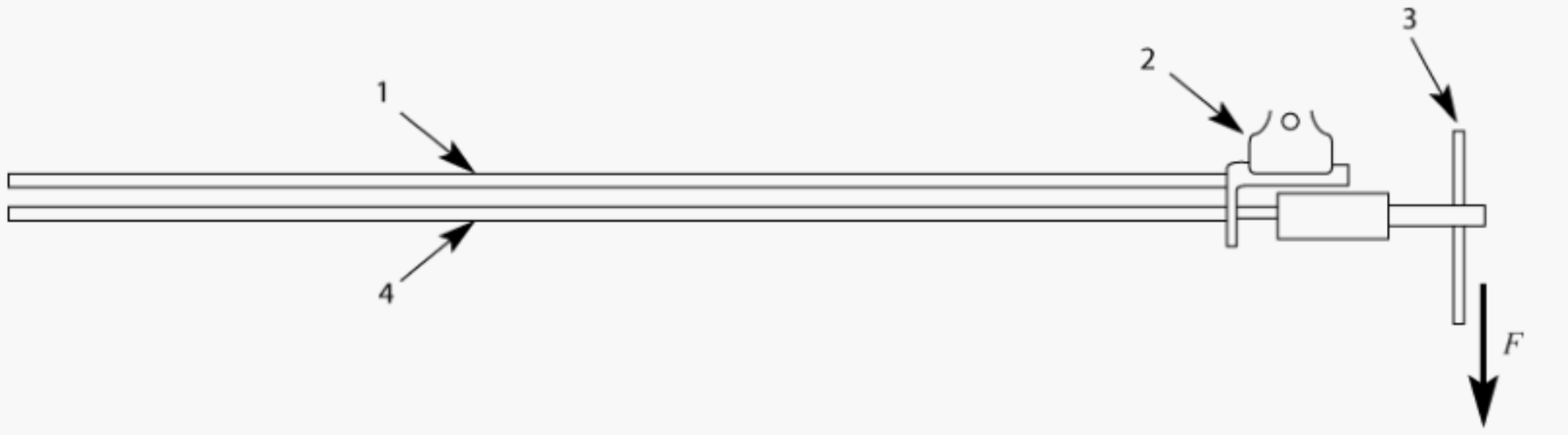
This test shall be repeated for each position of the jaws relative to the axis of the stick.

There shall be no change in position as a result of tensile force being applied to the metal rod.

5.8.5 Pliers stick

5.8.5.1 Tightening capability

A smooth metal test rod of 20 mm ± 1 mm in diameter shall be clamped between the jaws of the pliers and a coupling torque of 35 N·m shall be applied to the operating handle. The head of the stick shall be held firmly in place and a tensile force F shall be applied along the longitudinal axis of the test rod (see Figure 10) until the metal test rod slips.



IEC 169/10

Key

1 support handle

2 clamp

3 metal test rod of 20 mm ± 1 mm in diameter

4 operating handle

Figure 10 – Pliers stick – Tightening capability

The test shall be considered as passed when this slipping only occurs for a value of the tensile force greater than F_C, where F_C is the manufacturer's rated value for tightening capability.

5.8.5.2 Torsion strength of the support handle

A smooth metal test rod 20 mm in diameter shall be clamped between the jaws of the pliers. A torque of 35 N·m shall be applied to the operating handle. The head of the stick shall be held firmly in place as shown in Figure 11. A torque T shall be applied to the support handle up to a value of 1,25 times the torsion strength of the support handle supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

IEC 170/10

Key

1 metal test rod 20 mm in diameter

Figure 11 – Pliers stick – Torsion of the support handle

The test shall be considered as passed if no visible sign of damage is observed after the test.

The torque shall be applied again in the same manner as above using a maximum value of torque of 2,5 times the torsion strength of the support handle supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

The test shall be considered as passed if no permanent deformation or breakage is observed after the test.

5.8.5.3 Torsion strength of the operating handle

A smooth metal test rod 20 mm in diameter shall be clamped between the jaws of the pliers. The rod shall be fixed in a vice and the operating handle shall be positioned at an angle of 45° to the support handle (see Figure 12). A torque T shall be applied to the operating handle up to a value of 1,25 times the torsion strength of the operating handle supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

