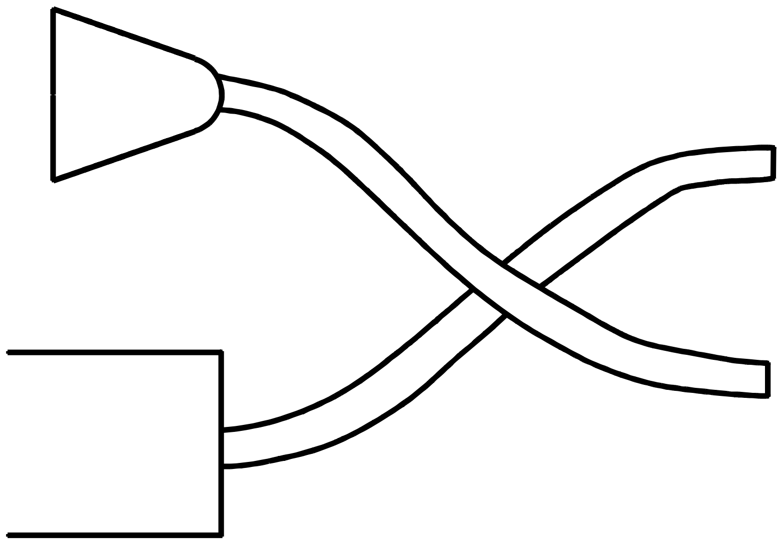
30.3 For all load conditions where leads are required, GTO cables intended for the voltages involved shall be used in lengths that are short and still functional.

30.4 All GTO splice connections shall be by twisting in accordance with Figure 30.1 and enclosed in a two-piece double back boot of the appropriate size.

