25.15 Temperatures on capacitors and on the case are to be measured by thermocouples. The 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). The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to comply with the requirements specified in 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.

25.15 revised December 6, 2013

25.16 A thermocouple junction and the adjacent thermocouple lead wire are to be securely held in thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will result from securely taping or cementing the thermocouple in place; but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

25.17 When thermocouples are used to determine temperatures, it is common to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan (Type J) wires. A potentiometer- or electronic-type instrument and such equipment is to be used whenever a referee temperature measurement by thermocouples is necessary. Thermocouples consisting of chromel-alumel (Type K) or copper-constantan (Type T) wires may be used if it is determined that high frequency ballast operation results in eddy current heating of iron and constantan thermocouples.

25.17 revised June 10, 2010

25.18 The temperature on a coil may be measured by the thermocouple method or determined by the change-of-resistance method (comparing the resistance of the winding at the temperature to be measured with its resistance at a known temperature) using the formula specified in 25.20.

25.19 The test is to continue until constant temperatures are obtained. A temperature is considered constant if:

a) The test has been running for at least 3 hours; and

b) Three successive readings, taken at 15 minute intervals, are within 1 degree C of one another and are still not rising.

25.20 The temperature of a winding is to be calculated by the following formula:

$$T_H = \frac{R_H}{R_C}(k + T_C) - k + (40 - T_o)$$

in which:

T_C is the room temperature of the coil in degrees C at the beginning of the test when R_C is measured;

T_H is the temperature of the coil in degrees C at the end of the test;

R_H is the resistance of the coil at the end of the test;

R_C is the resistance of the coil at the beginning of the test;

T_O is the temperature of the oven in degrees C at the end of the test when R_H is measured; and

No Text on This Page

k is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum. Values of the constant for other grades must be determined.

25.21 As it is generally necessary to de-energize the winding before measuring R_H, the value of R_H at the end of the test may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistive values and time may be plotted and extrapolated to give the value of R_H at the end of the test.

26 Abnormal-Temperature Test

26.1 A ballast shall be tested in accordance with 26.6 – 26.9; the maximum temperature:

a) Of a coil of a reactance ballast shall not be more than 135°C (275°F) when it incorporates a Class 105 insulation system and 160°C (320°F) when it incorporates a Class 130 insulation system, as measured by the resistance method.

b) On a capacitor shall not be more than 10°C (18°F) over the manufacturer's rating, except as noted in 26.4.

c) Of a component of an electronic ballast, other than as noted in (a), shall not exceed the values specified in Table 25.1 nor shall the temperature at any other point be so high as to result in a risk of fire or adversely affect any material used in the ballast.

Exception: The abnormal-temperature test may be waived if it is obvious that temperatures will be lower than they are for normal operation.

26.2 Regarding 26.1(a), a thermocouple measurement is to be made on the outer surface of a ballast coil and shall not be more than 130°C (266°F) when the coil incorporates a Class 105 insulation system, and 150°C (302°F) when it incorporates a Class 130 insulation system.

26.3 A thermal protective device provided with a ballast that complies with Protective Devices Provided in Class P Protected Ballast, Section 16, is to remain functional during the abnormal temperature test.

26.4 The maximum temperature for a capacitor specified in 26.1 and Table 25.1 applies to a power capacitor. Any other capacitor is to be judged on the basis of its performance at the temperatures to which it is subjected during the normal- and abnormal-temperature tests.

26.5 During the test described in 26.6 – 26.9, no compound or other material shall be emitted from the ballast.

26.6 For a resistance ballast operated under the conditions described in 26.7 and 26.9, the temperature on any material used in the ballast shall not exceed the temperature limit for that material.

26.7 For a rapid- or instant-start-circuit ballast, the test is to be conducted with a deactivated lamp for either a single lamp ballast or a multilamp ballast. For a preheat-circuit ballast, the test is to be conducted with either:

a) The starter short-circuited; or

b) A lamp deactivated, so that maximum heating will result.

26.8 For the requirements in this standard, a deactivated lamp is to be simulated by using two lamps with a lampholder connected to one end of each lamp; for an instant start circuit utilizing a circuit interrupting lampholder, the lamp is to be removed and the lampholder contacts are to be shorted together.

26.9 If a semiconductor component can be shorted but the ballast would appear to operate normally, the component shall be separately shorted.

26.10 Other than as noted in 26.11, all other conditions of the test, including the location of the ballast in the test chamber, dimensions of the chamber, and the like, are to be as described in the Normal-Temperature Test, Section 25. If the heat from the ballast causes the air in the test enclosure to exceed the maximum specified ambient value, the test is to be continued at whatever temperature is reached; but the results are to be corrected to the applicable ambient temperature for the ballast under test.

