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1080.7 Before each test and while the barrel is vertical and the burner is well away from the specimen, the gas flame is to be checked to make certain that its overall height is 125±10 mm or 4-7/8 inches and that the blue inner cone is 40 ±2 mm or 1-9/16 inches high, as established during calibration. A flame that changes from blue to luminous without any change of the settings is an indication that the fuel-gas content of the cylinder is exhausted and that the denser depletion-indicator material (propane, for example), which some suppliers add to their cylinders, is being burned instead. In this case, the cylinder is to be labeled as empty and then returned for refilling. Where the overall flame is blue and the height of the blue inner cone is other than 40 ±2 mm or 1-9/16 inches without any change of the settings, the contents of the cylinder likely are at low pressure. A gas-supply gauge pressure of 10 – 20 lbf/in^2 or 69 – 138 kPa or 690 – 1380 mbar or 700 – 1400 gf/cm^2 has been found to be adequate to maintain the required flame. A cylinder shall not be used when this range of pressure is no longer sustainable at room temperature.

1080.8 A wedge (typical dimensions are shown in Figure 1080.2) to which the base of the burner is to be secured is to angle the barrel of the burner 20° from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The wedge is to be positioned to place the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen. The wedge is also to be positioned to place point A, which is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel, 1-9/16 inches or 40 mm from point B, at which the extended longitudinal axis of the barrel meets the outer surface of the specimen. Point B is the point at which the tip of the blue inner cone is to touch the center of the front of the specimen during each application of the test flame.

1080.8 revised May 6, 2003

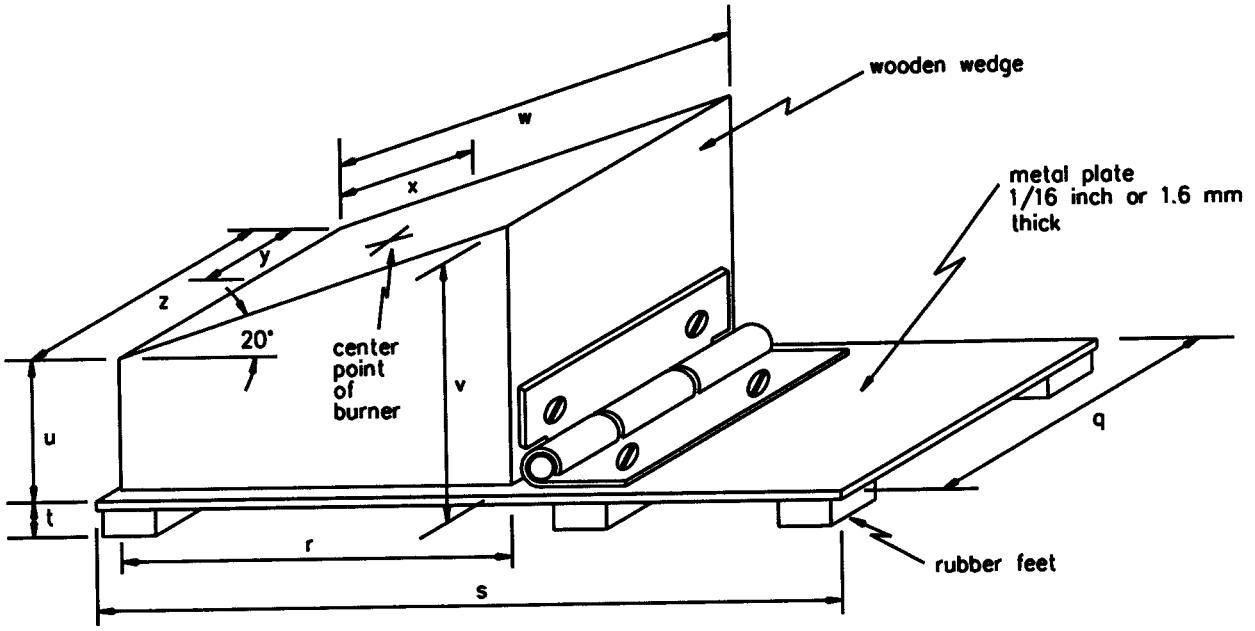
1080.9 The burner is to be mounted on the wedge. The wedge is to be hinged as shown in Figure 1080.2 to enable the gas flame to be repeatedly tilted away from and then returned precisely to application to the specimen. Tilting of the burner away from and toward the specimen is to be by mechanical means or by hand. The tilt away is to be against a stop (the metal plate) that results in the gas flame angling away from the specimen beyond a vertical position. The motion of the burner is not to disturb the layer of cotton on the floor of the enclosure or result in the cotton coming away from the wedge or the base of the burner.

1080.10 A strip of unreinforced 60-lb or 98-g/m^2 kraft paper that is 1/2 inch or 10 mm wide, at or near 5 mils or 0.1 mm thick, and is gummed on one side is to be used to make an indicator flag. The gumming is to be moistened just enough to facilitate adhesion. With the gum toward the specimen, the strip is to be wrapped around the specimen once with its lower edge 10 inches or 250 mm above B, the point at which the blue inner cone is to touch the specimen. The ends of the strip are to be pasted together evenly and trimmed to result in a flag that projects 3/4 inch or 20 mm from the specimen toward the rear of the draft-free chamber, with the flag in the vertical plane described in 1080.8 (see Figure 1080.1). In testing a flat specimen, the flag is to project from the center of the rear broad face of the specimen and the test flame is to be applied to the front broad face. The lower clamp or other support for the specimen is to be adjusted vertically to keep it from being any closer than 2 – 3 inches or 50 – 75 mm to point B.

1080.11 The burner is to be supported as indicated in 1080.9 in a position tilted away from the specimen and is then to be lit. Where the burner has a pilot light, the pilot light is to be disconnected for this test.

1080.12 The lit burner is to be tilted forward into position to apply the gas flame to the specimen, kept there for 15 s, quickly tilted back to the stop to remove the gas flame from the specimen for 15 s (the gas flame is to remain away from the specimen longer where flaming of the specimen persists– see 1080.13), and so forth for a total of five 15-s applications of the gas flame to the specimen with 15 s (longer where flaming of the specimen persists – see 1080.13) between applications. The gas flame is to be reapplied to the specimen 15 s after the previous application where flaming of the specimen ceases of its own accord within 15 s or less time of the previous application.

Figure 1080.2
Typical wedge hinged to plate



SM665

Rubber feet are to be used with this design to keep the assembly from shifting in position as the wedge is tilted back and forth during a test. Two of the rubber feet are to be under the area of the hinge to keep the plate from deflecting during motion of the wedge.

q	3-1/4 inches	83 mm	v	3-1/4 inches	83 mm
r	5-1/16	129	w	5-3/8	137
s	11	279	x	2	51
t	25/64	10	y	1-1/2	38
u	1-1/2	38	z	3	76

1080.13 Where flaming of the specimen persists longer than 15 s after the previous application of the gas flame, the gas flame is not to be reapplied until flaming of the specimen ceases of its own accord. The gas flame is to be reapplied as soon as flaming of the specimen ceases. Tilting the burner forward to apply the gas flame to the specimen and back to remove the gas flame from the specimen are both to be accomplished rapidly and with minimal movement of the air around the specimen.

1080.14 Where any specimen shows more than 25 percent of the indicator flag burned away or charred (soot that can be removed with a cloth or the fingers, and brown scorching, are to be ignored) after any of the five applications of flame, the wire, cable, or cord is to be judged capable of conveying flame along its length. Where any specimen emits flaming or glowing particles or flaming drops at any time that ignite the cotton (flameless charring of the cotton is to be ignored), or continues to flame longer than 60 s after any application of the gas flame, the wire, cable, or cord is to be judged capable of conveying flame to combustible materials in its vicinity. Where any specimen emits flaming or glowing particles or flaming drops at any time that fall outside the area of the testing surface covered by the cotton and/or that fall onto the wedge or burner, the test results are to be discarded and the test is to be repeated. For the repeat test, the cotton is to cover an area of the testing surface 12 inches or 305 mm wide by 14 inches or 355 mm deep centered on the vertical axis of the specimen and the specified cotton is to be clamped or otherwise secured to the wedge (no cotton under the wedge) and around the base of the burner. None of the cotton is to ignite in the repeat test nor is the specimen to continue flaming longer than 60 s after any application of the gas flame.