Key

1 metal test rod 20 mm in diameter

Figure 12 – Pliers stick – Torsion of the operating handle

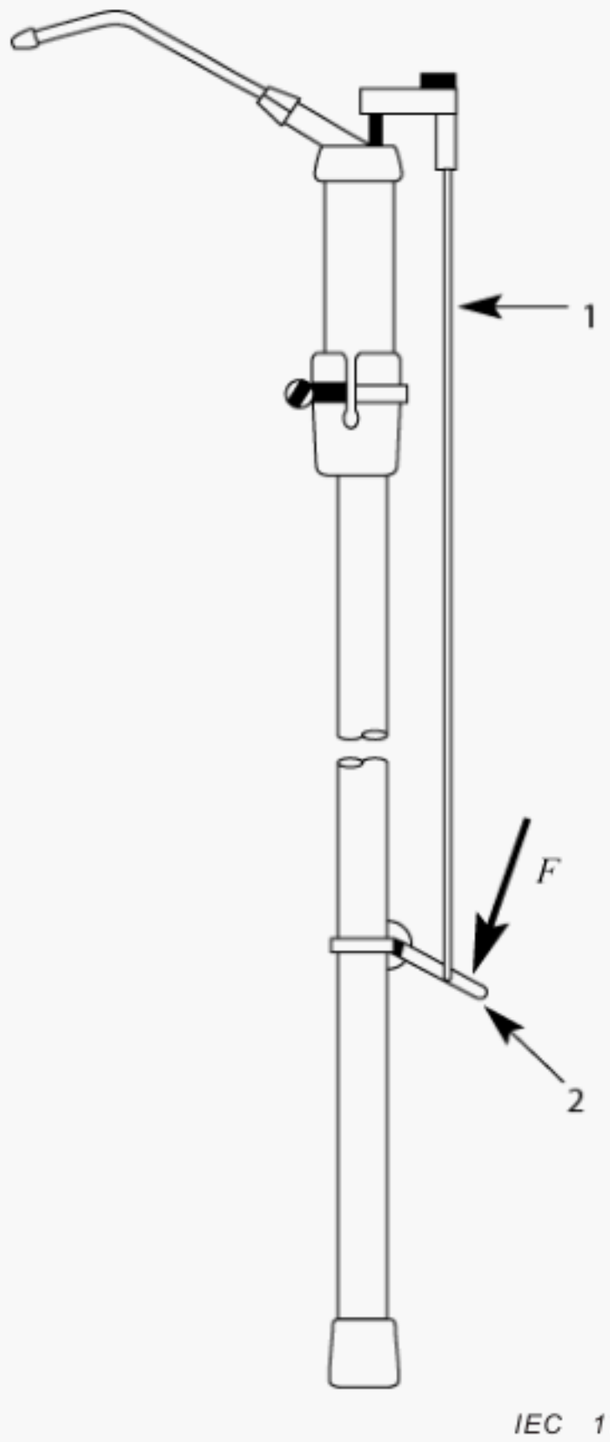
The test shall be considered as passed if no visible sign of damage is observed after the test.

The torque shall be applied again in the same manner as above using a maximum value of torque of 2,5 times the torsion strength of the operating handle supplied by the manufacturer and then maintained at this value for a period of not less than 1 min.

The test shall be considered as passed if no permanent deformation or breakage is observed after the test.

5.8.6 Insulating oiler stick – Functioning of the operating rod

The oil reservoir shall be filled with lubricant. The stick shall be held in the vertical position and a progressively increasing force F shall be applied to the end of the operating lever (see Figure 13) until a jet of oil comes out of the spout. This shall occur at a value of applied force of between 15 N and 50 N.



IEC 172/10

Key

1 operating rod

2 operating lever

Figure 13 – Insulating oiler stick – Functioning of the operating rod

Then a force of 150 N shall be applied to the operating lever in the same way as above.

The test shall be considered as passed if no visible sign of damage is observed after the test.

Then the oil reservoir shall be emptied almost entirely using the operating lever, and the operating force shall be measured. The value of the force measured shall remain between 15 N and 50 N.

5.8.7 Wire cutter stick – Binding-wire cutter stick – Cutting capability

Ten cutting operations shall be performed with the same stick for each maximum cross-section rating of wire/conductor (for a given piece of equipment) stated by the manufacturer for the wire cutter stick. The type of conductors and the rated cross-sections shall be chosen from those generally used.

For each cutting operation, the wire/conductor shall be successfully severed in one complete operation without damaging the cutting edge of the blade.

