UL 745-1

Portable Electric Tools

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Portable Electric Tools, UL 745-1

Second Edition, Dated June 15, 2007

Summary of Topics

This new Second edition of UL 745-1 was issued to clarify the UL effective date statement shown on the Preface page and to make other administrative changes. The technical content of the First edition has reproduced verbatim in this edition; the text of the standard has not been changed.

As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this IEC-based binational standard jointly. However, this Second edition dated June 15, 2007will not be issued by CSA since it addresses UL only administrative changes.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognized and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-132	June 15, 2007

Canadian Standards Association
CAN/CSA-C22.2 No. 745-1
First Edition

Underwriters Laboratories Inc.
UL 745-1
Second Edition

Portable Electric Tools

June 15, 2007

Approved
by
Standards Council
of Canada

Commitment for Amendments

This Standard is issued jointly by Canadian Standards Association and Underwriters Laboratories Incorporated. Amendments to this Standard will be made only after processing according to the Standards writing procedures by both Canadian Standards Association and Underwriters Laboratories Incorporated.

ISBN 1-55397-485-9

CONTENTS

Appendix C – Construction of safety isolating transformers

Appendix D – Measurement of creepage distances and clearances

Appendix E – Reference standards

Appendix F – Attachments and accessories

Appendix G – Sequence of tests

Appendix H – Translations

Preface

This is the common CSA and UL Standard for portable electric tools. It is the first edition of CSA Standard C22.2 No. 745-1, *Safety of portable electric tools Part 1: General requirements* and UL 745-1 , *Safety of portable electric tools Part 1: General requirements*. It is written in SI (metric) units.

This Standard was prepared by Canadian Standards Association and Underwriters Laboratories Inc. This common CSA and UL Standard is based on IEC Publication 745-1(1982) *Safety of hand-held motor-operated electric tools Part 1: General requirements*. Where Canadian and US deviations have necessitated the deletion of IEC Publication 745-1 text, the IEC text has been retained but has been over-stricken to indicate it as nonmandatory. Text added to IEC Publication 745-1 as mandatory has been underlined including, where feasible, Tables and Figures.

This Standard contains general requirements and is intended to be used in conjunction with the appropriate particular requirements Standard (if available), which contains Clauses to supplement or modify the corresponding Clauses in the general requirements Standard, to provide the relevant requirements for each type of product.

If the functions of a tool are covered by different particular Standards, the relevant particular requirements Standard is applied to each function separately, so far as is reasonable. If applicable, the influence of one function on the other is taken into account.

This Standard was reviewed by the CSA Subcommittee on Portable Electric Tools of the Technical Committee on Consumer and Commercial Products under the jurisdiction of the Standards Steering Committee on the Canadian Electrical Code, Part II, and was formally approved by these Committees.

This Standard was processed and reviewed in accordance with the method of development, revision and implementation of UL Standards for safety.

This Standard has been approved by the Standards Council of Canada as a National Standard of Canada.

UL Effective Date

The effective date for UL 745-1 is the date of publication.

When requested by the manufacturer in writing, products may be evaluated to UL 45 until June 1, 2007.

CSA Effective Date

The effective date for CSA will be announced through a *CSA Certification Notice*.

> **Note:** *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

1 Scope

1.1 This standard applies to ~~hand-held~~ portable electric motor-operated or magnetically-driven tools, intended for indoor or outdoor use, in non-hazardous locations, in accordance with the Canadian Electric Code, Part 1 and the National Electrical Code (NFPA70). It applies to tools rated not more than 440V (not more than 250V for tools employing a universal motor).

~~Hand-held electric motor-operated tools, hereinafter referred to as tools, which can be mounted on a support for use as fixed tools without any alteration of the tool itself, are within the scope of this standard.~~

Tools with an electric heating element incorporated are within the scope of this standard~~, but such tools should also comply with IEC publication 335-1 : Safety of Household and Similar Electric Appliances, Part 1: General Requirements, as far as it reasonably applies~~.

Special requirements for battery-powered tools ~~will be determined in Part 2. Requirements concerning mechanical safety, however, will also apply for these tools~~ are defined in UL 745-3 and C22.2 No. 745-3.

~~Special requirements for exchange type tools (see definition 2.2(16)) are under consideration. Moreover, the requirements of this standard apply where appropriate.~~

For tools intended to be used on board ships or aircraft, additional requirements may be necessary, and in hazardous locations, for example, where explosions are liable to occur, special constructions may be required.

For tools intended to be used in tropical countries, special requirements may be necessary.

This standard applies to accessories and mechanical attachments for use with portable electric tools. These requirements are outlined in Appendix F.

This standard applies to attachments that contain electrical and electronic components. In this case, the attachment shall be evaluated with the tool and a determination must be made as to which clauses apply.

This Standard applies to, but the scope is not limited to: hand tools, such as drills, screwdrivers, nut runners, tappers, hammers, impact wrenches, saws, sanders, polishers, buffers, shears, nibblers, grinders, staplers, valve seat grinders and lappers, cylinder borers, and concrete vibrators; transportable tools, such as diamond core drills, drain cleaners, magnetic drills presses, pipe threaders, and pipe benders.

This standard does not apply to fixed or stationary electric tools, gardening appliances, garage equipment, soldering irons or guns, painting equipment, floor-finishing machines, heat guns, or other equipment covered by individual requirements.

Covered within this standard are Class I, II, and III tools.

1.2 This standard is concerned with safety and takes into account the influence on safety of components necessary to achieve a ~~required~~ degree of radio and television interference suppression.

