UL 1692

STANDARD FOR SAFETY

Polymeric Materials – Coil Forms

UL Standard for Safety for Polymeric Materials – Coil Forms, UL 1692

Second Edition, Dated June 30, 1999

SUMMARY OF TOPICS

This revision of ANSI/UL 1692 dated January 8, 2024 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated October 20, 2023.

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UL 1692

Standard for Polymeric Materials – Coil Forms

First Edition – May, 1994

Second Edition

June 30, 1999

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through January 8, 2024.

The most recent designation of ANSI/UL 1692 as a Reaffirmed American National Standard (ANS) occurred on January 8, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover parts made of polymeric materials that are used in electrical equipment and describe the various test procedures and their use in the testing of such parts and equipment.

1.2 These requirements do not cover the specific insulating systems that are covered by the requirements contained in the Standard for Systems of Insulating Materials, General, UL 1446.

1.3 Test procedures are provided herein for the evaluation of polymeric materials in specific applications. These test procedures include references to data obtained from small-scale property tests conducted under standard conditions as well as other practical means of evaluation.

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

2 Glossary

2.1 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist at any part if:

a) The potential between the part and earth ground or any other accessible part is more than 42.4 V peak, and

b) The continuous current flow through a 1500 ohm resistor connected across the potential exceeds 0.5 mA.

2.2 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

a) The open circuit voltage is more than 42.4 V peak and the energy available to the circuit under any condition of load, including short circuit, results in a current of 8 A or more after 1 minute of operation, or

b) A power of more than 15 watts can be delivered into an external resistor connected between the two points.

3 General

3.1 If a value for measurement is followed by a value in other units, the use of either value can be expected to provide equivalent results in the application of such requirements. Each of the requirements is stated in SI units as well as in U.S. customary units. Equivalent, although not necessarily exactly identical results, are to be expected from applying a requirement in SI units or U.S. customary units. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

4 Thermoplastic Coil Forms

4.1 Sections 5 – 8 contain requirements for insulation systems which employ thermoplastic materials as major insulation, such as ground and interwinding insulation ultimate encapsulant that is not enclosed in metal, and are used in motors, contactors, relays, solenoids and transformers.

4.2 Sections 5 – 8 apply to such insulation systems operating at a hot-spot temperature of 105°C (221°F), or below.

4.3 Insulation systems operating above a hot-spot temperature of 105°C (221°F) shall be evaluated with respect to the requirements for Systems of Insulating Materials – General, UL 1446.

4.4 The requirements in Sections 5 – 8 only apply to thermoplastic materials used as major insulation. Samples of a product which have been evaluated under these requirements, and have been found not to comply, shall be analyzed to determine whether the noncompliance was due to the thermoplastic insulating material, or whether it was due to a material not covered by these requirements.

4.5 A thermoplastic insulating material used as major insulation in an insulation system electrically isolates the windings and other live parts of the system from other live parts and/or dead metal parts.

4.6 A thermoplastic insulating material used as major insulation in an insulation system, shall have short- and long-term electrical and mechanical properties such that the ability of the material to serve as electrical insulation and maintain physical spacings between windings and dead metal parts of the system is not impaired.

4.7 If a thermoplastic insulating material used as major insulation in an insulation system melts or distorts under intended and/or abnormal use, such melting or distortion shall not result in a risk of electric shock or fire.

4.8 A thermoplastic insulating material used as major insulation in an insulation system shall be acceptable for the end-use application under both intended and abnormal temperature conditions.

4.9 For the purposes of these requirements, each secondary winding tap other than a center tap, and each primary winding tap that is intended to supply power to a load, shall be considered to be the equivalent of a secondary winding.

5 Determination of Performance Requirements

5.1 Select the two columns, W and X or columns Y and Z, in part 1 of Table 5.1 that match the conditions of use for the insulating material under consideration.

5.2 Part 2 of Table 5.1 determines which one of the two previously selected columns in 5.1 is to be chosen for performance requirements based upon equipment description.

