

UL1004

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UL 1004

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Electric Motors

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Electric Motors, UL 1004

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with the corresponding reference.

Future Effective Dates	References
February 7, 2003	Paragraph 18.0

The new and revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated August 9, 2000. The bulletin(s) is now obsolete and may be discarded.

The revisions dated February 7, 2001 include a reprinted title page (page1) for this Standard.

The revisions dated November 24, 1999 were issued to reflect changes in requirements to motor insulation systems and correct editorial discrepancies.

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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, Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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Page	Date
1-2B	February 7, 2001
3	July 6, 1999
4	June 3, 1994
5-6D	February 7, 2001
7-8	March 26, 1996
8A-8B	February 7, 2001
8C	November 24, 1999
8D	February 7, 2001
8E	December 26, 1997
8F	March 26, 1996
9	February 7, 2001
10	July 6, 1999
10A	February 7, 2001
10B	February 14, 1997
11	July 6, 1999
12	June 3, 1994
13	February 14, 1997
14	March 26, 1996
15	June 3, 1994
16	February 14, 1997
17	June 3, 1994
18-24	February 7, 2001
25-26	June 3, 1994
27	March 26, 1996
28	July 6, 1999
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No Text on This Page

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1

UL 1004

Standard for Electric Motors

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June 3, 1994

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

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.

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No Text on This Page

CONTENTS

FOREWORD	4
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INTRODUCTION

1 Scope	5
2 References	6
2A Glossary	6
3 Components6C
4 Units of Measurement6C
5 Current/Horsepower Relation6C

CONSTRUCTION

6 Frame and Enclosure8B
7 Mechanical Assembly8E
8 Protection Against Corrosion8F
9 Supply Connections	9
9.1 Permanently connected motors	9
9.2 Cord-connected motors	14
10 Factory Wiring Terminals and Leads	16
11 Current-Carrying Parts	16
12 Internal Wiring	16
13 Electrical Insulation Supports	18
14 Insulation Systems	18B
15 Windings	19
16 Brush Holders	19
17 Nonmetallic Functional Parts	19
18 Capacitors	20A
18A Start Switches	20A
18B Motors Provided With Controls	20B
19 Spacings	21
20 Control Devices	24
21 Bonding for Grounding	25
21.1 Bonding conductor	25
21.2 Connections	26
21.3 Resilient rubber mountings	27
21A Grounding	27

PERFORMANCE

22 General	27
22A Continuity of Grounding Circuit Test	29
22B Rating	29
23 Auxiliary Switch Tests	30
23.1 General	30
23.2 Overload test	30
23.3 Endurance test	30
23.4 Dielectric voltage-withstand test	30A
23.5 Temperature test	30A
23A Start Switch Tests	30B

23A.1	General	.30B
23A.2	Temperature test	.30B
23A.3	Solid state start switch component failure test	.30C
23A.4	Start switch endurance test	.30C
24	Resilient Rubber Mounting Tests	.30D
24.1	General	.30D
24.2	Overcurrent test	.31
24.3	Limited short circuit test	.33
24.4	Humidity conditioning test	.34
24.5	Oven conditioning test	.34
24.6	Ozone conditioning test	.34
24.7	Oil conditioning test	.35
25	Non-Metallic Functional Part Tests	.35
25.1	Mold stress relief	.35
25.2	Locked rotor cycling	.35
26	Strain Relief Test	.36
26.1	Power-supply cord	.36
26.2	Interconnecting leads	.36
26.3	Clamps	.36A
27	Conduit Hubs	.36A
27A	Installation Test	.36A
27B	Electrolytic Capacitor Overvoltage Test	.36A

MANUFACTURING AND PRODUCTION TESTS

28	Dielectric Voltage-Withstand	.36B
29	Continuity	.38
29A	Grounding Continuity Test	.38

MARKING

30	Details	.38
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APPENDIX A

Standards for Components	A1
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No Text on This Page

FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover motors intended for use in appliances and equipment that comply with the requirements for such appliances and equipment.