2 Definitions

2.1 Where the terms voltage and current are used, they imply the r.m.s. values, unless otherwise specified.

2.1.1 Where in this standard the expressions ″With the aid of a tool,″ ″Without the aid of a tool,″ and ″requires the use of a tool″ occur, the word ″tool″ means a screwdriver, a coin or any other object which may be used to operate a screw or similar fixing means.

2.2 The following definitions apply for the purpose of this standard:

Rated voltage: denotes the voltage (for three-phase supply, the voltage between phases) assigned to the tool by the manufacturer.

Rated voltage range: denotes the voltage range assigned to the tool by the manufacturer, expressed by its lower and upper limits.

Working voltage: denotes the maximum voltage to which the part under consideration can be subjected when the tool is operating at its rated voltage and under normal conditions of use.

Normal conditions of use include changes of voltage within the tool imposed by likely occurrences such as the operation of a circuit breaker or the failure of a lamp.

When deducing the working voltage, the effect of possible transient voltages on the supply mains is ignored.

Rated input: denotes the input at rated voltage assigned to the tool by the manufacturer.

The term ″input″ refers to input power.

Rated current: denotes the current at rated voltage or at the lower limit of the rated voltage range assigned to the tool by the manufacturer.

If no current is assigned to the tool, the rated current for the purpose of this standard is determined by calculation from the rated input and the rated voltage and/or by measuring the current when the tool is operating at rated voltage under normal load and at normal operating temperature.

Rated frequency: denotes the frequency assigned to the tool by the manufacturer.

Rated frequency range: denotes the frequency range assigned to the tool by tool manufacturer, expressed by its lower and upper limits.

Rated no-load speed: denotes the no-load speed at rated voltage or at the upper limit of the rated voltage range assigned to the tool by the manufacture.

Detachable flexible cable or cord: denotes a flexible cable or cord, for supply or other purposes, intended to be connected to the tool by means of a suitable appliance coupler.

Cord sets are to comply with the applicable standard given in Appendix E ~~covered by IEC Publication 320; Appliance Couplers for Household and Similar General Purposes~~.

Power supply cord: denotes a flexible cable or cord, for supply purposes, fixed to, or assembled with, the tool according to one of the following methods:

type X attachment: which denotes a method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a flexible cable or cord not requiring any special preparation;

type M attachment: which denotes a method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a special cable or cord with, for example, a molded-on cord guard or crimped terminations;

type Y attachment: which denotes a method of attachment such that the flexible cable or cord can only be replaced with the aid of special purpose tools normally available only to the manufacturer or the manufacturer's ~~his~~ agents;

Type Y attachments may be used either with common flexible cables or cords or with special cables or cords.

type Z attachment: which denotes a method of attachment such that the flexible cable or cord cannot be replaced without breaking or destroying a part of the tool.

Cross-head, slotted-head, torx, socket head, clutch, and roberts tools are not considered special tools. Stiff wire, used to release push-in type terminals, is not precluded by this sub-clause.

Basic insulation: denotes the insulation applied to live parts to provide basic protection against electric shock.

Basic insulation does not necessarily include insulation used exclusively for functional purposes.

Supplementary insulation: denotes an independent insulation applied in addition to the basic insulation, in order to ~~ensure protection against~~ reduce the risk of electric shock in the event of a failure of the basic insulation.

Double insulation: denotes insulation comprising both basic insulation and supplementary insulation.

Reinforced insulation: denotes a single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard.

The term ″insulation system″ does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

Portable Tool: (in this standard abbreviated to ″tool″) denotes a hand-held or transportable tool.

Hand-held tool: ~~(in this standard abbreviated to ″tool″)~~ denotes an electric motor-operated or magnetically-driven machine intended to do mechanical work and so designed that the motor and the machine form an assembly which can easily be brought to the place of operation and which is held by hand or suspended during operation.

Hand-held tools may be provided with a flexible shaft~~, the motor being either fixed or portable~~. Hand-held tools may also have provisions for mounting on a support.

Hand-held tools include also hand-supported tools (such as paving breakers).

Transportable tool: is a tool that is not hand supported during use and which is intended to be taken to the work piece to perform its intended function.

Exchange type tool: denotes a tool which is intended not to be repaired at all, or to be repaired by the manufacturer's service organization only.

Class I tool: denotes a tool in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

For tools intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

Class I tools may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

Class II tool: denotes a tool in which protection against electric shock does not rely on basic insulation only, but in which additional ~~safety~~ precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective ~~earthing or reliance upon installation conditions~~.

Such a tool may be of one of the following types:

i) a tool having a durable and substantially continuous enclosure of insulating material which envelops all metal parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation; such a tool is called an insulation-encased Class II tool;

ii) a tool having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used, because the application of double insulation is manifestly impracticable; such a tool is called a metal encased Class II appliance;

iii) a tool which is a combination of the types i) and ii).

Class III tool: denotes a tool in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated.

~~Tools intended to be operated at safety extra-low voltage and having internal circuits which operate at a voltage other than safety extra-low voltage, are not included in the classification and are subject to additional requirements; these requirements are under consideration.~~

Extra-low voltage: denotes a voltage supplied from a source within the tool and, when the tool is operated at its rated voltage, not exceeding 42 V peak between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V peak between conductors and neutral, the extra-low voltage circuit being separated from other circuits by basic insulation only.

