21.3 Resilient rubber mountings

21.3.1 The requirements in 21.3.2 – 21.3.9 apply only to resilient rubber mountings that are depended upon for bonding.

21.3.2 An electrical bonding member across a resilient mounting shall be metal. Conductive rubber compounds – loaded rubber – are not acceptable for bonding.

21.3.3 Electrical bonding shall be such that a path for electric current exists regardless of the manner in which the motor is rotated with respect to the base.

21.3.4 A bonding member shall be welded, clamped, riveted, secured by screws, or the equivalent.

21.3.5 A bonding member shall be secured by a means that will provide retention if a motor is removed from its base. A connection that it is necessary to remove intentionally, such as a screw or a bolt, at one or both ends of a bonding member is considered to comply with this requirement.

21.3.6 A bonding member shall be enclosed, located, or otherwise protected so that it will be unlikely to be damaged during handling or installation.

21.3.7 A metal part of a resilient mounting that also serves as a bonding path shall be inherently resistant to corrosion or shall be plated or finished as protection against corrosion.

21.3.8 Metal parts in a bonding path shall be galvanically compatible so that there will be little or no electrolytic action between dissimilar metals.

21.3.9 A bonding member shall have the flexibility necessary to withstand normal mechanical stress due to vibration.

21A Grounding

21A.1 For a motor provided with an attached grounding-type power-supply cord, electrical continuity shall be provided between all exposed dead-metal parts and the point of connection of the grounding conductor of the power-supply cord of a motor.

21A.1 added March 26, 1996

PERFORMANCE

22 General

22.1 The voltage of the test circuit for the performance tests shall be as specified in Table 22.1.

Exception: A motor having a voltage rating other than those specified in Table 22.1 is to be tested at 100 to 105 percent of rated voltage, but no less than 100 percent. Consideration is to be given to the voltage of the intended source of supply, as this may result in a test at a higher percentage of rated voltage than specified in this Exception.

Table 22.1
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

22.2 Thermocouples are to be applied to the hottest accessible parts to measure the temperature. Thermocouples are to be of wires no larger than No. 24 AWG (0.21 mm^2) and no smaller than No. 30 AWG (0.05 mm^2). Thermocouple wire is to comply with the requirements for special thermocouples in the Standard for Temperature Measurement Thermocouples, ANSI MC96.1-1982(1991).

22.3 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will result from cementing the thermocouple in place or by any other acceptable means.

22.4 The resistance method for temperature measurement as specified in Table 23.1 consists of the calculation of the temperature rise of a winding using the equation:

$$\Delta T = \frac{r_2}{r_1}(k + t_1) - (k + t_2)$$

in which:

ΔT is the temperature rise of the winding in degrees C;

r_2 is the resistance of the coil at the end of the test in ohms;

r_1 is the resistance of the coil at the beginning of the test in ohms;

t_1 is the room temperature in degrees C at the beginning of the test;

t_2 is the room temperature in degrees C at the end of the test; and

k is 234.5 for copper, 225.0 for electrical conductor grade (EC) aluminum; values of the constant for other conductors are to be determined.

22.5 With respect to 22.4, the value of r_2 measured at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values versus time may be plotted and extrapolated to determine r_2 at shutdown.

22.6 The referee method of measuring the temperature of a coil is the thermocouple method; but temperature measurements by either the thermocouple or resistance method are acceptable; except that the thermocouple method is not to be employed at any point where supplementary insulation is employed. When thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is common practice to employ thermocouples consisting of No. 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

22.7 A motor/controller combination shall be subjected to the Temperature Test of 23.5. The motor shall be tested with the load at 25, 50, 75, 100, 125, and 150 percent of rated current. The temperatures in 22.2 shall not be exceeded for loads at or below 100 percent of rated current. When provided, a protective device shall not operate. For loads over 100 percent, there shall be no indication of a risk of fire or shock. When provided, a protective device is allowed to operate. When a speed control is part of the controller, the speed shall be adjusted to 25, 50, 75, and 100 percent of rated speed.

22.7 added February 7, 2001

22A Continuity of Grounding Circuit Test

22A.1 The resistance shall be not more than 0.1 ohm between any point required to be grounded, as specified in 21A.1, and the point to which the grounding conductor of the power-supply is connected.

22A.1 added March 26, 1996

22A.2 The resistance is able to be determined by any convenient method, except that when the results obtained do not meet the intent of the requirement, either a direct- or alternating-current, equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device employed with the motor, is to be passed from the equipment grounding terminal to the dead metal part. The resulting drop in potential is to be measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

22A.2 added March 26, 1996

22B Rating

22B.1 A motor shall be loaded to its rated load (horsepower or torque). A motor capable of operating at a range of speeds is to be tested at the lowest possible speed, at an intermediate speed, and at the highest speed.