5.3 Part 3 of Table 5.1 indicates which performance requirements are applicable for the column selected in 5.2.

5.4 Testing is required if the word “Yes” appears in part 3 for the column selected in 5.2.

Table 5.1
Tests related to use of insulating materials in insulating systems

Part 1 – Conditions of Use			Columns W	Columns X	Columns Y	Columns Z
The insulation system is used within a small component part such as a motor, relay, contactor, transformer or the like where the blocked armature or short-circuit current is less than twice the rated current.			Yes	Yes	No	No
Part 2 – Equipment Description						
Equipment is for attended, intermittent duty household use[a] and can be easily moved from one place to another in intended use.			Yes	No	Yes	No
Equipment is other than described above.			No	Yes	No	Yes
Part 3 – Applicable Requirements	Paragraphs		Columns			
	Motors	Solenoids Transformers, Relays, Contactors, Etc.	W	X	Y	Z
Thermal-aging considerations	6.1 – 6.7	6.1 – 6.7	Yes	Yes	Yes	Yes
Volume resistivity	7.1.1	8.1.1	Yes	Yes	Yes	Yes
Dielectric voltage-withstand	7.2.1, 7.2.2	8.2.1, 8.2.2	Yes	Yes	Yes	Yes
Normal conditioning	7.3.1	8.3.1	Yes	Yes	Yes	Yes
Abnormal conditioning	7.4.1	8.4.1	Yes	Yes	Yes	Yes
Severe conditioning	7.5.1, 7.5.2	8.5.1, 8.5.2	–	Yes	Yes	Yes
Overload-burnout conditioning	7.6.1 – 7.6.4	8.6.1 – 8.6.4		–	Yes	Yes
15-Day abnormal operation	7.7.1, 7.7.2	8.7.1, 8.7.2		–	–	Yes

[a] – Attended, intermittent duty household equipment is defined in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6 Thermal Aging Considerations

6.1 A thermoplastic material used as major insulation in the insulating system of small components of electrical equipment shall be acceptably resistant to thermal degradation at the maximum temperature that it is exposed during intended use of the equipment. The acceptability of the thermal-aging characteristics of the material are to be evaluated by the requirements of either 6.2, 6.3, 6.4, or 6.7.

6.2 Except as indicated in 6.3 or 6.3.1, the maximum temperature to which the material is exposed during intended use shall not exceed the Electrical Relative Thermal Index based upon historical data or a long-term thermal-aging investigation. See the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

6.3 The material shall be acceptable from a thermal-aging standpoint if the maximum temperature to which it is exposed during intended use does not exceed 65°C (149°F) for portable equipment, and 50°C (122°F) for all other equipment. Portable Equipment is defined in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.3.1 The material shall be acceptable from a thermal-aging standpoint if the insulation system complies with the requirements for Systems of Insulating Materials – General, UL 1446. See 4.3.

6.4 If the material does not comply with 6.3 and it is intended for use in a Class 105(A) insulation system at temperatures greater than its Electrical Relative Thermal Index, the system is to be evaluated by the procedure described in 6.7.