1.2 These requirements cover commutator motors of the series, shunt, compound, and permanent-magnet-field types rated 5 horsepower (3.7 kW) or less, 250 volts or less, alternating current or direct current.

1.3 These requirements cover electric motors other than those specified in 1.2 rated 7200 volts or less, including commutator motors of the repulsion type only.

1.3 revised February 7, 2001

1.4 The requirements cover both open and totally-enclosed motors.

1.5 These requirements cover motor parts and combinations of such parts.

1.6 These requirements do not cover:

a) Thermal protectors and impedance requirements for impedance-protected motors, which are judged under the Standard for Overheating Protection for Motors, UL 2111;

b) Other motor protection that is dependent upon requirements for the end-use equipment in which the motor is to be installed; or

c) Sealed (hermetic type) motor-compressor parts, which are judged under the Standard for Hermetic Refrigerant Motor-Compressors, UL 984.

1.6 revised December 26, 1997

1.7 These requirements do not cover motors for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.8 These requirements do not include performance requirements that depend upon application in the end-use equipment. Such features as current rating, temperature rise during normal and abnormal operation, motor protection, internal wiring and insulation, and similar features are evaluated in the end-use application.

1.8 revised December 26, 1997

1.9 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.9 revised February 7, 2001

2 References

2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.1 revised February 7, 2001

2A Glossary

2A.1 For the purpose of this standard, the following definitions apply.

2A.1 added November 24, 1999

2A.1.1 ARAMID PAPER – An aromatic polyamide (such as nylon).

2A.1.1 added February 7, 2001

2A.1.2 ARMATURE – The part of an electric motor that has windings and rotates.

2A.1.2 added February 7, 2001

2A.1.3 BRUSH – A conducting part that provides electrical connection to the armature of a motor through the commutator.

2A.1.3 added February 7, 2001

2A.1.4 BRUSH HOLDER – A structure that supports the brush and provides a means to maintain contact with the commutator of the armature.

2A.1.4 added February 7, 2001

2A.1.5 CAMBRIC – A varnish-impregnated white linen fabric using an electrical grade resin.

2A.1.5 added February 7, 2001

2A.1.6 COMMUTATOR – An assembly of conducting members insulated from one another, against which the brushes bear, that provides electrical connection to the circuits of the armature.

2A.1.6 added February 7, 2001

2A.1.7 ELECTRICAL GRADE PAPER – Paper produced from wood pulp formed by wood chips boiled in an alkaline solution containing sodium sulfate.

2A.1.7 added February 7, 2001

2A.1.8 ENCLOSED MOTOR – A motor that is totally enclosed in order to prevent the free exchange of air between the inside and outside of the enclosure for the windings. It may not be sufficiently enclosed to be airtight.

2A.1.8 added February 7, 2001

2A.1.9 END SHIELD – A part of the motor used to protect the windings and to support the bearing, but does not include either part. It is secured to the frame. Also called an end bell or bracket.

2A.1.9 added February 7, 2001

2A.1.10 FIELD TERMINAL COMPARTMENT – Where the incoming power is connected to the motor at the field installation site and the connection is a wire-to-terminal connection.

2A.1.10 added February 7, 2001

2A.1.11 FIELD WIRING COMPARTMENT – Where the incoming power is connected to the motor at the field installation site and the connection is a wire-to-wire connection.

2A.1.11 added February 7, 2001

2A.1.12 FIXED APPLIANCE – Any equipment or appliance that is intended to be permanently connected electrically to the wiring system.

2A.1.12 added February 7, 2001

2A.1.13 INSULATION SYSTEM – An assembly of insulating materials used to isolate the live parts from ground and from parts of opposite polarity. All materials in contact with windings are considered part of the system.

2A.1.13 added February 7, 2001

2A.2 MAJOR COMPONENTS – The components of an insulation system that are relied upon to prevent a risk of electric shock or fire. Examples of this type of insulation include ground, interwinding, turn, encapsulant, and varnish. See Table 4.2 in UL 1446, Standard for Systems of Insulating Materials – General.