5.8.8 Measuring stick

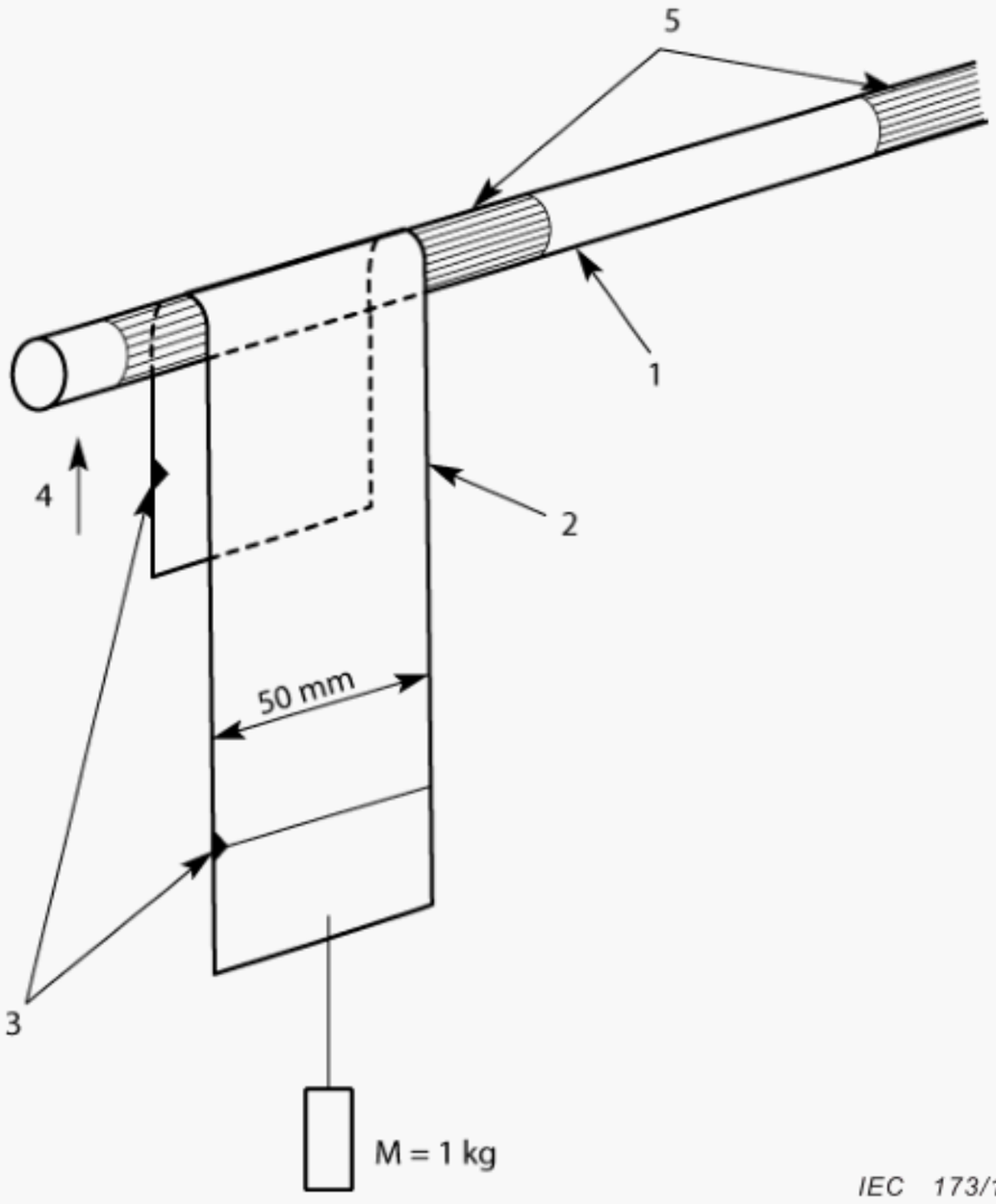
5.8.8.1 Resistance to solvents

The measuring stick shall be tested in accordance with 5.4.

The test shall be considered as passed if at the end of the test, there is no trace of colouring agent on the cloth.

5.8.8.2 Resistance to abrasion

The measuring stick shall be held stationary in a horizontal position. A 50 mm wide abrasive paper or cloth completely covered by grains referenced Corundum – F 150 (according to ISO 8486-1) with two markers 200 mm apart shall then be applied as shown in Figure 14. A 1 kg weight shall then be hung from one end of the abrasive paper or cloth.



NOTE The reference F 150 is well known as P 150 according to some regional standards.

Key

1 stick in a horizontal position

2 abrasive paper or cloth

3 two markers 200 mm apart

4 direction of move

5 coloured segments

Figure 14 – Measuring stick – Resistance to abrasion

The 200 mm length of abrasive paper or cloth between the two markers shall be slid over one of the coloured segments of the stick, for between 5 s and 10 s. The abrasive paper or cloth shall be in contact with a minimum of 40 % of the covered circumferential area (maximum: 50 %). The weight is released and returns to its initial position. The test shall be completed after five consecutive cycles.

The test shall be considered as passed if the original colour of the measuring stick does not appear (to the naked eye) underneath the colouring agent.

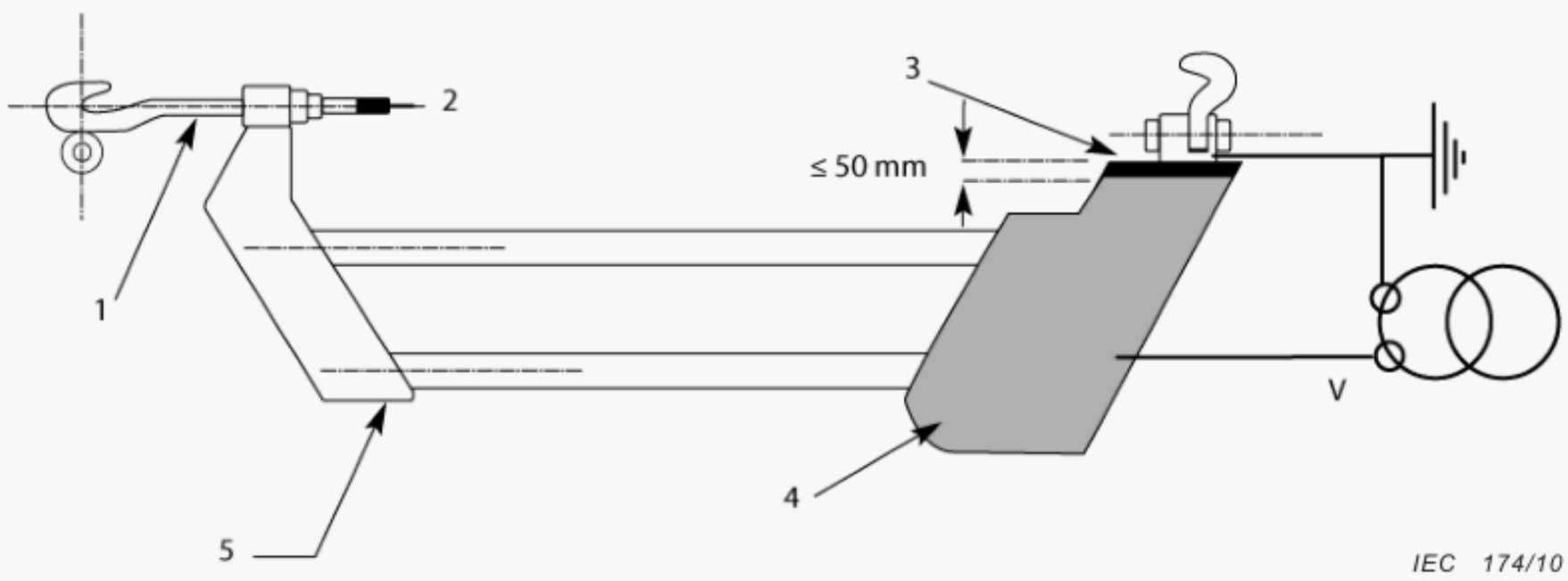
5.8.8.3 Electrical test after abrasion test