22B.1 added February 7, 2001

22B.2 The current shall not exceed the maximum rated current marked on the motor by more than 10 percent.

22B.2 added February 7, 2001

23 Auxiliary Switch Tests

23.1 General

23.1.1 The requirements in 23.1.2 – 23.5.1 are to be applied to an auxiliary switch that has been assigned a rating or an intended use by the manufacturer.

23.1.2 The performance of an auxiliary switch having a resistive rating shall be investigated by subjecting a representative sample to the tests described in 23.1.3 – 23.5.1. Unless otherwise specified, one sample shall be used through out all the tests.

23.1.3 The test sequence for an auxiliary switch shall be temperature, overload, endurance and dielectric voltage withstand. The temperature test may be conducted on a separate sample.

23.1.4 During the overload and endurance tests, an auxiliary switch shall be mounted and wired so that actual service conditions will be represented, and shall be connected to a load and to a supply circuit the voltage of which is within 5 percent of the rated voltage of the switch. The capacity of the test circuit shall be such that the potential across the load will have the required value when the switch under test is closed on the circuit with the required test current flowing. The rate of cycling the switch for the overload and endurance tests shall be 6 to 10 cycles of operation per minute except that a different rate may be used if agreeable to those concerned.

23.2 Overload test

23.2.1 An auxiliary switch shall be operated for 50 cycles of operation, making and breaking the required test current. The test current for a switch having a resistive rating shall be 150 percent of the rated current of the switch, and the cycling shall be accomplished by allowing the motor to come to full running speed and then to a complete stop.

23.3 Endurance test

23.3.1 When an auxiliary switch is subjected to the endurance test described in 23.3.2, there shall be no electrical or mechanical breakdown of the switch nor any undue burning or pitting of the contacts. At the conclusion of the test, the switch shall be capable of performing its normal function and shall show no undue wear, loosening of parts, or any other defects that will appreciably diminish the usefulness and reliability of the device.

23.3.2 An auxiliary switch is to be operated by means of the motor actuating member for 6000 cycles, making and breaking rated current of the switch while connected to a load and to a supply circuit the voltage of which is within 5 percent of the rated voltage of the switch. The cycling shall be accomplished by allowing the motor to come to full running speed and then to a complete stop.

23.4 Dielectric voltage-withstand test

23.4.1 An auxiliary switch shall withstand for 1 minute without breakdown the application of a 60 hertz essentially sinusoidal potential between live parts and dead metal parts. The test is to be conducted immediately following the endurance test. The test potential shall be based on either the rating assigned to the switch or the rating of the motor in which it is provided, whichever is higher, and shall be:

a) For a rating of 1/2 horsepower (373 watts) or less, 250 volts or less, 1000 volts; and

b) For any other rating, 1000 volts plus twice the rated voltage.

23.4.2 To determine whether a switch complies with the requirement in 23.4.1, the switch is to be tested by means of a 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test value is reached, and is to be held at that value for 1 minute. The increase in the applied potential is to be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

Exception: A 500 volt-ampere or larger capacity transformer need not be used if the transformer is provided with a voltmeter to measure directly the applied output potential.

23.5 Temperature test

23.5.1 An auxiliary switch shall carry its maximum rated current continuously without exceeding the temperature rises specified in Table 23.1.

Table 23.1
Maximum intended temperature rises

Table 23.1 revised December 26, 1997

Parts	Degrees C	Degrees F
Laminated contacts	50	90
Terminals	50	90
Solid contacts	65	117

23A Start Switch Tests

23A.1 General

23A.1.1 A start switch on a thermally protected motor shall be subjected to the running-heating test, the locked rotor test, and the locked rotor endurance test specified in the Standard for Overheating Protection for Motors, UL 2111. The results are determined to comply when the switch is operational after the test.

Exception: The running-heating test is not required to be performed when the motor is marked "T.P.L." or "Thermally Protected L."

23A.1.1 revised December 26, 1997

23A.2 Temperature test

23A.2.1 One motor sample with the start switch mounted as intended is to be subjected to the start switch test described in 23A.2.2 – 23A.2.4.

23A.2.1 revised November 24, 1999

23A.2.2 Thermocouples are to be attached to the following locations:

a) The motor winding;

b) The start switch components that dissipate maximum heat during operation; and

c) The hottest printed circuit board location, where applicable.