Safety extra-low voltage: denotes a nominal voltage not exceeding 42 V peak between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V peak between conductors and neutral, the no-load voltage not exceeding 50 V peak and 29 V peak respectively.

When safety extra-low voltage is obtained from the supply mains, it must be through a safety isolating transformer or a convertor with separate windings.

The voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

~~The d.c. value is under consideration.~~

Limitations to voltages lower than 50 V a.c. should be specified in the applicable power unit or transformer standard given in Appendix E ~~particular IEC standards~~, especially when direct contact with live parts is involved.

Separation from the mains by protective impedance is excluded.

Safety isolating transformer: denotes a transformer the input winding of which is electrically separated from the output windings by an insulation at least equivalent to double insulation or reinforced insulation, and which is designed to supply a distribution circuit, a tool or other equipment at safety extra-low voltage.

Normal load: denotes the load to be applied to a tool so that the stress imposed corresponds to that occurring under normal conditions of use, any marking of short-time or intermittent operation being observed and, unless otherwise specified, heating elements, if any, being operated as in normal use.

The normal load is based on the rated voltage or on the upper limit of the rated voltage range.

Rated operating time: denotes the operating time assigned to the tool by the manufacturer.

Continuous operation: denotes operation under normal load for an unlimited period.

Short-time operation: denotes operation under normal load for a specified period, starting from cold, the intervals between each period of operation being sufficient to allow the tool to cool down approximately to room temperature.

Intermittent operation: denotes operation in a series of specified identical cycles, each cycle being composed of a period of operation under normal load followed by a rest period with the tool running idle or switched off.

Non-detachable part: denotes a part which can only be removed with the aid of a tool.

Detachable part: denotes a part which can be removed without the aid of a tool.

Thermal cut-out: denotes a device which, during abnormal operation, limits the temperature of a tool, or parts of it, by automatically opening the circuit or by reducing the current, and which is so constructed that its setting cannot be altered by the user.

Non-self-resetting thermal cut-out: denotes a thermal cut-out which requires resetting by hand, or replacement of a part, in order to restore the current.

Creepage distance: denotes the shortest path between two conductive parts, or between a conductive part and the bounding surface of the tool, measured along the surface of the insulating material.

Clearance: denotes the shortest distance between two conductive parts, or between a conductive part and the bounding surface of the tool, measured through air.

The bounding surface of the tool is the outer surface of the enclosure, considered as though metal foil are pressed into contact with accessible surfaces of insulating material.

All-pole disconnection: denotes, for single-phase a.c. tools and for d.c. tools, disconnection of both supply conductors by a single switching action or, for tools to be connected to more than two supply conductors, disconnection of all supply conductors, except the earthed (grounded) conductor, by a

single switching action.

The protective earthing conductor is not a supply conductor.

Accessible part or **Accessible part:** denotes a part or surface which can be touched by means of the standard test finger shown in Figure 1~~, page 122~~. For accessible metal parts, it includes any other metal which is in electrical contact with such parts.

The term **body** includes all accessible metal parts, shafts of handles, knobs, grips and the like and metal foil in contact with all surfaces of insulating material; it does not include inaccessible metal parts.

Watertight tools denotes a tool so constructed that moisture will not enter the tool enclosure under specified test conditions.

Splash-proof tools denotes a tool so constructed or protected that the exposure to a beating rain will not result in the entrance of water into the enclosure under specified test conditions.

A **Type Test** is testing of a representative sample of the equipment with the objective of determining if the equipment, as designed and manufactured, can meet the requirements of this standard.

Routine Servicing denotes servicing of or replacement of motor brushes or fuses and other service that is recommended in the instruction manual to be performed by the user. It does not include maintenance that the instruction manual recommends be done by authorized service personnel.

Cautionary Markings denote markings required by this standard that are preceded by the signal words CAUTION, WARNING, or DANGER.

Appliance Coupler is a means enabling the connection and disconnection at will of a flexible cable or cord to a tool. It consists of two parts, 1) a connector which is the part integral with the tool, or attached to a flexible cable permanently attached to the tool, and 2) the mating connector which is attached to the power supply cord.

Areas not Protected Against Deposition of Dirt are defined as all points where air drawn through the tool (by the fan) can reach, especially areas where deposits of carbon dust, metal filings, and wood dust occur. The areas of concern are usually around the brush holders and to the rear of the commutator.

3 General requirement

3.1 Tools shall be so designed and constructed that in normal use they function ~~safely so as to cause no danger to persons or surroundings~~ so as to reduce the risk of injury or electric shock ~~even in the event of such careless use as may occur in normal service~~.

~~In general, c~~ Compliance is checked by confirming the tool meets the relevant construction requirements and by carrying out all the relevant tests.

4 General notes on tests

4.1 Tests according to this standard are type tests.

4.2 ~~Unless otherwise specified, the tests are made on a single sample as delivered, which shall withstand all the relevant tests.~~

The recommended sequence of tests is given in Appendix G.

If it is evident from the design of the tool that a particular test is not applicable, this test is not made.

If the tool is designed for different supply voltages, for both a.c. and d.c., for different speeds, etc., ~~more than one sample~~ additional samples may be required.

If the test of Sub-clause 11.6 has to be made, additional samples are required.

If it is necessary to dismantle a Class II tool for the relevant tests, one additional sample is required.

The testing of components may necessitate the submission of additional samples of these components. When the submission of such samples is necessary, they should be submitted together with the tool.

4.3 Unless otherwise specified, ~~the tests are carried out in the order of the clauses of Part I~~ each test may be conducted on a new sample.

