UL 2111

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Overheating Protection for Motors

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety
for
Overheating Protection for Motors, UL 2111

First Edition, Dated March 28, 1997

The new requirements are substantially in accordance with UL's Bulletin on this subject dated June 13, 1996. The bulletin is now obsolete and may be discarded.

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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 note following the affected item. 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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.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 Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

UL 2111

Standard for

Overheating Protection for Motors

Prior to the first edition, the requirements for the products covered by this Standard were included in the Standard for Impedance-Protected Motors, UL 519, and the Standard for Thermal Protectors for Motors, UL 547.

First Edition

March 28, 1997

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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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 The requirements in this standard cover:

a) Impedance-protected motors;

b) Thermal-device-protected motors; and

c) Thermal-protective devices.

1.2 The requirements in this standard apply only to motors rated 600 V or less.

1.3 The requirements in this standard do not cover:

a) A manual device for opening the circuit;

b) A motor intended for use in a hazardous location;

c) Motors employing a device that serves as a motor protector and a manual motor controller;

d) Motors employing a motor protector with contacts that control a relay coil in a motor starter;

e) Motors protected by devices responsive to current only;

f) Sealed (hermetic) type motor compressors;

g) Impedance-protected motors employing an automatic-starting switch; or

h) Thermal cutoff devices. Thermal cutoffs are covered by UL 1020, Standard for Thermal Cutoffs for Use in Electrical Appliances and Components.

1.4 The requirements in this standard are intended to evaluate a specific motor with a given protector. When either the motor or the protector is changed, a separate evaluation is required.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as required 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 is not judged to comply with this Standard. Where appropriate, revision of requirements are proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 Units of Measurement

2.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

3 Glossary

3.1 For the purpose of this standard, the following definitions apply.

3.2 AUTOMATICALLY RESET PROTECTOR – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and automatically closes the circuit once the device has cooled to a lower temperature.

3.3 FIELD-WIRING TERMINAL – A terminal to which connection is capable to be made in the field.

3.4 IMPEDANCE-PROTECTED MOTOR – A motor that relies solely upon the impedance of the windings alone to prevent overheating.

3.5 MANUALLY RESET PROTECTOR – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and requires manual resetting to reclose the motor circuit.

3.6 OPEN MOTOR – A motor having ventilating openings that provide for the passage of external cooling air over and around the windings.

3.7 SECONDARY (BACK-UP) PROTECTION – A protector that does not operate under normal running or locked rotor test conditions, without further stress applied to the motor by increased winding temperature, ambient temperature, or voltage.

3.8 SINGLE-OPERATION DEVICE – A device that incorporates a bimetal that is calibrated to open the motor circuit upon reaching a certain temperature and is resettable only by cooling to minus 35EC (minus 31EF), or lower.

3.9 THERMAL CUTOFF – A device that incorporates a melting alloy or other material that is calibrated to permanently open the motor circuit upon reaching a certain temperature.

3.10 THERMAL-DEVICE-PROTECTED MOTOR – A motor that relies upon a device (protector) to prevent overheating.

3.11 THERMAL PROTECTOR – A device installed integrally within a motor that is responsive to motor current and temperature or temperature only and that, when applied as intended, prevents overheating. Types are: thermal cutoff, automatically reset, manually reset and single-operation.

3.12 TOTALLY-ENCLOSED MOTOR – A motor that is enclosed to prevent the free exchange of air between the inside and outside of the winding enclosure and not so enclosed as to be airtight.

4 Application of Requirements

4.1 This standard is comprised of six parts. Part I applies to all motors. Part II applies to impedance-protected motors. Part III applies to motor/protector combinations. Part IV applies to thermal protectors employed within a motor. Part V consists of manufacturing and production tests. Part VI consists of marking requirements.

PART I – ALL MOTORS

5 General

5.1 The voltage of the supply circuit shall be as specified in Table 5.1. For motors intended for use over a range of voltages, all applicable nominal voltages shall be tested. For example, a motor rated 200 – 230 volts shall be tested at 208 volts and at 240 volts.

Exception No. 1: A motor having a voltage rating outside the ranges specified in Table 5.1 shall be tested at 100 – 105 percent of the rated voltage, and is not to be less than 100 percent.

Exception No. 2: When the motor is intended for a specific application where the source voltage is outside the range specified in Exception No. 1, the motor is able to be tested at greater than 105 percent of the intended source of supply.

Table 5.1
Test voltages

Motor nameplate rating, volts	Nominal test voltage
110 – 120	120
200 – 208	208
220 – 240	240
254 – 277	277
440 – 480	480
550 – 600	600

5.2 Thermocouples are to consist of wires not larger than No. 30 AWG (0.05 mm^2). The thermocouple wire is to conform with the requirements for special thermocouples as listed in the limits of error of thermocouples given in Temperature-Measurement Thermocouples, ANSI MC96.1-1982(1991).

5.3 A minimum of 4 thermocouples are to be used to measure the temperature.

5.4 The change-in-resistance method compares the heated coil resistance to the resistance at a known (ambient) temperature and uses the following equation to determine the heated coil temperature:

$$T_2 = R_2/R_1 (K + T_1) - K$$

in which:

T_2 is the coil temperature at the end of the test in degrees C;

R_2 is the coil resistance at the end of the test;

R_1 is the coil resistance at the beginning of the test;

K is 234.5 for copper, 225.0 for electrical conductor grade (EC) aluminum. The value of K for other conductors is to be determined;

T_1 is the room temperature at the beginning of the test.

5.5 A protector shall be bypassed during any resistance measurements.

5.6 The value of R_2 at shutdown is determined by taking at least 6 resistance measurements at 5 second intervals, beginning quickly at shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to determine the value of R at shutdown, or the values are to be calculated by using linear regression. Other means of measuring the winding resistance are able to be used when agreed upon by all concerned parties.