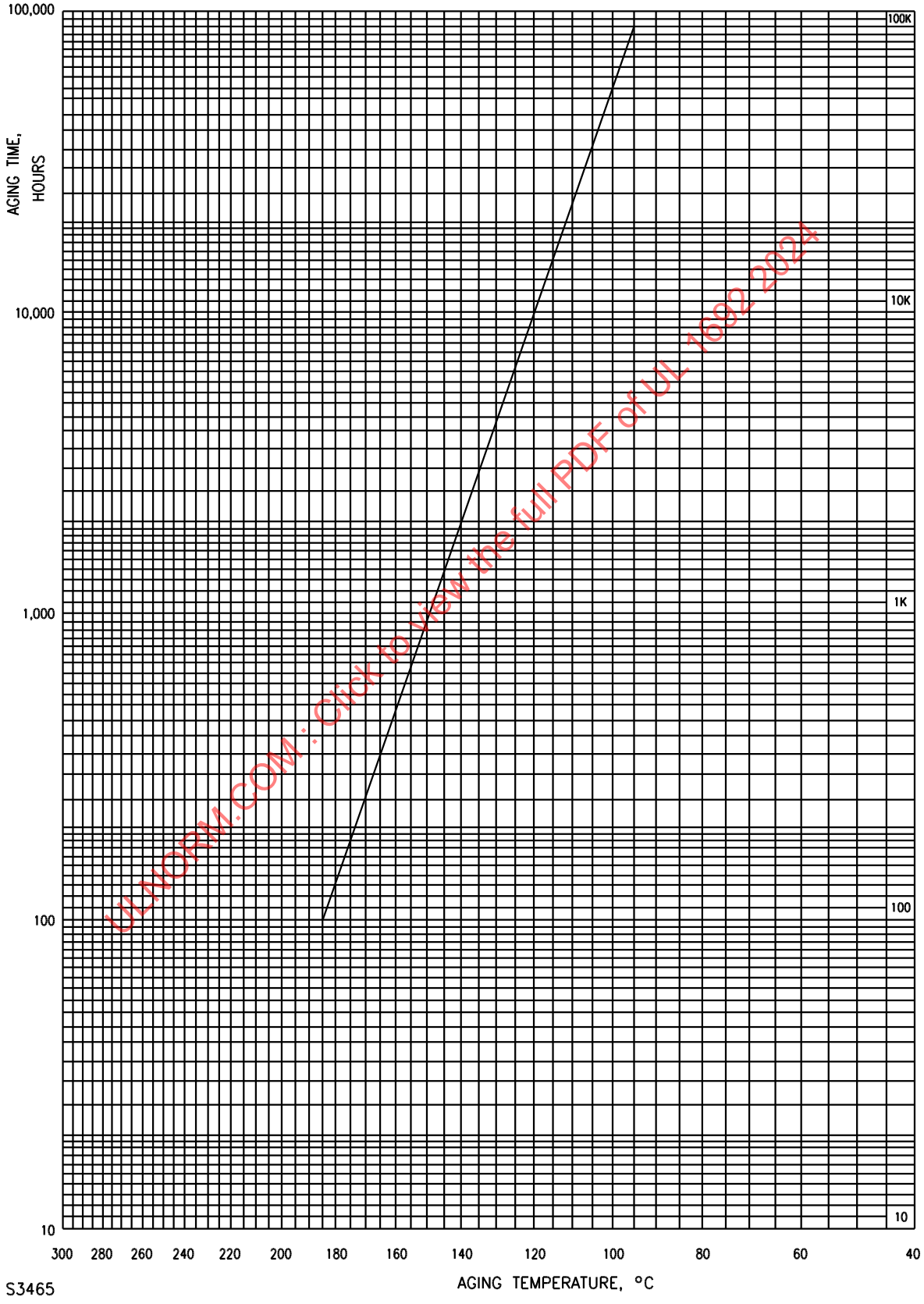
6.5 *Deleted*

6.6 *Deleted*

6.7 Five samples of the product containing the insulation system are to be aged for 300 hours or longer at the corresponding aging temperature that appears on the Class 105(A) system response shown in Figure 6.1. The insulation system shall then be cooled to room temperature and subjected to the applicable dielectric withstand requirements of the end-product equipment, but not less than 1000 V. In addition, the no-load current input at rated voltage after aging shall not be more than 150 percent of the unaged value and the insulation system shall not burn out electrically so as to present a risk of electric shock or fire, or both.

Figure 6.1

Historical class 105 (A) system response



7 Performance for Motors

7.1 Volume resistivity

7.1.1 The resistance per unit volume (volume resistivity) of the polymeric material shall be:

a) Not less than 50 megohm-centimeters in the as-received condition.

b) Not less than 10 megohm-centimeters after exposure for 96 hours at a relative humidity of 90 ±5 percent and at a temperature of 35.0 ±2.0°C (95.0 ±3.6°F).