Unless otherwise specified, each test is to be conducted only once.

~~If according to Clause 13, the interference levels are to be measured, these measurements will be made immediately after the tests of Clause 8.~~

Before testing is started, the tool is operated at rated voltage or at the lower limit of the rated voltage range in order to verify that it is in working order.

4.4 The tests are carried out with the tool, or any movable part of it, placed in the most unfavorable position which may occur in normal use.

4.5 If the test results are influenced by the temperature of the ambient air, the room temperature is, in general, maintained at 20 ±5°C. If, however, the temperature attained by any part is limited by a temperature sensitive device, or is influenced by the temperature at which a change of state occurs, for example, the temperature of boiling water, the room temperature is, in case of doubt, maintained at 23 ±2°C.

4.6 Tools for a.c. only are tested with a.c. at rated frequency, if marked; those for d.c. only are tested with d.c. and those for a.c./d.c. are tested at the more unfavorable supply.

Tools for a.c. which are not marked with rated frequency or marked with a frequency range of 50 Hz to 60 Hz are tested with either 50 Hz or 60 Hz, whichever is the national frequency.

Tools marked with a rated frequency range other than 50 Hz to 60 Hz are tested at the most unfavorable frequency within the range.

Tools designed for more than one rated voltage are tested at the most unfavorable voltage.

Unless otherwise specified, tools designed for one or more rated voltage ranges are tested at the most unfavorable voltage within the relevant range.

When it is specified, for tools marked with a rated voltage range, that supply voltage is equal to the rated voltage multiplied by a factor, the supply voltage is equal to:

– the upper limit of the rated voltage range multiplied by this factor, if greater than 1.

– the lower limit of the rated voltage range multiplied by this factor, if smaller than 1.

Where reference is made to maximum or minimum rated input, the rated input related to the upper limit or lower limit respectively of the rated voltage range is meant.

When testing tools for d.c. only, the possible influence of polarity on the operation of the tools is taken into consideration.

If the tool is designed for more than one rated voltage or rated voltage range, it may be necessary to make some of the tests at the minimum, the mean and the maximum values of the rated voltage or the rated voltage range in order to establish the most unfavorable voltage.

4.7 Tools for which alternative heating elements or accessories are available are tested in accordance with the relevant section of Part 2, with those elements or accessories which give the most unfavorable results, provided that the elements or accessories used are within the tool manufacturer's specifications.

4.8 If, in normal use, the heating element cannot be operated unless the motor is running, the element is tested with the motor running. If the heating element can be operated without the motor running, the element is tested with or without the motor running, whichever is the more unfavorable. Heating elements incorporated in the tool are connected to a separate supply unless otherwise specified, and tested according to ~~IEC Publication 335-1~~ the standard listed under "Heating Elements" in the Appendix E.

4.9 Unless otherwise specified, tools provided with a regulating device or a similar control~~, other than an electronic speed control,~~ are tested with these controls adjusted to their most unfavorable setting. If the setting can be altered by the user.

If the adjusting means of the control is accessible without the aid of a tool, this sub-clause applies whether the setting can be altered by hand or with the aid of a tool; if the adjusting means is not accessible without the aid of a tool, this sub-clause applies only if the setting can be altered by hand.

Adequate sealing is regarded as preventing alteration of the setting by the user.

4.10 When the conditions of normal load are specified in Part 2, the tool is loaded according to these conditions, irrespective of any marking of short-time or intermittent operation, unless it is evident from the design of the tool that these conditions will not occur in normal use.

When the conditions of normal load are not specified in Part 2, the tool is loaded according to the manufacturer's instructions; in the absence of such instructions, the tool is operated continuously at a load such that rated input is attained.

For accessories performing a function which is within the scope of one of the sections of Part 2, the tests are made in accordance with that section.

For other accessories, the tests are made in accordance with manufacturer's instructions; in the absence of such instructions, the tool is operated continuously at a load such that rated input is attained.

Electronic speed control devices are set for the highest speed.

~~The introduction of tests to be made at other settings is under consideration.~~

4.11 If torque is to be applied, the method of loading is chosen so as to avoid additional stresses, such as those caused by side thrust. Additional loads necessary for the correct operation of the tool are, however, taken into consideration.

4.12 Tools intended to be operated at safety extra-low voltage are tested together with their supply transformer, if this is normally sold with the tool.

4.13 For the purpose of Clauses 8, 15, 23, and 25, parts separated from live parts by double insulation or reinforced insulation are not regarded as likely to become live in the event of an insulation fault; connection of accessible metal parts to an earthing terminal or earthing contact does not remove the necessity for carrying out these tests.

4.14 If Class I tools have accessible conductive parts which are not connected to an earthing terminal and are not separated from live parts by an intermediate metal part which is connected to an earthing terminal, such parts are checked for compliance with the appropriate requirements specified for Class II tools.

4.15 Unless otherwise specified, if Class I or Class II tools have parts operating as safety, extra-low voltage, such parts are checked for compliance with the appropriate requirements specified for Class III tools.

4.16 For tools incorporating electronic circuits, see Appendix B.

4.17 ~~Routine tests are presently under consideration.~~

5 Rating

5.1 The maximum rated voltage is:

250 V for d.c. tools and tools employing universal motors;

440 V for other tools.

50 V for Class III tools~~, the preferred values of the rated voltage are 24 V and 42 V~~.

Compliance is checked by inspection of the marking.

The requirements of this standard are based on the assumption that in normal use the voltage between the supply lines and earth does not exceed ~~254 V~~ 250 V.