5.7 Testing is to be conducted at any ambient temperature between 10EC (50EF) and 40EC (104EF) unless a motor is marked with a rated ambient temperature that does not fall in this range, in which case the motor is to be tested at rated ambient.

5.8 For an impedance-protected motor or any motor for which a protector does not cycle during a given test, the measured temperatures are to be normalized to 25EC (77EF). For example: A measured temperature of 160EC at 35EC ambient is to be normalized downwards by 10EC to 150EC. A measured temperature of 110EC at 17EC ambient is to be normalized upwards by 8EC to 118EC.

Exception: Temperatures are not to be normalized for a motor tested at marked ambient.

5.9 A motor shall be tested under each intended operating condition with respect to each rated voltage, frequency, speed, and rotation direction.

Exception No. 1: Motors, such as split-phase motors, that are reversed by interchanging one winding with respect to another, are not required to be tested in both rotation directions.

Exception No. 2: The locked rotor tests, Sections 9 and 16, are able to be conducted under only certain operating conditions when it is shown that such conditions represent "worst-case" conditions.

5.10 For all locked rotor tests, Sections 7, 9, 14, and 16, the frame of the motor is to be grounded through a 3-ampere non-time-delay fuse.

5.11 For each test, the motor is to be mounted on wood or other material of low thermal conductivity. Blades or other load attachments are to be removed from the motor. Integral mounting brackets are to be left in place.

5.12 A motor is to be mounted accordingly when the motor has:

a) A permanently attached, fixed, or rigid base;

b) Instructions for mounting marked on the motor; or

c) A construction feature, such as an oil hole, indicating a mounting position.

A motor without one of these features shall be tested with the protector in the maximum possible down position. A motor with one of these features is able to be tested with the protector in the maximum possible down position when agreeable to those concerned.

5.13 A motor under locked-rotor conditions for which a protector does not open under any operating conditions (speed, direction) shall be identified as impedance-protected. At the manufacturer's request, informational testing is to be conducted under conditions causing the protector to operate to determine compliance with Part III requirements.

5.14 A motor for which a protector opens under at least one operating condition shall be identified as thermally-protected and shall comply with the requirements of Part III at each condition that results in a protector opening. At each condition that does not result in the protector opening, tests in Part II are performed.

5.15 A motor that complies with the requirements for a lower insulation class is not required to be re-tested for compliance to higher insulation class limits when the insulation materials are the same. For instance, when a Class A system on a motor is investigated and becomes a Class B system, no additional testing is required.

PART II – IMPEDANCE-PROTECTED MOTORS

CONSTRUCTION

6 General

6.1 An impedance-protected motor shall comply with the requirements in UL 1004, Standard for Electric Motors.

6.2 An unenclosed motor that uses multiple types of outerwrap tape shall have each construction subjected to the Locked Rotor Test (Sections 7 and 9). Following the test, the tape shall not shift to result in a reduction of spacings or expose uninsulated live parts.

6.3 A back-up protector shall not operate during the tests in Section 7 and Section 9.

PERFORMANCE

7 Locked-Rotor Temperature Test

7.1 Three motors are to be stalled, and the locked rotor wattage of each measured. The highest wattage sample is then to be locked in a stationary position using a low means of thermal conductivity.

7.2 Testing of a permanent-split capacitor motor is to be conducted with the capacitor either properly connected in the circuit or short-circuited, whichever results in the higher temperature.

Exception No. 1: A motor that employs an integrally mounted and enclosed capacitor is not required to be tested with the capacitor short-circuited.

Exception No. 2: A motor that employs a capacitor evaluated to the requirements in UL 810, Standard for Capacitors, is not required to be tested with the capacitor short-circuited.

7.3 Temperatures are to be measured:

a) With thermocouples on the enclosure for a totally enclosed motor or for a motor with an encapsulated coil complying with the requirements for a non-metallic enclosure in UL 1004, Standard for Electric Motors;

b) By the change-in-resistance method for a motor with an encapsulated coil other than as noted in (a); or

c) With a thermocouple applied directly to the actual conductor material, integrally applied conductor insulation, or coil wrap, as applicable, for any other type of motor.

7.4 Starting at room temperature, the motor is to be energized continuously for 72 hours, during which the winding temperatures are to be monitored.

Exception: The test is able to be discontinued when the winding temperatures stabilize at a constant temperature not exceeding 100EC (212EF).

7.5 During the 72 hours, the motor shall comply with the following:

a) The frame or coil temperature shall not exceed the temperature limits specified in Table 7.1.

b) The fuse in the grounding conductor shall not open.

Table 7.1
Maximum temperatures

Motor insulation system	Maximum temperature	
	EC	EF
Class A	150	302
Class B	175	347
Class F	200	392
Class H	225	437

7.6 At the request of the manufacturer, the above test is to be conducted under such conditions that result in the motor coils operating at the maximum temperature for the insulation class specified in Table 7.1. The maximum temperature is to be obtained by:

a) Increasing the test voltage;

b) Increasing the ambient temperature;

c) Using test samples constructed so that they maintain the maximum temperature; or

d) Any other equivalent means.

This test shall not be conducted by increasing the voltage for motors with the capacitor shorted.

7.7 When a "worst-case" condition is not evident (such as high speed for a tapped winding) a motor shall be tested at each condition until thermal stabilization. The condition resulting in the highest operating temperature is then to be subjected to the full Locked Rotor Temperature, Section 7 and Endurance Tests, Section 9.

8 Dielectric Voltage Withstand Test

8.1 Immediately following the conclusion of the Locked-Rotor Temperature Test, Section 7, a motor shall withstand a 1 minute application of a 60-hertz sinusoidal potential between live parts of opposite polarity and between live parts and dead metal parts that are grounded or that are exposed to contact. The potential shall be 1000 volts for a motor rated 250 volts or less; or 1000 volts plus twice the voltage rating of the motor for all other motors.

