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Amendment 1

Hand-held motor-operated electric tools – Safety –

Part 1: General requirements

Amendement 1

Outils électroportatifs à moteur – Sécurité –

Partie 1: Règles générales

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FOREWORD

This amendment has been prepared by subcommittee 61F: Safety of hand-held motor-operated electric tools, of IEC technical committee 61: Safety of household and similar electrical appliances.

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

FDIS	Report on voting
61F/460/FDIS	61F/484/RVD

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2006. At this date, the publication will be

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- withdrawn;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

The contents of the corrigendum of January 2003 have been included in this copy.

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CONTENTS

Add, on page 3, to the list of annexes, the titles of new annexes K and L as follows:

Annex K (normative) Battery tools and battery packs

Annex L (normative) Battery tools and battery packs provided with mains connection or non-isolated sources

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FOREWORD

Replace the first sentence of the reference concerning the annexes as follows:

Annexes A, B, C, D, E, F, G, I, K and L form an integral part of this standard.

Add, after the reference concerning the annexes, the following note:

NOTE In annexes B, K and L, subclauses which are additional to those in the main body of the text are numbered starting from 101.

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1 Scope

Add, in the fifth paragraph, after the sentence beginning “Requirements for motors not isolated...”, the following two new sentences:

Requirements for rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools are given in Annex K. Those for such tools that are also operated and/or charged directly from the mains or a non-isolated source are given in Annex L.

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Add, after annex J, the following new annexes K and L:

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Withdrawn

Annex K (normative)

Battery tools and battery packs

K.1 Scope

K.1.1 This annex applies to rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools. This annex applies to tools incorporating detachable, integral and separable battery packs. The maximum rated voltage for tools and battery packs is 75 V d.c.

Battery tools covered by this annex are not considered to be class I, class II, or class III tools and therefore are not required to have basic, supplementary or reinforced insulation. Electric shock hazard is considered to exist only between parts of opposite polarity.

Battery packs for tools covered under this annex intended to be charged by a non-isolated charger shall be evaluated by this annex and standard. When evaluating a battery pack for protection against electric shock, creepage distances, clearances and distances through insulation, the battery pack shall be fitted to the intended charger.

All clauses of this standard apply unless otherwise specified in this annex. If a clause is stated in the annex, the requirements replace the requirements of the standard.

For the purpose of the tools covered by this annex, the term “mains switch” as it appears in the standard is understood to refer to the power switch of the battery-operated tool.

This annex is not intended to apply to tools using general purpose batteries installed by the user, and this annex alone will not be sufficient to ensure all hazards are considered for these products’ “battery packs”.

This annex does not apply to battery chargers which are covered by IEC 60335-2-29.

K.2 Normative references

This clause is applicable except as follows:

Additional normative reference:

IEC 61558-2-6:1997, *Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolating transformers for general use*

K.3 Definitions

For the purpose of this annex, the following definitions apply.

K.3.101

battery pack

assembly of one or more cells intended to provide electrical current to the tool

K.3.101.1**detachable battery pack**

battery pack which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes

K.3.101.2**integral battery pack**

battery pack which is contained within the battery tool and is not removed from the battery tool for charging purposes. A battery pack that is to be removed from the battery tool for disposal or recycling purposes only is considered to be an integral battery pack

K.3.101.3**separable battery pack**

battery pack which is contained in a separate enclosure from the battery tool and is connected to the battery tool by a cord

K.3.102**fully charged battery pack**

battery pack which has been through at least two discharge and charge cycles with an interval of at least two hours after each cycle in accordance with the manufacturer's instructions

K.3.103**non-isolated source**

voltage source in which the output is not isolated from the mains supply by means of a safety isolating transformer as specified in IEC 61558-1 and IEC 61558-2-6

K.3.104**hazardous voltage**

voltage between parts having an average value exceeding 60 V d.c. or 42,4 V peak when the peak-to-peak ripple exceeds 10 % of the average value

K.3.105**power switch**

switch that controls the primary operating means of the tool

K.5 General conditions for the tests

K.5.7.1 This subclause is not applicable.