23A.2.2 added May 17, 1996

23A.2.3 The motor is to be energized at a test potential as indicated in Table 22.1 and loaded to the maximum rated load until constant temperatures are obtained.

Exception: The manufacturer is not prohibited from requesting to have the test conducted at a higher temperature, up to the temperature rating of the insulation class used in the motor being tested. When a motor series is being evaluated, the test is to be conducted on the most enclosed model in the motor series.

23A.2.3 added May 17, 1996

23A.2.4 The measured temperatures of components shall not attain a temperature at any point sufficiently high to:

a) Constitute a risk of fire;

b) Adversely affect any materials used in the motor;

c) Exceed the temperature rating of the individual materials or components; or

d) Exceed the maximum temperature rises of mechanical switch components, as specified in Table 23.1.

23A.2.4 added May 17, 1996

23A.3 Solid state start switch component failure test

23A.3.1 The solid state switch is to be mounted on the motor sample as intended in service. The fault condition is to be implemented while the motor is energized and before a single start.

23A.3.1 added May 17, 1996

23A.3.2 The fault condition is to consist of a single capacitor, triac, or other solid state component being short- or open-circuited. Only one condition of simulated malfunction or breakdown is to be imposed at a time.

23A.3.2 added May 17, 1996

23A.3.3 For the purpose of the test, the enclosure is to be connected to ground through a 3-ampere non-time delay fuse.

23A.3.3 added May 17, 1996

23A.3.4 There shall be no emission of flame or molten metal, nor ignition of cotton that is loosely placed around an open motor or over all the openings of a ventilated motor. The 3-ampere fuse connected between the enclosure and ground shall not open during the test.

23A.3.4 added May 17, 1996

23A.4 Start switch endurance test

23A.4.1 One sample of the start switch is to be subjected to a minimum of 100,000 cycles of endurance operation.

23A.4.1 added May 17, 1996

23A.4.2 When a motor is intended for a specific application, the number of cycles is to be increased as necessary.

23A.4.2 added May 17, 1996

23A.4.3 A 3-ampere non-time delay fuse is to be connected between the enclosure and ground.

23A.4.3 added May 17, 1996

23A.4.4 For a group of motors with different ratings, the switch shall be tested based on the ratings of the worst case condition, which includes highest voltage, highest current, and highest horsepower ratings.

Exception: When the switch is restricted for use with a specific motor, it is only required to be tested for use with that motor.

23A.4.4 added May 17, 1996

23A.4.5 The switch is to be cycled once every 10 seconds (1 second "on," and 9 seconds "off") or at a rate based on the motor characteristics. Cycle rate is expressed in terms of number of seconds the motor is energized ("on"), versus the number of seconds it is de-energized ("off").

23A.4.5 added May 17, 1996

23A.4.6 The motor test potential is to be in accordance with Table 22.1.

23A.4.6 added May 17, 1996

23A.4.7 There shall be no electrical or mechanical malfunction and the fuse shall not open during testing.

23A.4.7 added May 17, 1996

24 Resilient Rubber Mounting Tests

24.1 General

24.1.1 A means of electrical bonding that depends upon a resilient motor mounting for reliability shall be sufficiently resistant to deterioration to comply with the requirements in 24.2.1 – 24.7.1. See 24.1.2.

24.1.2 If a motor is intended for use in a specialized application in which weather, atmospheric conditions, contaminants, or the like may cause deterioration of the means for bonding, these factors are to be considered and may necessitate evaluation in addition to that required by 24.1.1.

24.2 Overcurrent test

24.2.1 The requirements in 24.2.2 – 24.2.4 apply if a resilient mounting is relied upon to retain a bonding member in place, whether or not the bonding member is in contact with the resilient material. The test current shall not result in:

a) A voltage drop through the bonding path exceeding the value specified in Table 24.1;

b) Softening or melting of the resilient material or damage to the connection – see 24.2.11; or

c) Molten metal or burning rubber falling on the surface supporting the sample.

24.2.2 The bonding system shall be tested as described in 24.2.4 both before and after the conditioning described in 24.5.2. The results shall comply with the requirements in 24.2.1.

24.2.3 The bonding system shall be tested as described in 24.2.4 after the conditioning described in 24.5.1.

24.2.4 Other than as noted in 24.2.6, a current equal to twice the current rating or setting of the intended branch-circuit overcurrent-protective device shall be passed through the bonding path for the time specified in Table 21.2.