8.2 To determine whether a motor complies with the requirements in 8.1, the motor is to be tested by means of a 500 volt-ampere or larger capacity transformer, the output voltage of which is sinusoidal and is able to be varied. The applied potential is to be increased from zero until the required test level is reached and is to be held at that level for 1 minute. The applied potential is to be increased at a substantially uniform rate as rapid as is consistent with correct indication of the potential by a voltmeter. The capacity of the transformer is able to be less than 500 volt-amperes when the test equipment used maintains the specified test potential at the output terminals for the duration of the test.

9 Locked-Rotor Endurance Test

9.1 Immediately following the Dielectric Voltage Withstand Test, Section 8, a motor is to be re-energized under the conditions of the Locked-Rotor Temperature Test, Section 7, for an additional 15 days.

9.2 At the conclusion of the 15 days, the motor shall comply with the following:

a) There shall be no evidence of excessive deterioration of the insulation. Simple discoloration of the insulation meets the intent of the requirement, and charring or embrittlement to the extent that the insulation flakes off or material is removed when the windings are rubbed with the thumb does not meet the intent of the requirement.

b) The fuse in the grounding conductor shall not open.

9.3 In addition, there shall be no dielectric breakdown as the result of a one minute application of a potential of twice the marked rated voltage of the motor between the windings and the frame.

PART III – THERMAL-DEVICE-PROTECTED MOTORS

CONSTRUCTION

10 General

10.1 A thermally-protected motor is not required to comply with the requirements in UL 1004, Standard for Electric Motors.

10.2 An evaluation of the motor/protector combination performance shall be required when there is a change in protector or motor insulation.

10.3 The electrical insulation system of a motor rated for a temperature class other than Class A shall comply with the requirements for the insulation class specified in UL 1446, Standard for Systems of Insulating Materials – General.

10.4 Any electrical insulation system that is an integral ground system, such as an epoxy resin coating, shall comply with the requirements for such systems in UL 1446, Standard for Systems of Insulating Materials – General.

10.5 An open motor that uses multiple types of outerwrap shall have each construction subjected to an 18-day or 60-cycle locked rotor endurance test as specified in this standard. As a result, the outerwrap tape shall not shift to result in a reduction of spacings, adversely affect the protector securement, or expose uninsulated live parts.

10.6 Any protector employed within a motor shall comply with the requirements of Part IV.

11 Spacings

11.1 Spacings at a protector terminal intended to be used as a field-wiring terminal shall not be less than those specified in Table 11.1. For a protector mounted within a motor enclosure, spacings between protector parts and other parts of the motor specified shall not be less than specified in Table 11.2. For a protector mounted outside a motor enclosure, the spacings shall not be less than specified in Table 11.3.

Table 11.1
Minimum spacings at field-wiring terminals within a motor enclosure

Potential involved	Minimum spacing between wiring terminals and between terminals and other uninsulated metal parts not always of the same polarity[a], through air or over surface	
Volts	Inch	(mm)
250 or less	1/4	(6.4)
More than 250	3/8	(9.5)

[a] Applies to the sum of the spacings involved where an isolated dead part is interposed. See 11.2.

Table 11.2
Minimum spacings at other than field-wiring terminals of a protector mounted within a motor enclosure

Potential involved	Minimum spacing between uninsulated live parts of opposite polarity, and an uninsulated live part and an exposed dead metal part, including the enclosure inch (mm)[a]							
	Motor diameter 7 inches (180 mm) or less[b]				Motor diameter more than 7 inches (180 mm)[b]			
Volts	Over surface		Through air		Over surface		Through air	
0 – 150	3/32[c]	(2.4)	3/32	(2.4)	1/4	(6.4)	1/8	(3.2)
151 – 300	3/32	(2.4)	3/32	(2.4)	1/4	(6.4)	1/4	(6.4)
301 – 600	1/4	(6.4)	1/4	(4.4)	3/8	(9.5)	3/8	(9.5)

[a] Film coated wire is an uninsulated live part.

[b] This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, and boxes, used solely for motor mounting, cooling, assembly, or connection.

[c] For a motor rated 1/3 horsepower (249 watts) or less, these spacings are not to be less than 1/16 inch (1.6 mm).

Table 11.3
Minimum spacings at other than field-wiring terminals of a protector mounted outside of a motor enclosure

Potential involved	Minimum spacing between an uninsulated live part and a metal enclosure							
	Motor diameter 7 inches (180 mm) or less[a]				Motor diameter more than 7 inches (180 mm)[a]			
Volts	Over surface		Through air		Over surface		Through air	
0 – 300	1/4	(6.4)	1/8	(3.2)	1/4	(6.4)	1/4	(6.4)
301 – 600	3/8	(9.5)	1/4	(6.4)	3/8	(9.5)	3/8	(9.5)

[a] This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, and boxes, used solely for motor mounting, cooling, assembly, or connection.

11.2 For an isolated dead metal part that is interposed between or is in close proximity to:

a) Live parts of opposite polarity;

b) A live part and an exposed dead metal part; or

c) A live part and a dead metal part that is capable of being grounded;

the spacing is to be a minimum of 3/64 inch (1.2 mm) between the isolated dead metal part and any one of the parts previously specified, when the total spacing between the isolated dead metal part and the two other parts is not less than the value specified in Table 11.2.

11.3 An insulating liner or barrier of vulcanized fiber or similar material is capable of being used where a spacing is otherwise less than the minimum intended value when the material is no less than 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it is not adversely affected by arcing.

Exception No. 1: Vulcanized fiber no less than 1/64 inch (0.4 mm) thick is able to be used with an air spacing of no less than 50 percent of the minimum required through-air spacing.

Exception No. 2: Insulating materials having a thickness less than that specified or other insulating materials are able to be used when they comply with the requirements specified in 17.2 – 17.4.

PERFORMANCE

12 General

12.1 All motors, except those protected by thermal cutoff or single operation devices, shall comply with the Locked Rotor Temperature, Section 14, and Locked-Rotor Endurance Tests, Section 16.