1080.14 revised May 6, 2003

1081 – 1089 *Reserved for Future Use*

1090 Horizontal-Specimen Appliance-Wire Flame Test

1090.1 A horizontal specimen of finished appliance wire:

a) Shall not convey flame along its length, and

b) Shall not convey flame to combustible materials in its vicinity

after a single 30-s application of a 225-W test flame (770 Btu/h) nominally 50 mm high. This test is to be conducted as described in 1080.2 – 1080.5 and 1090.2 – 1090.6 (specimen supported horizontally) using one of the fuels described in 1080.3 and the standard laboratory burner[a] described in ASTM D 5025-99. The gas flame produced by the burner is to be calibrated as described in ANSI/ASTM D 5207-98 with the following modifications to adapt the procedure for the 125-mm flame to the 50-mm flame:

c) The copper slug used for the 125-mm flame is also to be used for the 50-mm flame. For the 50-mm flame, the slug is to be positioned 25 mm or 1 inch above the tip of the burner during the calibration procedure.

d) The starting gas-flow rate for methane is to be 405 ±10 mL/min with a back pressure of 45 ±5 mm water.

e) The needle valve and air-inlet openings on the burner are to be adjusted until the overall height of the flame is 50 ±4 mm or 2 inches and the height of the blue inner cone is 16.5 ±1.5 mm or 11/16 inch.

f) The time for the temperature to rise from 100 to 700°C (212 to 1292°F) is to be 84 ±2 s.

The results of this test are to be judged as indicated in 1090.7.

[a] See note [a] to 1080.1 for examples of burners that comply with ASTM D 5025-99.

1090.2 The test is to be conducted in the draft-free chamber described in 1080.2. The burner is to be placed directly on the floor of the chamber or, for ease of testing, on a bench within the chamber. The testing surface (chamber floor or bench top) is to be at least 4 ft or 1200 mm below the top of the chamber walls (at the transition to the exhaust). The dimensions of the testing surface of the bench are to accommodate the rectangular layer of cotton described below. A specimen 24 inches or 610 mm long cut from a sample length of the appliance wire is to be secured with its longitudinal axis horizontal. The specimen supports are to be 22 inches or 560 mm apart, and three metal rods or equivalent permanent means whose free ends are no closer than 3/4 inch or 20 mm to the specimen are to be used to indicate three points on the specimen measuring 2 inches or 51 mm, 7 inches or 178 mm, and 13 inches or 330 mm from the left-hand point of support of the specimen. Where required, lab stands or other supports that do not create updrafts or impede the air supply to the flame are to be used to hold the test apparatus in place. A flat, horizontal layer of dry (untreated), pure, surgical cotton not more than 1/4 inch or 6 mm thick is to cover an area of the testing surface not less than 24 inches or 610 mm long by 6 – 8 inches or 150 – 200 mm wide, with the length centered on the horizontal axis of the test specimen. Cotton is not to be on or under the burner. There are not to be any openings through the layer of cotton. The upper surface of the cotton is to be 9 – 9-1/2 inches or 230 – 240 mm below the lower surface of the specimen (this is shown in Figure 1090.1). A flat specimen is to be tested with its flat surfaces horizontal and with the gas flame applied to the center of the bottom flat surface.

1090.2 revised May 6, 2003

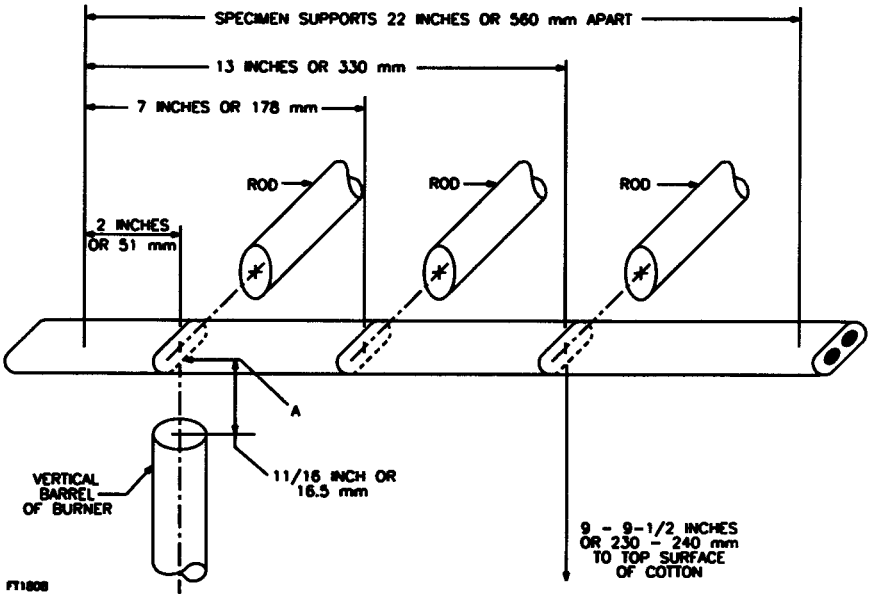
1090.3 Before each test and while the barrel is vertical and the burner is well away from the specimen, the gas flame is to be checked to make certain that its overall height is 50 ±4 mm or 2 inches and that the blue inner cone is 17 ±1 mm or 11/16 inch high, as established during calibration. A flame that changes from blue to luminous without any change of the settings is an indication that the fuel-gas content of the cylinder is exhausted and that the denser depletion-indicator material (propane, for example), which some suppliers add to their cylinders, is being burned instead. In this case, the cylinder is to be labeled as empty and then returned for refilling. Where the overall flame is blue and the height of the blue inner cone is other than 17 ±1 mm or 11/16 inch without any change of the settings, the contents of the cylinder likely are at low pressure. A gas-supply gauge pressure of 10 – 20 lbf/in^2 or 69 – 138 kPa or 690 – 1380 mbar or 700 – 1400 gf/cm^2 has been found adequate to maintain the required flame. A cylinder shall not be used when this range of pressure is no longer sustainable at room temperature.

1090.4 The burner is to be secured in an adjustable support jig with the longitudinal axis of the barrel vertical. The jig is to be positioned to place the longitudinal axis of the barrel in the vertical plane that intersects the specimen perpendicularly at the marker located 2 inches or 51 mm from the left-hand point of support of the specimen. The jig is also to be positioned to place the intersection of the longitudinal axis of the barrel and the plane of the tip of the barrel 16.5 ±1.5 mm or 11/16 inch below the point A at which the extended longitudinal axis of the barrel meets the outer surface of the underside of the specimen at the 2-inch or 51-mm marker. Point A is the point on the surface of the underside of the specimen at which the tip of the blue inner cone is to touch the specimen.

1090.4 revised May 6, 2003

1090.5 The support for the burner is to be arranged to enable the burner to be swung or slid into the position described in 1090.4 and quickly removed. The motion of the burner is not to disturb the layer of cotton on the testing surface or result in the cotton coming away from the base of the burner.

Figure 1090.1
Dimensions for horizontal-specimen appliance-wire flame test



Proportions exaggerated for clarity of detail

1090.6 The burner is to be supported as indicated in 1090.5 in a position away from the specimen and then lit (where the burner has a gas pilot light, the pilot is not be to be used). The lit burner is to be moved into position to apply the tip of the blue inner cone of its flame to the underside of the specimen at the 2-inch or 51-mm marker (point A), kept there for 30 s, removed to a position well away from the specimen, and then extinguished by closing the gas supply valve. Note is to be taken and recorded of whether any flaming of the specimen progresses beyond the 7-inch or 178-mm marker. Where flaming of the specimen passes this marker, the amount of time that the specimen flame takes to progress from the 7-inch or 178-mm marker toward the 13-inch or 330-mm marker is to be noted and divided into the total length of specimen burned between the 7-inch or 178-mm and the 13-inch or 330-mm markers. Note is also to be taken and recorded of whether particles or drops that ignite any of the cotton are emitted by the specimen during or after application of the gas flame.

1090.7 Where any specimen flames at a rate greater than 1 inch/min or 25 mm/min between the markers at 7 inches or 178 mm and 13 inches or 330 mm, measured as described in 1090.6, the appliance wire is to be judged capable of conveying flame along its length. Where any specimen emits flaming or glowing particles or flaming drops at any time that ignite the cotton (flameless charring of the cotton is to be ignored), the appliance wire is to be judged capable of conveying flame to combustible materials in its vicinity. Where any specimen emits flaming or glowing particles or flaming drops at any time that fall outside the area of the testing surface covered by the cotton and/or that fall onto the burner, the test results are to be discarded and the test is to be repeated. For the repeat test, the rectangular layer of cotton is to cover an area of the testing surface 24 inches or 610 mm long by 12 inches or 305 mm deep

centered on the horizontal axis of the specimen and the specified cotton is to be clamped or otherwise secured around the base of the burner. Cotton is not to be under the burner. None of the cotton is to ignite in the repeat test nor is the specimen to flame at a rate greater than specified in 1090.7.