7.2 Dielectric voltage-withstand

7.2.1 The insulation system shall withstand for 1 minute without breakdown the application of the 50–60 Hz essentially sinusoidal potential specified in the applicable end-product standard, between live parts and dead metal parts with the system still in a well-heated condition.

7.2.2 A potential of 1000 V plus twice the rated voltage shall be applied if the end-product standard does not specify a potential.

7.3 Normal conditioning

7.3.1 Except as indicated in Table 5.1, the insulation system shall be conditioned without resulting in any of the following:

a) Noticeable softening or distortion of the thermoplastic material after 1 hour under the conditioning described in 9.1.1.

b) Dielectric breakdown between windings and dead metal parts when subjected to the potential described in 7.2.1 or 7.2.2, immediately following the conditioning described in 9.1.1.

7.4 Abnormal conditioning

7.4.1 After being subjected to the abnormal conditioning described in 9.2.1 the insulation system shall comply with the following conditions:

a) The integrity of the thermoplastic material shall be such that the 3 A fuse specified in 9.2.1 remains intact during the test.

b) The thermoplastic material shall withstand the dielectric voltage-withstand potential specified in 7.2.1 or 7.2.2 immediately following the conditioning specified in 9.2.1 and with the 3 A fuse removed from the circuit.

c) Any molten metal or flaming shall be confined within the enclosure of the electrical equipment where the electrical component is used.

d) The maximum temperature of the windings shall not exceed a temperature equal to 45°C (81°F) over the insulation system's rated temperature when measured by thermocouples on the surface of the windings.

7.5 Severe conditioning

7.5.1 The insulation system shall be conditioned in accordance with each method described in 9.3 without dielectric breakdown between windings and dead metal parts when subjected to the dielectric

voltage-withstand test described in 7.2.1, or 7.2.2, immediately following the conditioning described in 9.3.1.

Exception: This test need not be conducted if the insulation system complies with the requirements in 7.4.1 after being tested as described in 9.2.1.

7.5.2 The clearing of the circuit by an overtemperature or over-current protective device is considered to be acceptable.

7.6 Overload-burnout conditioning

7.6.1 This test need not be conducted if burnout does not occur during the abnormal conditioning described in 9.2.1.

7.6.2 Except as indicated in 7.6.1 and 7.6.4, an insulation system employed in a product with a stalled-rotor current greater than twice the use operating current shall comply with the following:

a) After the overload-burnout conditioning described in 9.4.1, the 3 A fuse described in 9.4.1 shall remain intact.

b) Immediately following the overload-burnout conditioning described in 9.4.1, the 3A fuse is to be removed from the circuit and the dielectric voltage-withstand test described in 7.2.1 or 7.2.2 conducted.

c) The thermoplastic material shall show no appreciable softening or melting to affect spacing.

d) Any molten metal or flaming shall be confined within the enclosure of electrical equipment that the system is used.

7.6.3 The clearing of the circuit by an overtemperature or overcurrent protective device is considered to be acceptable.

7.6.4 7.6.2 (a), (b), and (c) are not applicable provided all of the following conditions apply:

a) The nature of the equipment is such that extreme overload conditions are not likely.

b) All metal parts of the motor (motor laminations, motor shaft, and the like) are housed within an enclosure of acceptable insulating material and are isolated from exposed dead metal parts by acceptable insulating materials.

c) An investigation indicates that the metal parts of the system do not become exposed to the user when the equipment is subjected to the rigors of use and reasonably foreseeable abuse.

7.7 15-Day abnormal operation

7.7.1 An insulation system shall be subjected to the abnormal conditioning described in 9.5.1 and shall comply with the following conditions:

a) The integrity of the thermoplastic material shall be such that the 3 A fuse specified in 9.5.1 shall remain intact during the test.

b) The thermoplastic material shall withstand the dielectric voltage-withstand potential specified in 7.2.1 or 7.2.2 immediately following the conditioning specified in 9.5.1 with the 3 A fuse removed from the circuit.

c) Any molten metal or flaming shall be confined within the enclosure of the electrical equipment where the electrical component is used.

d) The maximum winding temperature shall not exceed a temperature equal to 45°C (81°F) over the insulation system's rated temperature, when measured by thermocouples on the surface of the coil.

