Table 41.1
Maximum pressure for tubing

Outside diameter		Minimum wall thickness		Maximum pressure to which tubing is subjected, psig (MPa)					
inch	(mm)	inch	(mm)	Seamless copper		Butt-welded steel		Seamless steel	
3/8 or smaller	(9.5)	0.016	(0.41)	500	(3.45)	600	(4.14)	1000	(6.90)
1/2	(12.7)	0.016	(0.41)	400	(2.76)	480	(3.31)	800	(5.52)
5/8	(15.9)	0.016	(0.41)	320	(2.21)	384	(2.65)	640	(4.42)
5/8	(15.9)	0.021	(0.53)	420	(2.90)	504	(3.48)	840	(5.80)
3/4	(19.0)	0.021	(0.53)	360	(2.48)	432	(2.98)	720	(4.97)
3/4	(19.0)	0.025	(0.64)	420	(2.90)	504	(3.48)	840	(5.80)
1	(25.4)	0.021	(0.53)	260	(1.79)	312	(2.15)	520	(3.59)
1	(25.4)	0.025	(0.64)	320	(2.21)	384	(2.65)	640	(4.42)

41.2 Pressure relief means

41.2.1 A part in which pressure might be generated by an external fire shall be provided with a means of safely relieving pressure such as a pressure-relief device (see 41.3.6) a fusible plug, a soldered joint, nonmetallic tubing, or other equivalent pressure-relief means.

41.2.2 There shall be no shut-off valve between the pressure-relief means and the parts that it is intended to protect.

41.3 Pressure relief devices

41.3.1 A vessel having an inside minor dimension of more than 3 inches (76 mm) and subject to air or steam pressure generated or stored within the appliance shall be protected by a pressure-relief device.

41.3.2 A gasket shall not be used as the pressure-relief device required by 41.3.1.

41.3.3 Each pressure relief valve shall be set to function at a pressure no greater than the maximum allowable working pressure marked on any part of the protected system, where applicable. See Section 76, Start-to-Discharge Test.

Exception: The Start-to-Discharge Test is not required when the device bears the ASME code inspection symbol. In this case, the marked operating pressure is the pressure setting of the device.

41.3.4 A pressure-relief device shall comply with all of the following:

a) Be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect;

b) Be installed so that it is readily accessible for inspection and repair and cannot be readily rendered inoperative;

c) Have its discharge opening located and directed so that:

1) The risk of scalding is reduced to an acceptable degree; and

2) Operation of the device does not result in the deposit of moisture on bare live parts or on insulation or components detrimentally affected by moisture.

d) Have a discharge rate adequate to relieve the pressure as determined by the Relief Device Maximum Pressure Test, Section 77.

Exception: A relief device that is stamped "ASME" and can be clearly shown by ASME calculations to have the flow capacity and relief pressure sufficient for the application is not required to be tested in accordance with the Relief Device Maximum Pressure Test, Section 77.

41.3.5 A pressure-relief device having an adjustable setting is to be judged on the basis of its maximum setting unless the adjusting means is sealed at a lower setting.

41.3.6 A pressure-relief device is evaluated as a pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

41.4 Pressure Controls

41.4.1 A pressure control is required to regulate the pressure in the vessel to 90 percent or less of the pressure relief device setting under all conditions of operation as defined by Section 50, Normal Temperature Test. The control, including pressure sensing means, shall be subjected to the Pressure Controls Endurance Test, Section 78.

Exception No. 1: A pressure control is not required to be tested in accordance to Section 78, Pressure Controls Endurance Test, if the system demonstrates during the Normal Temperature Test, Section 50, to operate below 90 percent or less of the pressure relief device setting.

Exception No. 2: The Pressure Controls Endurance Test is not required when all of the following conditions are met:

a) The control complies with the endurance requirements for a temperature-regulating control in the same environment. See 27.3 and 27.4; and

b) A separate limiting device is provided that limits the pressure to 90% or less of the relief-device setting (See Section 76, Start-to Discharge Test) under all intended conditions of operation. This control shall comply with the endurance requirements for a temperature-limiting control in the same environment. See 27.3 and 27.4.