2A.2 added November 24, 1999

2A.3 MICA– Small pieces of inorganic mineral containing muscovite or phillogopite held in place by electrical grade resin.

2A.3 added February 7, 2001

2A.4 MINOR COMPONENTS– The components of an insulation system that are used typically in mechanical or thermal conduction capacities, and are not relied upon to prevent risk of fire or electric shock. Examples of minor components are balancing compound, crossover insulation, and lead wire. See Table 4.2 in UL 1446, Standard for Systems of Insulating Materials – General.

2A.4 added November 24, 1999

2A.5 OPEN MOTOR– A motor having ventilation openings that permits the passage of air between, over, and around the windings.

2A.5 added February 7, 2001

2A.6 PORTABLE APPLIANCE– An appliance that is easily carried or conveyed by hand, and is provided with a power-supply cord for connection to the supply circuit.

2A.6 added February 7, 2001

2A.7 ROTOR– A rotating part of a motor that does not have windings.

2A.7 added February 7, 2001

2A.8 SERVO MOTOR– A motor that employs feedback and has a characteristic of producing mechanical power to perform the desired motion of the servo mechanism.

2A.8 added February 7, 2001

2A.9 SIZE– The diameter of the motor measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, or the like, used solely for motor mounting, cooling, assembly, or connection.

2A.9 added February 7, 2001

2A.10 SHEET METAL SCREW— A screw with a thread pitch that exceeds the thickness of the sheet metal and is designed to engage an unextruded, unthreaded hole in the metal.

2A.10 added February 7, 2001

2A.11 STATIONARY APPLIANCE— Any equipment or appliance that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

2A.11 added February 7, 2001

2A.12 STATOR— The stationary part of a motor about which a rotor or armature turns.

2A.12 added February 7, 2001

2A.13 STEPPER MOTOR— A motor employing a device that accepts the translated electrical current and converts it to actual incremental motion.

2A.13 added February 7, 2001

2A.14 TERMINAL COMPARTMENT— Where the incoming power is connected to the motor in a factory and the connection is a wire-to-terminal connection.

2A.14 added February 7, 2001

2A.15 TREATED CLOTH— A varnish-impregnated material using an electrical grade resin.

2A.15 added February 7, 2001

2A.16 UNIVERSAL MOTOR— A series-wound or compensated series-wound motor designed to operate at the same speed and output on either direct-current or single-phase alternating-current with a specified frequency and at the same root-mean-square voltage.

2A.16 added February 7, 2001

2A.17 VULCANIZED FIBER— A term used in this standard to denote a material normally used as electrical insulation. Vulcanized fiber is made by combining layers of chemically gelled paper. The zinc chloride used in gelling the paper is subsequently removed by a water leaching treatment, and the resultant product, after being dried and finished by calendaring, is a dense material of partially regenerated cellulose where the fibrous structure is retained in varying degrees, depending upon the grade of fiber. Cellulose fiberboard, pressboard, fullerboard, or cardboard are not acceptable as the equivalent of fiber. Fishpaper is a designation commonly used in the trade to refer to thin sheets of electrical grade vulcanized fiber.

2A.17 added February 7, 2001

2A.18 WIRING COMPARTMENT— Where the incoming power is connected to the motor in a factory and the connection is a wire-to-wire connection.

2A.18 added February 7, 2001

3 Components

3.1 A component of a product covered by this standard shall comply with the requirements for that component and shall be used in accordance with its recognized rating and other limitations of use.

3.2 If the manufacturer assigns a rating or an intended use to a component of a motor – for example, an integral auxiliary switch intended to control an external circuit – the component is to be evaluated for that rating or use or both.

4 Units of Measurement

4.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4.1 revised February 7, 2001

5 Current/Horsepower Relation

5.1 For the purpose of this standard and unless otherwise indicated, the size of a motor refers to the diameter of the motor, that is, the diameter measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, or the like, used solely for motor mounting, cooling, assembly, or connection.