7.7.2 The abnormal tests may be conducted with a protective device having a rating specified by the manufacturer connected in the circuit. A protective device that is relied upon to open the circuit as a result of an abnormal test shall be one that has been found acceptable for the purpose.

8 Performance for Contactors, Relays, Solenoids and Transformers

8.1 Volume resistivity

8.1.1 The resistance per unit volume (volume resistivity) of the polymeric material shall be:

a) Not less than 50 megohm-centimeters in the as-received condition.

b) Not less than 10 megohm-centimeters after exposure for 96 hours at a relative humidity of 90 ±5 percent and at a temperature of 35.0 ±2.0°C (95.0 ±3.6°F).

8.2 Dielectric voltage-withstand

8.2.1 The insulation system shall withstand for 1 minute without breakdown the application of the 50 – 60 Hz essentially sinusoidal potential specified in the applicable end-product Standard, between live parts and dead metal parts with the system still in a well-heated condition.

8.2.2 A potential of 1000 V plus twice the rated voltage shall be applied if the end-product standard does not specify a potential.

8.3 Normal conditioning

8.3.1 Except as indicated in Table 5.1, an insulation system shall be conditioned without resulting in any of the following:

a) Noticeable softening or distortion of the thermoplastic material after 1 hour under the conditioning described in 10.1.1.

b) Dielectric breakdown between windings and dead metal parts when subjected to the potential described in 8.2.1 or 8.2.2, immediately following the conditioning described in 10.1.1.

8.4 Abnormal conditioning

8.4.1 After being subjected to the abnormal conditioning described in 10.2.1, the insulation system shall comply with the following conditions:

a) The integrity of the thermoplastic material shall be such that the 3 A fuse specified in 10.2.1 remains intact during the test.

b) The thermoplastic material shall withstand , the dielectric voltage-withstand potential specified in 8.2.1 or 8.2.2 immediately following the conditioning specified in 10.2.1 and with the 3 A fuse removed from the circuit.

c) Any molten metal or flaming shall be confined within the enclosure of the electrical equipment where the electrical component is used.

d) The maximum winding temperature shall not exceed the temperatures specified in Table 8.1 when measured by thermocouples on the surface of the winding.

8.5 Severe conditioning

8.5.1 The insulation system shall be conditioned in accordance with each method described in 10.3.1 without dielectric breakdown between windings and dead metal parts when subjected to the dielectric voltage-withstand test described in 8.2.1 or 8.2.2, immediately following the conditioning described in 10.3.1.

Exception: This test need not be conducted if the insulation system complies with the requirements in 8.4.1 after being tested as described in 10.2.1.

8.5.2 The clearing of the circuit by an overtemperature or over-current protective device is considered to be acceptable.

8.6 Overload-burnout conditioning

8.6.1 This test need not be conducted if burnout does not occur during the abnormal conditioning described in 10.2.1.

Table 8.1
Maximum acceptable temperature rise under abnormal conditions[a]

Class of insulation	Maximum acceptable temperature rise, °C (°F)
105(A)	125 (225)
[a] Based on an assumed ambient temperature of 25°C (77°F). Tests are to be conducted at any ambient temperature within the range of 20 – 30°C (68 – 86°F).	

8.6.2 Except as indicated in 8.6.1 and 8.6.4, an insulating system employed in a transformer with a short-circuit current greater than twice the use operating current shall comply with the following.

a) After the overload-burnout conditioning described in 10.4.4, the 3 A fuse described in 10.4.9 shall remain intact.

b) Immediately following the overload-burnout conditioning described in 10.4.1, the 3A fuse is to be removed from the circuit and the dielectric voltage-withstand test described in 8.2.1 conducted.

c) The thermoplastic material shall show no appreciable softening or melting to affect spacing.

d) Any molten metal or flaming shall be confined within the enclosure of electrical equipment that the system is used.