K.5.7.2 Tools having more than one rated voltage are tested on the basis of the most unfavourable voltage.

K.5.7.3 This subclause is not applicable.

K.5.10 This subclause is not applicable.

K.5.11 This subclause is not applicable.

K.5.14 This subclause is not applicable.

K.5.15 This subclause is not applicable.

K.5.16 This subclause is not applicable.

K.5.101 *Unless otherwise specified, a fully charged battery pack shall be used for each test.*

K.5.102 *When measuring voltage, the peak value of any superimposed ripple exceeding 10 % of the average value shall be included. Transient voltages are ignored, such as a temporary increase above rated voltage, for example after the battery pack is removed from the charger.*

K.7 Classification

This clause is not applicable.

K.8 Marking and instructions

K.8.1 Battery tools and detachable or separable battery packs shall be marked with:

- rated voltage(s) or rated voltage range(s), in volts;
- symbol for nature of supply;
- name or trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- manufacturer's address or country of origin;
- any mandatory mark showing compliance with legislation by reference to this standard.

Additional markings shall not give rise to misunderstanding.

Compliance is checked by inspection.

K.8.2 This subclause is not applicable.

K.8.5 This subclause is not applicable.

K.8.7 This subclause is not applicable.

K.8.8 This subclause is not applicable.

K.8.12.1 This subclause is applicable except as follows:

Item 5) Service, is replaced by the following:

Replacement:

5) Battery tool use and care

- a) **Ensure the switch is in the off position before inserting battery pack.** *Inserting the battery pack into power tools that have the switch on invites accidents.*
- b) **Recharge only with the charger specified by the manufacturer.** *A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack.*
- c) **Use power tools only with specifically designated battery packs.** *Use of any other battery packs may create a risk of injury and fire.*

- d) **When battery pack is not in use, keep it away from other metal objects like paper clips, coins, keys, nails, screws, or other small metal objects that can make a connection from one terminal to another. Shorting the battery terminals together may cause burns or a fire.**
- e) **Under abusive conditions, liquid may be ejected from the battery; avoid contact. If contact accidentally occurs, flush with water. If liquid contacts eyes, additionally seek medical help. Liquid ejected from the battery may cause irritation or burns.**

6) Service

- a) **Have your power tool serviced by a qualified repair person using only identical replacement parts. This will ensure that the safety of the power tool is maintained.**

K.9 Protection against electric shock

NOTE The title of this clause differs from that of the main standard.

Battery tools and battery packs shall be so constructed and enclosed that there is adequate protection against electric shock.

K.9.1 This subclause is not applicable.

K.9.2 It shall not be possible to have two conductive, simultaneously accessible parts where the voltage between them is hazardous unless they are provided with protective impedance.

In the case of protective impedance the short circuit current between the parts shall not exceed 2 mA for d.c. or 0.7 mA peak for a.c. and there shall not be more than 0,1 μ F capacitance directly between the parts.

Compliance for accessibility is checked by applying the test finger of Figure 1 to each conductive part.

The test finger of Figure 1 is applied without any appreciable force through openings to any depth that the finger will permit, and it is rotated or angled before, during and after insertion to any position.

If the opening does not allow entry of the finger, the force on the finger in the straight position is increased to 20 N and the test with the finger bent repeated.

Contact with the test finger is determined with all detachable parts removed and the battery tool operated in any possible position of normal use.

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

K.9.3 This subclause is not applicable.

K.9.4 This subclause is not applicable.

K.10 Starting

This clause is not applicable.

K.11 Input and current

This clause is not applicable.

K.12 Heating

K.12.1 Battery tools and battery packs shall not attain excessive temperatures.

Compliance is checked by determining the temperature rise of the various parts under the following conditions:

The tool is operated at no load until maximum temperature is reached or the tool no longer operates due to the battery pack being discharged.

During the test, thermal cut-outs and overload releases shall not operate. The temperature rises shall not exceed the values shown in Table K.1.