Exception No. 3: The Pressure Controls Endurance Test is not required when the control used to regulate the pressure in the vessel meets the requirements for Limit Controls, UL 353 or has been evaluated for 100,000 cycles endurance in accordance with the requirements for Industrial Control Equipment, UL 508.

42 Stability

42.1 An appliance equipped with wheels, casters, or the like shall have at least two manually operated locks for the wheels, a floor lock, or the equivalent.

42.2 A drawer shall have a means, such as a mechanical stop, to prevent inadvertent removal of the drawer from its frame, when inadvertent removal could result in a risk of injury to persons.

Exception: A grease drawer having a dimension more than 12 inches (305 mm) from front to back is not required have a mechanical stop.

43 Surface Mounted Appliances

43.1 General

43.1.1 These requirements for surface mounted units apply to appliances that are normally installed on a counter but have an option to be mounted to a wall or to a similar structural surface.

43.1.2 An appliance that can be mounted to a wall or under a cabinet or shelf shall comply with 43.2, 43.3, Section 64, Mounting Means Test, and shall be provided with installation instructions in accordance with 91.10.

Exception No. 1: An appliance either designed only for wall mounting or marked for wall mounting only in accordance with 88.13 is not required to comply with 43.3.

Exception No. 2: An appliance either designed only for under cabinet or shelf mounting or marked as such in accordance with 88.13 is not required to comply with 43.2, Section 64, Mounting Means Test, or 91.10.

43.2 Wall mounting

43.2.1 In determining compliance with the requirements of this section, the weight of the appliance shall be determined by weighing the complete appliance with the exception of the mounting hardware. When a shelf, bowl, hook or any means of support of any object is provided, the weight of the intended object shall be included.

43.2.2 A wall appliance shall comply with the conditions specified in Table 43.1.

Exception: A wall appliance is not prohibited from complying with the conditions applicable to a heavier appliance.

Table 43.1
Mounting requirements

Maximum weight		
Pounds	(kg)	Conditions
2-1/4	(1.0)	(A or B) and (C or D)
4-1/4	(1.9)	[(A or B) and D] or E
Greater than 4-1/4	(1.9)	F

A – A wall-mounted appliance shall not project more than 7-1/2 inches (190 mm) from a flat vertical wall on which the appliance is mounted in the intended manner. The projection is to be measured to the farthest point on the lampholder with an adjustable lamp adjusted to the position that gives the maximum projection from the wall.

B – The center of gravity of a wall-mounted appliance shall not be more than 3 inches (76.2 mm) from the vertical wall on which the appliance is hung in the intended manner, the center of gravity being determined with any adjustment that gives a maximum projection from the wall.

C – An appliance is provided with either a ring-hanger, keyhole slot(s), or notch(es).

D – An appliance is provided with mounting hardware consisting of at least two No. 6 Type A sheet metal screws of sufficient length that the screws, when installed in the mounting holds, will penetrate the mounting surface by not less than 3/4 inch (19 mm).

E – An appliance is provided with mounting hardware consisting of at least two No. 10 – 24 machine screws with mating hollow-wall anchors, or wing or expansion bolts. The screws shall be of sufficient length to permit the anchors, or wing or expansion bolts to be installed through the mounting holes and a 3/4-inch (19-mm) thick wall.

F – An appliance is to be provided with mounting hardware that complies with the Mounting Means Test, Section 64.

43.2.3 A wall appliance is not prohibited from being provided with a separable bracket used to secure the appliance to a vertical mounting surface in accordance with 43.2.2.

43.2.4 The wall appliance shall comply with the requirements for Electrical and Fire Enclosures in Section 8 and the requirements for Accessibility of Live Parts, Section 10, without dependence on the intended mounting surface or any separable bracket.

43.2.5 When provided with a power supply cord, the cord shall exit the appliance from a surface other than the one abutting the vertical wall.