26.11 A ballast is to be tested as specified in 26.10 at an ambient temperature of 40 ±5°C (104 ±9°F).

Exception: A reactor (simple reactance) ballast that is not provided with thermal protection and marked to operate only straight, tubular lamps is to be tested as specified in 26.10 in an ambient temperature of 25°C (77°F).

27 Fault Condition Test – Conventional Magnetic Ballast – Class P Protection

27.1 A ballast provided with an automatic reset thermal protector shall meet the following criteria while the ballast is subjected to any of the conditions of 27.6. When more than one thermal protector is employed, the protectors shall be electrically connected in series.

a) The temperatures on any point on the case of an enclosed ballast (including an electronic ballast without an automatic reset thermal protector) or the outer surface of an open core and coil ballast shall not exceed 150°C (302°F);

b) The locations in (a) that exceed 110°C (230°F) shall comply with the temperature versus time criteria specified in Table 27.1;

c) The locations in (a) that exceed 110°C (230°F) when the protector opens the circuit shall not exceed 85°C (185°F) when the protector cools and recloses the circuit. The locations in (a) that do not exceed 110°C (230°F) when the protector opens the circuit shall not exceed 100°C (212°F) when the protector cools and recloses the circuit;

d) A power capacitor provided as part of such a ballast shall not exceed 90°C (194°F) or the capacitor manufacturer's assigned rating, whichever is higher; and

e) For a simple reactance ballast of a through-cord or a direct plug-in type, the temperature on any point of the enclosure shall not exceed 90°C (194°F).

Table 27.1
Case- or open coil surface-temperature versus time relations

Maximum temperature				Time[a], minutes
More than		Not more than		
°C	(°F)	°C	(°F)	
145	(293)	150	(302)	5.3
140	(284)	145	(293)	7.1
135	(275)	140	(284)	10
130	(266)	135	(275)	14
125	(257)	130	(266)	20
120	(248)	125	(257)	31
115	(239)	120	(248)	53
110	(230)	115	(239)	120

[a] The time is to be measured between the instant the case or outer surface of an open core and coil ballast temperature exceeds 110°C (230°F) and the protector opens or the maximum temperature is reached, whichever is longer.

27.2 The temperatures of a ballast provided with a thermal cutoff type (one shot) thermal protector shall meet the requirements in 27.1(a), 27.1(b), and 27.1(d) while being subjected to any of the conditions of 27.6.

27.3 If the temperature of the enclosure of an enclosed ballast, or outer surface of an open core and coil ballast, exceeds 110°C (230°F) for a specific fault condition in 27.6, the protector shall open the circuit or the current shall be limited for an inherently protected electronic ballast.

Exception: The protector need not open if the fuse described in 27.7 does not open, and if the temperature of the case of an enclosed ballast or the outer surface of an open core and coil ballast does not exceed 110°C (230°F).

27.4 With reference to the requirement in 27.3, if the case of an enclosed ballast or the outer surface of an open core and coil ballast attains a temperature of 110°C (230°F) or less and either remains at that temperature or starts to decrease, the test may be discontinued after 1 hour of operation after the 110°C (230°F) temperature is first reached.

27.5 During the test described in 27.6, there shall be no:

a) Ignition of a compound;

b) Dripping of a compound from the enclosure; or

c) Emission of flames or molten metal from the ballast enclosure.

27.6 To determine whether a Class P protected ballast complies with the requirements in 27.1 or 27.2, whichever applies, the ballast is to be energized at an input voltage and frequency in accordance with 21.6, and is to be operated at thermal equilibrium under normal conditions as described in 22.1– 22.3 and the Normal Temperature Test, Section 25. The following fault conditions are to be introduced, one at a time and not necessarily in the order indicated, and are to be applied throughout each complete test:

a) For a primary winding, two outer layers of a layer wound ballast or 20 percent of the turns of a random wound ballast are short circuited.

b) For a secondary winding, two outer layers of a layer wound ballast or 20 percent of the turns of a random wound ballast are short circuited.

c) Any power capacitor short circuited, when such condition does not short circuit the ballast primary winding.

d) The abnormal conditions described in 26.8, except that this test is not required when the temperature does not exceed 110°C (230°F) during the test.