Figure 30.1
Twisted leads
Option 1
Step 1



SM801

Step 2

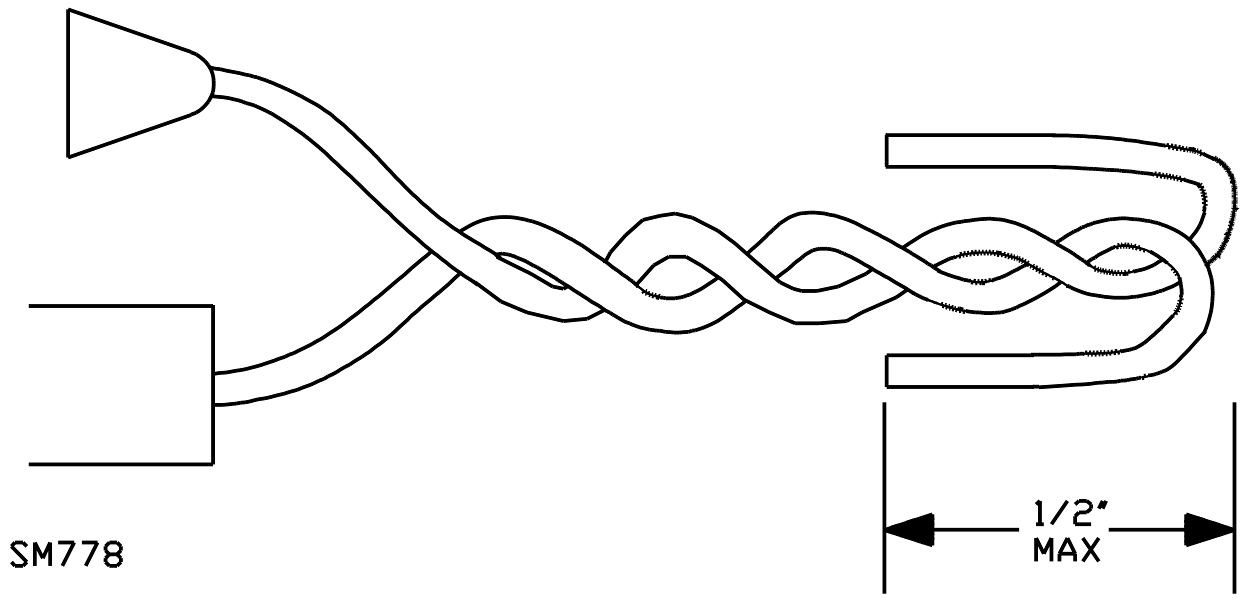
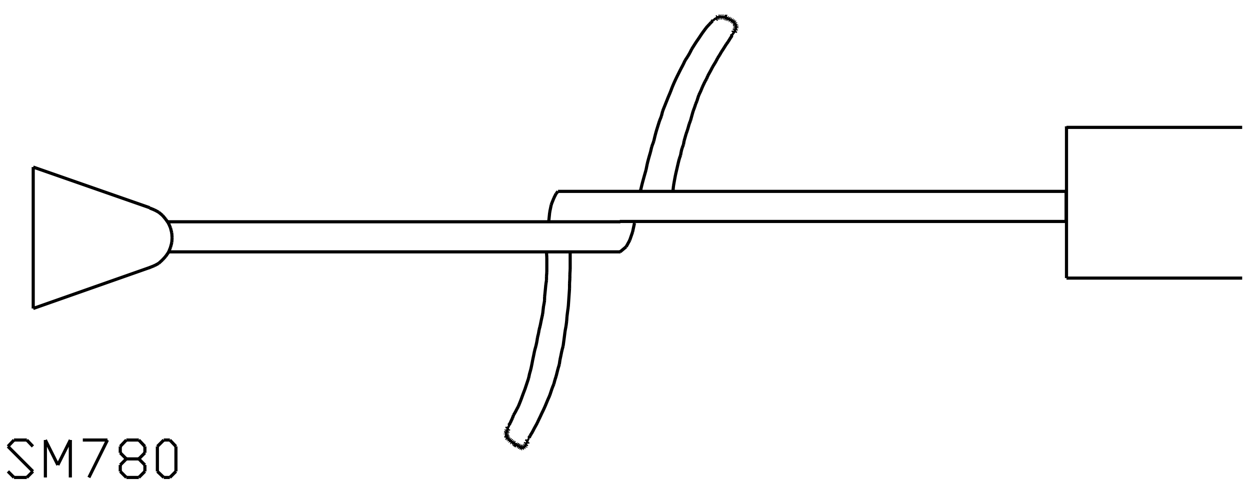
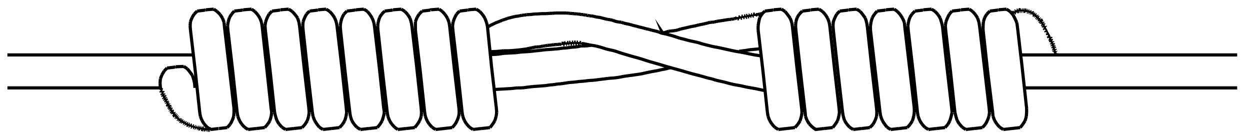