1090.7 revised May 6, 2003

1091 – 1099 *Reserved for Future Use*

1100 Horizontal-Specimen / FT2 Flame Test

1100.1 A horizontal specimen of the finished wire, cable, cord, or assembly:

a) Shall not convey flame along its length, and

b) Shall not convey flame to combustible materials in its vicinity

during, or after a single 30-s application of a standard test flame. The standard test flame is to be nominally 125 mm high and is to produce heat at the nominal rate of 500 W (1700 Btu/h). This test is to be conducted as described in 1080.2 – 1080.5, 1100.2 (specimen supported horizontally), 1080.7–1080.9, 1080.11, and 1100.3 using one of the fuels described in 1080.3 and the standard laboratory burner and calibration as specified in 1080.1. The results of this test are to be judged as indicated in 1100.4.

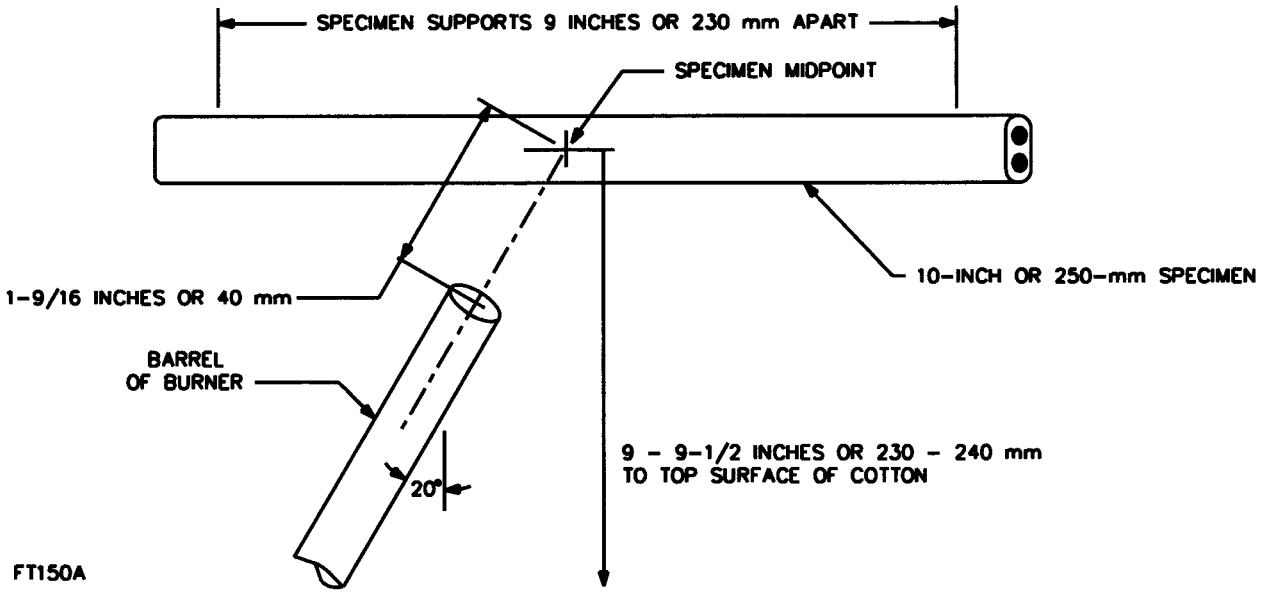
1100.2 This test is to be conducted in the draft-free chamber described in 1080.2. The burner is to be placed directly on the floor of the chamber or, for ease of testing, on a bench within the chamber. The testing surface (chamber floor or bench top) is to be at least 4 ft or 1200 mm below the top of the chamber walls (at the transition to the exhaust). The dimensions of the testing surface of the bench are to accommodate the rectangular layer of cotton described below. A 10-inch or 250-mm specimen cut from a sample length of the finished wire, cable, or assembly is to be secured with its longitudinal axis horizontal. The specimen supports are to be 9 inches or 230 mm apart. Where required, lab stands or other supports that do not create updrafts or impede the air supply to the flame, are to be used to hold the test apparatus in place. A flat, horizontal layer of dry (untreated), pure, surgical cotton not more than 1/4 inch or 6 mm thick is to cover an area of the testing surface not less than 12 inches or 305 mm by 6 – 8 inches or 150 – 200 mm deep, with its depth centered on the horizontal axis of the test specimen. There are not to be any openings through the layer of cotton. The upper surface of the cotton is to be 9 – 9-1/2 inches or 230 – 240 mm below the point on the surface of the specimen at which the tip of the blue inner cone touches the specimen (this is shown in Figure 1100.1). A flat specimen is to be tested with its flat surface vertical and with the gas flame applied to the center of one flat surface.

1100.2 revised May 6, 2003

1100.2A A wedge (typical dimensions are shown in Figure 1080.2) to which the base of the burner is to be secured is to angle the burner 20° from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The wedge is to be positioned to place the longitudinal axis of the barrel in the vertical plane that is perpendicular to the specimen length and bisects the specimen at its midpoint. The wedge is also to be positioned to place the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel 1-9/16 inches or 40 mm from the midpoint of the specimen as shown in Figure 1100.1. The midpoint is the point at which the tip of the blue inner cone is to touch the center of the front of the specimen during each application of the test flame.

1100.2A added May 6, 2003

Figure 1100.1
Dimensions for horizontal-specimen / FT2 flame test
Proportions exaggerated for clarity of detail



1100.3 The burner is to be tilted forward into position to apply the gas flame to the specimen, kept there for 30 s and quickly tilted back to the stop to remove the flame from the specimen. Tilting the burner forward to apply the gas flame to the specimen midpoint and back to remove the gas flame from the specimen are both to be accomplished rapidly and with minimal movement of the air around the specimen. Note is to be taken and recorded of the length of the charred portion of the specimen and whether particles or drops that ignite any of the cotton are emitted by the specimen during or after application of the gas flame.

1100.4 Where any specimen emits flaming or glowing particles or flaming drops at any time that ignite the cotton (flameless charring of the cotton is to be ignored), the wire, cable, or assembly is to be judged capable of conveying flame to combustible materials in its vicinity. Where any specimen emits flaming or glowing particles or flaming drops at any time that fall outside the area of the testing surface covered by the cotton and/or fall onto the wedge or burner, the test results are to be discarded and the test is to be repeated. For the repeat test, the cotton is to cover an area of the testing surface 12 inches or 305 mm wide by 14 inches or 355 mm deep centered on the horizontal axis of the specimen and the specified cotton is to be clamped or otherwise secured to the wedge (no cotton under the wedge) and around the base of the burner. None of the cotton is to ignite in the repeat test nor is the specimen to char for a total length greater than specified in 1100.4.

1100.4 revised May 6, 2003

1101 – 1159 *Reserved for Future Use*

1160 UL Vertical-Tray Flame Test

This test method is described in the Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685.m

1161 – 1163 *Reserved for Future Use*

1164 FT4/IEEE 1202 Vertical-Tray Flame Test

This test method is described in the Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685.

1165 – 1199 *Reserved for Future Use*

SUNLIGHT RESISTANCE

1200 Carbon-Arc and Xenon-Arc Tests

1200.1 As specified in the wire standard, this test is to be conducted on five complete specimens.

1200.2 The specimens are to be conditioned either by xenon-arc radiation and water spray as described in 1200.3 – 1200.6, or by carbon-arc radiation and water spray as described in 1200.7 – 1200.10, and then are to be prepared and tested for retention of tensile strength and ultimate elongation as described in 1200.11– 1200.15. For the conditioning of flat cable, one of the broad faces of the cable is to face the arc(s). For the conditioning of a jacket, the outer surface of the jacket specimen is to face the arc(s). The long dimension of each specimen is to be parallel to the arc(s). The temperature and the cycling are to be programmed automatically.

1200.3 CONDITIONING BY XENON-ARC – The specimens are to be mounted in the specimen holders of xenon-arc-radiation and water-spray exposure equipment as specified in the American Society of Testing and Materials "Standard Practice for Operating Xenon-Arc Light Apparatus for Exposure of Nonmetallic Materials", ASTM G 155-00, and "Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources", ASTM G151–00. The radiation is to be produced by a lamp assembly of the long-arc water-cooled type. The lamp assembly is to consist of a quartz xenon burner tube that is centered inside concentric inner and outer cylindrical optical filter tubes of soda borosilicate glass (7740 Pyrex glass or its equivalent). Operation of the lamp assembly is to maintain a level of spectral irradiance at the specimens of at least 0.35 W/m^2 monitored at a wavelength of 3400 Å or 340 nm. The spectral power distribution of the emission from the tubes is to comply with Table 1 of ASTM G155–00.