The test shall be carried out according to 5.7.1.1.

5.8.9 Tension puller (dead-end tool)

5.8.9.1 Type A – Electrical test

This test shall be performed only when the dead-end tool is designed to be fitted with an insulating cover on the flange “earth end” (see Figure 15). With the insulating cover in place, an electrode made of metal gauze or conductive fabric shall be placed on the insulating cover with an air gap of not more than 50 mm between the electrode and the metal part of the flange.



Key

1 jack

2 articulation axis

3 flange with insulating cover “earth end”

4 electrode made of metal gauze or conductive fabric

5 flange at the line end

V test voltage

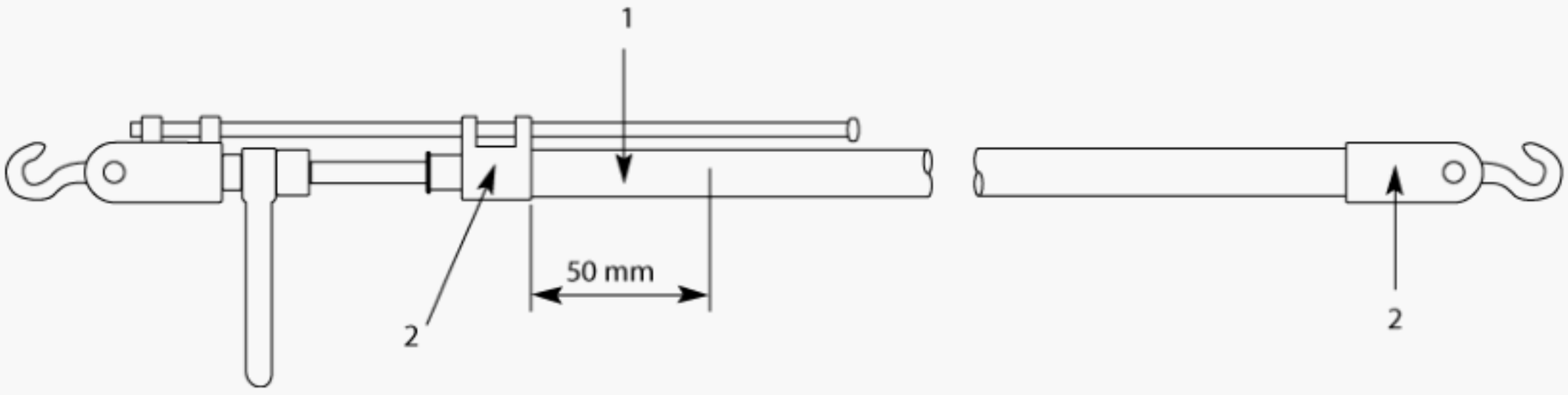
Figure 15 – Electrical test on type A tension puller

Alternating voltage at power frequency with a rate of increase not more than 5 kV/s shall be applied between the flange (earth end) and the electrode until the voltage reaches 20 kV r.m.s. The voltage shall be maintained for a period of not less than 1 min.

The test shall be considered as passed if during the voltage application, there is no sparkover, puncture or flashover.

5.8.9.2 Type B (jacking screw) – Electrical test on the jacking screw end of the puller

This test shall be carried out on tension pullers that by design have a metal part of the jacking screw that penetrates into the insulating material further than the visible metal parts of the tool (see Figure 16).



IEC 175/10

Key

1 insulating tube

2 metal part

Figure 16 – Electrical test on type B tension puller

An electrode made of wire gauze, conductive fabric or braid shall be placed on the insulation at a position not more than 50 mm from the metal part of the jacking screw end. This electrode shall be positioned at least 20 mm beyond the furthest position of the metal part inside the insulating material. The contact with this electrode shall be as good as possible. If adhesive tape is used to fix the braid, it shall be conductive tape.