43.3 Under cabinet units

43.3.1 An appliance intended to be mounted under a cabinet, shelf, or similar structural surface shall be provided with means for mounting and instructions in accordance with 43.2 and 91.10 except as follows:

a) Only Conditions C and F from Table 43.1 are applicable. The keyhole slots in Condition C are capable of being opened to facilitate mounting in place and tightening of mounting screws.

b) Each term "wall mounted appliance" shall be replaced with "under cabinet mounted appliance" and each term "vertical" that references the mounting surface shall be replaced with "horizontal" in Subsection 43.2 and Section 64, Mounting Means Test.

c) The Exception to 64.2 does not apply and the surface mounted instructions in 91.10 shall specify the intended mounting surface.

d) The weight specified in 64.3 is to be applied to the point most likely to cause unacceptable results.

44 Gas-Tube Signs

44.1 A gas-tube sign (for example, neon) employed as part of an appliance shall comply with the requirements in the Standard for Electric Signs, UL 48.

PERFORMANCE – COMPLETE APPLIANCE

45 General

45.1 The performance of an appliance shall be investigated by subjecting the required number of samples to all the applicable tests described in Sections 46 – 65. Insofar as is practical, the tests shall be conducted in the order in which they are presented.

45.2 An appliance intended for operation on direct current as well as on alternating current is to be tested with a direct current supply. An appliance intended for operation at more than one frequency is to be tested at the most adverse frequency. Where the most adverse frequency is not obvious, more than one test may be needed.

Exception: When an appliance contains components that are not affected by changes in frequency, these components are not prohibited from being energized at any convenient rated frequency during the tests.

45.3 When a pressure gauge is required, it is to be attached so as to prevent leakage. Special fittings for direct connection to the system or commercial tubing or pipe may be employed for gauge connections. Volume of the pressure-measuring gauge and lines shall be held to a minimum relative to pressure vessel size.

45.4 Unless otherwise specified, the test voltage is to be the higher of the following:

a) The marked voltage rating; or

b) The highest voltage of the applicable range of voltages specified in 83.3 when the marked voltage is within one of the voltage ranges specified in 83.3.

45.5 Appliances containing parts that are removable without the use of tools are to be tested in the worst case condition (i.e., with or without the removable part).

Exception: When the appliance is marked in accordance with 85.7, the removable part is to be secured in place during the Normal Temperature Test, Section 50.

46 Leakage Current Test

46.1 A cord-connected appliance rated for a nominal 250-volt or less single phase supply shall be tested in accordance with 46.2 – 46.9. Leakage current shall not be more than:

a) 0.5 MIU for a three-wire (including grounding conductor) cord-and plug-connected portable appliance; and

b) 0.75 MIU for a three-wire (including grounding conductor) cord- and plug-connected 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.

Exception No. 1: The leakage current of an appliance incorporating a sheath type heating element is to be monitored during heat-up and cool-down. The maximum allowable leakage current for periods not exceeding 5 minutes during heat-up and not exceeding 5 minutes during cool-down, after reaching the leakage current limit of 0.5 MIU or 0.75 MIU, as applicable, is 2.5 MIU. For all other periods of operation, the leakage current shall be not more than the 0.5 MIU or 0.75 MIU limit, as applicable.

Exception No. 2: Conductive parts of an appliance that comply with the following conditions (1) – (4) and that have a leakage current greater than specified in (a) or (b) shall have a leakage current from simultaneously accessible parts to the grounded supply conductor no greater than 3.5 MIU. The leakage current between simultaneously accessible parts shall not exceed 0.5 MIU.

1) The appliance requires electromagnetic interference (EMI) suppression filtering for compliance with other requirements, such as Federal Communications Commission (FCC) Regulations;

2) There is a low probability that a path for available current through the body exists in the expected environment. If the available current flows to ground, this will involve consideration of the probability that the user will be grounded during the use of the product;

3) There is a low probability that high leakage conductive parts will be contacted during normal use of the appliance; and

4) The probability of injury resulting from an involuntary reaction is small.

