38.3.2 A bonding conductor shall be copper, copper alloy, aluminum, or other material that has been investigated for use as an electrical conductor.

38.3.3 Ferrous metal in the grounding path shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

38.3.4 Metal-to-metal hinge-bearing members for doors or covers are considered to be means for bonding the door or cover for grounding if a multiple bearing-pin type (piano-type) hinge is used.

38.3.5 A separate bonding conductor:

a) Shall be protected from mechanical damage or located within the outer enclosure and

b) Shall not be secured by a removable fastener used for a purpose in addition to bonding unless the bonding conductor is not likely to be omitted if the fastener is removed and replaced as intended.

A bonding conductor shall be in metal-to-metal contact with the parts to be bonded.

38.3.6 A splice shall not be employed in a bonding conductor.

38.3.7 Other than as specified in 36.2.1, in a cord-connected appliance, a bonding conductor shall have a cross-sectional area not less than that of the grounding conductor of the supply cord.

38.3.8 Other than as specified in 38.3.9 in a permanently-connected appliance, the size of a conductor employed to bond an electrical enclosure or a motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. The size of the conductor shall be in accordance with Table 38.1.

Table 38.1
Minimum bonding conductor size

Maximum rating or setting of automatic overcurrent device in circuit, amperes[b]	Size of grounding/bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
20	12	(3.3)	10	(5.3)
60	10	(5.3)	8	(8/4)

[a] A conductor with an equivalent cross-sectional area may be used.

[b] See 38.3.10.

38.3.9 A bonding conductor for a component or electrical enclosure is not required to be larger than the conductors supplying power to the component or components within the enclosure.

38.3.10 If more than one size of branch-circuit overcurrent-protective device is used, the size of a component-bonding conductor is to be based on the rating of an overcurrent-protective device providing ground-fault protection for that component. For a component individually protected by a branch circuit overcurrent-protective device rated less than the overcurrent-protective device used in the power-supply circuit, a bonding conductor is to be sized on the basis of the component overcurrent-protective device rating.

39 Motors

39.1 Construction

39.1.1 A motor provided as part of an appliance shall be capable of handling the load it is intended to drive without introducing a risk of fire, electric shock, or injury to persons.

39.1.2 A motor winding shall be such as to resist the absorption of moisture.

39.1.3 With reference to the requirement in 39.1.2, film-coated wire is not required to be additionally treated to prevent absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated to prevent moisture absorption.

39.1.4 A brush cap accessible from outside the enclosure of a portable appliance that prevents contact with a live part at a potential of more than 30 volts (42.4 volts peak) to any other part or to ground shall be fastened in place so that removal cannot be accomplished by an ordinary tool used in the intended manner.

39.2 Brush wear out

39.2.1 A brush-holder assembly shall be constructed so that when a brush is worn out (no longer capable of performing its function), the brush, spring, and other parts of the assembly will be retained to the degree necessary to reduce the risk of:

a) Accessible dead-metal parts becoming energized and

b) Live parts becoming accessible.

39.2.2 With reference to the requirement in 39.2.1, the parts of a brush holder assembly are considered to be acceptably retained if:

a) The motor is enclosed, independently of the appliance enclosure, to the degree that the brush, spring, or other parts of the assembly will be contained within the motor enclosure, and no conductive parts of the motor enclosure are accessible to contact; or

b) The appliance has spacings such that parts of the brush holder assembly which can become free to move will not become live and accessible to contact nor bridge live parts to accessible metal parts, and the motor enclosure is not accessible to contact; or

c) Other constructions equivalent to (a) or (b).

39.3 Overload protection

39.3.1 An appliance shall incorporate thermal or overload protection in accordance with 39.3.2 if it is intended to be:

a) Permanently-connected, continuous-duty, and manually started, employing a motor rated 1 horsepower (746 watts output) or less or

b) Remotely or automatically controlled.

39.3.2 Motor-overload protection required for an appliance shall consist of one of the following:

a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3. Electronically protected motors shall comply with the Standard for Electronically Protected Motors, UL 1004-7. See 39.3.10.

Exception No. 1: For an appliance that includes a control that positively and reliably limits the length of time the appliance can operate, the duration of the temperature test and the endurance test, both under locked-rotor conditions, may be less than that specified but shall be not less than the time the appliance can operate.