Figure 30.1 (Cont'd)
Option 2
Step 1



Step 2

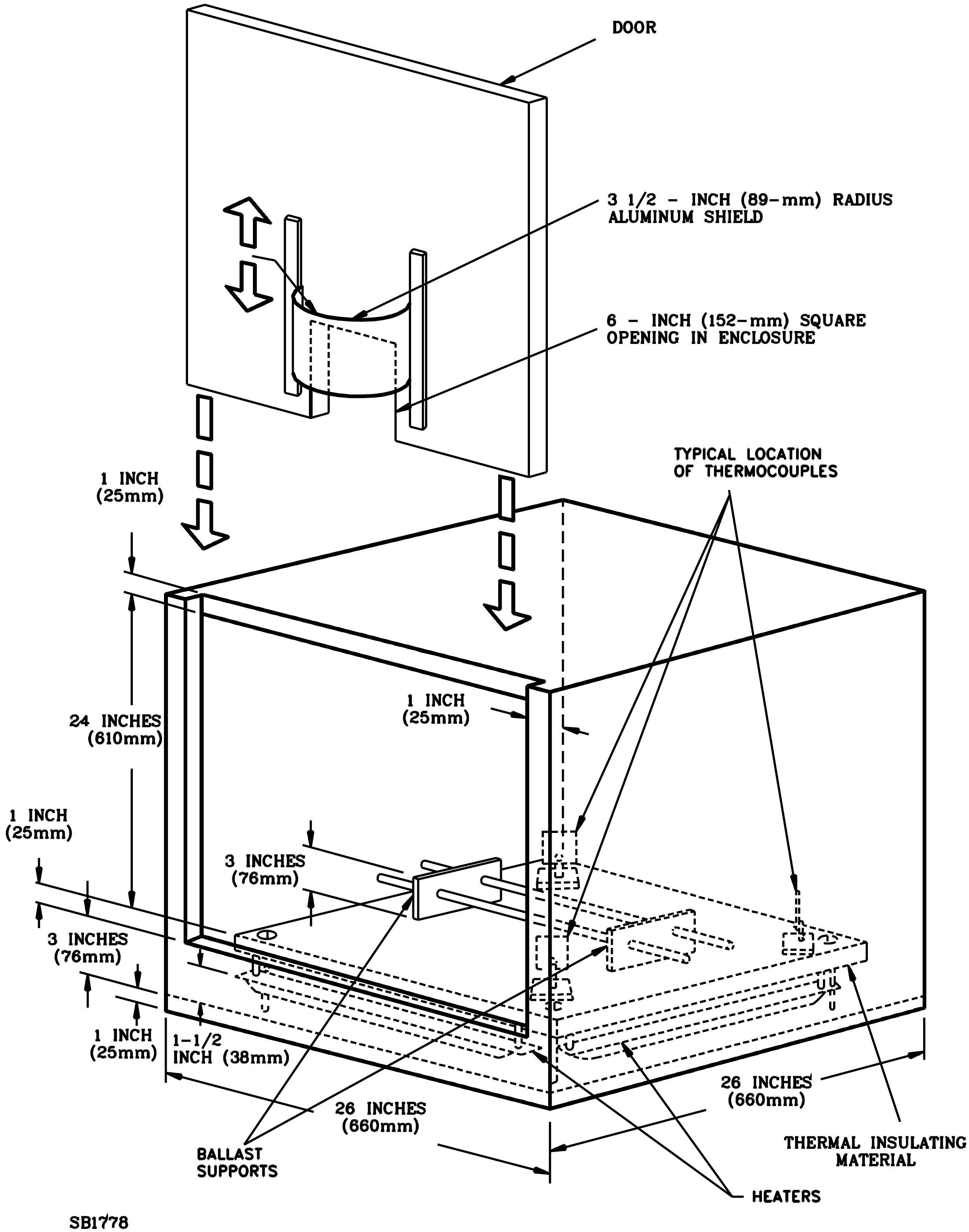


SM800

30.5 The neon supply is to be operated in an ambient environment of 40 ±5°C (104 ±9°F) in the test oven specified in 30.5 – 30.7.

30.6 During the test, the neon supply is to be supported as described in 30.9 and as illustrated in Figure 30.2. The floor between the heaters and the neon supply under test is to be of a thermal insulating material. The test compartment of the enclosure is to have internal dimensions of 24 by 24 in (610 by 610 mm). The floor of the test compartment is to be 22 by 22 in (559 by 559 mm), with an air space of 1 in (25.4 mm) all around the floor for circulation of the heated air. A 3-in (76.2-mm) deep heater compartment is to be provided below the floor of the test area for the heating elements. One side of the test compartment is not prohibited from being removable, and is to be constructed so that it is capable of being securely fastened to the remainder of the enclosure. One of the sides is to have a 6-in (152-mm) square opening located centrally at the bottom edge of the test compartment, and the enclosure is to be constructed so that the only possibility of air circulation is through this opening. The opening is to be covered by an aluminum shield positioned so that it extends 1/2 in (12.7 mm) beyond the perimeter of the opening.

Figure 30.2
Test enclosure



30.7 The heat source used for the test enclosure described in 30.5 is to consist of four 300-W, 230-V, strip heaters having heating surface dimensions of 1-1/2 by 12 in (38 by 305 mm). The elements are to be connected in parallel to a 120-V supply source. The elements are to be mounted in the 3-in (76.2-mm) deep heater compartment located midway between the test-compartment floor and the base, and are to be arranged so that they form a square with the outside edge of each element 2-1/2 in (63.5 mm) from the adjacent inside wall of the compartment. The elements are to be controlled by a thermostat.