Exception No. 3: For an appliance that upon loss of grounding, dependably disconnects all sources that can produce leakage current, the leakage current to ground shall not exceed 5 MIU with the grounding conductor open and with the loss-of-grounding circuit disabled. The leakage current between simultaneously accessible parts on the appliance shall not be more than 5 MIU.

46.2 All accessible conductive parts are to be tested for leakage currents. Leakage currents from these parts are to be measured to the grounded supply conductor individually as well as collectively when simultaneously accessible, and from one part to another when simultaneously accessible. A part is determined to be accessible unless it is guarded by an enclosure that is intended for protection against the risk of electric shock as defined in Section 10, Accessibility of Live Parts. Conductive parts are determined 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 that do not involve a risk of electric shock. When all accessible conductive parts are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current is to be measured between the grounding conductor of the product and the grounded supply conductor.

46.3 When a conductive part other than metal is used for an enclosure or part of an enclosure, leakage current is to be measured using a metal foil with an area of 10 by 20 centimeters (3.9 by 7.9 inches) in contact with the surface. When the conductive surface has an area less than 10 by 20 centimeters (3.9 by 7.9 inches), the metal foil is to be the same size as the surface. The metal foil is to conform to the shape of the surface but is not to remain in place long enough to affect the temperature of the product.

46.4 An appliance employing water or other liquid is to be tested with a hard water solution of 0.5 grams of calcium sulphate ($CaSo_4$) per liter of distilled water (0.07 ounces $CaSo_4$ per gallon of distilled water).

Exception: The composition of the water solution is not specified when it is determined by engineering evaluation that the leakage current will not be affected.

46.5 Typical measurement circuits for leakage current with the ground connection open are illustrated in Figure 46.1. The measurement instrument is defined in Figure 46.2. The meter that is used for a measurement is only required to indicate the same numerical value for a particular measurement as would the defined instrument; it is not required to have all the attributes of the defined instrument. Over the frequency range 20 Hz to 1 MHz with sinusoidal currents, the performance of the instrument is to be as follows:

a) The measured ratio V1/I1 with sinusoidal voltages is to be as close as feasible to the ratio V1/I1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 46.2.

b) The measured ratio V3/I1 with sinusoidal voltages is to be as close as feasible to the ratio V3/I1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 46.2. V3 is to be measured by the meter M in the measuring instrument. The reading of meter M in RMS volts can be converted to MIU by dividing the reading by 500 ohms and then multiplying the quotient by 1,000. The mathematic equivalent is to simply multiply the RMS voltage reading by 2.

46.6 Unless the measurement instrument is being used to measure leakage current from one part of an appliance to another, it is to be connected between accessible parts and the grounding and supply conductor connected to ground (the grounded or grounding conductor) that has the least extraneous voltages introduced from other equipment operated on the same supply. For products rated 120 volts or 240 volts, with one supply conductor grounded, this is likely to be the grounded supply conductor.

46.7 Prior to the test specified in 46.8, an appliance utilizing one or more sheathed heating elements is to be conditioned for 24 hours in a chamber having a temperature of 30 ±5° C (86 ±9° F) and a relative humidity of 50 ±5 percent, followed by conditioning for 48 hours in a chamber having a temperature of 30 ±5°C (86 ±9°F), and a relative humidity of 90 ±5 percent. The test in 46.8 is to be conducted as soon as is practical after the conditioning, but in no case more than 24 hours after the appliance is removed from the conditioning chamber.

Exception No. 1: The entire appliance is not required to be conditioned if the sheathed heating elements are removed from the appliance and conditioned as stated. The elements are to be re-installed in the appliance before the test is conducted.

Exception No. 2: The conditioning is not required if all sheathed heating elements in the appliance comply with the requirements of the Resistance to Moisture Test in the Standard for Sheathed Heating Elements, UL 1030.