12.2 The Running Heating Test, Section 13, shall be conducted only at the manufacturer's request, or in accordance with an end-use standard. A motor that has been tested for running heating protection only shall be marked in accordance with 22.6.

12.3 All protectors shall comply with the Limited Short Circuit Test, Section 18, and when required, the Protector Insulation Test, Section 19.

12.4 The performance tests are to be conducted on representative samples of motor/protector combinations. The number of samples specified are to be in accordance with the range of motors to be protected.

12.5 A protector calibrated to have a tolerance in excess of ±5EC (9EF) of the nominal opening temperature or ±15EC (27EF) of the closing temperature, shall be tested in accordance with 12.6 to determine that the wider tolerance protector has an intended locked-rotor cycling life.

12.6 As required by 12.5, the following motor/protector combinations are to be tested:

a) One sample protector calibrated to open at the maximum temperature is to be subjected to all tests required in this standard; and

b) One sample calibrated to open at the minimum temperature and close at the maximum temperature is to be subjected to the Locked-Rotor Endurance Test, Section 16, except the duration is to be 18 days.

12.7 Thermocouples are to be placed on the surfaces of coils of all windings and on parts, other than a commutator, exposed in the interior of the motor. A thermocouple on a coil is to be applied to the actual conductor material, or it is to be separated from that material by not more than the integrally applied conductor insulation.

12.8 Testing is to be conducted on individual or multiple samples of a motor/protector combination. When individual samples are used, then the tests shall be conducted in the sequence presented in the following sections.

12.9 When a secondary or back-up protector operates during a test, the primary protector is to be removed or shunted from the circuit and the test is to be repeated.

12.10 Polyphase motors shall be provided with protectors so that each phase winding is protected from overheating.

12.11 A single-operation device shall not reset itself at a temperature higher than minus 35EC (minus 31EF).

13 Running Heating Temperature Test

13.1 Continuous duty motors

13.1.1 General

13.1.1.1 A continuous-duty motor is to be operated under load at its nameplate current and at the applicable test voltage until the motor winding temperature becomes constant. The protector shall not open when operating at the nameplate current. The load is then to be increased in small increments to the maximum load that does not result in the protector opening.

Exception: This is not required for fan duty motors.

13.1.1.2 When a motor-protector combination is running with the maximum load it is capable of carrying without resulting in the protector opening the circuit, the stabilized winding temperature under maximum load shall not exceed the values specified in Table 13.1.

Table 13.1
Maximum winding temperatures

Motor insulation system	Maximum winding temperature	
	EC	EF
Class A	140	284
Class B	165	329
Class F	190	374
Class H	215	419

13.1.2 Polyphase motors

13.1.2.1 A continuous-duty polyphase motor is to be tested under both the normal polyphase operation and under single-phasing conditions.

Exception: Fan duty motors are not required to be tested under single phase.

13.1.2.2 For the single phase test, the motor is to be energized and the load adjusted so that the motor operates at the rated current. One motor supply conductor is to be opened. The motor winding temperature is to stabilize again before beginning to load the motor. After opening the supply conductor, the motor is able to stall or continue to operate for a short time before the protector opens. This meets the intent of the requirement when the winding temperatures do not exceed the locked-rotor limits specified in Table 14.1. The single-phasing running heating test is to be discontinued at this point.

13.1.3 Ultimate trip current

13.1.3.1 The ultimate trip current of a protector in a motor rated more than 1 horsepower (746 W) shall not exceed the percentage of motor full-load current specified in Table 13.2. The full-load current of a motor is to be one of the values specified in either Table 18.3 or 18.4, not the marked nameplate value. When requested by the manufacturer, the ultimate trip current shall be determined at a 40EC (104EF) referee ambient.

Table 13.2
Maximum ultimate trip current

Full-load current[a] Amperes	Ultimate trip current: Maximum percentage of full-load current[b]
9.0 or less	170
9.1 to 20.0	156
20.1 or more	140

[a] See 13.1.3.1.

[b] See 13.1.3.3.

13.1.3.2 A motor shall comply with the requirements of 13.1.3.1 at each voltage and speed connection.

Exception: This requirement does not apply to the lower speeds of a multi-speed motor marked 1 horsepower or less on the lower speeds.

13.1.3.3 Table 13.2 does not apply to a polyphase motor operating under single-phasing conditions.

13.2 Intermittent duty motors

13.2.1 An intermittent-duty motor is to be operated under load at its nameplate current and at the applicable test voltage. The load and/or voltage is to be adjusted until the motor is able to operate without the protector tripping.

13.2.2 Following the procedure of 13.2.1, the stabilized winding temperature under maximum load shall not exceed the values specified in Table 13.1.

13.2.3 Polyphase motors are to be tested only under polyphase conditions.

13.3 Fan duty motors

13.3.1 A motor that is to be coupled to a fan-blade or blower-wheel load is to be operated at the applicable test voltage and under no-fan, no-load conditions with the shaft running free.

a) When the protector does not open the circuit the winding temperature at thermal equilibrium shall not exceed the temperature limits specified in Table 7.1; or

b) When the protector opens the circuit, the winding temperature shall not exceed the values specified in Table 14.1.

13.3.2 Polyphase motors are to tested only under polyphase conditions.

14 Locked-Rotor Temperature Test

14.1 General

14.1.1 The rotor is to be locked in a stationary position using means of low thermal conductivity.

14.1.2 As a result of this test, a motor shall comply with the following:

a) The coil temperature shall not exceed the values specified in Table 14.1.

b) The fuse in the grounding conductor shall not open.

c) There shall be no severe or prolonged smoking or flaming;

d) There shall be no flaking, embrittlement or charring of the insulation. Simple discoloration of the insulation meets the intent of the requirement, and charring or embrittlement to the extent that the insulation flakes off or material is removed when the windings are rubbed with the thumb does not meet the intent of the requirement;

e) There shall be no electrical or mechanical malfunction of any associated component parts such as capacitors or starting relays.