Table K.1 – Maximum normal temperature rises for battery tools

Parts	Temperature rise K
External enclosure, except handles held in normal use	60
Handles, knobs, grips, and the like which, in normal use, are continuously held:	
– of metal	30
– of porcelain or vitreous material	40
– of molded material, rubber or wood	50
Handles, knobs, grips, and the like which, in normal use, are held for short periods only (e.g. switches):	
– of metal	35
– of porcelain or vitreous material	45
– of molded material, rubber or wood	60
Parts in contact with oil having a flash point of t °C	$t-50$

K.12.2 to K.12.6 These subclauses are not applicable.

K.13 Leakage current

This clause is not applicable.

K.14 Moisture resistance

This clause is not applicable.

K.15 Electric strength

K.15.1 Materials providing insulation from electric shock shall be adequate.

Compliance is checked by subjecting the insulating material for 1 min to 750 V with a substantially sinusoidal wave from having a frequency of 50 Hz or 60 Hz. This provision does not exclude the testing of the material as situated within the tool, providing care is taken to ensure that materials not under consideration are not subjected to the test voltage.

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

K.15.2 This subclause is not applicable.

K.16 Overload protection of transformers and associated circuits

This clause is not applicable.

K.17 Endurance

This clause is not applicable.

K.18 Abnormal operation

K.18.1 All tools when operating under battery power and their battery packs shall be so designed that the risk of fire or electric shock as a result of abnormal operation is obviated as far as is practical.

Compliance is checked by the following tests.

The battery tool and battery pack, as is appropriate, are to be placed on a soft wood surface covered by two layers of tissue paper; the battery tool and battery pack are to be covered by one layer of untreated 100 % cotton medical gauze. The test is to be conducted until failure or until the test sample returns to room temperature. A new sample can be used for each fault listed below. There shall be adequate protection against electric shock as defined in clause K.9 and no charring or burning of the gauze or tissue paper shall result when a battery tool and battery pack are subjected to any one of the following fault conditions shown below in tests a to f.

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable.

Thermal cut-outs and thermal overloads may operate during the above tests. In this case, the same test is to be repeated three more times, using three additional samples. The resistance for the short in items a), b), d), e) and f) shall not exceed 10 m Ω .

- a) *The terminals of a detachable battery pack with exposed terminals are shorted. Battery pack terminals that can be contacted using either Figure 1 or Figure 2 probes are considered exposed. The means of shorting shall not attain excessive temperatures so as to char or ignite the tissue paper or gauze.*
- b) *The motor terminals are shorted.*
- c) *The motor rotor is locked.*
- d) *A cord provided between the separable battery pack and the battery tool shall be shorted at the point likely to produce the most adverse effects.*
- e) *A cord provided between the tool and the charger shall be shorted at the point likely to produce the most adverse effects.*
- f) *For battery tools a short is introduced between any two uninsulated parts of opposite polarity not in accordance with the spacings given in clause K.28.*

K.18.2 to K.18.9 These subclauses are not applicable.

K.18.12 This subclause is not applicable.

K.19 Mechanical hazards

K.19.101 If a tool is marked with a direction of movement, it shall not be possible to connect a battery pack such that the marking is not correct.

K.20 Mechanical strength

K.20.1 Battery tools and battery packs shall have adequate mechanical strength, and shall be so constructed that they withstand such rough handling as may be expected in normal use.

Compliance is checked by the tests of 20.2 and K.20.3.

Following the test, the battery tool and battery pack shall meet the requirements of clauses K.9, K.19 and either K.18.1 (f) or K.28.1.

K.20.3 A battery tool with its battery pack attached shall withstand being dropped three times on a concrete surface from a height of 1 m. The sample shall be positioned to vary the point of impact.

For battery tools with detachable or separable battery packs, the test is repeated three more times without the battery pack attached to the tool.

In addition for detachable or separable battery packs the test is repeated three more times on the battery packs separately.

New samples may be used for each series of three drops.