46.8 A sample of the appliance, conditioned as specified in 46.7, where required, is to be tested for leakage current starting with the as-received condition – the as-received condition being without prior energization, except as may occur as part of the production-line testing. The supply voltage is to be adjusted to rated voltage.

The test sequence is to be as follows, with reference to the measurement circuit shown in Figure 46.1:

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 normal operating positions.

b) Switch S1 is then to be closed, energizing the appliance. Within 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the appliance product switching devices in all their normal operating positions.

c) Leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation as in the normal temperature test.

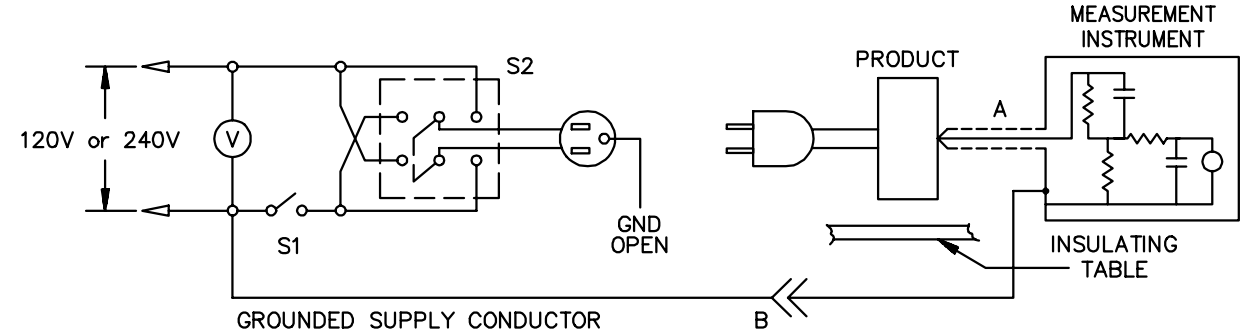
d) The leakage current is also to be monitored with switch S1 open while the appliance is at operating temperature and while cooling.

46.9 A sample is to be subjected to the entire leakage current test, as specified in 46.8, without interruption for other tests.

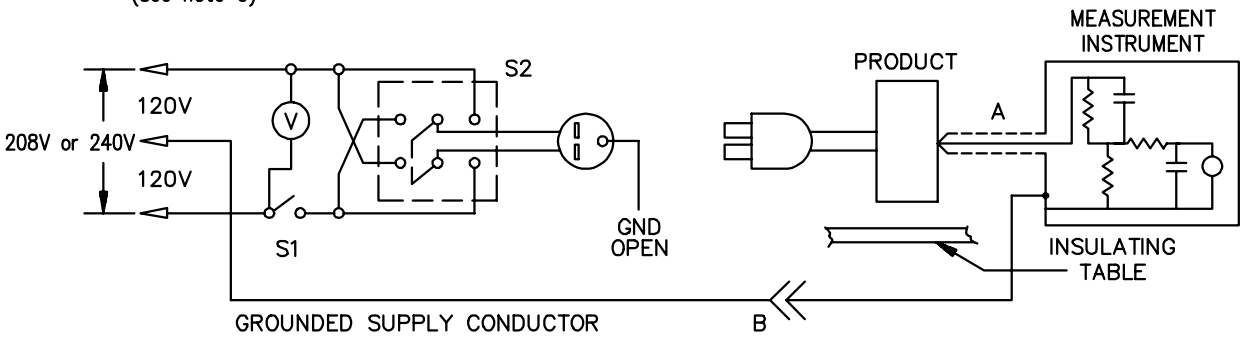
Exception: With the concurrence of those concerned, the leakage current test is not prohibited from being interrupted to conduct other nondestructive tests.