Exception No. 2: A motor intended to move air only by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running-overload protection.

b) Impedance protection complying with the applicable requirements in Standard for Impedance Protected Motors, UL 1004-2, when the motor is tested as used in the appliance under stalled-rotor conditions;

c) Other protection that is shown by test to be equivalent to the protection mentioned in (a).

Exception: A motor as described in Exception No. 2 to (a) is not required to have running-overload protection.

39.3.3 Motor-overload protection provided for an appliance not required to have such protection shall:

a) Comply with the requirements in 39.3.2 or

b) Be shown by test not to result in a risk of fire, electric shock, or injury to persons.

39.3.4 The motor of an appliance with load characteristics likely to result in an overload or stalled condition that will not be evident to the user shall incorporate thermal or overload protection in accordance with the requirements in 39.3.2.

Exception: Motors indicated below are not required to comply with the overload protection requirement:

a) Motors rated less than 1 horsepower and:

1) Which are manually started;

2) Where the operator is in attendance during the entire operating cycle; and

3) Where malfunction of the motor is evident.

39.3.5 A multispeed motor in an appliance as specified in 39.3.1 which is provided with a separate overload protective device to provide running overload protection shall have the protection at all speeds at which the motor is intended to operate.

39.3.6 Overload devices employed for running overload protection, other than those that are inherent in a motor, shall be located in at least one ungrounded conductor of a single-phase supply system and in each ungrounded conductor of a 3-phase supply system.

39.3.7 If a requirement in this standard refers to the horsepower rating of a motor and the motor is not rated in horsepower, the appropriate table in the National Electrical Code, ANSI/NFPA 70, is to be used to determine the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating-current motor is to be used if the appliance is marked for use on alternating current only; otherwise the table applying to direct-current motors is to be used.

39.3.8 Motor-overload protection in which contacts control a relay coil in a motor starter shall comply with the requirements of 39.3.1.

39.3.9 Fuses used in motor-overload-protective devices shall be configured so that the motor is investigated with the largest size of fuse that is capable of being inserted in the fuseholder.

39.3.10 Electronically protected motor circuits shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. When the protective electronic circuit is relying upon software as a protective component, it shall comply with the requirements in the Standard for Software in Programmable Components, UL 1998. If software is relied upon to perform a safety function, it shall be considered software Class 1;

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1. If software is relied upon to perform a safety function, it shall be considered software Class B; or

c) Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or injury to persons during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this standard is then required.

39.4 Insulation systems

39.4.1 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in Table 39.1 at the thicknesses specified are permitted to be used without further evaluation.

Table 39.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	Inch	(mm)
Vulcanized fiber	0.028	(0.71)
Polyethylene terephthalate film	0.007	(0.018)
Cambric	0.028	(0.71)
Treated cloth	0.028	(0.71)
Electrical grade paper	0.028	(0.71)
Mica	0.006	(0.15)
Aramid paper	0.010	(0.25)

39.4.2 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 39.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 39.4.3.

39.4.3 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall be:

a) Unfilled or glass-reinforced nylon;

b) Polycarbonate;

c) Polybutylene terephthalate;

d) Polyethylene terephthalate;

e) Phenolic; or

f) Acetal

and shall have a relative or generic thermal index for electrical properties of 105°C (221°F) minimum. Leads shall be rated 90°C (194°F) minimum.

Exception No. 1: Other polymeric materials used in a Class 105 (A) insulation system shall comply with the requirements for thermal aging in 72.4.

Exception No. 2: Class (105) A DC motor located in limited energy primary circuit (See 4.36) or Class 2 circuit, shall comply with the applicable requirements in this standard.

39.4.4 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

39.4.5 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446

Exception: Class (105) A DC motor located in limited energy primary circuit (See 4.36) or Class 2 circuit, shall comply with the applicable requirements in this standard.

PERFORMANCE

40 General

40.1 The tests described in Sections 42 – 47 are to be conducted in that order, on the same samples.

Exception: Some tests on hand-supported hair dryers will require more than one sample, as noted in the description of the individual tests.

40.2 Unless otherwise noted in the individual requirements, all tests are to be conducted with the appliance connected to a supply circuit of rated frequency, and having a potential of:

a) 120 volts, for an appliance rated from 110 volts – 120 volts, inclusive;

b) 240 volts, for an appliance rated from 220 volts – 240 volts, inclusive; and

c) The maximum rated voltage of the appliance, for an appliance other than as mentioned in (a) or (b).