When examination of the motor windings requires disassembly of the motor, the examination shall be conducted after the Locked-Rotor Endurance Test, Section 16.

Table 14.1
Maximum locked-rotor temperature limits

Motor insulation class:	A		B		F		H	
Protector type	**EC**	**EF**	**EC**	**EF**	**EC**	**EF**	**EC**	**EF**
1. Automatically reset:								
a) During 1st hour	200	392	225	437	250	482	275	527
b) After 1st hour[a]	175	347	200	392	225	437	250	482
c) Average[b]	150	302	175	347	200	392	225	437
2. Manually reset, single operation;	200	392	225	437	250	482	275	527
3. Thermal cutoff:								
a) During 1st hour	200	392	225	437	250	482	275	527
b) After 1st hour	150	302	175	347	200	392	225	437

[a] The temperatures are to be recorded for:

a) The second hour of operation or until the temperatures stabilize, whichever is longer, and

b) The seventy-second hour of the test.

Stabilized temperatures are obtained when the maximum temperatures readings of three successive cycles are within 2EC (3.6EF) of each other and are not showing a successive increase or a successive decrease in temperature.

[b] Refer to 14.1.3.

14.1.3 The average temperature referenced in Table 14.1 is to be determined for both the second and seventy-second hours. For each of these periods, the average temperature is to be determined by taking the arithmetic mean of the locked-rotor trip temperature and reset temperature. The temperatures of the hottest thermocouple are to be used.

14.1.4 When determining the "worst-case" operating condition(s), a motor is to be operated at each condition (see 5.9) until the motor has stabilized, but not less than two hours. Stabilization occurs when the cycle rate is constant, and the maximum temperature is no longer rising and does not vary by more than 2EC (3.6EF). Following this, the condition(s) determined to be "worst-case" are to be subjected to the full Locked-Rotor Temperature, Section 14, and Endurance Tests, Section 16.

14.2 Automatically reset protectors

14.2.1 Starting at room temperature, a motor provided with an automatically reset protector is to be energized continuously for 72 hours, during which the winding temperatures are to be monitored.

14.2.2 A polyphase motor that is not provided with an automatically reset protector in each phase shall also be tested under single-phasing conditions. Each open conductor shall be tested. The motor is to be locked and energized with one supply-conductor opened. The test duration shall be such that the first and second hour winding temperatures are recorded or until temperatures stabilize, whichever is longer.

14.3 Manually reset protectors

14.3.1 Starting at room temperature, a motor provided with a manually reset protector is to be energized for 10 cycles of protector operation, with the protector being reset quickly after it has opened the circuit.

14.3.2 A polyphase motor shall also be tested under single-phasing conditions with one supply-conductor opened. Each open conductor shall be tested.

14.4 Thermal cutoffs

14.4.1 Starting at room temperature, three samples of a motor provided with a thermal cutoff protector are to be energized continuously until the thermal cutoff opens the circuit.

14.5 Single-operation devices

14.5.1 Starting at room temperature, three samples of a motor provided with a single-operation device are to be energized continuously until the protector opens the circuit.

15 Dielectric Voltage-Withstand Test

15.1 Immediately following the conclusion of the Locked-Rotor Temperature Test, Section 14, a motor shall withstand a 1 minute application of a 60-hertz sinusoidal potential between live parts of opposite polarity and between live parts and dead metal parts that are grounded or that are exposed to contact. The potential shall be 1000 volts for a motor rated 1/2 horsepower (373 W) or less and 250 volts or less; or 1000 volts plus twice the voltage rating of the motor for all other motors.

15.2 To determine whether a motor complies with the requirements in 15.1, the motor is to be tested by means of a 500 volt-ampere or larger capacity transformer, the output voltage of which is sinusoidal and able to be varied. The applied potential is to be increased from zero until the required test level is reached and is to be held at that level for 1 minute. The applied potential is to be increased at a substantially uniform rate as rapid as is consistent with correct indication of the potential by a voltmeter. The capacity of the transformer is able to be less than 500 volt-amperes when the test equipment used maintains the specified test potential at the output terminals for the duration of the test.

16 Locked-Rotor Endurance Test

16.1 General

16.1.1 Immediately following the Dielectric Voltage Withstand Test, Section 15, a motor is to be re-energized under the conditions of the Locked-Rotor Temperature Test, Section 14.

16.1.2 At the conclusion of the test, the motor shall comply with the requirements of 14.1.2 (b) – (e).

16.1.3 In addition to 16.1.2, there shall be no dielectric breakdown as the result of a one minute application of a potential of twice the marked rated voltage of the motor between the windings and the frame.

16.1.4 Polyphase motors are only to be tested under polyphase conditions.

16.1.5 For multiple voltage motors, the Locked-Rotor Endurance Test is to be conducted at each voltage. A different sample is able to be used for each test.

16.2 Automatically reset protectors

16.2.1 A motor is to be tested for an additional 15 days.

16.2.2 A protector in a motor rated more than 1 horsepower (746 W) shall operate a minimum of 2000 cycles during the 18 day locked-rotor period. When required, the Locked-Rotor Endurance Test is to continue beyond 15 days until 2000 cycles have been completed.

16.2.3 The automatically reset protector shall not open the circuit permanently prior to the completion of 15 days unless:

a) It is specifically intended to do so; and

b) Testing of three samples shows that it is capable of doing so consistently and reliably without permanent damage to the motor.

16.2.4 When a motor insulation system has previously been found to meet the requirements for the same or higher locked-rotor temperatures, the protector is able to be separately investigated for locked-rotor endurance for a minimum of 2000 cycles using an artificial load. The cycling rate shall be the same as when used in the motor except that the rate is able to be increased when agreeable to those concerned. The current is to be the same or greater than the locked-rotor current of the motor and the power factor is to be 0.4 – 0.5.

16.2.5 For dual rotation and multi-speed motors, the Locked-Rotor Endurance Test is to be conducted only at the condition resulting in the highest current. When the currents are similar, the condition with the fastest protector cycling rate is to be tested. When the cycling rates are also similar, the condition with the highest temperature is to be tested.