5.2 Deleted February 7, 2001

5.3 Deleted February 7, 2001

5.4 In the application of requirements based on horsepower to a motor not rated in horsepower, use shall be made of the appropriate tables (Tables 430-147 – 430-150) of the National Electrical Code, ANSI/NFPA 70-1999, (Tables 5.1 – 5.4 of this standard) that gives the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating-current motor shall be used when the motor is marked for use on alternating-current only; otherwise, the table applying to direct-current motors shall be used.

5.4 revised November 24, 1999

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Table 5.1
Full-load current in amperes, direct current motors

Table 5.1 added March 26, 1996

HP	Armature voltage rating ^a					
	90V	120V	180V	240V	500V	550V
1/4	4.0	3.1	2.0	1.6		
1/3	5.2	4.1	2.6	2.0		
1/2	6.8	5.4	3.4	2.7		
3/4	9.6	7.6	4.8	3.8		
1	12.2	9.5	6.1	4.7		
1-1/2		13.2	8.3	6.6		
2		17	10.8	8.5		
3		25	16	12.2		
5		40	27	20		
7-1/2		58		29	13.6	12.2
10		76		38	18	16
15				55	27	24
20				72	34	31
25				89	43	38
30				106	51	46
40				140	67	61
50				173	83	75
60				206	99	90
75				255	123	111
100				341	164	148
125				425	205	185
150				506	246	222
200				675	330	294

^a These are average direct-current quantities.

Table 5.2
Full-load currents in amperes single-phase alternating-current motors

Table 5.2 added March 26, 1996

HP	115V	200V	208V	230V
1/6	4.4	2.5	2.4	2.2
1/4	5.8	3.3	3.2	2.9
1/3	7.2	4.1	4.0	3.6
1/2	9.8	5.6	5.4	4.9
3/4	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8
1-1/2	20	11.5	11	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28
7-1/2	80	46	44	40
10	100	57.5	55	50

NOTE – The values in this table are full-load currents for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents, and multispeed motors will have full-load current varying with speed, in which case the nameplate current ratings shall be used. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 100 – 120, and 220 – 240 volts.

Table 5.3
Full-load current two-phase alternating-current motors (4-wire)

Table 5.3 added March 26, 1996

HP	Induction type squirrel-cage and wound-rotor amperes				
	115V	230V	460V	575V	2300V
1/2	4	2	1	0.8	
3/4	4.8	2.4	1.2	1.0	
1	6.4	3.2	1.6	1.3	
1-1/2	9	4.5	2.3	1.8	
2	11.8	5.9	3	2.4	
3		8.3	4.2	3.3	
5		13.2	6.6	5.3	
7-1/2		19	9	8	
10		24	12	10	
15		36	18	14	
20		47	23	19	
25		59	29	24	
30		69	35	28	
40		90	45	36	
50		113	56	45	
60		133	67	53	14
75		166	83	66	18
100		218	109	87	23
125		270	135	108	28
150		312	156	125	32
200		416	208	167	43

NOTE – The values in the table for full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full-load current varying with speed, in which case the nameplate current rating shall be used. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the values given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 – 120, 220 – 240, 440 – 480, and 550 – 600 volts.

Table 5.4
Full-load current three-phase alternating-current motors

Table 5.4 revised February 14, 1997

HP	Induction type squirrel-cage and wound-rotor amperes							Synchronous type unity power factor ^a amperes			
	115V	200V	208V	230V	460V	575V	2300V	230V	460V	575V	2300V
1/2	4.4	2.5	2.4	2.2	1.1	0.9					
3/4	6.4	3.7	3.5	3.2	1.6	1.3					
1	8.4	4.8	4.6	4.2	2.1	1.7					
1-1/2	12.0	6.9	6.6	6.0	3.0	2.4					
2	13.6	7.8	7.5	6.8	3.4	2.7					
3		11.0	10.6	9.6	4.8	3.9					
5		17.5	16.7	15.2	7.6	6.1					
7-1/2		25.3	24.2	22	11	9					
10		32.2	30.8	28	14	11					
15		48.3	46.2	42	21	17					
20		62.1	59.4	54	27	22					