Figure 46.1

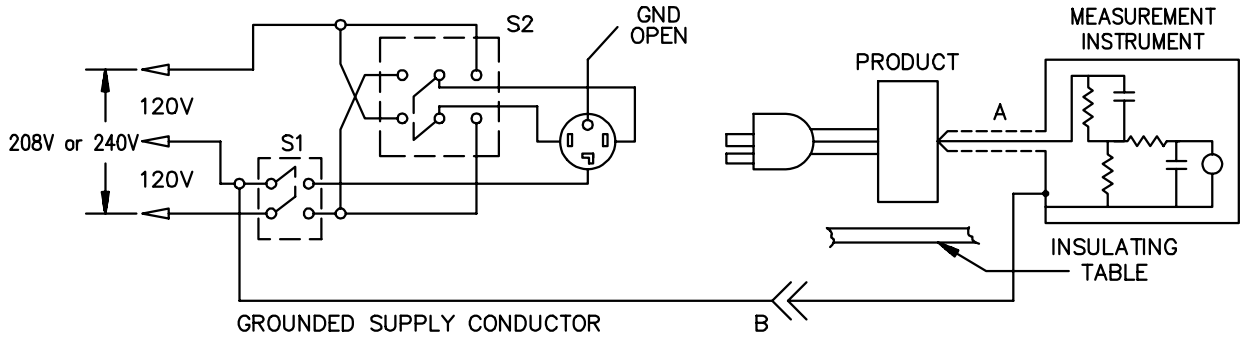
Typical leakage-current measurement circuits



Equipment intended for connection to a 120–volt or an end–grounded 2–wire, 240–volt power supply (see note C)



Equipment intended for connection to a 2–wire grounded–neutral 208–volt or 240–volt power supply (see note C)



Equipment intended for connection to a 3–wire grounded–neutral 208–volt or 240–volt power supply

A – Probe with shielded lead.

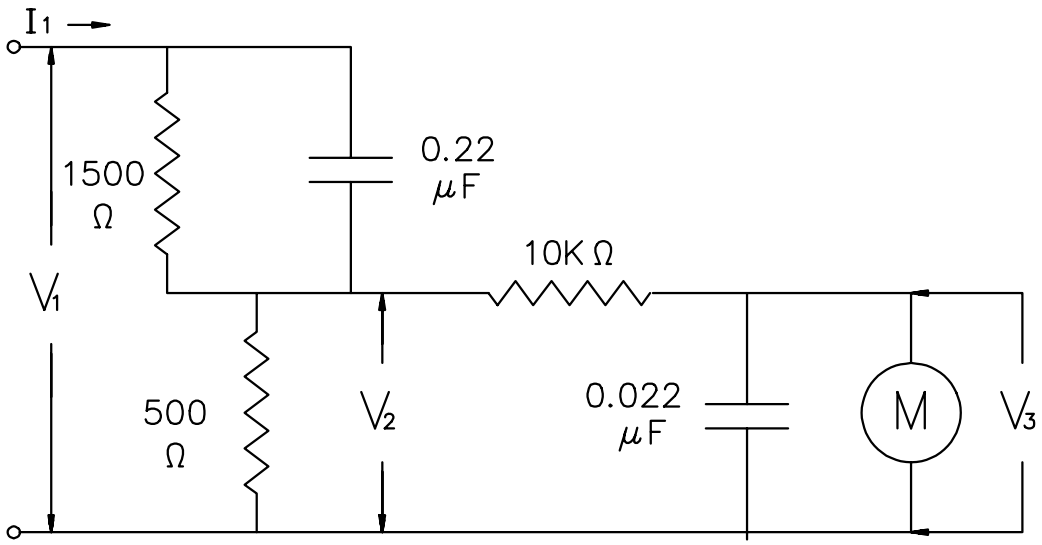
B – Separated and used as clip when measuring currents from one part of equipment to another.

C – Equipment intended for connection to a 2–wire 240–volt power supply is to be tested assuming that the product will be connected to an end–grounded supply (top circuit, above), unless the product is marked in accordance with paragraph 86.11 of UL 197, in which case it is to be tested for connection to a grounded–neutral supply (middle circuit, above).

LC100T

Figure 46.2

Measurement instrument for reaction (leakage) current



S3263B

Note – Detailed specifications and guidance for the calibration of this instrument are given in the American National Standard for Leakage Current for Appliances, ANSI C101.