1200.4 Radiation from the xenon arc is to be kept by positive, nonmakeshift means from reaching persons within sight of the apparatus. The inner and outer optical filters are to be replaced at intervals that minimize the risk of spontaneous breakage of the filters because of stresses that develop in the glass from exposure to the arc. For this safety reason, and also to maintain the levels of irradiation, ASTM suggests replacing the inner filter after no more than 400 h of use and the outer filter after no more than 2000 h of use.

1200.5 All points of each specimen are to be subjected to a fine spray of water once during the 18 min portion of a 2 h programmed cycle of 102 min of light followed by 18 min of light and water spray each time that the cycle is repeated as noted in 1200.6. The water used in the spray is to be clean (it is not to leave any deposit on the specimens and is not to stain the specimens), its pH is to be 6.0 – 8.0, and its temperature is to be 16.0 ±5.0°C (60.0 ±9.0°F). The water used in the spray is not to be recirculated unless these conditions are maintained. While the xenon arc is in operation and the spray is off, the equilibrium black-panel temperature at the specimens is to be 63.0 ±3.0°C (145.0 ±5.4°F).

1200.6 With the xenon arc operating continuously, and with prudent attention to the risk to eyesight and to other health risks presented by the arc, the water spray is to be operated for 18 min on and 102 min off. This 2 h cycle is to be repeated resulting in the total elapsed operating time specified in the wire standard. The apparatus is to be turned off after the specified total operating time. The specimens are to be removed from the test apparatus and kept in still air under conditions of ambient room temperature and atmospheric pressure for not less than 16 and not more than 96 hours before being subjected to physical tests.

1200.7 CONDITIONING BY TWIN CARBON-ARCS – The specimens are to be mounted in the specimen holder of carbon-arc-radiation and water-spray exposure equipment as specified in the American Society for Testing and Materials "Standard Practice for Operating Carbon-Arc Type Light Apparatus for Exposure of Nonmetallic Materials", ASTM G 153–00, and "Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources", ASTM G151–00. The apparatus is to include twin arcs struck between two sets of vertical carbon electrodes that are 1/2 inch or 13 mm in diameter and are individually enclosed in clear globes of heat-resistant optical glass (9200-PX Pyrex glass or its equivalent) that is opaque at wavelengths shorter than 2750 Å or 275 nm (1 percent transmission at 275 nm as the nominal cutoff point) and whose transmission improves to 91 percent at 3700 Å or 370 nm. The globes are to be replaced after whichever of the following occurs first: either 2000 h of use or appearance in the globes of pronounced discoloration, milkiness, or both. The globes are to be washed with detergent and water, rinsed thoroughly, and air dried at room temperature immediately before each day's operation. The spectral power distribution of the emission from the globes is to comply with Table 1 of ASTM G153–00.

1200.8 Radiation from the carbon arcs is to be kept by positive, nonmakeshift means from reaching persons within sight of the apparatus. Ventilation is to keep the products of combustion in the carbon arcs from contaminating the specimens, and these products and the ozone generated are to be kept from being in any significant concentration in air breathed by persons.

1200.9 All points of each specimen are to be subjected to a fine spray of water once during the 3 min portion of a 20 min programmed cycle of 17 min of light followed by 3 min of light and water spray each time that the cycle is repeated as noted in 1200.10. The water is to be clean (it is not to leave any deposit on the specimens and is not to stain the specimens), its pH is to be 6.0 – 8.0, its temperature is to be 16.0 ±5.0°C (60.0 ±9.0°F), and the water is not to be recirculated unless these conditions are maintained. While the carbon arcs are in operation and the spray is off, the equilibrium black-panel temperature at the specimens is to be 63.0 ±2.5°C (145.0 ±4.5°F).

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1200.10 With the carbon arcs operating continuously and carrying a current of 15 – 17 A each at a drop in rms potential of 120 – 145 V, and with prudent attention to the risk to eyesight and to other health risks presented by the arcs, the spray is to be operated for 3 min on and 17 min off. This 20 min cycle is to be repeated six times resulting in operation with each specimen being subjected to radiation from the arcs for a total of 102 min and to the water spray with radiation from the arcs for a total of 18 min. This sequence is to be repeated resulting in the total elapsed operating time specified in the wire standard. The apparatus is to be turned off after the total specified operating time. The specimens are to be removed from the test apparatus and retained in still air under conditions of ambient room temperature and atmospheric pressure for not less than 16 and not more than 96 hours before being subjected to physical tests.

1200.11 PREPARATION AFTER CONDITIONING – The core (the conductors, insulation, any fillers, and the like) of a cable or flexible cord having a separable overall jacket is to be removed from the five conditioned specimens and from five identical unconditioned specimens. Die-cut specimens are to be prepared from the jacket conditioned in the apparatus and are to include the portions of the jacket closest to the arcs. The surfaces facing the arcs are not to be buffed, skived, or planed away.

1200.12 The conductor is to be removed from the five conditioned specimens and from five identical unconditioned specimens of a thermoplastic-insulated cable. Die-cut specimens are to be prepared from the insulation and nylon jacket conditioned in the apparatus and are to include the portions of the insulation and nylon jacket closest to the arcs. The surfaces facing the arcs are not to be buffed away.

1200.13 The conductor (conductor plus insulation in the case of a single-conductor cable with a separable jacket) is to be removed from each of the five conditioned specimens and from each of the five identical unconditioned specimens of a thermoset-insulated cable. Die-cut specimens are to be prepared from the single-conductor insulation or jacket or from the overall jacket of the multiple-conductor cable conditioned in the apparatus and are to include the portions of the insulation or jacket closest to the arcs. The surfaces facing the arcs are not to be buffed or planed away.

1200.14 In the case of a service cable, all materials other than the individual jacket or unjacketed insulation and the overall jacket or PVC finish are to be removed from five identical unconditioned specimens. Tubular specimens are to be used in the case of specimens having an inside diameter no larger than 0.130 inch or 3.3 mm. Die-cut specimens are to be prepared from specimens having larger inside dimensions. In any case, the PVC finish, the individual or overall jacket, or the insulation is not to be buffed or otherwise prepared.

1200.15 TESTING AND PROPERTY-RETENTION LIMITS– The five conditioned specimens and the five unconditioned specimens are to be tested separately and in close succession for tensile strength and ultimate elongation. Nylon jackets are to be tested at a speed of 2 inches/min. The respective averages are to be calculated from the five tensile-strength and ultimate-elongation values obtained for the conditioned specimens and are to be divided by the averages of the five tensile-strength and ultimate-elongation values obtained for the unconditioned specimens. The wire, cable, or flexible cord is not appropriate for sunlight-resistant use where either the tensile-strength or ultimate-elongation ratio is less than 0.85 after 300 h of carbon-arc exposure or xenon-arc exposure or is less than 0.80 after 720 h of carbon-arc exposure or xenon-arc exposure, as specified in the wire standard. Service cable that does not comply with the requirement for 85 percent retention of physical properties and is retested after the sequence of exposures (100, 300, and 500 h) specified in UL 854 does not comply where the requirements for 65 percent retention and 15 and 5 percent rates of decrease are not met as stated in UL 854.

1201 – 1249 *Reserved for Future Use*

GLASS CONTENT

1250 Test

1250.1 In the case of an all-glass or glass-and-cotton or glass-and-rayon braid from Type SA wire or an all-glass or glass-and-cotton or glass-and-rayon braid from other wire, the test is to be made on specimens prepared from the finished braid. The braid is to be removed from a 40-inch or 1-m sample length of the finished wire and is to be cut into short sections about 1/8 inch or 3 mm in length. Reinforcing threads and binder threads of cotton or other organic material are not to be removed, even where such threads serve as an identifying marker. The short pieces are then to be well mixed and the saturant is to be removed from them by means of an organic solvent.

1250.2 A specimen of the extracted braid containing glass and weighing 5 g is to be dried to a constant weight W_1 in a weighed crucible at a temperature of 110 ±5°C (230 ±9°F), ignited in an electric furnace at a temperature of 800 ±20°C (1472 ±36°F) for 1 h, cooled to room temperature in a desiccator, and then weighed again W_2. The percentage of glass in the specimen is then to be calculated by means of the formula

$$70 \leq X_{all\text{-}glass} = \frac{100W_2}{W_1}$$

in which:

X is the percentage of glass,

W_1 is the weight of the dried specimen before ignition, and

W_2 is the weight after ignition and drying.