24.2.5 Other than as noted in 24.2.6, if a bonding member is secured by being clamped between a resilient mounting and a metal part, the bonding connection shall comply with the requirement in 24.2.1; and shall also perform acceptably, both before and after being conditioned in accordance with 24.5.2 and 24.6.1, as specified in 24.2.4 and 24.2.11 with a current flowing through the connection equal to:

a) 110 percent of the current rating or setting of the intended branch-circuit overcurrent-protective device – see Table 24.1 – for 7-1/2 hours; and

b) 135 percent of the current rating or setting of the intended branch-circuit overcurrent-protective device – see Table 24.1 – for the time specified in Table 21.2.

24.2.6 If the rating or setting of the intended branch-circuit overcurrent-protective device is less than four times the full-load-current rating of the motor, the test current is to be selected from Table 24.1 using that value in column 1 that is equal to or next greater than four times the full-load-current rating of the motor.

24.2.7 A separate set of three samples is to be subjected to each of the tests required by 24.2.2 – 24.2.5.

24.2.8 The samples are to be supported on a softwood surface that is covered with two layers of white tissue paper.

24.2.9 The tests may be conducted at any convenient voltage, using either an alternating or a direct potential.

Table 24.1
Overcurrent test currents and maximum voltage drops for bonding connections

Ampacity of intended branch-circuit overcurrent-protective device[a,b]	Percent of ampacity of branch-circuit overcurrent-protective device and test current, amperes			Maximum voltage drop
	110	135	200	
15	16.5	20.2	30.0	1.5
20	22.0	27.0	40.0	2.0
25	27.5	33.8	50.0	2.5
30	33.0	40.5	60.0	3.0
35	38.5	47.5	70.0	3.5
40	44.0	54.0	80.0	4.0
45	49.5	60.8	90.0	4.5
50	55.0	67.5	100.0	5.0
60	66.0	81.0	120.0	6.0
70	77.0	94.5	140.0	7.0
80	88.0	108.0	160.0	8.0
90	99.0	121.5	180.0	9.0
100	110.0	135.0	200.0	10.0
110	121.0	148.5	220.0	11.0
125	137.5	168.8	250.0	12.5
150	165.0	202.5	300.0	15.0
175	192.5	236.2	350.0	17.5
200	220.0	270.0	400.0	20.0
225	247.5	303.8	450.0	22.5
250	275.0	337.5	500.0	25.0
300	330.0	405.0	600.0	30.0
350	385.0	472.5	700.0	35.0
400	440.0	540.0	800.0	40.0
450	495.0	607.5	900.0	45.0
500	550.0	675.0	1000.0	50.0
600	660.0	810.0	1200.0	60.0

[a] A bonding connection may also be tested for use with an overcurrent-protective device of higher rating. The maximum acceptable voltage drop is to be calculated by multiplying the rating of the overcurrent-protective device by 0.1 ohm.

[b] The value in column 1 to be used in selecting the test current is to be whichever of the following is higher:

a) The ampacity of the intended branch-circuit overcurrent-protective device, or

b) That value equal to or next higher than four times the current rating of the motor.

24.2.10 The voltage drop through the bonding path is to be measured between a point on the motor frame and a point on the mounting base that are not less than 1/16 inch (1.6 mm) from the connection of the bonding member.

24.2.11 Discoloration is acceptable if there is no loss of mechanical strength of the connection.

24.3 Limited short circuit test

24.3.1 A bonding connection shall withstand the appropriate short-circuit current specified in Table 24.2, both before and after being conditioned in accordance with 24.5.2 and 24.6.1, when tested in series with a fuse as described in 24.3.2. The results of the test are acceptable if there is:

a) No ignition of the cotton described in 24.3.4 or other manifestation of a risk of fire,

b) The bonding member is undamaged, and

c) The connections are found to be intact by means of an ohmmeter or by an equivalent test for continuity.

Table 24.2
Limited-short-circuit-test currents

Horsepower (W output)	Rating of motor in volts and test current in amperes	
	0 – 250	251 – 600
1/2 (373) or less	200	1000
More than 1/2 – 1 (746)	1000	1000
More than 1 – 3 (2238)	2000	5000
More than 3 – 7-1/2 (5595)	3500	5000
More than 7-1/2 – 50 (37300)	5000	5000
More than 50	10000	10000

24.3.2 The test fuse specified in 24.3.1 shall be a nonrenewable cartridge fuse having a current rating at least four times the full-load-current rating of the motor or equal to the current rating setting of the intended branch-circuit overcurrent-protective device, whichever is higher, but shall not be less than 20 amperes for a motor rated 150 volts or less, and not less than 15 amperes for a motor rated 151 – 600 volts. A test fuse rated 15 or 20 amperes shall be a time-delay fuse. A test fuse rated more than 20 amperes shall be a nontime-delay fuse.