K.20.4 This subclause is not applicable.

K.21 Construction

K.21.5 This subclause is not applicable.

K.21.6 This subclause is not applicable.

K.21.8 to K.21.16 These subclauses are not applicable.

K.21.21 This subclause is not applicable.

K.21.25 to K.21.34 These subclauses are not applicable.

K.21.101 Tools shall not readily accept general purpose batteries (either primary or rechargeable).

NOTE Examples of general purpose batteries are AA, C, D, etc.

K.22 Internal wiring

K.22.3 This subclause is applicable only for hazardous voltages.

K.22.4 This subclause is not applicable.

K.23 Components

K.23.1.10 Power switches shall have adequate breaking capacity.

Compliance is checked by subjecting a switch to 50 operations of making and breaking the locked output mechanism current of the fully charged battery-operated tool. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s.

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

K.23.1.11 Power switches shall withstand, without excessive wear or other harmful effect, the mechanical, electrical, and thermal stresses occurring in normal use.

Compliance is checked by subjecting a switch to 6 000 cycles of operation making and breaking the current encountered in the fully charged battery tool operated at no-load. The switch is operated at a uniform rate of 30 operations per minute. During the test the switch shall operate correctly. After the test, inspection of the switch shall show no undue wear, no discrepancy between the position of the operating means and that of the moving contacts, no loosening of electrical or mechanical connections, no seepage of sealing compound.

K.23.5 This subclause is not applicable.

K.24 Supply connection and external flexible cords

This clause is not applicable, except as follows:.

K.24.101 For battery tools with separable battery packs, the external flexible cable or cord shall have anchorages such that the conductors are relieved from strain, including twisting, where they are connected within the tool, and protected from abrasion.

Compliance is checked by inspection.

K.25 Terminals for external conductors

This clause is not applicable.

K.26 Provision for earthing

This clause is not applicable.

K.27 Screws and connections

K.27.1 This subclause is applicable except as follows: the sixth paragraph and the accompanying note, which refers to earthing connections, are not applicable.

K.28 Creepage distances, clearances and distances through insulation

K.28.1 Creepage distances and clearances shall not be less than the values in millimetres shown in Table K.2. The clearances specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the clearances vary with the movement of the contacts. Creepages and clearances also do not apply to the construction of battery cells or the interconnections between cells in a battery pack. The values specified in Table K.2 do not apply to cross-over points of motor windings.

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

NOTE Figure K.1 provides clarification on the measurement method.

Compliance is checked by measurement.

The way in which creepage distances and clearances are measured is indicated in annex A.

For parts of different polarity, clearance and creepage distances less than those given in Table K.2 are acceptable if the shorting of the two parts does not result in the tool starting.

NOTE The risk of fire due to spacings below the required values is covered by the requirements of 18.1.

**Table K.2 – Minimum creepage distances and clearances
between parts of opposite polarity**

Millimetres					
≤15 V		>15 V and ≤32 V		>32 V	
Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
–	0,8	–	1,5	2,0	1,5

Distances through slots or openings in external parts of insulating material are measured to the metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test finger of Figure 1, but is not pressed into openings.

The sum total of distances measured between parts operating at hazardous voltage and accessible surfaces is determined by measuring the distance from each part to the accessible surface. The distances are to be added together to determine the sum total. See Figure K.1. For the purpose of this determination, one of the distances shall be 1,0 mm or greater. See annex A, cases 1 to 10.

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

The force is applied by means of a test finger having a tip as shown in Figure 1 and has a value of:

- 2 N for bare conductors;*
- 30 N for enclosures.*

If a barrier is interposed, and if it is in two parts which are not cemented together, the creepage distance is also measured through the joint.

If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

When assessing creepage distances and clearances, the effect of insulating lining of metal enclosures or covers is taken into consideration.

Means provided for fixing the tool to a support are considered to be accessible.

K.28.2 This subclause is not applicable.