1251 – 1269 *Reserved for Future Use*

TIGHTNESS OF INSULATION

1270 Test for Tightness of Conductor Insulation in Decorative-Lighting Cords and Wire

1270.1 A sample of the wire or the individual cord conductor 11 inches or 275 mm long is to have 2 inches or 50 mm of insulation and any separator stripped from one end. At the other end of the sample, the insulation is to be slit longitudinally for a length of 3 inches or 75 mm, thereby resulting in a specimen of insulated conductor 6 inches or 150 mm long. The 3-inch or 75-mm conductor is to be cut and removed and the empty insulation and any separator are to be taped back together. A weight for exerting a pull of 4 lbf or 18 N or 1.81 kgf is to be attached to the specimen by tying the taped insulation to the weight. The bare conductor at the other end of the specimen is to be secured in a clamp, vise, or other support and the weight is to be gently lowered and released so that it is supported by the specimen. With the weight and specimen thus suspended vertically, slipping of the conductor, separator, or combination of conductor and separator more than 1/8 inch or 3 mm (as observed at the top of the specimen at the point at which the bare conductor enters the insulation and any separator) during a period of 60 s does not comply.

1271 – 1279 *Reserved for Future Use*

1280 Test for Tightness of Circuit-Conductor Insulation in Integral Parallel Cord Other Than Tinsel Cord

1280.1 A 16-inch or 407-mm length of cord is to have 2 inches or 51 mm of insulation and any separator stripped from both circuit conductors at each end to result in a 12-inch or 305-mm test specimen. One bare circuit conductor is to be cut off even with the insulation at one end of the specimen, and the other bare circuit conductor is to be cut off even with the insulation at the other end of the specimen. Any grounding conductor is to be cut off even with the insulation at both ends of the specimen. A weight for exerting a pull of 8 lbf or 35.6 N or 3.63 kgf is to be attached to the stripped circuit conductor at one end, and the weight and attached specimen are then to be supported at the stripped end of the other circuit conductor. With the weight and specimen thus suspended, slipping of either conductor, separator, or combination of conductor and separator more than 1/8 inch or 3.2 mm (as observed where the conductor was cut off even with the insulation) during a period of 30 s does not comply.

1281 – 1299 *Reserved for Future Use*

LEAKAGE

1300 Test of Type TBS for Surface Leakage Resistance

1300.1 Metal foil bands are to be wrapped tightly around a specimen of the finished wire with a spacing of 2 inches or 50 mm between the bands. The specimen is then to be suspended in a closed chamber over an open container of water at a temperature of 23.0 ±1.0°C (73.4 ±1.8°F). After a period of 18 h in the saturated, moist atmosphere in the chamber at the specified temperature, the specimen is to be removed, any surface condensation is to be removed with fresh blotting paper, and the surface resistance between the two bands is to be measured by an appropriate method.

1300.2 The surface leakage resistance is to be determined from the formula

$$R_s = R_m \frac{C}{D}$$

in which:

R_s is the surface leakage resistance in megohms,

R_m is the measured resistance in megohms,

C is the circumference of the specimen in inches or millimeters, and

D is the distance between the foil bands in inches or millimeters.

1301 – 1319 *Reserved for Future Use*

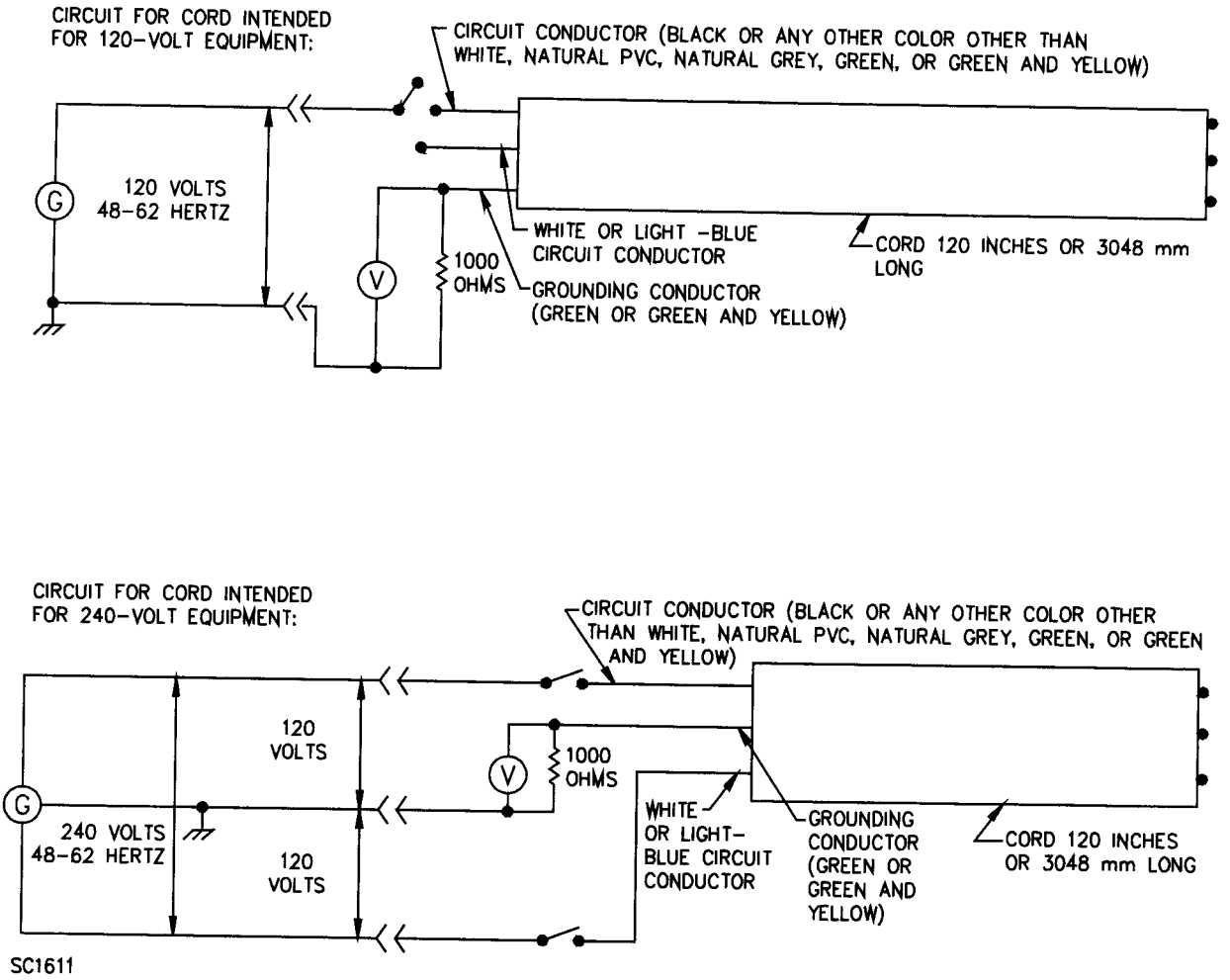
1320 A-C Leakage-Current Tests of Low-Leakage-Current Service Cords

Each circuit conductor to grounding conductor

1320.1 A 120-inch or 3048-mm length of the finished cord is to be formed into a coil of exactly two complete turns and is to be placed on a dry, flat, horizontal wooden board nominally 3/4 inch or 20 mm thick. At one end of the cord, the ends of all three of the conductors are to be flush with the end of the jacket and in a plane perpendicular to the longitudinal axis of the cord. This is to be accomplished without contamination or deformation at the cut ends that results in distortion of the test results caused by surface leakage. At the other end of the cord, the circuit conductors and the grounding conductor are to be connected to an sinusoidal or nearly sinusoidal 48 – 62 Hz 120- or 240-V supply circuit as shown in the applicable part of Figure 1320.1, the choice of supply circuit depending on whether the cord is intended for use with 120- or 240-V equipment.

1320.2 The exact value of the resistor is to be determined by means of an accurate bridge, and the voltmeter is to be an oscilloscope, vacuum-tube voltmeter, or other high-impedance type. It is convenient to have the resistance exactly at 1000 ohms and the voltmeter calibrated to read directly in millivolts because, in such case, the meter readings for a 120-inch or 3048-mm cord are numerically equal to the current flow in microamperes per 10 ft or 3048 mm of the cord.

Figure 1320.1
Circuit for measuring a-c leakage current from each circuit conductor to grounding conductor



1320.3 The circuit conductors are to be energized separately and in succession and the reading of the voltmeter recorded for each. The leakage current from each circuit conductor to the grounding conductor is to be calculated by dividing the voltage indicated by the voltmeter by the accurately known resistance of the resistor. The highest of the two leakage currents is to be used in choosing the range of current that determines the "µA to green" value for the cord-surface marking.