6 Classification

Tools are classified:

6.1 According to protection against electric shock:

– Class I tools;

– Class II tools;

– Class III tools.

The class numbers are not intended to reflect the safety level of the tools, but only the means by which the safety is obtained.

6.2 According to degree of protection against moisture:

– ordinary tools;

– splash-proof tools;

– watertight tools.

~~The class numbers are not intended to reflect the safety level of the tools, but only the means by which the safety is obtained.~~

If Class III tools are sold with a separate safety isolating transformer for their supply from the mains, their classification is not altered. Tools that require splashproof or watertight classifications are specified in Clause 20.

7 Marking

7.1 Tools shall be marked with:

– rated voltage(s) or rated voltage range(s), in volts;

– symbol for nature of supply, if applicable;

– rated frequency or rated frequency range, in hertz, unless the tool is designed for d.c. only or for a.c. of both 50 Hz and 60 Hz;

– rated input (if greater than 25 W) in watts or kilowatts, or rated current, in amperes;

– manufacturer's name, trade mark, or identification mark;

The manufacturer's identification may be in a traceable code if the tool is identified by the brand or trademark of a private labeler.

– manufacturer's model or type reference;

– rated operating time, or rated operating time and rated resting time, in hours, minutes or seconds, if applicable;

This marking, if applicable, will be specified in the Part 2 requirements.

– symbol for Class II construction, for Class II tools only;

– rated no-load speed;

Applies only to tools with a rotating output means. A tool provided with more than one speed (by mechanical or electrical means) shall be marked with the no load speed obtainable with the unit in the highest possible speed setting. This does not apply to nut setters, screwdrivers, drain cleaners, belt sanders, band saws, and tools with predominately linear work function motion.

– WARNING – To reduce the risk of injury, user must read and understand instruction manual;

The word "Warning" shall be in capital letters not less than 2.4 mm high, and shall not be separated from the cautionary statement.

The statement shall be verbatim except the term "Operator's manual," or "User guide" may be used for the term "instruction manual."

The word "Warning" shall not be separated from the cautionary statement.

– date of manufacture;

The date of manufacture may be a dating period not exceeding any one month. The date of manufacture may be abbreviated or in established, accepted code, or a code affirmed by the manufacturer. The code shall not require reference to the manufacturer's records to determine when the product was manufactured.

– symbol for degree of protection against moisture, if applicable.

Tools for star-delta connection should be clearly marked with the two rated voltages (e.g. 200Δ /380 Y.)

~~The rated input or current to be marked on the tool is the total maximum input or current that can be on circuit at the same time.~~

If a tool has alternative components which can be selected by a control device, the rated input is that corresponding to the highest loading possible.

~~Additional markings are allowed, provided that they do not give rise to misunderstanding.~~

If the motor of a tool is marked separately, the marking of the tool and that of the motor should be such that there can be no doubt with regard to the rating and manufacturer of the tool itself.

7.1.1 If a nameplate carries a required marking and is on a part that must be removed for normal servicing of the tool, the construction shall be such that the nameplate must be returned to its proper location for the tool to be operable;

7.1.2 A cautionary marking shall be permanent and shall be located on a part permanently attached to the tool or on a part that cannot be removed without impairing the operation or the appearance of the tool.

A fold-over label attached to the power supply cord is acceptable.

7.1.3 Cautionary markings shall be used verbatim as stated. Optional cautionary statements may be added to the markings, as deemed necessary, by the manufacturer. Cautionary statements having the same signal word may be combined into one paragraph under one signal word. The order of statements shall be markings required by Part 1, markings required by the applicable Part 2, and any optional markings.

7.1.4 In cases where danger, warning, and caution appear together, the cautionary markings shall be in the order of severity, i.e., danger, warning, and caution.

7.2 Tools for short-time operation or intermittent operation shall be marked with rated operating time or rated operating time and rated resting time respectively, unless the operating time is limited by the construction of the tool or by the description of normal load given in Part 2.

The marking of short-time operation or intermittent operation shall correspond to normal use.

The marking of intermittent operation shall be such that the rated operating time precedes the rated resting time, both markings being separated by an oblique stroke.

7.3 For tools with heating elements incorporated, the complete marking for heating elements required in ~~IEC Publication 335-1~~ the standard listed under Heating Elements in Appendix E, shall in addition, be given on the marking plate of the tool.

7.4 If the tool can be adjusted to suit different rated voltages or different rated inputs, the voltage or input to which the tool is adjusted shall be easily and clearly discernible.

This requirement does not apply to tools for star-delta connection.

The term "star delta" is the same as "Y delta."

For tools where frequent changes in voltage setting are not required, this requirement is deemed to be met if the rated voltage or the rated input to which the tool is adjusted, can be determined from a wiring diagram fixed to the tool; the wiring diagram may be on the inside of a cover which has to be removed to connect the supply conductors. This diagram may be on a card which is riveted to the cover, or on a paper or similar label secured to the cover by an adhesive, but it must not be on a label loosely attached to the tool.

7.5 For tools marked with more than one rated voltage or rated voltage range, the rated input for each of these voltages or ranges shall be marked, if greater than 25 W.

The upper and lower limits of the rated input shall be marked on the tool so that the relation between input and voltage appears distinctly, unless the difference between the limits of a rated voltage range does not exceed 10 percent of the mean value of the range, in which case the marking for rated input may be related to the mean value of this range.