8.6.3 Insulating systems employed in contactors, relays or solenoids need not be subjected to the overload-burnout test described in 10.4.4.

8.6.4 8.6.2 (a), (b), and (c) are not applicable provided all of the following conditions apply:

a) The nature of the equipment is such that extreme overload conditions are not likely.

b) All metal parts of the transformer are housed within an enclosure of acceptable insulating material and are isolated from exposed dead metal parts by acceptable insulating materials.

c) An investigation indicates that the metal parts of the transformer do not become exposed to the user when the equipment is subjected to the rigors of use and reasonably foreseeable abuse.

8.7 15-Day abnormal operation

8.7.1 An insulation system employed in a contactor, relay, solenoid or transformer shall be subjected to the abnormal conditioning described in 10.5.2 or 10.5.5 and shall comply with all of the following conditions:

a) The integrity of the thermoplastic material shall be such that the 3 A fuse specified in 10.5.2 remains intact during the test.

b) The thermoplastic material shall withstand the dielectric voltage-withstand potential specified in 8.2.1 or 8.2.2 immediately following the conditioning specified in 10.5.2 or 10.5.5 with the 3 A fuse removed from the circuit.

c) Any molten metal or flaming shall be confined within the enclosure of the electrical equipment in which the electrical component is used.

d) The maximum coil winding temperature shall not exceed the temperature specified in Table 8.1 when measured by thermocouples on the surface of the windings.

8.7.2 The abnormal tests may be conducted with a protective device having a rating specified by the manufacturer connected in the circuit. A protective device that is relied upon to clear the circuit as a result of an abnormal test shall be one that has been found acceptable for the purpose.

COIL FORMS

9 Performance for Motors

9.1 Normal conditioning

9.1.1 The current in the windings of the sample is to be increased by increasing the mechanical load, until the surface temperature on the windings, measured by a thermocouple, is equal to a temperature which is 10°C (18°F) over the temperature rating of the insulation system but not less than 90°C (194°F).

9.1.2 If increasing the current does not produce the desired surface temperature, the energized winding may be placed in an oven where the temperature is adjusted to produce the desired winding surface temperature.

9.2 Abnormal conditioning

9.2.1 A sample of the product containing the insulation system is to be subjected to the following conditioning. After stalling the rotor of the motor and connecting dead metal parts to ground through a 3A fuse, the winding is to be energized by applying the rated voltage for 7 hours or until any of the conditions described in 7.4.1 have been met.

Exception: When the length of the test is limited by an external factor – such as the functioning of a reliable, nonuser-serviceable device (such as a fuse or circuit breaker), or the functioning of the maximum-size branch-circuit protective device that the equipment is likely to be connected (but not less than 30 amperes) – the test shall be terminated when the limiting device functions to open the circuit.

9.3 Severe conditioning

9.3.1 The conditioning tests below are to be conducted as indicated:

a) The equipment is to be operated at 106 percent of rated voltage (see 9.3.2).

b) The equipment is to be operated at 94 percent of rated voltage (see 9.3.2).

9.3.2 Unless otherwise indicated or if primary-circuit adjustments are not provided, the test is to be conducted with the equipment connected to a supply circuit of maximum rated voltage and rated frequency except that, if the marked voltage is in the 105 – 120 V range, the potential of the supply circuit is to be 120 V and, if the marked voltage is in the 210 – 240 V range, the potential of the supply circuit is to be 240 V. If primary-circuit adjustments are provided, they are to be set for the minimum voltage in the 105 – 120 V range, or in the 210 – 240 V range, and the potential of the supply circuit is to be 120 V, or 240 V, whichever is applicable.