30.8 In lieu of the oven construction described in 30.5 and 30.6, the oven is to be a commercially manufactured oven having still-air convection heating. The heaters are to be located below the floor of the oven compartment, and are to be thermostatically controlled to provide the required oven temperature regardless of the heat gain from the device under test. The volume of the oven compartment is to be between 5-1/2 ft^3 (0.156 m^3) and 8 ft^3 (0.226 m^3).

30.9 Prior to the test, the neon supply not energized is to be placed in the test enclosure until all parts reach the temperature of the heated air.

30.10 The neon supply is to be in its normal operating position, supported 3 in (76.2 mm) above the floor of the test enclosure by two 3-in wooden cleats, and is to be centrally located with respect to the sides of the enclosure. Electrical connections are not prohibited from being brought out of the enclosure through the 6-in (152-mm) square opening specified in 30.5. During the test, the enclosure is to be located so that the shielded opening is not exposed to drafts or rapid air currents.

30.11 During the temperature test, with the neon supply operating under the load conditions specified in Table 26.1, and no load conditions, the operating temperatures shall not exceed the temperatures in Tables 30.1 and 30.2.

Table 30.1
Maximum temperature rises

	Materials and components	°C	(°F)
1.	On any point of the enclosure of a neon supply	50	(90)
2.	Field-wiring conductors or any surface that is contacted by field-wiring	20[a]	(36[a])
3.	Field-wiring terminals	35	(63)
4.	Class 105 (A) coil insulation systems of a relay, a solenoid, or similar part:		
	Thermocouple method	55[b]	(99[b])
	Resistance method	65[c]	(117[c])
5.	Class 130 (B) coil insulation systems of a relay, a solenoid, or similar part:		
	Thermocouple method	70[b]	(126[b])
	Resistance method	80[c]	(144[c])
6.	Class 105 (A) transformer insulation systems:		
	Thermocouple method	55[b]	(99[b])
	Resistance method	65[c]	(117[c])
7.	Class 130 (B) transformer insulation systems:		
	Thermocouple method	70[b]	(126[b])
	Resistance method	80[c]	(144[c])
8.	Class 155 (F) transformer insulation systems:		
	Thermocouple method	95[b]	(171[b])
	Resistance method	100[c]	(180[c])
9.	Class 180 (H) transformer insulation systems:		
	Thermocouple method	110[b]	(198[b])
	Resistance method	120[c]	(216[c])
10.	Electrode splice enclosure (boot)	65[c,d]	(117[c,d])

Table 30.1 Continued on Next Page

Table 30.1 Continued

	Materials and components	°C	(°F)
11.	GTO cable insulation	65[c,d]	(117[c,d])
12.	Varnished-cloth insulation	45	(81)
13	Fiber used as electrical insulation	50	(90)
14.	Thermoset electrical insulation (phenolic, urea, and similar materials)	110[d]	(198[d])
15.	Wood or other combustible material	50	(90)
16.	Wire insulation or insulating tubing/sleeving	20[e]	(36[e])
17.	Fuses:		
	Class G, J, L, T, or CC	85	(153)
	Tube, ferrule, or blade	70	(126)
	Other	50[f]	(90[f])
18.	Capacitors:		
	Electrolytic	25[g]	(45[g])
	Other than electrolytic	50[g]	(90[g])
19.	Sealing or potting compound	h	(h)
20.	Power switching semiconductor devices	i	(i)

[a] The maximum temperature rise for wire rated 75°C (167°F) is 35°C (63°F), and for wire rated 90°C (194°F) the temperature rise is 50°C (90°F).

[b] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple is not prohibited from being 5°C (9°F) higher than that specified, when the temperature rise of the coil as measured by the resistance method is not more than that specified.

[c] See 30.12 for test guidelines.

[d] These limitations do not apply to a material that has been investigated and rated for a higher temperature.

[e] The maximum temperature rise is the temperature rating of the material minus 40°C (104°F) (ambient temperature).

[f] A fuse investigated and determined to be capable of being used at a higher temperature is not prohibited from being used at that temperature.

[g] The limitation does not apply to a capacitor that is marked for a higher temperature rating.

[h] Unless a thermosetting compound, the maximum sealing compound temperature, when corrected to a 40°C (104°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined in accordance with the Test of Softening Point by the Ball-and-Ring Apparatus, ASTM E28.