16.3 Manually reset protectors

16.3.1 A motor is to be tested for an additional 50 cycles.

PART IV – THERMAL PROTECTORS

CONSTRUCTION

17 General

17.1 A thermal cutoff shall comply with the requirements in UL 1020, Standard for Thermal Cutoffs for Use in Electrical Products and Components, in addition to the requirements of this standard.

17.2 Insulation for a protector intended for use in a Class A or Class B insulated motor shall be:

a) 1/32 inch (0.8 mm) [0.028 inch (0.7 mm)] nominal thickness treated fiber;

b) 0.004 inch (0.1 mm) nominal thickness polyethylene terepthalate (PETP);

c) 0.015 inch (0.4 mm) nominal thickness silicone-impregnated fiberglass;

d) 0.017 inch (0.4 mm) nominal thickness isocyanate-resin-impregnated fiberglass; or

e) 0.006 inch (0.152 mm) nominal thickness aramid paper.

Exception: Other materials are capable of being used when they comply with the protector insulation test requirements in the Protector Insulation Test, Section 19, or the equivalent, and with the traceability requirements specified in UL 746A, Standard for Polymeric Materials – Short Term Property Evaluations.

17.3 Any insulation for a protector intended for use in a Class F or higher insulated motor shall comply with Protector Insulation Test, Section 19 and with the traceability requirements specified in UL 746A, Standard for Polymeric Materials – Short Term Property Evaluations.

17.4 For Class B or higher insulated motors, any protector insulation material shall be covered in the manufacturer's previously evaluated insulation system, or be investigated in accordance with UL 1446, Standard for Systems of Insulating Material – General, to determine compatibility with the insulation system.

17.5 Current-carrying parts of a protector shall be metal inherently resistant to corrosion or shall be treated to resist corrosion. Iron and steel parts shall be protected by enameling, galvanizing, plating or other means when the corrosion of such parts results in risk of electric shock, fire, or injury to persons.

Exception: Multimetallic thermal elements and heater elements are not required to be protected.

17.6 Protector components, such as wiring or polymeric materials, shall be rated for the maximum protector calibration temperature plus the tolerance.

17.7 Automatic tripping of a manually reset protector shall be independent of the position or manipulation of the reset handle or button. That is:

a) The bimetal shall open the circuit regardless of the handle or button position or manipulation; and

b) Manipulation of the handle or button shall not reset the protector until the bimetal closes the circuit again.

17.8 The construction of a protector shall be such that it reduces the risk of substitution of a protector or thermal element of higher calibration than the protector or element originally provided.

17.9 A protector shall be mounted in place and shall employ materials of such strength, rigidity, and insulating properties as to be capable of withstanding the stresses to which there is a risk of it being subjected.

17.10 A polyphase protector shall comply with the spacing requirements of Table 11.2.

PERFORMANCE

18 Limited Short Circuit Test

18.1 Three samples of a motor protector shall be subjected to a short-circuit-current as determined by Table 18.1.

Exception: Protectors connected in the common point of a wye-connected polyphase motor are not subjected to this test.

Table 18.1
Limited short circuit test current

Motor horsepower (kW)[a]	Motor voltage	Test current, amperes
1/2 (0.373) or less	250 or less	200
More than 1/2 (0.373) up to 1 (0.746)	250 or less	1000
1 (0.746) or less	More than 250	1000
More than 1 (0.746) up to 3 (2.24)	250 or less	2000
More than 3 (2.24) up to 7-1/2 (5.60)	250 or less	3500
More than 7-1/2 (5.60)	250 or less	5000
More than 1 (0.746)	More than 250	5000

[a] For the purpose of determining the circuit capacity of a motor not marked in horsepower (watts), a horsepower rating is to be assumed on the basis of the marked full-load amperes in accordance with Tables 18.3 and 18.4.

18.2 A protector is to be tested:

a) Separately on a test bench with or without any insulation;

b) Within the motor it is intended to protect; or

c) Positioned between two copper bars to simulate the motor enclosure within which it is intended to be used.

18.3 A protector that is tested within a motor shall not be connected to the motor windings.

18.4 The protector is to be connected in series with a non-renewable non-time-delay cartridge fuse rated not less than four times the rated full-load current marked on the motor with which it is intended to be used. The fuse rating is to be not less than 20 amperes for a device rated 150 volts or less, and is to be not less than 15 amperes for a device rated more than 150 volts and not more than 600 volts.

18.5 The test voltage is to be in accordance with Table 18.2.

Table 18.2
Test voltages

Motor nameplate		Nominal test
Rating,	Volts	Voltage, volts
110	120	120
200	208	240
220	240	240
254	277	277
440	480	480
550	600	600

18.6 When requested, the test is to be conducted at a higher voltage, current or fuse size than specified to represent lower values.

18.7 The power factor is to be 0.9 – 1.0, unless a lower power factor is agreeable to those concerned. The circuit capacity is to be measured without the protector in the circuit.

18.8 The enclosure of the protector is to be connected, without a fuse, to the same test terminal as the protector-switched side of the line.

18.9 The protector or overall enclosure is to be wrapped in cotton.

18.10 As a result of this test, the cotton shall not ignite. When the protector cycles, the test is to be continued until the protector or fuse permanently opens the circuit.

18.11 One of the three tests for a manually reset protector is to be conducted by closing the protector on the short circuit.