40.3 An appliance having a single frequency rating is to be tested at that frequency. An appliance rated AC/DC or 60 Hz/DC is to be tested on direct current or 60-Hz alternating current, whichever results in the most severe condition. An appliance rated 25 – 60 Hz or 50 – 60 Hz is to be tested on 60-Hz alternating current.

40.4 A simulated head used for temperature testing is to consist of a foamed plastic wig form, approximately 21-1/2 inches (546 mm) in circumference, closely wrapped with two layers of cheesecloth.

Pieces of black (exposed and developed) cellulose acetate, photographic film to represent hair-holding devices are to be attached to the top and sides.

40.5 Wherever cheesecloth is mentioned in connection with either a temperature test or an abnormal test, the cloth is to be bleached cheesecloth 36 inches (914 mm) wide, running 14 – 15 yards per pound mass (approximately 28 – 30 m^2/kg mass), and having what is known in the trade as a "count of 32 × 28," which means that for any square inch there are 32 threads in one direction and 28 threads in the other direction (for any square centimeter there are 13 threads in one direction and 11 threads in the other direction).

40.6 Wherever a hardwood surface is specified in connection with a test, the hardwood surface is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of nominal 3/4 inch (19.1 mm) plywood. The oak flooring is to be nominally 3/4 inch thick [actual size 3/4 inch by 2-1/4 inch (19.1 mm by 57.2 mm)]. The assembly is to rest on a concrete floor or an equivalent nonresilient floor during the test.

41 Ionization Circuits

41.1 Grooming appliances which employ ionization technology shall comply with 40.2 and 40.3.

41.2 The high voltage power supply used in the ionizer shall be evaluated to the applicable construction and component requirements for power supplies contained in the Standard for Electrostatic Air Cleaners, UL 867. The following performance tests of UL 867 shall be considered:

a) Output Test;

b) Temperature Test;

c) Dielectric Voltage Withstand Test – High Voltage Transformer Core;

d) Dielectric Voltage Withstand Test – Induced Energy, (for linear-type transformer only);

e) Abnormal Operations Test – Component Short- And Open-Circuit Test, and;

f) High Voltage Insulating Materials Arcing Test.

41.3 The high voltage pins (electrodes) of ionizer shall not be accessible per 9.4.

41.4 A grooming appliance employing ionization circuitry shall not produce a concentration of ozone exceeding 0.05 parts per million by volume when tested as described in 74.2 – 74.7.

42 Leakage Current Test

42.1 The leakage current of a cord-connected appliance rated for a nominal 250-volt or less supply when tested in accordance with 42.3 – 42.8 shall be not more than:

a) 0.5 milliampere for an ungrounded 2-wire appliance,

b) 0.5 milliampere for a grounded 3-wire portable appliance, and

c) 0.75 milliampere for a grounded 3-wire appliance:

1) Employing a standard attachment plug rated 20 amperes or less and

2) Intended to be fastened in place or located in a dedicated space.

42.2 Leakage current refers to all currents, including capacitively coupled currents that may be conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

42.3 All exposed conductive surfaces are to be tested for leakage current. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure that reduces the risk of electric shock as described in 9.4.1 – 9.4.8. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages considered not to present a risk of electric shock.

42.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil having an area of 10 by 20 centimeters in contact with the surface. Where the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance.

42.5 The measurement circuit for leakage current is to be as shown in Figure 42.1. The measurement instrument is described in (a) – (c). The meter actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used is not required to have all the attributes of the defined instrument.

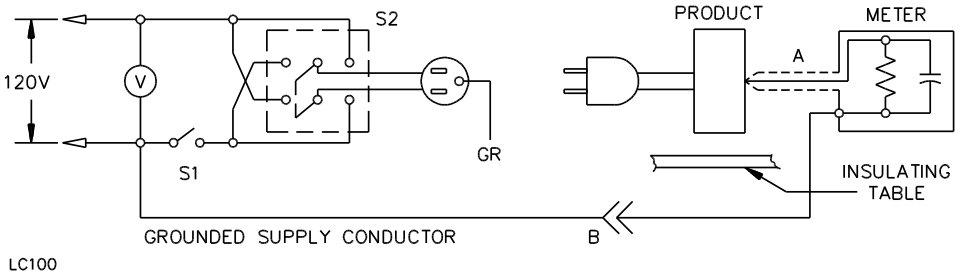
a) The meter is to have an input impedance of a 1500-ohm resistor shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of the voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated-to-actual value of current) equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