Alternating voltage at power frequency with a rate of increase not more than 5 kV/s shall be applied between the electrode and the metal end at the jacking screw end of the rod until the voltage reaches 20 kV r.m.s., then the voltage shall be maintained for a period of not less than 1 min.

The test shall be considered as passed if during the voltage application, there is no sparkover, puncture or flashover.

5.9 Instructions for use

5.9.1 Type test

A visual check shall be performed to verify that all the requirements of 4.8 are fulfilled.

5.9.2 Alternative test in case of insulating sticks having completed the production phase

At the production level, it is only needed to check for the availability of the instructions for use.

6 Conformity assessment of insulating sticks having completed the production phase

For conducting the conformity assessment during the production phase IEC 61318 shall be used in conjunction with the present standard.

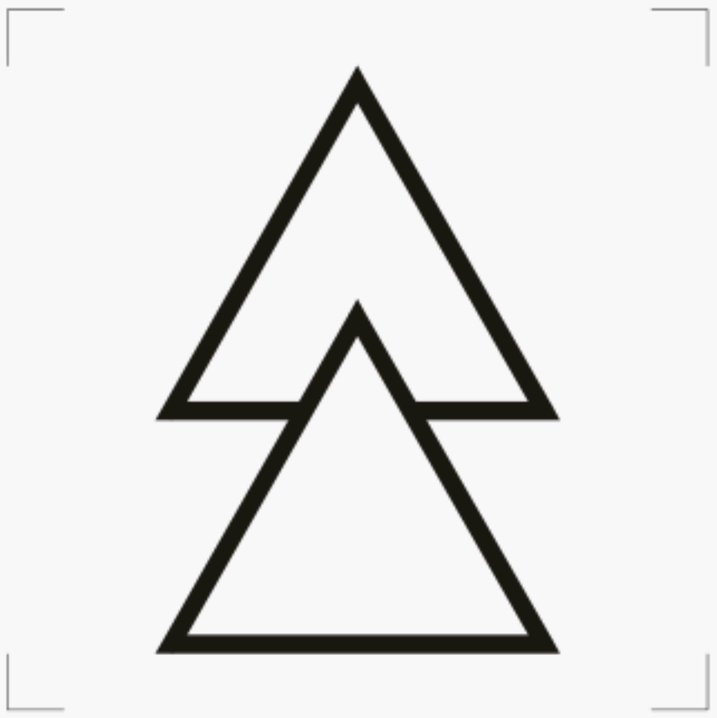
Annex C issued of a risk analysis on the performance of the insulating sticks provides the classification of defects and identifies the associated tests applicable in case of production follow-up.

7 Modifications

Any modifications of the tool 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 tool reference literature.

Annex A
(normative)

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



Annex B
(normative)

Chronology of type tests

In Tables B.1 and B.2, every reference to the subclauses where the tests are explained, are contained within parenthesis. Some columns for certain types of tools are divided into as many sub-columns as there are specified destructive mechanical tests for the tool. The test sequence for each test is given in these sub-columns. Tests with the same sequential number can be performed in the more convenient order. Within a test group, type tests out of sequence are performed on the same three sticks. Test groups do not have to be performed in the given order.

Table B.1 – Type tests for hand sticks

Type tests	Type of tools									
	Tie stick		Hook stick				Hook stick extension			
	Group 1	Group 2	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
Visual inspection (5.2)	1	1	1	1	1	1	1	1	1	1
Dimensional check (5.3)	1		1				1			
Cold impact test (5.5.1)		2				2				2
Torsion 1,25 T_N 2,5 T_N (5.5.2)				2 3		3			2 3	3
Bending 1,25 F_{BN} 2,5 F_{BN} (5.5.5)			3 4				2 3			
Tension 1,25 F_{TN} 2,5 F_{TN} (5.5.3)					2 3					
Dye penetration test (5.6)	3		5	4	4		4	3	4	
Electrical test after water conditioning (5.7.1.1)		4				4				4
Dielectric strength of internal insulation (5.7.2.1)		5				5				5
Specific tests	2 (5.8.1)	Test to 1,25 F_{TN} 3 (5.8.1)	2 (5.8.2)					2 (5.8.3)		
Type tests out of sequence										
Durability of marking (5.4)	X		X				X			
Instructions for use (5.9.1)	X		X				X			

Table B.1 – Type tests for hand sticks *(continued)*

Type tests	Type of tools										
	Universal hand stick			Wire holding stick			Pliers stick				
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 4	Group 5
Visual inspection (5.2)	1	1	1	1	1	1	1	1	1	1	1
Dimensional check (5.3)	1			1			1				
Cold impact test (5.5.1)			2			2					2
Torsion 1,25 T_N 2,5 T_N (5.5.2)	3 4		3	3 4		3					
Bending 1,25 F_{BN} 2,5 F_{BN} (5.5.5)										2 3	
Tension 1,25 F_{TN} 2,5 F_{TN} (5.5.3)		2 3			2 3			2 3			
Torsion test of wing screw(s) (5.5.6)	2										
Dye penetration test (5.6)	5	4		5	4		5	4	3	4	
Electrical test after water conditioning (5.7.1.1)			4			4					5
Dielectric strength of internal insulation (5.7.2.1)			5			5					6
Specific tests				2 (5.8.4)			2 (5.8.5.1)		2 (5.8.5.3)		Test to 1,25 T_N 3 (5.8.5.2)
							Test to 1,25 T_N 3 Test to 2,5 T_N 4 (5.8.5.2)				Test to 1,25 T_N 4 (5.8.5.3)
Type tests out of sequence											
Durability of marking (5.4)	X			X			X				
Instructions for use (5.9.1)	X			X			X				