K.29 Resistance to heat, fire and tracking

K.29.1 External parts of non-metallic material, the deterioration of which might cause the tool or battery pack to fail to comply with this annex, shall be sufficiently resistant to heat.

Compliance is checked by subjecting of the relevant parts to a ball-pressure test, which is made by means of the apparatus shown in Figure 5.

Before starting the test the part is maintained for 24 h in an atmosphere having a temperature between 15 °C and 35 °C, and a relative humidity between 45 % and 75 %.

The part is supported so that its upper surface is horizontal and the spherical part of the apparatus is pressed against this surface with a force of 20 N. The thickness of the part under test shall be at least 2,5 mm. The required thickness may be obtained by using two or more sections of the part.

The test is made in a heating cabinet at a temperature of (40 ± 2) °C plus the maximum temperature rise determined during the test of K.12, but it shall be at least:

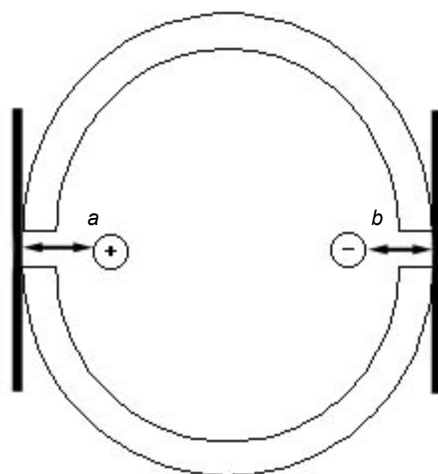
- for external parts (75 ± 2) °C.*

Before the test is started, the test apparatus is brought to the temperature determined above.

After 1 h, the apparatus is removed and the part is immediately immersed in cold water so that it is cooled to room temperature within 10 s. The diameter of the impression shall not exceed 2 mm. The test is not made on parts of ceramic material.

K.29.2 This subclause applies only to the external enclosure enclosing the current-carrying part of the tool or battery pack.

K.29.3 This subclause is not applicable.



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

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

$a + b$ is the sum total as defined in K.28.1.

Figure K.1 – Measurement of clearances

Annex L

(normative)

Battery tools and battery packs provided with mains connection or non-isolated sources

L.1 Scope

This annex applies to rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools that are also operated and/or charged directly from the mains or a non-isolated source, including tools provided with integral battery chargers. This annex applies to tools incorporating detachable, integral and separable battery packs. The maximum rated voltages for tools are 250 V single phase a.c. or d.c. mains source and 75 V d.c. battery source. The maximum rated voltage for battery packs is 75 V d.c.

Battery packs for tools covered under this annex intended to be charged by a non-isolated charger shall be evaluated by this annex and standard. When evaluating a battery pack for protection against electric shock, creepage distances, clearances and distances through insulation, the battery pack shall be fitted to the intended charger.

All clauses of this standard apply unless otherwise specified in this annex. If a clause is stated in the annex, the requirements replace the requirements of the standard.

For the purpose of the tools covered by this annex, the term “mains switch” as it appears in the standard is understood to refer to the power switch of the battery-operated tool.

This annex is not intended to apply to tools using general purpose batteries installed by the user and this annex alone will not be sufficient to ensure all hazards are considered for these products.

This annex does not apply to battery chargers which are covered by IEC 60335-2-29.

L.2 Normative references

This clause is applicable except as follows:

Additional normative reference:

IEC 61558-2-6:1997, *Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolating transformers for general use*

L.3 Definitions

For the purpose of this annex, the following definitions apply:

L.3.101

battery pack

assembly of one or more cells intended to provide electrical current to the tool

L.3.101.1

detachable battery pack

battery pack which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes

L.3.101.2

integral battery pack

battery pack which is contained within the battery tool and is not removed from the battery tool for charging purposes. A battery pack that is to be removed from the battery tool for disposal or recycling purposes only is considered to be an integral battery pack

L.3.101.3

separable battery pack

battery pack which is contained in a separate enclosure from the battery tool and is connected to the battery tool by a cord