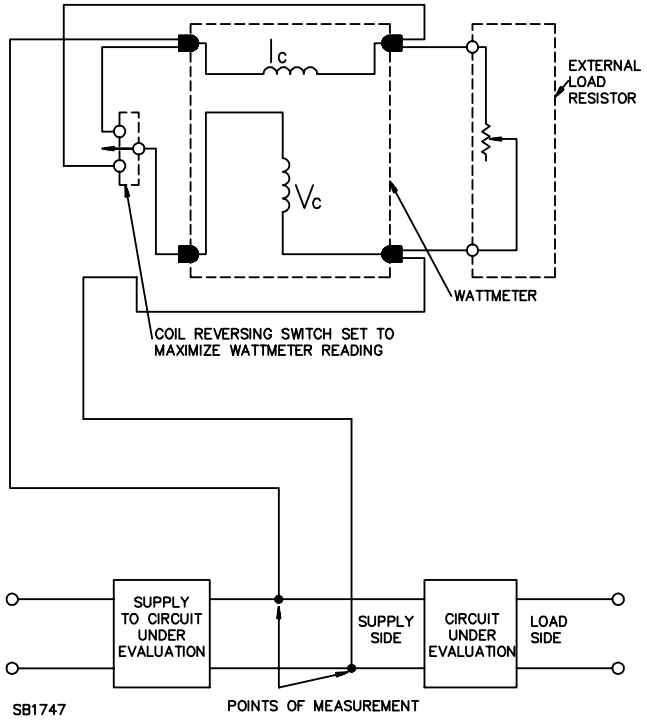
e) For a simple reactance ballast or a single coil device that provides ballast impedance for a lamp – two outer layers of winding or 20 percent of the turns short circuited.

27.7 During the test described in 27.6, the supply circuit is to be connected in series with a 20-ampere fuse (time-delay type), of which the characteristics are such that the fuse will not open in less than 12 seconds when carrying 40 amperes.

27.8 Opening of the 20 ampere supply circuit fuse is determined to be the equivalent of opening of the protector under the test condition described in 27.6(a) and the fuse shall not open under any other test condition.

27.9 If a ballast is marked for use with several different lamps, the lamps causing the highest wattage during the input test are to be used for the tests in this section. If a lamp becomes inoperative during any test, the lamp is to be replaced and the test continued for the specified duration.

Figure 27.1
Connection of wattmeter



27.10 Temperatures of the case of an enclosed ballast or the outer surface of an open core and coil ballast are to be measured during a sufficient number of cycles to determine whether a ballast complies with the requirement in 27.2. Normally for this purpose, measurement of temperatures during 3 to 5 cycles of the thermal protector will be necessary.

27.11 If necessary to cause the protector to reclose the circuit, the temperature of the test enclosure may be reduced below the minimum value specified in 25.1.

27.12 Temperatures are to be measured by thermocouples on the ballast and on the power-capacitor case.

27.13 Temperatures on the case of an enclosed ballast or the coil of an open core and coil ballast are continued to be measured after the protector opens.

Exception: If the protector – reclosing temperature in 27.1(c) is not being determined, the test may be discontinued when temperatures start to decrease following the opening of the protector.

28 Increased-Ambient Temperature Test for Ballasts – Class P Protection

28.1 When tested under the method described in 28.2, the protector of a Class P ballast shall operate, or the circuit of an inherently limited Class P electronic ballast shall open to limit the current, before the temperature of the enclosure of an enclosed ballast, or the outer surface of an open core and coil transformer, exceeds 110°C (230°F) or within 2 hours after the ballast exceeds 110°C (230°F).

Exception: This test is not required to be conducted when 16.2 applies.

28.2 The ballast is to be energized at an input voltage and frequency in accordance with 21.6, and is to be operated until thermal equilibrium is reached under normal conditions as described in the Normal Temperature Test, Section 25, except that the 6-inch (152-mm) square opening in the test enclosure may be closed and the test-enclosure ambient is to be 60.0 ±1.0°C (140.0 ±1.8°F). The temperature in the test enclosure is then to be raised as rapidly as is convenient by a value 2.0°C (3.6°F) more then the difference between 110°C (230°F) and the maximum temperature that the case of an enclosed ballast or the outer surface of an open core and coil ballast reached when the test-enclosure temperature was 60°C (140°F), and is to be maintained at this temperature.

28.3 If the protector has not opened and the temperature of the case of an enclosed ballast or the outer surface of an open core and coil ballast has not reached 110°C (230°F) within 4 hours or if the inherent circuit has not operated so that the temperatures have not stabilized under the conditions described in 28.2, the test-enclosure ambient is to be increased again by a value 2.0°C (3.6°F) more than the difference between 110°C (230°F) and the maximum ballast temperature 4 hours following the first increase in test-enclosure temperature.

28.4 If a ballast is marked for use with several different lamps, the lamps causing the highest wattage during the input test are to be used for the test in this section. If a lamp becomes inoperative during the test, the lamp is to be replaced and the test continued for the specified duration.