24.3.3 The power factor of the test circuit is to be 0.9 – 1.0, unless a lower power factor is agreeable to those concerned. The circuit capacity is to be measured with the bonding connection in the circuit.

24.3.4 The bonding connection is to be loosely draped with untreated surgical cotton.

24.3.5 Three samples of the bonding connection are to be subjected to the limited-short-circuit tests. Each sample is to be tested until ultimate results occur.

24.3.6 With reference to 24.3.1, a fuse of higher rating may be specified by the manufacturer if required for the end-use equipment. In some applications, the combined full-load current of the motor and other simultaneous load or loads may necessitate that the test be conducted using a circuit of higher capacity. Such tests are to be conducted in accordance with 24.3.1 – 24.3.5 except that cheesecloth may replace the cotton indicator specified in 24.3.4. The cheesecloth is to be bleached cotton cloth running 14 – 15 square yards per pound (approximately 26 – 28 square meters per kilogram) and having what is known to the trade as a count of 32 by 28, that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 in the other direction).

24.3.7 Unless a cotton indicator is used for the test described in 24.3.6, it is not considered representative of the tests described in 24.2.9 – 24.3.2 that is required for a motor intended to be used as a single load.

24.4 Humidity conditioning test

24.4.1 After being conditioned as described in 24.4.2, a bonding member shall remain reliably secured in place as determined by visual inspection. See 24.2.3.

24.4.2 Six complete samples of a motor, with resilient mountings assembled in the intended manner, are to be conditioned for 720 hours at a temperature of 35°C (95°F) and a relative humidity of 100 percent.

24.5 Oven conditioning test

24.5.1 After being conditioned as described in 24.5.2 and 24.6.1:

a) A bonding member shall remain reliably secured in place, and

b) A resilient mounting shall not be visibly cracked when examined using 7-power magnification.

24.5.2 A number of samples sufficient for a separate set of three samples to be used for each applicable test required by 24.2.4, 24.2.5, 24.3.1, and 24.3.6 and for the examination required by 24.5.1 are to be conditioned for 720 hours in an air-circulating oven. Each sample is to be complete, and is to have the resilient mounting assembled in the intended manner. The oven is to be maintained at the temperature specified in Table 24.3.

Table 24.3
Temperatures, oven conditioning

Maximum temperature of resilient mounting during normal operation		Conditioning temperature	
°C	°F	°C	°F
60 or less	140 or less	90	194
61 – 80	142 – 176	110	230
81 – 100	178 – 212	130	266
101 – 120	214 – 248	150	302

24.6 Ozone conditioning test

24.6.1 A number of samples sufficient for a separate set of three samples to be used for each applicable test required by 24.2.4, 24.2.5, 24.3.1, and 24.3.6 and for the examination required by 24.5.1 are to be conditioned. Each sample is to be complete, and is to have the resilient mounting assembled in the intended manner. The samples are to be conditioned for 24 hours in an atmosphere free of ozone. They are then to be conditioned for 70 hours in a test chamber regulated to maintain an ozone concentration of 1 part per million and a temperature of 50°C (122°F).

24.7 Oil conditioning test

24.7.1 The material of a resilient mounting shall not swell more than 25 percent or shrink more than 5 percent when samples are immersed for 70 hours at room ambient in IRM immersion oil 903. The change in volume is to be determined in accordance with the Test Method for Rubber Property – Effect of Liquids, ASTM D471-1996.

24.7.1 revised December 26, 1997

25 Non-Metallic Functional Part Tests

25.1 Mold stress relief

25.1.1 One sample of the complete motor or part is to be placed in a full draft circulating air oven maintained at a uniform temperature of 100°C (212°F). The sample is to remain in the oven for 7 hours. After its careful removal from the oven and return to room temperature, the sample is to be investigated for compliance in accordance with 13.6.

Exception: If the maximum temperature measured under actual operating conditions of the complete motor or part under consideration is known to be less than 60°C (140°F), then the oven temperature can be maintained at 70°C (158°F).

25.2 Locked rotor cycling

25.2.1 A motor sample is to be energized at a test potential as indicated in Table 22.1 with the rotor locked. The motor circuit is to be cycled on and off as quickly as the motor allows. The winding temperatures shall reach the maximum temperature and the minimum temperature shown in Table 25.1, as determined with a thermocouple. The test duration is to be for 18 days with the motor at room temperature at the beginning of the test. The motor enclosure is to be connected to ground through a 3-ampere non-time delay cartridge fuse with voltage rating based on the rating of the motor. As a result, there shall be no softening, cracking, warping or other deformation to result in a reduction in spacings of the nonmetallic part being tested, nor shall the fuse open. Protective devices shall be by-passed. When the motor does not function throughout the test, a different motor shall be chosen, and the test started from the beginning. When a part, such as a capacitor, can be replaced in order for the motor to function, then the test may continue.