Each circuit conductor through jacket to foil

1320.4 A straight 120-inch or 3048-mm length of the finished cord is to be wrapped for its entire length with strip metal foil. The foil is to be in intimate contact with the jacket throughout the length of the cord. The straight length of foil-wrapped cord is to be placed on a dry, flat, horizontal wooden board nominally 3/4 inch or 20 mm thick. This is to be accomplished without contamination or deformation at the cut ends that results in distortion of the test results caused by surface leakage. At one end of the cord, the ends of all three of the conductors are to be flush with the end of the jacket and in a plane perpendicular to the longitudinal axis of the cord. At the other end of the cord, the grounding conductor is to be cut off flush with the end of the jacket, and the circuit conductors and foil are to be connected to a sinusoidal or nearly sinusoidal 48 – 62 Hz 120- or 240-V supply circuit as shown in the applicable part of Figure 1320.2, the choice of supply circuit depending on whether the cord is intended for use with 120 or 240 V equipment. See 1320.2.

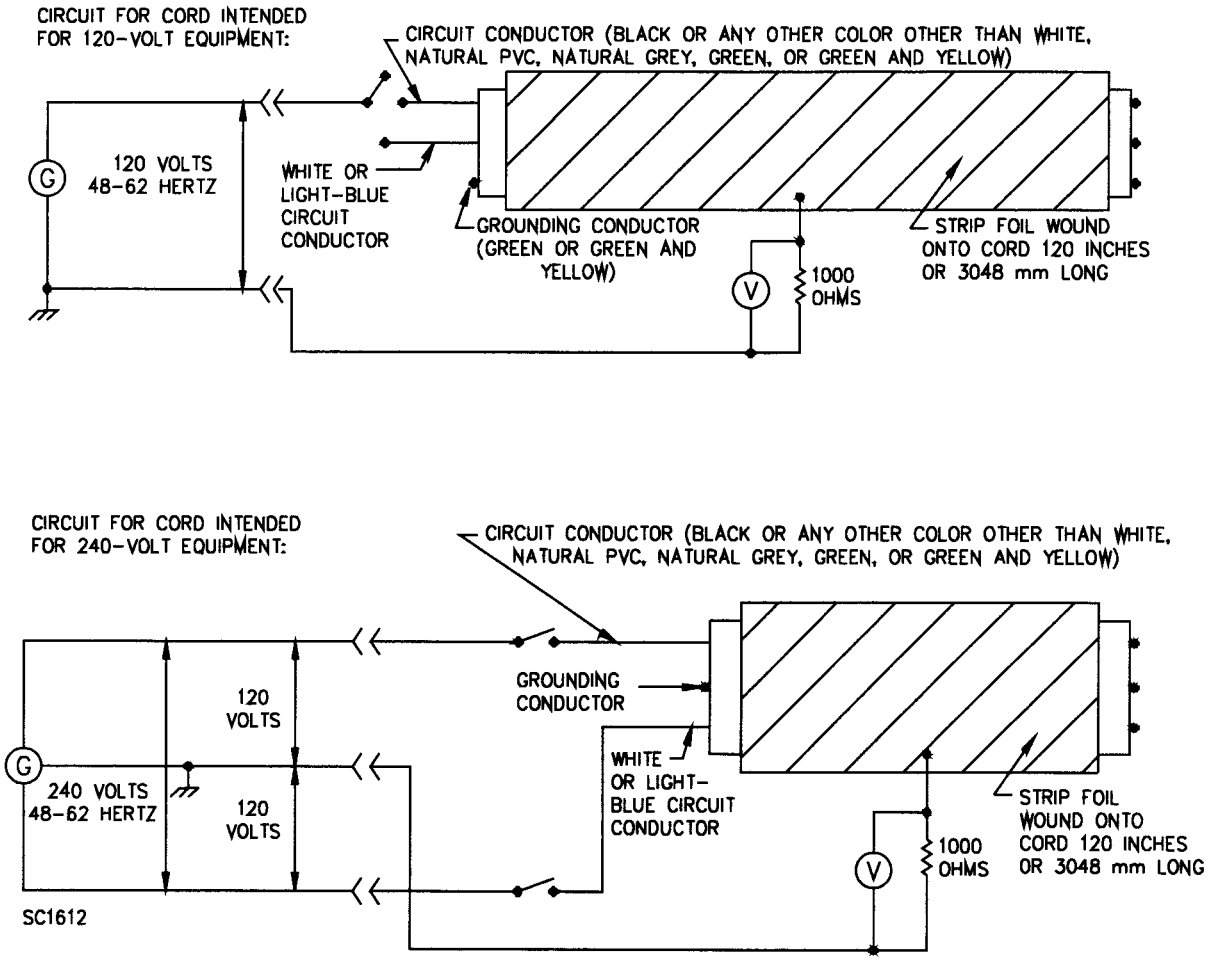
1320.5 The circuit conductors are to be energized separately and in succession and the reading of the voltmeter recorded for each. The leakage current from each circuit conductor through the jacket to the foil is to be calculated by dividing the voltage indicated by the voltmeter by the accurately known resistance of the resistor. The highest of the two leakage currents is to be used in choosing the range of current that determines the "µA thru jacket" value for the cord-surface marking.

1321 – 1339 *Reserved for Future Use*

1340 Test for D-C Resistance of Nonintegral Cord Jacket

1340.1 A length of at least 4 inches or 102 mm of the complete, finished cord is to be tested, The test is to be conducted at any convenient temperature and humidity; however, for referee purposes, the sample is to be conditioned for 96 h in air maintained at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and at a relative humidity of 50 ±5 percent. The entire length and circumference of the outer surface of the jacket is to be wiped three or more times with a soft, clean, lintless, absorbent cloth with only the cloth touching the center 2-inch or 51-mm portion of the sample. Two strips of metal foil 1/2 inch or 13 mm wide are then to be wrapped around the cord with the strips in intimate contact with the jacket, within the center 2-inch or 51-mm portion of the sample, and separated by a distance of 0.500 inch or 13 mm. Only air is to touch the jacket between the strips during application of the foil and during the rest of the test. Each of the foil strips is to be connected to a megohm bridge or equivalent equipment that supplies a direct potential of 500 V and is capable of measuring a resistance of 100 megohms with a 3-percent or smaller error. The jacket does not comply where, while 500 V dc is applied between the two foil strips, the resistance reading is less than 100 megohms.

Figure 1320.2
Circuit for measuring a-c leakage current from each circuit conductor through the cord jacket



1341 – 1399 *Reserved for Future Use*

IMPACT RESISTANCE

1400 Test

1400.1 The impact anvil is to consist of a solid rectangular block of steel 8 inches long, 6 inches wide, and 4-1/8 inches high or 203 mm by 152 mm by 105 mm. The block is to be secured to a rigid support such as to a vertical steel load-bearing building column or to a concrete floor immediately adjacent to such a column.

1400.2 The impact energy is to be supplied by a 1-lb or 454-g steel weight that is 1-1/2 inches or 38 mm in diameter and 2 inches or 51 mm high. The lower end of the weight is to serve as the impact face of the weight and is to be flat and perpendicular to the longitudinal axis of the weight. The edges of the impact face are to be rounded. The end of the weight that is opposite to the impact face is to have an attachment by means of which the machine is to lift, suspend, and release the weight to fall freely.

1400.3 The weight is to be supported with its impact face horizontal. A vertical line through the centers of gravity of the impact weight and the stationary anvil is to be coincident with a vertical line through the dimensional center of the impact face of the weight. A vertical guide is to constrain the weight and keep its impact face horizontal while the weight is falling and after it has struck the specimen. The guide is not to interfere with the free fall of the weight. A mechanism is to be provided at the top of the guide for releasing the weight to fall freely through the height and strike the specimen. The weight is to be kept from striking the specimen more than once during each drop.

1400.4 The specimens, the anvil, the weight, and the remainder of the test equipment are to be in thermal equilibrium with one another and the surrounding air at a temperature of 25.0 ±5.0°C (77.0 ±9.0°F) throughout the test.

1400.5 A 100-inch or 2540-mm straight length of the finished wire is to be tested without any conditioning. The specimen is to be tested at each of ten points that are evenly spaced along its length. These points are not to be closer together than 10 inches or 254 mm, and no point is to be closer than 5 inches or 127 mm to an end of the specimen. The weight is to be secured several specimen diameters above the anvil and the specimen is to be placed across the width of the anvil, with the first test point at the center of the length of the anvil. For a distance of at least 10 inches or 254 mm to each side of the test point, the longitudinal axis of the specimen is to be horizontal and in the vertical plane that contains the coincident vertical lines described in 1400.3. The conductor in the specimen is to be connected in series with a 3-W 120-V neon lamp to the energized conductor of a 120-V 48 – 62 Hz a-c supply circuit. The weight and all metal parts of the impact apparatus are to be connected together, to earth ground, and to the grounded supply wire.