29 Fault-Condition Test – Electronic Ballasts – Class P Protection

29.1 An electronic ballast shall meet the following criteria while the ballast is subjected to the tests described in 29.2 – 29.7:

a) The temperatures on any point on the case of an enclosed ballast (including an electronic ballast without an automatic reset thermal protector) or the outer surface of an open core and coil ballast shall not exceed 150°C (302°F).

b) The locations in (a) that exceed 110°C (230°F) shall comply with the temperature versus time criteria specified in Table 27.1.

c) For a through-cord or a direct plug-in type, the temperature on any point of the enclosure shall not exceed 90°C (194°F).

29.2 An increase in a risk of fire exists when any one of the following conditions develops. There shall be no:

a) Ignition of a compound;

b) Dripping of a compound from the enclosure; or

c) Emission of flames or molten metal from the ballast enclosure.

29.3 The sample shall not be used for an additional fault condition unless the sample is operable after a fault condition and possible replacement of a fuse.

29.4 The ballast is to be energized at an input voltage and frequency in accordance with 21.6. The supply circuit is to be connected in series with a 20 ampere fuse (time delay type), of which the characteristics are such that the fuse does not open in less than 12 seconds when carrying 40 amperes. A thermocouple (or thermocouples) such as the type used in the Temperature Test, is to be attached to the ballast enclosure in order to monitor the progress of the test. The ballast is to be tested as described in 29.5. Unless already conducted for Fault Condition Tests, Section 27, the following fault conditions are to be introduced, one at a time and not necessarily in the order indicated, and are to be applied throughout each complete test:

a) For a transformer primary winding, two outer layers of a layer wound ballast or 20 percent of the turns of a random wound ballast are short circuited.

b) For a transformer secondary winding, two outer layers of a layer wound ballast or 20 percent of the turns of a random wound ballast are short circuited.

c) The abnormal conditions described in 26.8, except that this test is not required when the temperature does not exceed 110°C (230°F) during the test.

d) Any electrolytic capacitor or semiconductor junction located in a circuit capable of delivering 50 watts or more of power to an external resistor for 1 minute, as determined in accordance with 29.6, is to be short circuited or open circuited.

29.5 Regarding the ambient temperature of the ballast under test as described in 29.4, the intent of this requirement is met when the test condition operates in an ambient temperature of 25°C ±5°C (77°F ±5°F) until:

a) It is obvious within 30 minutes that a component has opened and the ballast is no longer operable; or

b) For a period of 30 minutes or less and when it is determined that the ballast enclosure or power capacitor temperatures are no longer rising and the ballast operation is stable; or

c) For a period of 30 minutes and when it is determined that the ballast enclosure or power capacitor temperatures are continuing to rise. In this case, the test is to be stopped, the ballast is to be placed in a ambient temperature oven as described in 25.1 – 25.3, and the test restarted. The test is to continue in the elevated ambient temperature until the ultimate result is known, and not exceeding 7 hours.

29.6 When it is not obvious what the power available is at various points in the circuit, a wattmeter and an adjustable external load resistor are to be arranged as illustrated in Figure 27.1 to determine the maximum power transfer. The external load resistor is set for its maximum resistance. After the connection is made, and when there is no protective device in the ballast, the adjustable resistance is to be reduced gradually to the point of maximum wattage as indicated by a peak reading on the wattmeter. When there is a protective device in the ballast, a closed shorting switch is to be connected across the protector, and the resistor is then to be adjusted to result in a power dissipation of exactly 50 watts as indicated by the meter. The switch across the protective device is then to be opened and the time required for the protective device to open is to be recorded. When the protective device opens the circuit in less than 60 seconds, the point is not capable of delivering 50 watts for 1 minute. Similarly, when a circuit component opens in less than 1 minute effectively limiting the available power to less than 50 watts or when the current is inherently limited by the circuit, the point is not capable of delivering 50 watts for 1 minute.

29.7 Opening of the 20 ampere supply circuit fuse as a result of the particular component fault condition signifies compliance.

30 Arcing Test

30.1 An electronic ballast marked “Type CC” shall comply with the requirements in Type CC Ballasts, Supplement SD.

Revised 30.1 effective February 9, 2015

30.2 Deleted effective February 9, 2015

30.3 Deleted effective February 9, 2015

30.4 Deleted effective February 9, 2015

Figure 30.1
Arcing test set-up

Figure 30.1 deleted effective February 9, 2015

31 Voltage Measurement – Power Capacitors

31.1 The voltage across a power capacitor shall not exceed its rating in accordance with 15.2– 15.4.

31.2 The test is to be conducted with the ballast energized at the input voltage and frequency specified in 21.6. It may be necessary to make more than one measurement in order to ascertain the voltage while using various lamps for which the ballast is marked.