Table 5.4 Continued on Next Page

Table 5.4 Continued

HP	Induction type squirrel-cage and wound-rotor amperes							Synchronous type unity power factor ^a amperes			
	115V	200V	208V	230V	460V	575V	2300V	230V	460V	575V	2300V
25		78.2	74.8	68	34	27		53	26	21	
30		92	88	80	40	32		63	32	26	
40		120	114	104	52	41		83	41	33	
50		150	143	130	65	52		104	52	42	
60		177	169	154	77	62	16	123	61	49	12
75		221	211	192	96	77	20	155	78	62	15
100		285	273	248	124	99	26	202	101	81	20
125		359	343	312	156	125	31	253	126	101	25
150		414	396	360	180	144	37	302	151	121	30
200		552	528	480	240	192	49	400	201	161	40
250					302	242	60				
300					361	289	72				
350					414	336	83				
400					477	382	95				
450					515	412	103				
500					590	472	118				

^a For 90 and 80 percent power factor, the above figures shall be multiplied by 1.1 and 1.25 respectively.

CONSTRUCTION

6 Frame and Enclosure

6.1 A motor shall employ materials that are acceptable for use, and shall be manufactured with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

6.2 A motor shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

6.3 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 inch (3.2 mm) thick, except that malleable iron may be not less than 3/32 inch (2.4 mm) and die-cast metal may be not less than 5/64 inch (2.0 mm) thick. See 9.1.6. Corresponding thicknesses of not less than 3/32, 1/16, and 3/64 inch (2.4, 1.6, and 1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size or both of the surface is such that adequate mechanical strength is provided.

6.3 revised November 24, 1999

6.4 An enclosure of sheet metal is judged with respect to its size, shape, thickness of metal, and the particular application, considering the intended use of the motor.

6.5 An enclosure of sheet steel shall not be less than 0.026 inch (0.66 mm) thick if uncoated or less than 0.029 inch (0.74 mm) thick if galvanized. The average thickness of a nonferrous sheet metal enclosure shall not be less than 0.036 inch (0.91 mm). See 9.1.7.

Exception No. 1: Relatively small areas or surfaces that are curved or otherwise reinforced need not be as thick.

Exception No. 2: The enclosure need not be as thick as specified if an investigation shows that the material has sufficient strength for the application.

6.6 Among the factors taken into consideration when the acceptability of an enclosure is being judged are its:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Combustibility,
- e) Resistance to corrosion,
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use, and
- g) Resistance to ignition from electrical sources.

6.7 For a nonmetallic enclosure, 6.6 (a) – (g) are to be evaluated with respect to thermal aging. (See 6.10 for polymeric enclosures or enclosure parts.)

6.7 revised March 26, 1996

6.8 An enclosure that serves as a part of the enclosure of end-use equipment will also be judged under the requirements for the end-use equipment.

6.9 Acceptability of the size, number, and location of openings in an enclosure will depend upon requirements for the end-use equipment. Among the factors that are taken into consideration when the end-use equipment is being judged are:

- a) Environment;
- b) Degree of exposure;
- c) Protection against unintentional contact with live parts, including film-coated wire; and
- d) Prevention of expulsion of molten metal, burning insulation, flaming particles and the like onto combustible materials, if applicable.

6.10 A polymeric electrical enclosure or a polymeric part of an electrical enclosure shall comply with the applicable requirements specified in UL 746C, Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, and with the additional requirements specified in this standard. See Table 6.1 for an overview of the evaluation.

Exception: A polymeric plug or other enclosure part less than 1 inch²(6.45 cm²) made of a material classified in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and assembled to a sheet-metal or aluminum frame to form a part of an enclosure is able to be used when the material is rated minimum V-2 or VTM-2, or rated HB and complying with the 3/4-inch or 12 mm Flame Tests as specified in UL 746C.

6.10 revised February 7, 2001