1400.6 The position of the weight is to be adjusted to place the impact face of the weight 24 inches or 610 mm above the upper surface of the specimen. The weight is to be released from this height. The weight is to fall freely in the guide, is to strike the specimen once, and is then immediately to be raised to and secured at the 24-inch or 610-mm height. Each of the remaining nine test points on the specimen is to be impacted in the same way. The impact resistance of the wire is not in compliance where the conductor is visible at more than two of the test points or where the lamp lights momentarily or longer at more than two of the test points.

1401 – 1499 *Reserved for Future Use*

ABRASION OF 22 AWG TYPE XTW AND CXTW WIRE AND CORD

1500 Test

1500.1 Six straight specimens 40 inches or 1000 mm long are to be cut from a sample length of the finished wire or straightened conductor from the finished cord and are to be tested without any conditioning. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±8.0°C (73.4 ±14.4°F) throughout the test.

1500.2 One end of each specimen is to be attached to a horizontal reciprocating table while the table is at one end of its travel. The other end of each specimen is to be attached to a weight that exerts 4.0 ±0.5 ozf or 1.1 ±0.1 N or 113 ±13 gf. Each specimen is to be laid over a quarter cylinder to whose outer surface an unused sheet of Grade 1/2 (medium) emery cloth is attached. The radius of the surface of the emery cloth is to be 3.5 inches or 90 mm. The longitudinal axis of the cylinder is to be horizontal and perpendicular to each of the vertical planes that contain the specimens as they move on and are abraded by the emery cloth.

1500.3 The table is to be started in its horizontal reciprocating motion (simple harmonic motion) at the rate of 28 cycles per minute, each cycle consisting of one complete back-and-forth motion with a stroke of 6-1/4 inches or 160 mm. The table is to be stopped every 50 cycles and the emery cloth is to be shifted slightly to one side so that in subsequent cycles each specimen is abraded by a fresh surface of the cloth. The wire or cord does not comply where the strands are exposed anywhere on any of the six specimens in 400 or fewer cycles of the abrasion.

1501 – 1509 *Reserved for Future Use*

ABRASION

1510 Test

1510.1 Six straight specimens of the finished solid 14 AWG wire 40 inches or 1000 mm long are to be tested without any conditioning. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 25.0 ±5.0°C (77.0±9.0°F) throughout the test.

1510.2 One end of each specimen is to be attached to a horizontal, reciprocating table while the table is at one end of its travel. The other end of each specimen is to be attached to a weight that exerts 12.0 ±0.5 ozf or 3.3 ±0.1 N or 340 ±13 gf. Each specimen is to be laid over a quarter cylinder to whose outer surface an unused sheet of Grade 1/2 (medium) emery cloth is attached. The radius of the surface of the emery cloth is to be 3.5 inches or 90 mm. The longitudinal axis of the cylinder is to be horizontal and perpendicular to each of the vertical planes that contain the specimens as they move on and are abraded by the emery cloth.

1510.3 The table is to be started in its horizontal reciprocating motion (simple harmonic motion) at the rate of 28 cycles per minute, each cycle consisting of one complete back-and-forth motion with a stroke of 6-1/4 inches or 160 mm. The table is to be stopped every 50 cycles and the emery cloth is to be shifted slightly to one side so that in subsequent cycles each specimen is abraded by a fresh surface of the cloth. The wire does not comply where the nylon jacket and insulation on any of the six specimens wear through and expose the conductor in 800 or fewer cycles.

1511 – 1519 *Reserved for Future Use*

FLEXING OF 22 AWG TYPE XTW AND CXTW WIRE AND CORD

1520 Test

1520.1 Six specimens are to be cut from a sample length of the finished wire or cord and are to be tested without any conditioning. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±8.0°C (73.4±14.4°F) throughout the test.

1520.2 Each specimen is to be bent into the form of a flat-bottomed square-cornered U with the legs of the U straight and of equal length. The bottom of the U in each case is to be taped to the underside of a movable round horizontal rod (A in Figure 1520.1) with the axis of the conductor or conductors parallel to the longitudinal axis of the movable rod and the legs of the U extending vertically downward between a pair of fixed round rods (B in Figure 1520.1) that are 0.50 inch or 12.7 mm in diameter. A weight exerting 0.75 ±0.01 ozf or 0.210 ±0.003 N or 21.3 ±0.3 gf is to be attached to the free end of each leg. The conductors of the specimens are to be connected in series. The longitudinal axes of the two fixed rods are to be in a horizontal plane and are to be parallel to one another and to the longitudinal axis of the movable rod to which the specimens are taped. The distance between the two rods is to be adjusted to result in the specimens hanging midway between the rods, with a space from specimen to rod of near 1/32 inch or 1 mm on each side. A current of 1.5 A is to be passed through the conductor(s).

1520.3 The movable rod is to be started in the pivoted motion (simple harmonic motion) depicted by the dashed lines in Figure 1520.1 at the rate of 12 cycles per minute, each cycle consisting of one complete back-and-forth motion through an angle of 180° centering about the points of flexure. The motion is to be stopped after 6000 cycles and each specimen is to be cut open and examined for broken strands at the points of flexure against the two fixed rods. The wire or cord does not comply where more than half of the strands are broken in any leg of any specimen (12 legs in all) in the 6000 cycles of flexing.

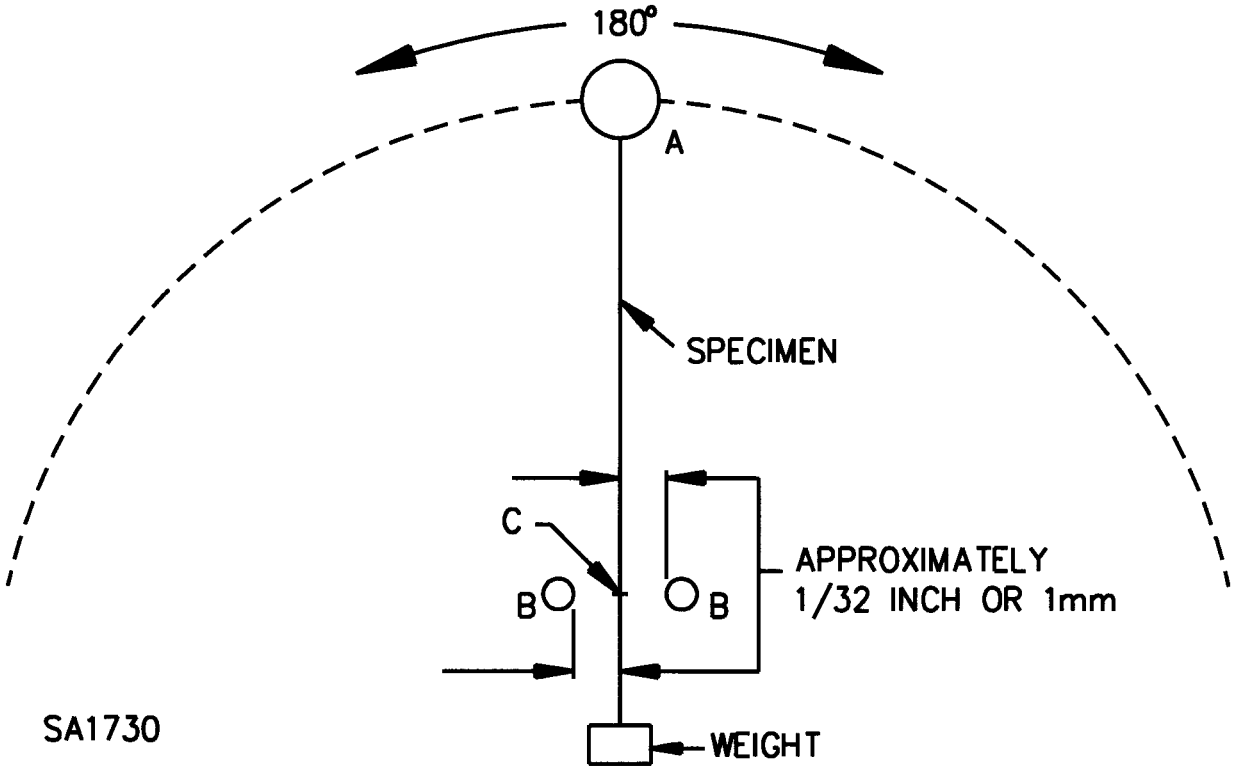
1521 – 1539 *Reserved for Future Use*

CRACKING OF NYLON COVERING ON COAXIAL-CABLE MEMBERS OF ELEVATOR CABLES OR OF NYLON JACKET ON TYPES TFN, TFFN, AND SPT-1 AND OF INSULATED CONDUCTORS IN SERVICE CORDS

1540 Test

1540.1 The apparatus for the air-oven aging of the specimen is to be as described in 420.8 and 420.9. The temperature of the oven and duration of the aging are to be the same as for the insulation material over which the nylon is used and are dependent upon the temperature rating of the cord, coaxial member, or wire. The finished coaxial-cable member for or from an elevator cable, or an insulated and jacketed conductor taken from the finished cord or fixture wire (complete jacketed cord in the case of nylon-jacketed Type SPT-1) is to be used as the test specimen. Following the air-oven aging, the specimen is to be removed from the oven and cooled in still air to a room temperature of 23.0 ±8.0°C (73.4 ±14.4°F) for 16 – 96 h prior to flexing. Each specimen is to be tightly wound for six complete turns around a mandrel having the same diameter as the coaxial-cable member or the insulated and jacketed conductor. Successive turns are to be in contact with one another and both ends of the specimen are to be securely held in place by means of friction tape. Wrinkling or folds of the nylon do not constitute noncomplying performance.