Table 18.3
Full-load motor-running currents in amperes corresponding to various alternating-current horsepower (wattage) ratings

Horse-power	(kW)	110 – 120 Volts			220 – 240 Volts[a,b]			440 – 480 Volts			550 – 600 Volts		
		Single phase	Two phase	Three phase	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase
1/6	(0.124)	4.4	–	–	2.2	–	–	–	–	–	–	–	–
1/4	(0.187)	5.8	–	–	2.9	–	–	–	–	–	–	–	–
1/3	(0.249)	7.2	–	–	3.6	–	–	–	–	–	–	–	–
1/2	(0.373)	9.8	4.0	4.4	4.9	2.0	2.2	2.5	1.0	1.1	2.0	0.8	0.9
3/4	(0.560)	13.8	4.8	6.4	6.9	2.4	3.2	3.5	1.2	1.6	2.8	1.0	1.3
1	(0.746)	16	6.4	8.4	8	3.2	4.2	4.0	1.6	2.1	3.2	1.3	1.7
1-1/2	(1.12)	20	9.0	12.0	10	4.5	6.0	5.0	2.3	3.0	4.0	1.8	2.4
2	(1.49)	24	11.8	13.6	12	5.9	6.8	6.0	3.0	3.4	4.8	2.4	2.7
3	(2.24)	34	16.6	19.2	17	8.3	9.6	8.5	4.2	4.8	6.8	3.3	3.9
5	(3.73)	56	26.4	30.4	28	13.2	15.2	14	6.6	7.6	11.2	5.3	6.1
7-1/2	(5.60)	80	38	44	40	19	22	20	9	11	16	8	9
10	(7.46)	100	48	56	50	24	28	25	12	14	20	10	11
15	(11.19)	135	72	84	68	36	42	34	18	21	27	14	17

[a] To obtain full-load currents for 200- and 208-volt motors, increase corresponding 220 – 240 volt ratings by 15 to 10 percent respectively.

[b] To obtain full-load currents for the 265- and 277-volt motors, decrease the corresponding 220 – 240 volt ratings by 13 and 17 percent respectively.

Table 18.4
Full-load motor-running currents in amperes corresponding to various direct-current horsepower (wattage) ratings

Horsepower	(kW)	110 – 120 Volts	220 – 240 Volts	550 – 600 Volts
1/4	(0.187)	3.1	1.6	–
1/3	(0.249)	4.1	2.0	–
1/2	(0.373)	5.4	2.7	–
3/4	(0.560)	7.6	3.8	1.6
1	(0.746)	9.5	4.7	2.0
1-1/2	(1.12)	13.2	6.6	2.7
2	(1.49)	17	8.5	3.6
3	(2.24)	25	12.2	5.2
5	(3.73)	40	20	8.3
7-1/2	(5.60)	58	29	12.2
10	(7.46)	76	38	16
15	(11.19)	110	55	24

19 Protector Insulation Test

19.1 Eighteen samples of the tubular style insulation are to be conditioned in accordance with Table 19.1. Three samples are to be installed on metal mandrels representative of the size and shape of the protector to be insulated. Fifteen samples are to be 4 inches (102 mm) diameter or square in the minimum thickness used or is to be of a size representative of the end-use.

Table 19.1
Protector insulation conditioning

No. of samples	Conditioning
5	As received
5	Oven exposure at 100 ±2EC (212 ±3.6EF) for 72 hours
5	Exposure to moist air at a temperature of 30 ±2EC (86 ±3.6EF) for 24 hours
3	18-day oven temperature cycling per 19.4 – 19.6

19.2 Following the conditioning, each sample is to be subjected to a dielectric voltage within a test chamber. The voltage is to be applied at a uniform rate of 500 volts per second until breakdown occurs. When physical evidence of dielectric breakdown is not apparent, the voltage is to be reapplied until a more positive indication is produced.

19.3 As a result of this test, the average breakdown value for each set of samples shall be no less than 5000 volts. In addition, the average breakdown value for all 13 conditioned samples shall be at least one-half the value of the as-received samples.

19.4 The samples to be subjected to 18 days of oven temperature are to be suspended vertically in an air-circulating oven. The oven temperature is to be cycled as specified in Table 19.2. This table is based upon the maximum temperature that meets the requirements for the insulation class and a minimum temperature such that the average equals the maximum average temperature for the insulation class as specified in Table 14.1.

Table 19.2
Oven cycling temperature limits

Insulation class	Maximum temperature		Minimum temperature	
	EC	EF	EC	EF
A	175	347	125	257
B	200	392	150	302
F	225	437	175	347
H	250	482	200	392

19.5 The cycle rate shall be such that at least 2000 cycles are completed within a minimum 18-day duration to represent the full locked-rotor test period.

19.6 This oven cycling is to be conducted with the insulated protector laced to the motor windings and the windings cycled in accordance with Table 19.2.

PART V – MOTOR MANUFACTURING AND PRODUCTION LINE TESTS

20 Dielectric Voltage-Withstand Test

20.1 Each production-line motor shall withstand, without electric breakdown, a potential between live parts (including the windings and connected components) and accessible dead metal parts that risk becoming energized.

20.2 The potential and test duration shall be in accordance with Condition A or Condition B, as specified in Table 20.1. The potential shall be at a frequency within the range of 40 – 70 hertz.

Table 20.1
Production-line test conditions

Motor rating	Condition A		Condition B	
	Potential (volts)	Time (sec)	Potential (volts)	Time (sec)
250 volts or less or 1/2 hp or less	1000	60	1200	1
More than 250 volts or 1/2 hp	1000 + 2 V[a]	60	1200 + 2.4 V[a]	1

NOTE – When a dc potential is required, the values specified in this Table are to be multiplied by 1.414.

[a] Maximum rated voltage.

20.3 The motor is not prohibited from being in a heated or unheated condition for the test.

20.4 The test is to be conducted on a fully assembled motor. It is not intended that the motor be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover or a friction-fit knob that has a risk of interfering with the performance of the test is not required to be in place.

Exception No. 2: The test is able to be performed before final assembly when the test represents the completed motor.

20.5 For the test, all power leads are to be connected to one test-equipment terminal and the second test-equipment terminal is to be connected to the accessible dead metal; except that a motor having all circuits internally interconnected is to be tested with at least one lead of each circuit connected to one terminal of the test equipment and the second terminal is to be connected to the accessible dead metal.