L.3.102

fully charged battery pack

battery pack which has been through at least two discharge and charge cycles with an interval of at least two hours after each cycle in accordance with the manufacturer's instructions

L.3.103

non-isolated source

voltage source in which the output is not isolated from the mains supply by means of a safety isolating transformer as specified in IEC 61558-1 and IEC 61558-2-6

L.3.104

hazardous voltage

voltage between parts having an average value exceeding 60 V d.c. or 42,4 V peak when the peak-to-peak ripple exceeds 10 % of the average value

L.3.105

power switch

switch that controls the primary operating means of the tool

L.3.106

interconnecting cord

external flexible cord provided as part of a complete tool for purposes other than connection to the supply mains

NOTE A remote hand-held switching device, an external interconnection between two parts of a tool and a cord connecting an accessory to the tool or to a separate signalling circuit are examples of **interconnecting cords**.

L.5 General conditions for the tests

L.5.101 *Unless otherwise specified, a fully charged battery pack shall be used for each test.*

L.5.102 *When measuring voltage, the peak value of any superimposed ripple exceeding 10 % of the average value shall be included. Transient voltages are ignored, such as a temporary increase above rated voltage, such as after the battery pack is removed from the charger.*

L.7 Classification

L.7.1 This subclause applies except that class III tools are not considered in this annex.

L.8 Marking and instructions

L.8.1 The first paragraph of this subclause is replaced by the following:

Non-isolated sources that can supply a tool, or tools that can be supplied directly from the mains, shall be marked with the following. In the case of tools supplied directly from the mains, these markings shall include those for both mains and battery operation:

- rated voltage(s) or rated voltage range(s), in volts;
- symbol for nature of supply;
- rated input, in watts, or rated current in amperes;
- name or trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- symbol for class II construction, for class II tools only;
- manufacturer's address or country of origin;
- any mandatory mark showing compliance with legislation by reference to this standard.

Compliance is checked by inspection.

L.8.1.101 Tools, other than those that can be supplied directly from the mains, and detachable or separable battery packs shall be marked with:

- rated voltage(s) or rated voltage range(s), in volts;
- symbol for nature of supply;
- name or trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- manufacturer's address or country of origin;
- any mandatory mark showing compliance with legislation by reference to this standard.

Additional markings shall not give rise to misunderstanding.

Compliance is checked by inspection.

L.8.12.1 This subclause is applicable except as follows

Item 5) Service, is replaced by the following:

5) **Battery tool use and care**

- a) **Ensure the switch is in the off position before inserting battery pack.** *Inserting the battery pack into power tools that have the switch on invites accidents.*
- b) **Recharge only with the charger specified by the manufacturer.** *A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack.*
- c) **Use power tools only with specifically designated battery packs.** *Use of any other battery packs may create a risk of injury and fire.*
- d) **When battery pack is not in use, keep it away from other metal objects like paper clips, coins, keys, nails, screws, or other small metal objects that can make a connection from one terminal to another.** *Shorting the battery terminals together may cause burns or a fire.*

- e) **Under abusive conditions, liquid may be ejected from the battery; avoid contact. If contact accidentally occurs, flush with water. If liquid contacts eyes, additionally seek medical help. Liquid ejected from the battery may cause irritation or burns.**

6) Service

- a) **Have your power tool serviced by a qualified repair person using only identical replacement parts. This will ensure that the safety of the power tool is maintained.**

L.9 Protection against electric shock

NOTE The title of this clause differs from that of the main standard.

The requirements of 9.1 through 9.4 apply for all conditions along with the following addition:

Addition

Tools covered by this annex and their battery packs shall be so constructed and enclosed that there is adequate protection against electric shock.

The clause of the standard applies to tools when they are connected to the mains or are supplied by a non-isolated source. During the evaluation in this condition, battery packs are to be connected to the tool in the normal fashion. The tool is also evaluated with the battery pack removed if such removal can be accomplished without the use of a tool.