9.4 Overload-burnout conditioning

9.4.1 To determine whether an insulation system complies with the requirements of 7.6.2, each of three previously untested samples of the system are to be subjected to the following:

a) Operation at 'X' percent of the rated load for 14-1/2 minutes followed by operation at no load for 1/2 minute, where 'X' shall begin at 120, and shall be increased by 10 each successive 15 minute cycle to a maximum value of 200.

b) The test shall continue until the end results described in 7.6.3 and 9.4.2 occur or until the last cycle has been completed at 200 percent of the rated load.

c) If the end result occurs in less than 1/2 hour, the operation in (a) is to be repeated using a different sample and starting at 'X' equal to 100 instead of 120.

d) During the test, dead metal parts of the component are to be connected to ground through a 3 A fuse.

9.4.2 With reference to 9.4.1, failure of the insulation system to operate is considered to have occurred if:

a) Flame appears,

b) An open circuit occurs,

c) The motor stalls or

d) A short circuit develops in the winding that results in a spontaneous increase in current of 50 percent or more of the previous value.

9.4.3 If condition (c) occurs, the motor stalls except that it will run at rated load, the load shall be reapplied at the highest level that the motor will operate under.

9.4.4 If the end results occur as a short-circuit in the winding [9.4.2(d)], operation is to be continued for 30 seconds under load after the short circuit occurs, unless condition (a) flame, condition (b) open circuit, or condition (c) stalling occurs earlier.

9.4.5 If conditions (a), (b), or (c) occur, operation is to be terminated immediately.

9.4.6 If neither condition (a), (b), or (c) occurs during the 30 second interval, the system is then to be permitted to cool to room temperature. Without adjustment of the load from the value during the 30 second

interval, operation of the system is to be resumed for one period of up to 30 seconds until condition (a) flame, condition (b) open circuit, or condition (c) stalling occurs, whichever occurs first.

9.5 15-Day abnormal operation

9.5.1 The sample of the product containing the insulation system is to be subjected to the following conditioning. After stalling the rotor of a motor, the winding is to be energized by applying the rated voltage. The dead metal of the component is to be connected to ground through a 3 A fuse. The conditioning is to be continued for 15 days or until the system fails to comply with the conditions in 7.7.1 (a), (b), (c), and (d).

Exception: When the length of the test is limited by an external factor – such as a timer or the functioning of a reliable manual reset, nonuser-serviceable device (such as a fuse or circuit breaker), or the functioning of the maximum-size branch-circuit protective device that the equipment is likely to be connected (but not less than 30 A) – the test is to be terminated when the limiting device functions to open the circuit.

10 Performance for Contactors, Relays, Solenoids, and Transformers

10.1 Normal conditioning

10.1.1 The load on the secondary winding is to be increased until the surface temperature on the windings, measured by a thermocouple, is equal to a temperature which is 10°C (18°F) over the temperature rating of the insulation system but not less than 90°C (194°F).

10.1.2 If increasing the load does not produce the desired surface temperature, the energized winding may be placed in an oven where the temperature is adjusted to produce the desired surface temperature.

10.2 Abnormal conditioning

10.2.1 A sample of the product containing the insulation system is to be subjected to the following conditioning. After the movable part of the system has been prevented from moving (for example, the plunger of a solenoid blocked in the position that results in the highest load), or after short-circuiting the secondary winding of a transformer, the primary winding is to be energized by applying the rated voltage for 7 hours or until any of the conditions described in 8.4.1 have been met. The dead metal of the product shall be connected to ground through a 3 A fuse.

Exception: When the length of the test is limited by an external factor – such as a timer or the functioning of a reliable, manual reset, nonuser-serviceable device (such as a fuse or circuit breaker), or the functioning of the maximum-size branch-circuit protective device that the equipment is likely to be connected (but not less than 30 A) – the test shall be terminated when the limiting device functions to open the circuit.

10.3 Severe conditioning

10.3.1 The conditioning tests below are to be conducted as indicated.

a) The equipment is to be operated at 106 percent of rated voltage (see 9.3.2).

b) The equipment is to be operated at 94 percent of rated voltage (see 9.3.2).