20.6 A motor employing a solid-state or other component that is not relied upon to reduce the risk of electric shock and that is capable of being damaged by the dielectric potential is to be tested before the component is electrically connected when a random sampling of each day's production is tested at the potential specified in Table 20.1. The circuitry is to be rearranged for the purpose of the test to reduce the risk of solid-state-component damage while retaining representative dielectric stress of the circuit. A dc potential is able to be used when an ac potential is capable of damaging solid-state or other components.

20.7 The test equipment shall include a transformer having an sinusoidal adequate output, a means of indicating the test potential, an audible or visible indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic feature that rejects any unit that does not meet the requirements.

20.8 When the output of the test-equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit that indicates the test potential directly.

20.9 When the output of the test-equipment is 500 volt-amperes or more, the test potential is able to be indicated by:

a) A voltmeter in the primary circuit or in a tertiary-winding circuit;

b) A selector switch marked to indicate the test potential; or

c) For equipment having a single test-potential output, a marking in a readily visible location to indicate the test potential.

When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

20.10 Test equipment, or a test procedure, other than as described in this section is not prohibited from use when found to accomplish the intended factory control.

PART VI – MARKINGS

21 Impedance-Protected Motors (Part I)

21.1 Each motor shall be marked with the following:

a) Name, tradename, or trademark of the company or other descriptive marking by which the company is identified;

b) The complete electrical rating;

c) The insulation class when higher than Class A;

d) A distinctive identifying catalog or model number or the equivalent;

e) At least the month and year of manufacture. Date coding, serial numbers, or equivalent means are not prohibited from being used; and

f) The words "Impedance-Protected."

Exception: A motor rated 100 watts or less is not prohibited from being marked "Z.P." instead of "Impedance-Protected."

21.1 effective March 28, 1998

21.2 The complete electrical rating consists of the following:

a) Rated voltage;

b) Rated frequency, specified with one of the following: hertz, Hz, dc or equivalent;

c) Full-load or locked-rotor input amperage, full-load or locked-rotor input watts, or output horsepower or watts. Ratings shall be provided at each speed provided unless the motor is of the shaded-pole or permanent-split-capacitor type; and

d) Other information as required by an intended end-use product.

21.3 A distinctive factory identifying marking shall be provided on a motor manufactured at more than one factory.

21.4 For impedance-protected motors rated 100 watts or less with a back-up protector that complies with 5.14, the motor is not prohibited from being marked "ZP-TPL."

22 Thermal-Device-Protected Motors (Part II)

22.1 Each motor shall be marked in a readily visible location on the outside of the motor with the following:

a) Name, tradename, or trademark of the company or other descriptive marking by which the company is identified;

b) The complete electrical rating;

c) The insulation class when Class B or higher;

d) A distinctive identifying catalog or model number or the equivalent;

e) At least the month and year of manufacture. Date coding, serial numbers, or equivalent means are not prohibited from being used;

f) Name, tradename, or trademark of the protector manufacturer or other descriptive marking by which the manufacturer is identified; and

g) Protector model number or type designation.

Exception: When the motor marking also serves as a means of identifying the manufacturer and model of protector, the information required by (f) and (g) are not required to be separately marked.

22.1 effective March 28, 1998

22.2 The complete electrical rating required in 22.1(b) consists of the following:

a) Rated voltage;

b) Rated frequency, specified with one of the following: hertz, Hz, cycles per second, cps, cycles/second, c/s, ac – dc, (number of cycles)/dc (for example, 60/dc);

c) Full-load input amperage, locked-rotor input amperage, full-load input wattage, locked-rotor input wattage, output horsepower, or output wattage. Ratings shall be provided at each speed provided unless the motor is of the shaded-pole or permanent-split-capacitor type;

d) Number of phases when intended for use on a polyphase circuit; and

e) Other information as required by an intended end-use product.

Exception: A motor rated 1/8 horsepower or less is not prohibited from being marked with locked-rotor amperage, full-load amperage, rated wattage or locked-rotor wattage.

22.3 A distinctive factory identifying marking shall be provided on a motor manufactured at more than one factory.

22.4 A motor that has been tested for running-heating and locked-rotor protection shall be marked "Thermally-Protected."

Exception: A motor rated 1/8 horsepower or less, or 100 watts or less, is not prohibited from being marked "T.P."

22.5 A motor that has been tested for locked-rotor protection only shall be marked "Thermally-Protected L."

Exception: A motor rated 1/8 horsepower or less, or 100 watts or less, is not prohibited from being marked "T.P.L."

22.6 A motor that has been tested for running heating protection only shall be marked "THERMALLY-PROTECTED R" or "T.P.R."

Exception: A motor rated 1/8 horsepower or less, or 100 watts or less, is not prohibited from being marked "T.P.R."

22.7 A motor rated for short-time or intermittent duty shall be marked on the nameplate with the words "intermittent duty" or "int. duty" or with a time rating in minutes or hours or a combination of minutes and hours. The rating is able to be for "On" time only or include specifications for both "On" and "Off" periods.

22.8 Instructions shall be provided for manual reset operation, when not self-evident.

22.8 effective March 28, 1998

23 Thermal Protectors (Part III)

23.1 A protector shall be marked with the following:

a) Name, tradename, or trademark of the manufacturer or other descriptive marking by which the manufacturer is able to be identified;

b) A distinctive type identification that is indicative of the design and electrical rating; and

c) Opening temperature; and, for an automatically reset protector, closing temperature.

Exception: A protector for which the catalog number identifies the temperature ratings is not required to be marked with the temperature ratings when the complete catalog number is marked on the protector.

23.1 effective March 28, 1999

23.2 A distinctive factory identifying marking shall be provided on a protector manufactured at more than one factory.

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard – UL Standard Designation

Insulating Materials – General, Systems of – UL 1446
Motors, Electric – UL 1004
Polymeric Materials – Short Term Property Evaluations – UL 746A
Thermal Cutoffs for Use in Electrical Products and Components – UL 1020

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