7.6 When symbols are used, they shall be as follows:

V	.....	volts
A	.....	amperes
Hz	.....	hertz
W	.....	watt
kW	.....	kilowatts
μF	.....	microfarads
l	.....	liters
kg	.....	kilograms
N/cm^2	.....	newtons per square centimeter
Pa	.....	paschals
h	.....	hours
min	.....	minutes
s	.....	seconds
⏦	.....	alternating current
3 ⏦	.....	three-phase alternating current
3N ⏦	.....	three-phase alternating current with neutral
⎓	.....	direct current
n_0	.....	no load speed
⏦ with overline	.....	alternating or direct current
⧈	.....	Class II Construction

Table Continued on Next Page

Table Continued

⚠	.....	splash-proof construction
💧💧	.....	watertight construction
…/min	.....	revolutions or reciprocation per minute

The symbol for nature of supply shall be placed next to the marking for rated voltage.

The dimensions of the symbol for Class II construction shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall not be less than 5 mm, unless the largest dimension of the tool does not exceed 15 cm, in which case the dimensions of the symbol may be reduced, but the length of the sides of the outer square shall not be less than 3 mm.

The symbol for Class II construction shall be so placed that it will be obvious that it is a part of the technical information and is unlikely to be confused with any other marking.

~~A revision of the symbols for the types of construction with regard to protection against moisture is under consideration.~~

7.7 Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.

The ″N″ mark is only required in multi-phase circuits.

Protective e~~E~~arthing terminals shall be indicated by the ⏚ symbol.

These indications shall not be placed on screws, removable washers or other parts which might be removed when conductors are being connected.

7.8 Tools to be connected to more than two supply conductors shall be provided with a connection diagram, fixed to the tool, unless the correct mode of connection is obvious.

The correct mode of connection is deemed to be obvious if the terminals for the supply conductors are indicated by arrows pointing towards the terminals. The earthing conductor is not a supply conductor. For tools for star-delta connection, the wiring diagram should show how the windings are to be connected.

The connection diagram may be that referred to in Sub-clause 7.4.

7.9 Unless it is obviously unnecessary, switches shall be marked or placed so as to indicate clearly which part of the tool they control.

Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages, national standards, etc.

7.10 A push-button shall be colored red only if it serves to open the circuit to be controlled and has no other function.

This requirement does not apply to push-buttons used for locking the mains switch. This requirement refers to emergency-off switches only and does not preclude the use of red trigger, rocker, toggle, or other switches and controls.

For tools which might ~~cause danger~~ result in a risk of injury when started unexpectedly, the ″off″ position of the mains switch shall be indicated, unless this position is obvious; the indication, if required, shall be the figure 0.

The figure 0 shall not be used for any other indication.

This requirement does not preclude the use of the figure 0 for the minimum setting of a variable speed control, 0 degree, 0 depth of cut, or similar indication.

The position of the moving contacts of the mains switch shall correspond to the indications for the different positions of its operating means.

7.11 Regulating devices and the like, intended to be adjusted during operation shall be provided with an indication for the direction of adjustment to increase or to decrease the value of the characteristic being adjusted.

An indication of + and - is considered to be sufficient.

If figures are used for indicating the different positions, the ″off″ position shall be indicated by the figure 0 and the position for a greater output, input, speed, etc., shall be indicated by a higher figure.

The first requirement does not apply to regulating devices provided with an adjusting means, if its ″fully-on″ position is opposite to its ″off″ position.

The indications for the different positions of the operating means of a control device need not be placed on the device itself.

7.12 Tools provided with electronic regulating devices shall ~~either have a special marking or~~ be accompanied by ~~an instruction sheet giving~~ the necessary instructions for the use of the tool.

7.13 ~~Instruction sheets~~ Cautionary markings shall be written in the official language(s) of the country in which the tool is to be sold. See Appendix H for translations.

Where symbols are used, they shall be those indicated in this standard.

Compliance with the requirements of Sub-clauses 7.1 to 7.13 is checked by inspection.

7.14 Required m~~M~~arking shall be easily visible, legible, and durable.

To comply with this clause a marking shall be etched, molded, die-stamped, paint-stenciled; permanently secured, stamped, or etched metal; or indelibly stamped lettering on pressure-sensitive labels secured by adhesive. Ordinary usage, handling, storage, and the like, of the tool will be considered in determination of the permanence of marking.

Marking specified in Sub-clauses 7.1 to 7.12 shall be on a main part of the tool in such a way that it is clearly discernible when the tool is ready for use.

~~Provisionally, self-adhesive labels glued in recesses in the body of the tool are allowed for ordinary tools.~~

Marking on, and indications for, switches, thermostats, thermal cut outs and other control devices shall be placed in the vicinity of these components; they shall not be placed on removable parts if these parts can be replaced in such a way that the marking is misleading.

Compliance is checked by inspection and, if the label is not in compliance with the standards specified in Appendix E, the following tests: ~~by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.~~

After being subjected to the conditions described below, a pressure sensitive label or a label secured by cement or adhesive is considered to be of a permanent nature if (1) immediately following removal from each test medium and (2) after being exposed to room temperature for 24 hours following removal from each medium:

A. *Each sample demonstrates good adhesion and the edges are not curled.*

B. *The label resists defacement or removal as demonstrated by scraping across the test panel with a flat steel blade, held at right angles to the test panel. The blade is to be 0.8 mm thick and of any convenient width.*

C. *The printing is legible and is not defaced by rubbing with thumb or finger pressure.*

Label Heating Test

Three samples of the label applied to test surfaces as in the intended application are to be placed for 240 hours in an oven maintained at the temperature specified below.