Table B.1 – Type tests for hand sticks *(continued)*

Essais de type	Type of tools								
	Insulating oiler stick		Wire cutter stick Binding-wire cutter stick		All-angle cog spanner stick		Flexible insulated spanner stick		Clip-on ammeter stick
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1
Visual inspection (5.2)	1	1	1	1	1	1	1	1	1
Dimensional check (5.3)	1		1		1		1		1
Cold impact test (5.5.1)		2		2		2		2	
Torsion 1,25 T_N 2,5 T_N (5.5.2)					2 3	3	2 3	3	
Bending 1,25 F_{BN} 2,5 F_{BN} (5.5.5)									
Tension 1,25 F_{TN} 2,5 F_{TN} (5.5.3)									
Dye penetration test (5.6)	3		3		4		4		
Electrical test after water conditioning (5.7.1.1)		3		3		4		4	
Dielectric strength of internal insulation (5.7.2.1)		4		4		5		5	
Specific tests	2 (5.8.6)		2 (5.8.7)						
Type tests out of sequence									
Durability of marking (5.4)	X		X		X		X		X
Instructions for use (5.9.1)	X		X		X		X		X

Table B.1 – Type tests for hand sticks *(continued)*

Type tests	Type of tools				
	Extensible universal hand stick				Measuring stick
	Group 1	Group 2	Group 3	Group 4	Group 1
Visual inspection (5.2)	1	1	1	1	1
Dimensional check (5.3)	1				1
Cold impact test (5.5.1)				2	
Torsion 1,25 T_N 2,5 T_N (5.5.2)			2 3	3	
Bending 1,25 F_{BN} 2,5 F_{BN} (5.5.5)	3 4				
Tension 1,25 F_{TN} 2,5 F_{TN} (5.5.3)		2 3			
Torsion test of wing screw(s) (5.5.6)	2				2
Dye penetration test (5.6)	5	4	4		5
Electrical test after water conditioning (5.7.1.1)				4	4
Dielectric strength of internal insulation (5.7.2.1)				5	
Specific tests					3 (5.8.8.1 and 5.8.8.2)
Type tests out of sequence					
Durability of marking (5.4)	X				X
Instructions for use (5.9.1)	X				X

Table B.2 – Type tests for support sticks

Type tests	Type of tools						
	Conductor support stick			Tension stick [a]		Tension puller (dead-end tool)	
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 1	Group 2
Visual inspection (5.2)	1	1	1	1	1	1	1
Dimensional check (5.3)	1			1		1	
Cold impact test (5.5.1)			2		2		2
Tension 1,25 F_{TN} 2,5 F_{TN} (5.5.3)	 2 4		3	 2 4	3	 2 5	3
Compression 1,25 F_{CN} 2,5 F_{CN} (5.5.4)		 2 3					
Dye penetration test (5.6)	5	4		5		6	
Electrical test after water conditioning (5.7.1.1)	3			3		3	
Dielectric strength of internal insulation (5.7.2.1)			4		4		4
Specific tests						4 (5.8.9)	
Type tests out of sequence							
Durability of marking (5.4)	X			X		X	
Instructions for use (5.9.1)	X			X		X	
[a] Tension stick: clevis/tongue stick, tension link stick, roller link stick, swivel link stick, spiral link stick.							

Example of test sequence: universal hand stick

Group 1 (three tools)

Tests within the sequence:

– first: visual inspection and dimensional check in the more convenient order
– second: torsion test of wing screws
– third: torsion: 1,25 T_N
– fourth: torsion: 2,5 T_N
– fifth: dye penetration test

Tests out of sequence: Durability of marking and instructions for use

Group 2 (three more tools)

Tests:

– first: visual inspection

– second: tension: 1,25 F_{TN}
– third: tension: 2,5 F_{TN}
– fourth: dye penetration test

Group 3 (three more tools)

Tests:

– first: visual inspection
– second: cold impact test
– third: torsion: 1,25 T_N
– fourth: electrical test after water conditioning
– fifth: dielectric strength of internal insulation

Annex C
(normative)

Classification of defects and associated tests

This annex was developed to address the type of defects of a manufactured insulating stick (critical, major or minor) in a consistent manner (see IEC 61318). For each requirement identified in Tables C.1 and C.2, both the type of defect and the associated test are specified.