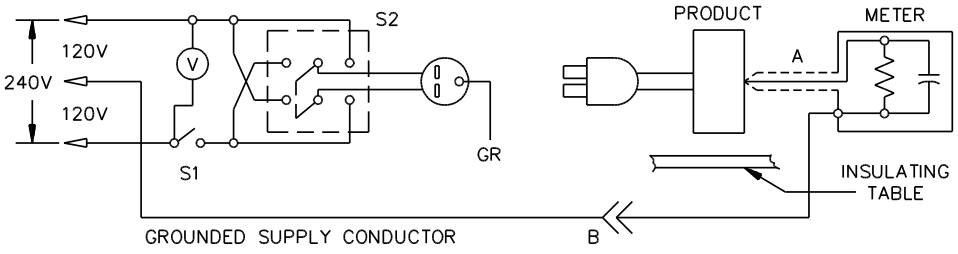
Figure 42.1

Leakage current measurement circuits



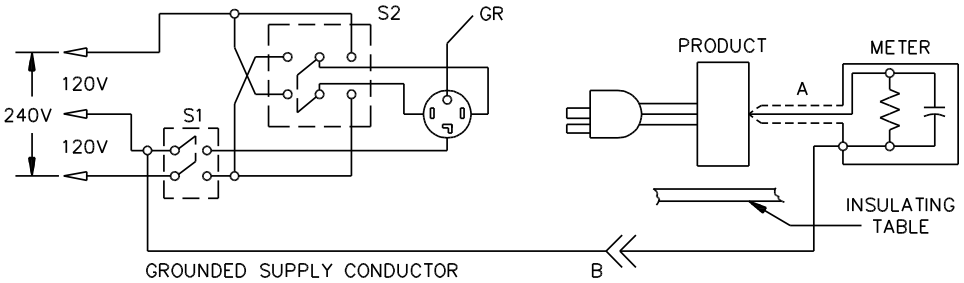
LC100

Appliance intended for connection to a 120-volt power supply.



LC200

Appliance intended for connection to a 3-wire, grounded-neutral power supply, as illustrated above.



LC300

Appliance intended for connection to a 3-wire, grounded-neutral power supply, as illustrated above.

A – Probe with a shielded lead.

B – Separated and used as a clip when measuring currents from one part of an appliance to another.

42.6 Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between an accessible part and the grounded supply conductor.

42.7 A sample of the appliance is to be tested for leakage current starting with the as received condition, but with its grounding conductor, if any, open at the attachment plug (open at receptacle as shown in Figure 42.1). The as received condition is without prior energization, other than that which may have occurred as part of the production-line testing. The supply voltage is to be adjusted to 120 or 240 volts, depending on the rating. Thermostats are to be closed. The test sequence, with reference to the measurement circuit (Figure 42.1), is to be as follows:

a) With switch S1 open, the appliance is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2, and with the appliance switching devices in all their operating positions.

b) Switch S1 is then to be closed, energizing the appliance, and within 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the appliance operated at the maximum heat setting of controls.

c) Leakage current is to be monitored until thermal stabilization under the maximum heat conditions occurs. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is considered to be obtained as in the normal temperature test. If any temperature-regulating thermostat does not cycle at the maximum setting, the setting is to be lowered until the thermostat does cycle before the final measurements at thermal stabilization are taken. Measurements are to be made with the thermostat, if any, open and closed. Upon evidence of stabilizing readings, monitoring periods may be increased.

d) If the appliance employs a single-pole switch or a thermostat with an off position, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the appliance is turned off. Both positions of switch S2 are to be used.

42.8 Normally a sample will be carried through the complete leakage current test program as covered in 42.7, without interruption for other tests. With the concurrence of those concerned, the leakage current test may be interrupted for the purpose of conducting other nondestructive tests.

43 Operational Test

43.1 Operation of an appliance as described in 43.2, shall not increase the risk of fire, electric shock, or injury to persons.

43.2 With reference to 43.1, an as-received sample of the appliance is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated, in accordance with the manufacturer's instructions, with respect to the intended uses of the appliance, including maintenance and cleaning recommended by the manufacturer and lack of such maintenance and cleaning; and with all accessories recommended by the manufacturer for use with the appliance. The appliance is to be manipulated as it would be in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected. The appliance is to be operated for a sufficient length of time or through a sufficient number of cycles so that all reasonably foreseeable complications are revealed.