Maximum Temperature During Temperature Test of Surface to Which Applied	*Oven Temperature*
°C	°C
60 or less	*87*
80 or less	*105*
100 or less	*121*
125 or less	*150*
150 or less	*180*
Over 150	*a*

[a] A label that is applied to a surface attaining a temperature greater than 150°C, during the temperature test, is to be heated at a temperature representative of the temperatures attained by the appliance during intended use and abnormal use.

Label Immersion Tests

Six samples of the labels applied to text surfaces as in the intended application are to be placed in a controlled atmosphere maintained at 23.0 ±2.0°C with a 50 ±5 percent relative humidity for 24 hours. Three samples are then to be immersed in water and three samples immersed in IRM 903 (Calumet Oil No. 3) as specified in Tests for Rubber Property – Effect of Liquids ANSI/ASTM D 471 – 1979 at a temperature of 21.0 ±2.0°C for 48 hours in each case.

Label Standard Atmosphere Test

Three samples of the label applied to test surfaces as in the intended application are to be placed for 72 hours in a controlled atmosphere maintained at 23.0 ±2.0°C with a 50±5 percent relative humidity.

After all the tests of this standard, the marking shall be easily legible; it shall not be easily possible to remove marking plates and they shall show no curling.

~~A revision of the test for checking the durability of the marking and requirements for glued-on marking plates is under consideration.~~

8 Protection against electric shock

8.1 Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts and, for Class II tools, with metal parts separated from live parts by basic insulation only, even after removal of detachable parts.

The insulating properties of lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound shall not be relied upon to give the required protection against accidental contact with live parts.

The enclosure of the tool shall have no openings other than those necessary for the use and working of the tool, giving access to live parts and, for Class II tools, to parts separated from live parts by basic insulation only.

Unless otherwise specified, parts operating at safety extra-low voltage not exceeding ~~24~~ 42.4 V peak are not considered to be live parts.

Compliance is checked by inspection and by a test with the standard test finger shown in Figure 1~~, page 122~~.

In addition apertures in Class II tools and apertures in Class I tools, other than those in metal parts connected to an earthing terminal or earthing contact, are tested with the test pin shown in Figure 2~~, page 122~~.

After removal of detachable parts, the test finger and the test pin are applied in every possible position, the test finger being applied without appreciable force and the test pin with a force of 10 N.

Apertures preventing the entry of the test finger are further tested by means of a straight unjointed test finger of the same dimensions, which is applied with a force of 50 N; if this finger enters, the test with the finger shown in Figure 1~~, page 122~~, is repeated, except that the force necessary to push the finger through the aperture is exerted. An electrical contact indicator is used to show contact.

It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compound only, with the test finger. For Class II tools it shall not be possible to touch bare live parts with the test pin shown in Figure 2 ~~, page 122~~, or, to touch metal parts, separated from live parts by basic insulation only with the test finger shown in Figure 1.

The standard test finger must be so designed that each of the jointed sections can be turned through an angle of 90° with respect to the axis of the finger in the same direction only.

It is recommended that a lamp be used for the indication of contact and that the voltage be not less than 40 V.

Ventilation openings shall not be excessively large.

Compliance is checked by inspection and by trying to insert a steel ball, 6 mm in diameter, through the air-intake openings other than those adjacent to the fan.

The ball shall not enter.

This requirement does not imply that live parts must not be visible through ventilation openings.

8.2 Shafts of operating knobs, handles, levers and the like shall not be live.

8.3 For tools other than those of Class III, handles and grasping surfaces ~~or knobs of~~ containing switch operating means, if of metal, shall either be adequately covered by insulating material, or their accessible parts shall be separated from ~~their shafts or fixings~~ other conductive parts of the tool by supplementary insulation and separated from live parts by double or reinforced insulation.

In the case of tools that do not contain the switching means in a handle or grasping surface, the handle or grasping surface primarily used to control the tool are to comply with clause 8.3.

8.3.1 For tools other than those of Class III, switch actuators shall be formed of insulating material or, if of metal, shall be either adequately covered by insulating material or their accessible parts shall be separated from live parts by double or reinforced insulation.

8.3.2 For tools of Class II construction, auxiliary handles and auxiliary grasping surfaces, as recommended in the instruction manual, shall be formed of insulating material or, if of metal, shall be either adequately covered by insulating material or their accessible parts shall be separated from live parts by double insulation and separated from their output shafts by double or reinforced insulation.

Compliance with the requirements of Sub-clauses 8.2, ~~and~~ 8.3, 8.3.1, and 8.3.2 is checked by inspection and by the tests of Clauses 15 and 19.

8.4 For Class II tools, capacitors shall not be connected to accessible metal parts, and their casings, if of metal, shall be separated from accessible metal parts by supplementary insulation.

Compliance is checked by inspection and by the tests specified for supplementary insulation.

8.5 Tools intended to be connected to the supply by means of a plug shall be so designed that in normal use there is no risk of electric shock from charged capacitors when touching the pins of the plug.

Compliance is checked by the following test, which is made ten times.

The tool is operated at rated voltage or at the upper limit of the rated voltage range.

The tool switch if any, is then moved to the "off" position and the tool is disconnected from the supply by means of the plug.

One second after disconnection, the voltage between the pins of the plug is measured with an instrument which does not appreciably affect the value to be measured.

This voltage shall not exceed 34 V.