47 Power Input Test

47.1 The power or current input to an appliance shall not differ from the marked rating by more than +5 or -10 percent, when the appliance is connected to a supply of rated frequency and voltage. See 83.8.

47.2 To determine whether an appliance complies with the requirement in 47.1, the power input is to be measured with the appliance at the intended operating temperature under full-load conditions and while connected to a power-supply circuit of rated voltage and frequency. An appliance rated for a voltage range, such as 110 – 120 volts, is to be tested at the mean of the range.

47.3 In addition to the test required by 47.1 and 47.2, the following tests are to be conducted when applicable. Provisions for connection to the source of supply are to be evaluated based upon the rated input current or power, or upon the input current or power measured during these tests, whichever is higher. See 16.3.2, 17.1.4, and 28.1.4.

a) When the marked voltage rating of an appliance falls within a voltage range mentioned in 83.3, the input is to be determined at the maximum voltage of the range.

b) When an appliance is rated in watts only, and not in amps, the current input to the appliance is to be measured with the voltage adjusted to cause the appliance to operate at rated wattage.

47.4 The power input to an appliance that employs a nonmetallic heating element, such as carbon, is to be determined when the element is new – that is, when it is first subjected to heat.

47.5 When an appliance incorporates a receptacle connected to the same electrical source as that supplying the appliance, which is not intended as a disconnecting means for any part of the appliance, and which is capable of being used as a general-use receptacle, the added load that the receptacle imposes

on the appliance – 80 percent of the current rating of the receptacle – and its supply connection shall be taken into consideration when conducting the tests in 47.1 – 47.4.

Exception: When the receptacle is marked for a specific load in accordance with 86.15, the marked load is to be used in calculating the total power or current input.

48 Input Averaging Test

48.1 This test is to be conducted when required by 28.1.4 or the Exception to 17.1.4. When tested as indicated in (a) and (b) for a minimum of 3 hours, the time weighted average input shall not exceed 80 percent of the anticipated branch circuit protected device in accordance with 28.1.3 and 28.1.5. The supply voltage shall be as specified in 47.3. General use receptacles shall be loaded as described in 47.5. The appliance is to be operated in a no-load condition or with the intended food load, whichever results in the maximum average current draw. When a food load is used, the food is to be replaced and the cooking cycle repeated as intended throughout the test period.

a) When the appliance is designed for a specific operation which requires the appliance to be energized and deenergized, and this operation has an inherent human limitation of cycle time, that cycle time shall be used for this test.

b) When the appliance is limited to a duty cycle by a controller, the test is to be conducted with the controller adjusted to the most severe operating conditions available using user adjustable controls.

49 Short-Circuit Tests

49.1 Devices and conductors referenced in Exception No. 2 to 28.5.3.2 shall withstand short circuit and ground fault conditions when protected by:

a) A device that is acceptable for branch circuit protection and is located in the heater, or

b) A branch circuit overcurrent protective device of the type and maximum rating specified on the heater nameplate. There shall be no damage to the conductor or its termination, no ignition of the cheesecloth surrounding the enclosure housing the components under test, and no arc-over between line- and low-voltage circuits.

49.2 For the purpose of these tests:

a) Circuit breakers and fuses are not considered to be interchangeable;

b) Fuses of the same rating are considered to be interchangeable;

c) HACR type circuit breakers of the same rating are considered to be interchangeable; and

d) Circuit breakers of other than the HACR type are not considered to be interchangeable with each other or with HACR type circuit breakers.

49.3 Each device and each conductor is to be connected in a circuit having a minimum capacity based on the maximum rated current and voltage of the heater in accordance with Table 49.1. Each concurrent load condition is to be considered separately, and the maximum resulting current employed as the basis of selection of the capacity of the test circuit. The voltage source for the test circuit is to be an alternating voltage and the circuit capacity is to be measured without the devices or the conductors in the circuit.