Table C.1 – Classification of defects and associated requirements and tests for hand sticks

Requirements	Type of sticks							Tests
	Tie stick	Hook stick	Hook stick extension	Universal hand stick	Wire holding stick	Pliers stick	Insulating oiler stick	
	Type of defect							
Electrical insulation (4.2): - Appropriate tubes and/or rods - Penetration of humidity (+4.5.1) - Dielectric strength	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	5.2 5.7.1.2 5.7.1.1[a]
Electrical category of end fitting (4.3): Dielectric strength of internal isolation	Critical	Critical	Critical	Critical	Critical	Critical	Critical	5.7.2.2
Dimensional (4.4)	Major	Major	Major	Major	Major	Major	Major	5.3
Mechanical: Torsion (4.4.2)		Major	Major	Major	Critical			5.5.2
Mechanical: Bending (4.4.2)		Major	Major			Major		5.5.5
Mechanical: Tension (4.4.2)		Major		Major	Critical	Major		5.5.3
Specific requirements (4.4.2)	Major (5.8.1)	Major (5.8.2)	Major (5.8.3)		Major (5.8.4)	Major (5.8.5)	Major (5.8.6)	5.8
Mechanical: Torsion of wing screw(s) (4.4.2)				Major				5.5.6
Mechanical strength in cold impact of the end fitting (4.5.1)	Major	Major	Major	Major	Major	Major	Major	5.5.1
Protection against corrosion (4.5.2)	Minor	Minor	Minor	Minor	Minor	Minor	Minor	5.2
Conductive parts (4.5.3)	Critical	Critical	Critical	Critical	Critical	Critical	Critical	5.2
Marking: items (4.7)	Critical	Critical	Critical	Critical	Critical	Critical	Critical	5.2
Marking: durability (4.7)	Minor	Minor	Minor	Minor	Minor	Minor	Minor	5.4
Instructions for use (4.8)	Major	Major	Major	Major	Major	Major	Major	5.9.2

[a] At the production level, the test is performed without water conditioning.

Table C.1 – Classification of defects and associated requirements and tests for hand sticks *(continued)*

Requirements	Type of sticks						Tests
	Wire cutter stick Binding-wire cutter stick	All-angle cog spanner stick	Flexible insulated spanner stick	Clip-on ammeter stick	Extensible universal hand stick	Measuring stick	
	Type of defect						
Electrical insulation (4.2): - Appropriate tubes and/or rods - Penetration of humidity (+4.5.1) - Dielectric strength	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	5.2 5.7.1.2 5.7.1.1[a]
Electrical category of end fitting (4.3): Dielectric strength of internal isolation	Critical	Critical	Critical	Critical	Critical	Critical	5.7.2.2
Dimensional (4.4)	Major	Major	Major	Major	Major	Major	5.3
Mechanical: Torsion (4.4.2)	Major	Major	Major		Major	Major	5.5.2
Mechanical: Bending (4.4.2)					Major		5.5.5
Mechanical: Tension (4.4.2)					Major		5.5.3
Specific requirements (4.4.2)	Minor (5.8.7)					Major (5.8.8)	5.8
Mechanical: Torsion of wing screw(s) (4.4.2)					Major	Major	5.5.6
Mechanical strength in cold impact of the end fitting (4.5.1)	Major	Major	Major		Major	Major	5.5.1
Protection against corrosion (4.5.2)	Minor	Minor	Minor	Minor	Minor	Minor	5.2
Conductive parts (4.5.3)	Critical	Critical	Critical	Critical	Critical	Critical	5.2
Marking: items (4.7)	Critical	Critical	Critical	Critical	Critical	Critical	5.2
Marking: durability (4.7)	Minor	Minor	Minor	Minor	Minor	Minor	5.4
Instructions for use (4.8)	Major	Major	Major	Major	Major	Major	5.9.2

[a] At the production level, the test is performed without water conditioning.

Table C.2 – Classification of defects and associated requirements and tests for support sticks

Requirements	Type of sticks			Tests
	Conductor support stick	Tension stick [b]	Dead-end tool	
	Type of defect			
Electrical insulation (4.2): - Appropriate tubes and/or rods - Penetration of humidity (+4.5.1) - Dielectric strength	Critical Critical Critical	Critical Critical Critical	Critical Critical Critical	5.2 5.7.1.2 5.7.1.1[a]
Electrical category of end fitting (4.3): Dielectric strength of internal isolation	Critical	Critical	Critical	5.7.2.2
Dimensional (4.4)	Major	Major	Major	5.3
Mechanical: Tension (4.4.2)	Critical	Critical	Critical	5.5.3[c]
Mechanical: Compression (4.4.2)	Critical			5.5.4[d]
Specific requirements (4.4.2)			Critical (5.8.9)	5.8
Mechanical strength in cold impact of the end fitting (4.5.1)	Major	Major	Major	5.5.1
Protection against corrosion (4.5.2)	Minor	Minor	Minor	5.2
Conductive parts (4.5.3)	Critical	Critical	Critical	5.2
Marking: items (4.7)	Critical	Critical	Critical	5.2
Marking: durability (4.7)	Minor	Minor	Minor	5.4
Instructions for use (4.8)	Major	Major	Major	5.9.2

[a] At the production level, the test is performed without water conditioning.

[b] Tension stick: clevis/tongue stick, tension link stick, roller link stick, swivel link stick, spiral link stick

[c] At the production level, only the test with 1,25 F_{TN} is performed.

[d] At the production level, only the test with 1,25 F_{CN} is performed.

Annex D
(informative)

In-service recommendations

This annex is to help the users giving at least the following information.