Capacitors having a rated capacitance not exceeding 0.1 µF are not considered to entail a risk of electric shock.

8.6 Parts providing protection against electric shock shall have adequate mechanical strength and shall not work loose in normal use. It shall not be possible to remove them without the aid of a tool.

Compliance is checked by inspection, by manual test and by the tests of Clauses 16 and 19.

9 Starting

9.1 Motors shall start under all normal voltage conditions which may occur in use.

Centrifugal and other automatic starting switches shall operate reliably and without contact chattering.

Compliance is checked by operating the tool with no load ten times at a voltage equal to 0.85 times rated voltage, regulating devices, if any, being set as in normal use.

Tools provided with a centrifugal or other automatic starting switch are, in addition, operated ten times at a voltage equal to 1.1 times rated voltage. The interval between consecutive starts is made sufficiently long to prevent undue heating.

In all cases, the tool shall function ~~safely and correctly~~.

9.2 Overload protection devices shall not operate under normal starting conditions.

The test of Sub-Clause 9.1 checks compliance with this requirement.

10 Input and current

10.1 The input of the tool at rated voltage and under normal load shall not deviate from the rated input by more than:

Rated input (W)	Deviation
Up to and including 33.3	+10 W
over 33.3 up to and including 150	+30 percent
over 150 up to and including 300	+45 W
over 300	+15 percent

Compliance is checked by measuring the input of the tool operated under normal load at rated voltage or at the mean value of the rated voltage range if the voltage range does not exceed 10 percent of its mean value.

For tools marked with a rated voltage range having limits differing by more than 10 percent of the mean value of the range, the permissible deviations apply for both limits of the range.

10.2 If the tool is marked with rated current, the current taken by the tool under normal load shall not exceed the rated current by more than 15 percent.

Compliance is checked by measuring the current taken by the tool operating under normal load conditions, at rated voltage or at the mean value of the rated voltage range, if the voltage range does not exceed 10 percent of its mean value.

For tools marked with a rated voltage range having limits differing by more than 10 percent of the mean value of the range, the permissible deviations apply for both limits of the range.

11 Heating

11.1 Tools shall not attain excessive temperatures in normal use.

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

11.2 The tool is operated in still air under load, or under the torque load necessary to attain rated input or under the loading conditions as specified in Part 2, whichever causes the higher temperature rise, and at a supply voltage equal to 0.94 times rated voltage, 1.00 times rated voltage or 1.06 times rated voltage, whichever is the most unfavorable.

The torque is kept constant at the value recorded when operating at rated voltage, or at the mean of the rated voltage range, under the most unfavorable of the three loading conditions quoted while the voltage is adjusted to 0.94 or 1.06 times the rated voltage or mean of the rated voltage range.

When applying the torque load necessary to attain rated input, the operating time to be chosen is that specified for normal load.

Heating elements, if any, are operated as indicated in Sub-clauses 4.7 and 4.8 the conditions being as specified in the standards listed under "Heating Elements" in Appendix E ~~Clause II of IEC Publication 335-1~~, when the tool is operated at a voltage equal to 1.06 times rated voltage. When the tool is operated at a voltage equal to 0.94 times rated voltage, the input of heating elements is reduced to 0.90 times rated input.

If it is necessary to make the test at an intermediate voltage, the input of the heating elements is adjusted proportionally.

11.3 Temperature rises of windings are determined by the resistance method unless the windings are non-uniform or it involves severe complications to make the necessary connections for the resistance measurements. In this case, the measurement is made by thermocouples.

Such temperature rises are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test.

Referee measurements shall be made with 30 AWG type J thermocouple wire.

In determining the temperature rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use and, if of insulating material, to those parts in contact with hot metal.

The temperature rise of electrical insulation, other than that of windings, is determined on the surface of the insulation, at places where failure could cause a short circuit, contact between live parts and accessible metal parts, bridging of insulation or reduction of creepage distances or clearances below the values specified in Sub clause 27.1.

11.4 The tool is operated:

– for the rated operating time for tools for short time operation;

– on consecutive cycles of operation, until steady conditions are established, for tools for intermittent operation, the "on" and "off" periods being the rated "on" and "off" periods;

– until steady conditions are established for tools for continuous operation.

11.5 During the test, thermal cut-outs shall not operate. The temperature rises shall not exceed the values shown in the following table except as allowed by Sub-clause 11.6.

Sealing compound, if any, shall not flow out.

Parts	Temperature rise deg C ~~(K)~~
Windings[1], and core laminations in contact therewith, if the winding insulation is:	
– of Class A material [2]	*75(65)*
– of Class E material [2]	*90(80)*
– of Class B material [2]	*95(85)*
– of Class F material [2]	*115*
Ambient of switches and thermostats marked with individual ratings: [3]	
– without T-marking	*30*
– with T-marking	*T–25*
~~*Pins of appliance inlets[9]:*~~	
~~*– for very hot conditions*~~	~~*130*~~
~~*– for hot conditions*~~	~~*95*~~
~~*– for cold conditions*~~	~~*40*~~
Rubber or polyvinyl chloride insulation of internal and external wiring including power supply cords:	
– without T-marking	*50 [4]*
– with T-marking	*T–25 [5]*
Cord sheaths used as supplementary insulation:	
– without T-marking	*35*
– with T-marking	*T–25[5]*
Rubber used for gaskets or other parts, the deterioration of which could ~~affect safety~~ result in risk of injury to persons:	
– when used as supplementary insulation or as reinforced insulation	*40*

Table Continued on Next Page