25.2.1 revised February 7, 2001

Table 25.1
Locking rotor cycling temperature limits

Table 25.1 revised March 26, 1996

Insulation class	Maximum temperature		Minimum temperature	
	°C	°F	°C	°F
A	175	347	125	257
E	190	374	140	284
B	200	392	150	302
F	225	437	175	347
H	250	482	200	392

26 Strain Relief Test

26.1 Power-supply cord

26.1.1 The strain-relief means provided on a flexible cord shall be tested as described in 26.1.2. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord to indicate that stress would have resulted on the internal connections.

26.1.2 To determine whether a strain relief complies with the requirement in 26.1.1, the cord connections within the motor are to be disconnected. A 35-pound (16-kg) weight is then to be suspended on the cord and supported for 1 minute by the motor so that the strain-relief means will be stressed from any angle that the construction of the motor permits.

26.2 Interconnecting leads

26.2.1 Each lead or flexible cord provided for wiring to or for interconnection between parts of a motor, for example, motor windings to capacitor, shall be subjected to the test described in 26.1.1 and 26.1.2 except that the pull shall be 20 pounds (89 N). Each lead or cord is to be tested with the 20-pound (9-kg) weight.

Exception: The test is to be waived if the cord or leads are not intended to be exposed in the final application and are only handled when the motor is being installed in an appliance.

26.3 Clamps

26.3.1 For the investigation of a clamp for Types SPT-1, SPT-2, SVT, or SVTO cord specified in 9.2.7, six samples of the clamp that are secured to the cord in the intended manner are to be used. Three samples are to be subjected to the dielectric voltage-withstand and strain-relief tests in the as received condition. Three samples are to be conditioned for 168 hours in an air oven. The oven temperature is to be 100°C or 10°C higher than the temperature rating of the insulation of the cord, whichever is higher. The samples are to comply with the dielectric voltage-withstand test requirements in 23.4.1 and 23.4.2, the value of applied potential being based on the rating of the motor. The potential is to be applied between conductors, and if the clamp is metal the potential is also to be applied between the clamp and all conductors spliced together. After cooling to room temperature, the conditioned samples are to comply with the strain-relief requirement in 26.1.1 or 26.2.1 whichever applies.

27 Conduit Hubs

27.1 A conduit hub not integrally cast with a metal enclosure shall not turn in the enclosure and shall not strip any threads when the torque specified in 27.2 is applied.

27.2 To determine whether a conduit hub complies with the requirement in 27.1, the torque is to be applied to a short length of rigid-metal conduit that has been threaded into the hub of the enclosure in the intended manner. The applied torque is to be 800 pound-inches (90 N·m) for 1/2- and 3/4-inch sizes, 1000 pound-inches (113 N·m) for 1- and 1-1/2-inch sizes, and 1600 pound-inches (180 N·m) for 2-inch and larger sizes.

27A Installation Test

27A.1 When required to determine compliance with 9.1.8.1 and 9.1.9, one sample of the motor is to be installed in accordance with the manufacturer's installation instructions. The terminal compartment shall be capable of accommodating all field wiring conductors and connections.

Added 27A.1 effective February 15, 1999

27B Electrolytic Capacitor Overvoltage Test

27B.1 Three samples of the capacitor, mounted in the usual manner and with cotton placed around openings in the capacitor enclosure, are to be subjected to such overvoltage as to cause breakdown or malfunction.

27B.1 added February 7, 2001

27B.2 When the cotton ingites upon breakdown or malfunction of the capacitor, the results are not in compliance.

27B.2 added February 7, 2001

MANUFACTURING AND PRODUCTION TESTS

28 Dielectric Voltage-Withstand

28.1 Each motor shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 hertz, between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized.

28.2 The production-line test shall be in accordance with either Condition A or Condition B of Table 28.1.

Table 28.1
Production-line test conditions

Motor rating	Condition A		Condition B	
	Potential, volts	Time, seconds	Potential, volts	Time, seconds
250 volts or less and 1/2 horsepower (373 W output) or less	1000	60	1200	1
More than 250 volts or more than 1/2 horsepower	1000+2V[a]	60	1200+2.4V[a]	1

[a] Maximum rated voltage.

28.3 The motor may be in a heated or unheated condition for the test.

28.3.1 When an on-off switch is provided as an integral part of the motor, the production-line test shall be performed with the switch in the "on" position.