D.1 In-service inspection and repair

The tools should be inspected upon each use, and should be inspected, maintained, electrically tested and repaired at employer specified intervals.

D.2 Inspection procedure

When visual inspection indicates that a tool might have been mechanically or electrically overstressed, it should be carefully inspected, cleaned, refinished, or repaired and, if required, electrically tested before being returned to service.

The purpose of the inspection is to look for visible damage to the insulating portion of the tool as well as the fittings.

Alterations or modifications that may adversely affect the electrical or mechanical capability of the tool should not be allowed. Any of the following observations warrant immediate removal of the tool from service:

- a tingling or “fuzzy” sensation when the tool is in contact with an energized conductor or piece of equipment;
- a deterioration on the surface of the tube or rod, i.e., a lack of glossy appearance, cuts, gouges, dents, or delamination;
- an electrically stressed tool showing evidence of tracking;
- a tool showing evidence of bent or cracked components;
- evidence of mechanical overloading.

D.3 Cleaning and care

Tools should be kept clean. Workers should use clean hands or gloves while handling the tools to avoid contamination of the dielectric surface. While performing live work, workers should place the tools on tarps or special tool holders. Tools should not be placed on the ground or against sharp objects such as barbed wire fences or metal towers.

The surface of each tool should be inspected for contamination such as dirt, creosote, and grease. Contaminants should be removed with a clean, absorbent cloth or non-abrasive paper towel. If this does not remove the contaminant, follow the manufacturer’s recommendations for cleaning and refinishing. The tools should be wiped with a silicone-treated cloth.

D.4 Storage and transportation

Tools, when not in use, should be kept in weatherproof enclosures and stored in a dry and warm location when possible. Tools should be stored in clean, dry polyvinyl chloride (PVC) tubes and secured in a protected location where indoor storage is not available. Electric heaters in live work tool trailers are designed to prevent condensation and are not recommended for drying the tools.

All tools should be stored and transported, separate from each other, in such a manner as to prevent abrasion or physical contact with any surface that would damage the tool surface.

D.5 Testing

The tool's cleanliness, i.e., one that is not contaminated, and glossy waxed surface are keys to providing the maximum dielectric qualities. All tools should be electrically tested at least every two years.

D.6 Additional information

D.6.1 Cleaning

Do not use soap detergents, liquid or powdered form, to clean tools under field conditions because of the following possible problems:

– the above described cleaning agents will leave conductive residue unless rinsed with generous amounts of water (usually not available in the field);

– abrasive cleaners will destroy the surface gloss on the tool.

D.6.2 Testing guidelines

All tests should be performed by personnel thoroughly familiar with the testing equipment and the procedures. Safety precautions and the testing equipment instruction manuals should be observed at all times.

A label should be attached to each tool that passes the electrical test indicating the next test date (for instance two years from the date testing performed).

D.6.3 Inspection procedure

All tools should be inspected for surface irregularities or structural damage. All tools with significant surface irregularities should be cleaned, dried, and electrically tested. All tools with structural damage to the surface or at a joint, such as a hinged, pinned, or epoxied location should be repaired prior to electrically testing. All tools that fail the electrical test should be tagged and put aside for repair and refinishing before re-testing or they should be discarded. All tools should be cleaned and dried prior to testing.

D.6.4 Refinishing procedure

All tools which

- have significant surface irregularities,
- cannot be cleaned sufficiently, or
- show excessive leakage current during the testing,

should be refinished and tested before being placed back in service.

Spot refinishing is acceptable, depending on the general condition of the tool. The spot refinishing should be made according to the manufacturer's instructions and will be accomplished by using the following procedure.

a) Light sanding is necessary to remove any marks or contamination remaining on the surface and to provide a more suitable surface for refinishing. Sand the surface of the tool with fine flint sandpaper. Scratches and dents should receive special attention to be sure that all dirt and impurities are removed.

b) Deep dents or gouges will be filled with a two part epoxy material available from the respective tool manufacturers in colours to match their tools. Clear epoxy resin, which is obtainable at most boating or automotive parts stores, may be used if the above materials are not readily available. After the epoxy has been mixed and applied according to the manufacturer's instructions, a piece of cellophane tape, adhesive side out, may be pulled over the repaired area to produce a smooth surface which will blend with the circumference of the tool. Allow the epoxy to harden, then remove the tape. The area should then be sanded to restore the original profile and surface smoothness and to remove particles of tape remaining on the repaired areas.

c) Wipe the tool down with a degreasing solvent and a clean soft cloth to remove the sanding dust and oily hand prints.

d) The tool is now ready to have the finish applied. Use a manufacturer-recommended high gloss, pre-mixed polyurethane refinishing material which may be applied directly from the can, using a sponge applicator. Thinning, if necessary, should be done according to the directions on the label. Mixing and application instructions are supplied with these products and should be followed explicitly.

NOTE 1 In dry, cold weather, the prepared tool should be wiped with a clean, slightly damp cloth to reduce static before the finish is applied. This will prevent dust and lint particles that are in the air from becoming attracted to the tool during the refinishing process.

NOTE 2 Solvents must not be used on a newly finished surface for at least 48 h after application.

e) The tool should then be electrically tested according to the instructions given above.

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