L.9.1.101 For battery packs which may be disconnected from the tool and tools operated under battery power it shall not be possible to have two conductive, simultaneously accessible parts where the voltage between them is hazardous, unless they are provided with protective impedance.

In the case of protective impedance the short circuit current between the parts shall not exceed 2 mA for d.c. or 0,7 mA peak for a.c. and there shall not be more than 0,1 μ F capacitance directly between the parts.

Compliance for accessibility is checked by applying the test finger of Figure 1 to each conductive part.

The test finger of Figure 1 is applied without any appreciable force through openings to any depth that the finger will permit, and it is rotated or angled before, during and after insertion to any position.

If the opening does not allow entry of the finger, the force on the finger in the straight position is increased to 20 N and the test with the finger bent repeated.

Contact with the test finger is determined with all detachable parts removed and the battery tool operated in any possible position of normal use.

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

L.10 Starting

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.11 Input and current

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source. In the case of tools that can also charge the battery while performing their intended function, the test is conducted while charging a previously discharged battery pack.

L.12 Heating

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source. In the case of tools that can also charge the battery pack while performing their intended function, they are tested with the charger connected and are operated at no load until the tool stops operating due to the battery pack being discharged or until thermal stabilization is achieved, whichever occurs first. The test is repeated, allowing the battery pack to charge while the tool is not operating.

L.13 Leakage current

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.14 Moisture resistance

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.15 Electric strength

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source. Care shall be taken that the premature failure of electronic devices does not prevent the application of the test voltage across insulation. If this is the case, electronic devices may be bypassed to enable the test to be conducted.

L.16 Overload protection of transformers and associated circuits

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.17 Endurance

This clause applies to tools capable of continuous operation when they are supplied directly from the mains or from a non-isolated source. Tools that are not capable of continuous operation shall be operated under battery power for the duration of the test but shall be evaluated for electric strength with their charger connected.

L.18 Abnormal operation

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.18.101 All tools when operating only under battery power and their battery packs shall be so designed that the risk of fire or electric shock as a result of abnormal operation is obviated as far as is practical.

Compliance is checked by the following tests.

The battery tool and battery pack, as is appropriate, are to be placed on a soft wood surface covered by two layers of tissue paper; the battery tool and battery pack are to be covered by one layer of untreated 100 % cotton medical gauze. The test is to be conducted until failure or until the test sample returns to room temperature. A new sample can be used for each fault listed below. There shall be adequate protection against electric shock as defined in clauses L.9 and L.13 and no charring or burning of the gauze or tissue paper shall result when a battery tool and battery pack are subjected to any one of the following fault conditions shown below in tests a) to f).

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable.

Thermal cut-outs and thermal overloads may operate during the above tests. In this case, the same test is to be repeated three more times, using three additional samples. The resistance for the short in items a), b), d), e) and f) shall not exceed 10 m Ω .

- a) *The terminals of a detachable battery pack with exposed terminals are shorted. Battery pack terminals that can be contacted using either Figure 1 or Figure 2 probes are considered exposed. The means of shorting shall not attain excessive temperatures so as to char or ignite the tissue paper or gauze.*
- b) *The motor terminals are shorted.*
- c) *The motor rotor is locked.*
- d) *A cord provided between the separable battery pack and the battery tool shall be shorted at the point likely to produce the most adverse effects.*
- e) *A cord provided between the tool and the charger shall be shorted at the point likely to produce the most adverse effects.*
- f) *For battery tools a short is introduced between any two uninsulated parts of opposite polarity not in accordance with the spacings given in L.28.101.*

L.19 Mechanical hazards

L.19.101 If a tool is marked with a direction of movement it shall not be possible to connect a battery pack such that the marking is not correct.

L.20 Mechanical strength

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

L.20.101 With the battery connected, battery tools and battery packs shall have adequate mechanical strength, and shall be so constructed that they withstand such rough handling as may be expected in normal use.

A battery tool with its battery pack attached, shall withstand being dropped three times on a concrete surface from a height of 1 m. The sample shall be positioned to vary the point of impact.