28.3.1 added March 26, 1996

28.4 The test shall be conducted when the motor is complete – fully assembled. It is not intended that the motor be unwired, modified, or disassembled for the test.

Exception No. 1: Parts, such as snap covers or friction-fit knobs, that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed motor.

Exception No. 3: A motor employing a solid-state component that is not relied upon to prevent electric shock and that can be damaged by the dielectric potential may be tested before the component is electrically connected provided that random sampling of each day's production is tested at the potential specified in Table 28.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

28.5 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature of any unacceptable unit.

28.6 If the output of the test equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

28.7 If the output of the test equipment transformer is 500 volt-amperes or larger, the test potential may be indicated by a voltmeter in the primary circuit or in a tertiary-winding circuit, by a selector switch marked to indicate the test potential, or for equipment having a single test-potential output, by 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.

28.8 Test equipment, other than that described by 28.5 – 28.7, may be used if found to accomplish the intended factory control.

28.9 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the motor are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

Exception No. 1: A motor having circuitry – resistive, high-impedance winding, or the like – not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested with a single-pole primary switch, if used, in the off position, or with only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.

Exception No. 2: The primary switch is not required to be in the on position if the testing means applies full test potential between primary wiring and dead metal parts with the switch not in the on position.

29 Continuity

29.1 If a resilient mounting is depended upon for bonding, the manufacturer shall employ a production-line test by which it can be determined that electrical continuity exists in the bonding circuit of the motor.

29.2 For the test described in 29.1, the manufacturer shall test each motor or, if agreeable to those concerned, may use statistical sampling methods.

29A Grounding Continuity Test

29A.1 Each motor that has a power-supply cord having a grounding conductor shall be tested to determine the grounding continuity between the grounding blade of the attachment plug and the accessible dead metal parts of the motor that become energized.

29A.1 added March 26, 1996

29A.2 Only a single test is required to be conducted when the accessible metal specified is conductively connected by design to all other accessible metal.

29A.2 added March 26, 1996

29A.3 Any indicating device, such as an ohmmeter, a battery and buzzer combination, or similar device, is able to be used to determine compliance with the grounding-continuity requirement in 29A.1.

29A.3 added March 26, 1996

MARKING

30 Details

30.1 Each motor, each motor part investigated as a single part, and at least one part of each group of motor parts investigated as a combination shall be marked with a model number, catalog number, or similar identifying designation and with the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified so as to:

a) Make it distinguishable from other motors, parts, and combinations of parts; and

b) If it is produced or assembled at more than one factory, identify it as the product of a particular factory.

30.2 A motor shall be marked to indicate:

a) Rated voltage;

b) Full-load input amperes or watts, or both;

c) Rated full-load speed;

d) Rated temperature rise or the insulation system class;

e) Rated ambient temperature;

f) Time rating, or if it is a continuous duty motor then "Continuous" or "CONT";

g) Rated horsepower when 1/8 horsepower (93 W) or more;

h) Code letter to indicate locked-rotor amperes in accordance with the National Electrical Code, ANSI/NFPA 70-1999, for an alternating-current motor rated 1/2 horsepower (373 W output) or more;

i) Secondary volts and full-load amperes, when a wound-rotor induction motor;

j) Rated frequency – expressed in one of the following terms: hertz, Hz, cycles per second, cps, cycles/second, c/s, ac-dc, (number of cycles)/dc (for example, 60/dc), or ac only – or direct current; and, for a motor intended for use on a polyphase circuit, number of phases;

k) Winding – straight shunt, stabilized shunt, compound, or series, for a direct-current motor; and

l) Amperes and horsepower at each speed, for a multi-speed motor other than a shaded-pole or a permanent-split-capacitor motor.

Exception: A motor having a diameter of 7 inches (178 mm) or less is only required to be marked to indicate:

a) Rated voltage;

b) Rated frequency – expressed in one of the following terms: hertz, Hz, cycles per second, cps, cycles/second, c/s, ac-dc, (number of cycles)/dc (for example, 60/dc), or ac only – or direct current; and, for a motor intended for use on a polyphase circuit, number of phases; and

c) Other information required to be marked on the motor in the end-use application, such as capacitor rating where the capacitor is not supplied with the motor.

30.2 revised February 7, 2001

30.2.1 A stepper or servo motor shall be marked in accordance with 30.2 (b), (c), (d), and (e). In addition, the motor shall be marked with rated continuous torque and the back emf.