44 Starting Current Test

44.1 A motor-operated appliance shall start and continue to operate on a test circuit protected by a nontime-delay fuse that has a current rating corresponding to that of the branch circuit to which the appliance is intended to be connected. The performance is unacceptable if the fuse opens the circuit.

Exception: A time-delay fuse may be used if all of the following conditions are met:

a) The construction of the product or its intended use is such that it is likely to be used only on the same branch circuit after installation;

b) The appliance will start and continue to operate on a circuit protected by a time-delay fuse; and

c) The appliance is marked in accordance with 79.5.1.

44.2 In a test to determine whether an appliance complies with the requirement in 44.1, the appliance is to be started three times, with the appliance at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation (the beginning of the normal operating cycle, in the case of an automatic appliance) and the motor is to be allowed to come to rest between successive starts.

45 Power Input Test

45.1 The current or power input to an appliance rated 50 watts or less shall be within the inclusive range of 75 – 110 percent of that rating. If the marked rating is greater than 50 watts, the current or power input shall be within the inclusive range of 90 – 110 percent of the rating.

45.2 The current or power input to the appliance is to be measured with the appliance at intended operating temperature under full-load conditions, and while connected to a circuit of a voltage in accordance with 40.2. Control switches or the equivalent, if provided, are to be set to give the maximum power input.

Exception: The current or power input of an appliance that uses a positive temperature coefficient (PTC) heating element shall be measured 1 minute after it has become energized.

46 Temperature Test

46.1 General

46.1.1 An appliance, when tested under the conditions described in 46.1.18 – 46.1.25, shall not attain a temperature at any point sufficiently high to constitute a risk of fire or to damage any of the materials employed in the appliance, or show maximum temperatures at specific points greater than those indicated in Table 46.1 and Table 46.2.

Exception: An initial temperature transient on a cycling, thermostatically-controlled appliance may be in excess of the values shown in Table 46.1 for such materials as molded phenolic, when the duration and extent of the excursion do not:

a) Result in performance that may have a damaging effect and

b) Unduly shorten the life of the appliance.

The maximum temperature transient permitted shall not exceed the temperature that is representative of the temperature used to investigate the material involved.

Table 46.1
Maximum temperatures

Materials and component parts	°C	(°F)
A. MOTORS		
1. Class 105 insulation system on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), of a DC motor, and of a universal motor:		
a. In an open motor:		
Thermocouple method[b]	90	(194)
Resistance method[b]	100	(212)
b. In a totally enclosed motor:		
Thermocouple method[b]	95	(201)
Resistance method[b]	105	(221)
2. Class 105 insulation systems on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), or less, not including a universal motor:		
a. In an open motor (thermocouple or resistance method)[b]	100	(212)
b. In a totally enclosed motor (thermocouple or resistance method)[b]	105	(221)
3. Class 130 insulation systems on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), of a DC motor, and a universal motor:		
a. In an open motor:		
Thermocouple method[b]	110	(230)
Resistance method[b]	120	(248)
b. In a totally enclosed motor:		
Thermocouple method[b]	115	(239)
Resistance method[b]	125	(257)
4. Class 130 insulation systems on coil windings of an AC motor having a frame diameter[a] of 7 inches (178 mm) or less, not including a universal motor:		
a. In an open motor:		
Thermocouple or resistance method[b]	120	(248)
b. In a totally enclosed motor:		
Thermocouple or resistance method[b]	125	(257)
B. COMPONENTS		
1. Class 130 insulation systems except as indicated in subitems (3) and (4) to item (A) and subitem (2) to item (B):		
Thermocouple method	110	(230)
Resistance method	120	(248)
2. Class 130 insulation systems on vibrator coils:		
Thermocouple or resistance method	120	(248)
3. Class 105 insulation systems on windings of a relay, a solenoid, or a transformer:		
Thermocouple method	90	(194)
Resistance method	110	(230)
4. Class 105 insulation systems on vibrator coils:		
Thermocouple or resistance method	100	(212)
5. Sealing compounds:	c	c
6. Capacitors:		
a. Electrolytic[d]	65	(149)

Table 46.1 Continued on Next Page