[i] The maximum temperature rise on the case is the maximum case temperature for the applied power dissipation specified by the manufacturer minus an assumed ambient of 40°C (104°F).

Table 30.2
Case temperature code

Maximum case temperature,[a]		Marking code
°C	(°F)	
50	(122)	2161HX
60	(140)	2161KX
75	(167)	2161MH
90	(194)	2161WX

[a] The maximum case temperature on any point of the enclosure of a neon supply, as measured during the Temperature Test in 30.1– 30.7. All temperature limit values are based on an assumed ambient temperature of 40°C (104°F).

30.12 Coil and winding temperatures of a neon supply are to be measured by thermocouples located on exposed surfaces, except that the resistance method specified in 30.13 is to be used for a coil that is inaccessible for attaching thermocouples, such as a coil immersed in sealing compound, wrapped with thermal insulation, or wrapped with more than two layers of insulating material totaling more than 1/32-in (0.8-mm) thick.

30.13 The temperature rise of a winding is determined by the resistance method according to the following formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise of the winding in °C;

R is the resistance of the coil at the end of the test in Ω;

r is the resistance of the coil at the beginning of the test in Ω;

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;

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

t_2 is the room temperature in °C at the end of the test.

30.14 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2), and not smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of 30 AWG iron and constantan or copper and constantan wire, and a potentiometer type instrument. Such equipment is to be used whenever reference temperature measurements by thermocouples are required. The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to comply with the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

30.15 A temperature measured by the thermocouple method is determined to be constant when three successive readings taken at intervals of 10% of the previously elapsed duration of the test, and not less than 15 min, indicate no further temperature increase.

30.16 Just prior to measuring the thermocouples, the power to the neon supply is to be disconnected from the neon supply.

31 Dielectric Voltage-Withstand Tests

31.1 General

31.1.1 A neon supply shall not provide evidence of dielectric breakdown when subjected to the dielectric voltage-withstand tests specified in 31.1.2 – 31.2.6.

31.1.2 Dielectric voltage-withstand tests are to be conducted using a 500 VA or larger capacity testing transformer. The output voltage of the testing transformer is to be sinusoidal and capable of being varied. The applied potential as specified in 31.2.1, 31.2.2 and 31.2.4, is to be increased from zero until the required test level is reached and is to be held at that level for 1 min. 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. The tests are to be conducted at the rated supply input frequency of the neon supply unless otherwise noted.

31.1.3 A neon supply rated for an ac input shall be subjected to an ac potential, and a neon supply that is rated for a dc input shall be subjected to a dc potential.

31.1.4 When a dielectric test is being conducted between current-carrying parts and an insulating type material (polymeric enclosure, accessibility barrier, and similar parts), the outer surface of the insulating material shall be covered with metal foil and the test shall be conducted between the current-carrying parts and the metal foil.

31.1.5 The sensitivity of the test equipment is to be such that when a 120,000-Ω resistor is connected across the output, the test equipment does not indicate a dielectric breakdown for any voltage less than the specified test voltage, and does indicate dielectric breakdown for any output voltage equal to or greater than the specified test voltage. The calibrating resistor shall be adjusted to have a resistance as close to 120,000 Ω as instrumentation will permit, and not more than 120,000 Ω.

31.2 Primary and secondary circuits

31.2.1 While still warm from the temperature test as specified in the Temperature Test, Section 30, an isolated output neon transformer shall withstand for one minute without breakdown the application of a 60-Hz sinusoidal potential of:

a) 1000 V plus twice the maximum rated primary voltage (line-to-ground) applied between the primary-circuit and dead-metal parts (enclosure, core, and similar parts);

b) 1.25 times the maximum measured secondary potential or rated secondary voltage, whichever is greater, applied between the primary and secondary circuit; and

c) With the grounded end of the primary winding solidly connected to the enclosure, 1.50 times the rated primary voltage (line-to-line) applied across the ends of the primary winding. The test is to be conducted first with one end of the secondary and then the other, in turn connected to the enclosure.