30.2.1 added February 7, 2001

30.3 A motor part, and a combination of motor parts need only be marked as required by 30.1.

30.4 A motor provided with a terminal box or wiring compartment that is intended to be wired in the field shall be marked in readily visible location with the following or the equivalent: "Acceptable for field wiring."

Exception: If the marking on the motor on which the compartment is provided will serve as a means for determining whether the compartment is acceptable for field wiring, the information need not be separately marked on the motor.

30.5 The designation of the insulation system shall be on the motor nameplate, motor part, or provided as part of the motor model designation when the insulation is Class E or higher, or has integral ground insulation.

30.5 added March 26, 1996

30.6 A stepper or servo motor shall be marked to indicate the manufacturer and model number or series of the controller used to control the motor.

30.6 added February 7, 2001

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

Capacitors – UL 810
Industrial Control Equipment – UL 508
Insulating Materials – General, Systems of – UL 1446
Marking and Labeling Systems – UL 969
Overheating Protection for Motors – UL 2111
Polymeric Materials – Short Term Property Evaluations – UL 746A
Polymeric Materials – Long Term Property Evaluations – UL 746B
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Polymeric Materials – Fabricated Parts – UL 746D
Quick-Connect Terminals, Electrical – UL 310
Terminal Blocks – UL 1059
Thermal Cutoffs for Use in Electrical Products and Components– UL 1020

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Subjects 1004A(1004)

12 Laboratory Drive
Research Triangle Park, NC 27709

TO: **Industry Advisory Conference of UL for Electric Motors,**
Electrical Council of Underwriters Laboratories Inc.,
Fire Council of Underwriters Laboratories Inc.,
Subscribers to UL's
Standards Service for Electric Motors, Listees to UL's Recognition Service for Electric Motors

SUBJECT: **Announcement of Effective Date for Field Wiring Compartment Size for Fire Pump Motors**

UL 1004 has been updated to correspond with the 1996 National Electric Code revisions which include the revised requirements for field wiring compartments. The revised requirements in UL 1004 have an effective date of February 15, 1999.

An Outline of Investigation, UL 1004A, was created to identify requirements applicable to fire pump motors. The requirements for field wiring compartment sizes are required to comply with the 1996 NEC requirements for terminal housings.

In order to allow for sufficient time for manufacturers to revise their field wiring compartments, UL announces that an effective date of February 15, 1999 has been established for field wiring compartments for Listing Fire Pump Motors to coincide with the effective date for the corresponding changes in UL 1004.

While the field wiring compartment size requirements now have an effective date of February 15, 1999, manufacturers are encouraged to provide a larger compartment than the present standard size in order to help alleviate the concerns that have been expressed.

The effective date for the field wiring compartment size requirements does not have any effect on the requirements in NFPA 20, the Standard for the Installation of Centrifugal Fire Pumps. According to NFPA 20, all fire pump motors will have to be Listed by January 1, 1998.

This bulletin should be kept with your copy of the outline and standard.

Questions regarding interpretation of requirements should be directed to the responsible UL Staff. Please see Appendix A of this bulletin regarding designated responsibility for the subject product category.

UNDERWRITERS LABORATORIES INC.

NEIL DALMAS
Engineer
Standards Department
RESEARCH TRIANGLE PARK OFFICE
(919) 549-1879
Fax: (919) 547-6192

REVIEWED BY:

BRUCE BOHREN (Ext. 42017)
Engineering Group Leader
Engineering Services 418C
NORTHBROOK OFFICE
(847) 272-8800
Fax: (847) 509-6256

SR:JAH

1004ANN.004

APPENDIX A

DESIGNATED RESPONSIBILITY FOR UL

PRODUCT CATEGORY

PRGY2, ELECTRIC MOTORS

The individuals shown in the following table are involved with the investigation of products covered under the subject category. The Primary Designated Engineer **(shown in UPPERCASE letters)** coordinates the establishment and uniform interpretation of UL requirements applicable to the product category. The Designated Engineers **(shown in lowercase letters)** work with the Primary Designated Engineer to interpret requirements and maintain standards.

Should you have questions regarding the requirements that affect your product, you are encouraged to contact the individual at the office to which you normally submit your products.

The Industry Advisory Conference (IAC) Chairman for the subject category is Lee Hewitt at UL's Northbrook office. The IAC Chairman oversees the significant interpretations made by the Primary Designated Engineer and arbitrates any differences regarding interpretation of UL requirements.

CCN	Office/Subsidiary	Responsible Engineer	Extension
PRGY2	Melville	Darrin Conlon	22872
	Northbrook	BRUCE BOHREN	42017
	RTP	Patricia Harding-Paul	11529
	Santa Clara	Anil Patel	32610

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