31.2.2 While still warm from the temperature test as specified in the Temperature Test, Section 30, and the outputs open-circuited, a neon transformer with a ground-referenced secondary shall withstand for one minute without breakdown the application of a 60-Hz sinusoidal potential of:

a) 1000 V plus twice the maximum rated primary voltage (line-to-ground) applied between the primary-circuit and dead-metal parts (enclosure, core, and similar parts);

b) 1.50 times the secondary voltage induced by applying 1.5 times the maximum rated primary voltage (line-to-line) across the ends of any primary winding, with the grounded end of the primary solidly connected to the enclosure; and

c) When the neon supply is constructed so that the primary winding and each half of the secondary winding are wound on separate legs of the core, with the magnetic paths in parallel and with secondary ground-fault protection defeated, the test described in (b) is to be repeated with first one secondary terminal and then the other, in turn, connected to the enclosure.

31.2.3 The tests described in 31.2.1(c) and 31.2.2 (b) and (c) are to be conducted at a higher frequency when the exciting current at rated frequency is such as to result in excessive heating of the primary winding.

31.2.4 While still in a heated condition, a neon power supply shall withstand for one minute without breakdown the application of a 60-Hz sinusoidal potential of:

a) 1000 V plus twice the maximum rated input voltage (line-to-ground) applied between the input circuit and dead-metal parts;

b) 1.25 times the maximum measured output voltage (line-to-line) applied between the input and output circuits; and

Exception: The potential is to be applied between the primary and secondary of an output transformer when the power supply complies with 33.2(b).

c) 1.25 times the maximum measured voltage between an output circuit operating at more than 1000 Vrms and dead-metal parts.

Exception: Chassis-connected components are to be disconnected at the chassis. Components connecting the secondary mid-point or end-point to the chassis are permitted to be disconnected at the output mid-point or end-point when the voltage across those components to ground is a maximum 30 Vrms under all conditions including ground faults.

31.2.5 When the current through a capacitor of capacitor-type filter connected across the line, or from line-to-earth ground, is large enough to make it difficult to maintain the required alternating-current test potential, the neon supply is to be tested with a dc test potential of 1.414 times the rms value of the test voltage specified in 31.2.1(a), 31.2.2(a), or 31.2.4(a), between primary-circuits and dead-metal parts.

31.2.6 A neon supply with integral electrode receptacles shall be constructed to withstand without breakdown, for a period of 1 min, the application of a dielectric voltage potential as specified in Table 31.1, between current-carrying parts of the electrode receptacles and the neon supply enclosure with the electrodes of gas-filled tubes in place.

Table 31.1
Electrode receptacle dielectric test potential

Rated output voltage of neon supply, V	Applied test potential, Vrms
1000 – 2500	6,500
2501 – 5000	12,000
5001 – 6000	14,000
6001 – 7500	17,000
7501 – 10,000	22,000
10,001 – 12,000	26,000
12,001 – 15,000	33,000

31.3 Barrier and insulating materials

31.3.1 An insulating material used in accordance with the Exception to 25.1 or Exception No. 2 to 15.1 shall be subjected to a dielectric voltage-withstand potential as specified in 31.3.3 or 31.3.4 in accordance with 31.3.2.

31.3.2 The dielectric voltage-withstand potential for an insulating material shall comply with 31.3.3, when insulating between live parts having a potential difference of 1000 V or less and 31.3.4, when insulating between live parts having a potential difference greater than 1000 V.

31.3.3 An insulating material shall withstand a dielectric voltage-withstand potential of 1000 V plus two times the maximum potential voltage difference between the live parts insulated from each other. The dielectric voltage shall be raised gradually, within 10 s, to the test voltage and the test voltage maintained for one minute. During the test, there is to be no indication of dielectric breakdown.

31.3.4 An insulating material shall withstand a dielectric voltage-withstand potential of 1750 V plus 1.25 times the maximum potential voltage difference between the live parts being insulated from each other. The dielectric voltage is to be raised gradually, within 10 s, to the test voltage and the test voltage maintained for one minute. During the test, there is to be no indication of dielectric breakdown.

31.3.5 A material or a combination of materials and air space when functioning as an accessibility barrier in accordance with 8.8, shall withstand a dielectric voltage-withstand potential of 1750 V plus 1.25 times the maximum potential voltage difference between ground and the live part being insulated from user or service personnel contact. The dielectric voltage is to be raised gradually, within 10 s, to the test voltage and the test voltage maintained for one minute. During the test, there is to be no indication of dielectric breakdown.