Figure 1520.1
End view of flexing



A – Movable rod.

B – Fixed rods.

C – Point of flexure.

1541 – 1559 *Reserved for Future Use*

FLEXING OF TYPE SF-1, SF-2, SFF-1, AND SFF-2 FIXTURE WIRES

1560 Test

1560.1 The physical properties of a finished fixture wire employing Class 22 silicone rubber shall make specimens that have been aged for 60 d at the specified temperature in a full-draft, circulating-air oven show neither rupture of the braid nor cracking of the insulation when cooled to room temperature and wrapped for six complete turns around a mandrel. The mandrel diameter shall be 1/4 inch or 6.5 mm for Type SF-1 and SFF-1 wires, and 1/2 inch or 13 mm for Type SF-2 and SFF-2 wires.

1561 – 1581 *Reserved for Future Use*

FLEXING OF SHIELDED CORDS

1582 Test

1582.1 Six specimens, each about 15 ft or 5 m long, are to be cut from a sample length of the finished shielded flexible cord. The specimens are to be tested without being conditioned in any way. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±8.0°C (73.4 ±14.4°F) throughout the test.

1582.2 The test is to be made using the apparatus diagrammed in Figure 1582.1, or such apparatus in multiple. The pulleys are to be mounted on the shuttle so that the specimen is horizontal as it passes between the pulleys. The weight, pulleys, and current used in the test are to be as indicated in Table 1582.1. The clamps at the ends of the specimens are to be positioned as shown in relation to the stops so that the pull is always applied by the weight away from which the shuttle is moving. The circuit conductors in the specimen(s) are to be connected in series and are to carry the current indicated in Table 1582.1 throughout the test. The circuit is to include a means for counting the number of cycles until 15,000 cycles have been completed or until a circuit conductor opens, thereby opening the circuit and stopping the test.

Figure 1582.1
Apparatus for flexing of shields

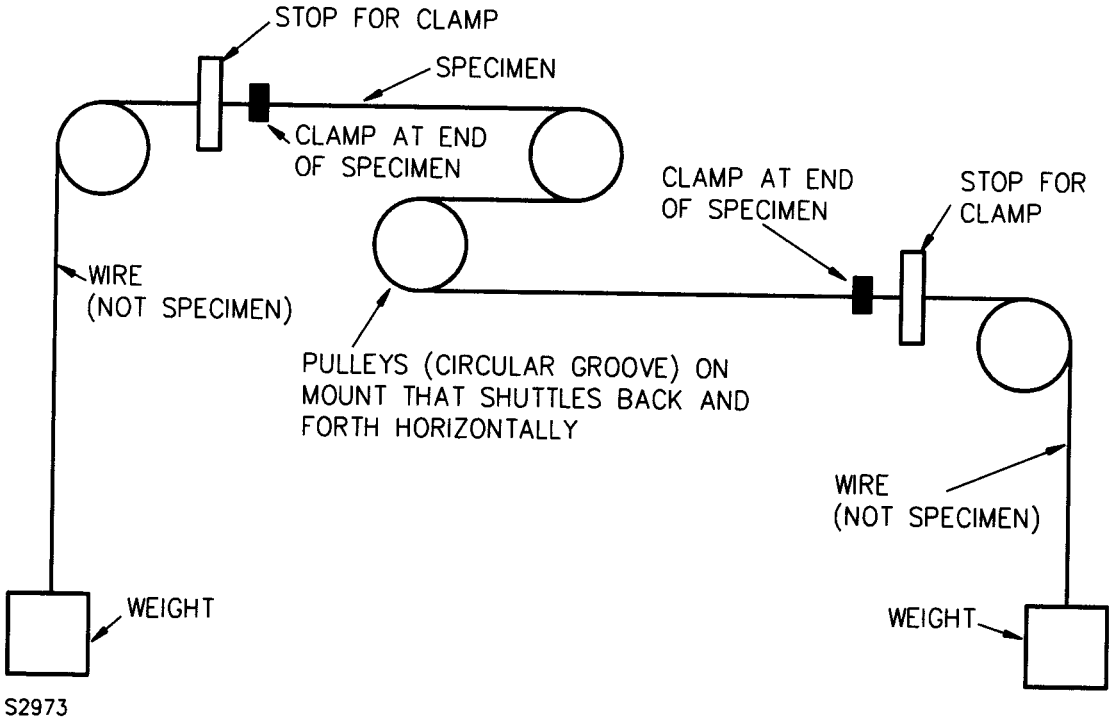


Table 1582.1
Weight, pulley diameter, and current for flexing test

AWG size of circuit conductors in cord	Force exerted by a weight at each end of cord specimen			Diameter at bottom of pulley (circular groove)		Current in circuit conductors	
						Cord with 2 circuit conductors	Cord with 3 circuit conductors
	kgf	N	lbf	mm	inch	A	A
18	1	9.79	2.2	80	3.15	10	7
17	1	9.79	2.2	80	3.15	12	–
16	1.5	14.7	3.3	120	4.72	13	10
15	1.5	14.7	3.3	120	4.72	–	–
14	1.5	14.7	3.3	120	4.72	18	15
12	1.5	14.7	3.3	120	4.72	25	20
10	1.5	14.7	3.3	120	4.72	30	25
8	1.5	14.7	3.3	120	4.72	40	35
6	1.5	14.7	3.3	120	4.72	55	45
4	1.5	14.7	3.3	120	4.72	70	60
2	1.5	14.7	3.3	120	4.72	95	80

1582.3 With a specimen(s) in place and rated current flowing in the circuit conductors, the shuttle is to be started in its horizontal reciprocating motion. The motion is to be constant at the rate of 0.33 m/s or 12 cycles per minute, each cycle consisting of one complete back-and-forth motion through a stroke of approximately 1 m or 39.4 inches. The motion is to be continued until 15,000 cycles have been completed or a circuit conductor opens and the test stops automatically after fewer cycles.

1582.4 The cord does not comply where any circuit conductor opens in fewer than 15,000 cycles in any of six specimens.

1583 – 1589 *Reserved for Future Use*

MANDREL TEST OF NYLON JACKET ON TYPE THWN-2, THWN, AND THHN WIRES

1590 Test

1590.1 A specimen of finished 14, 12, or 10 AWG Type THWN-2, THWN, or THHN wire is to be wrapped for four turns around a smooth metal mandrel of a diameter six times that of the specimen. The ends of the specimen are to be secured to the mandrel so that four complete turns of the specimen are exposed to the air between the securing means. The specimen and mandrel are to be suspended for 24 h in a full-draft circulating-air oven operating at a temperature of 95.0 ±1.0°C (203.0 ±1.8°F), after which the specimen and mandrel are to be removed from the oven and cooled for 1 h in a desiccator maintained at 24.0 ±3.0°C (75.2 ±5.4°F). The specimen is to be unwound at a rate of 4 seconds per turn immediately upon removal from the desiccator and is then to be inspected for surface cracks. Any cracking of the jacket on any specimen constitutes noncomplying performance.

1591 – 1599 *Reserved for Future Use*

1600 Comparison of Metal Sheaths

1600.1 CRUSHING TEST – The cable is to be crushed between a flat, horizontal steel plate and a solid steel rod by the application of dead weight or in a compression machine whose jaws close at the rate of 0.50 ±0.05 in/min or 10 ±1 mm/min. Each plate is to be 2 inches or 50 mm wide. A solid steel rod 3/4 inch or 19 mm in diameter and of a length equal to at least 6 inches or 150 mm is to be bolted or otherwise secured to the upper face of the lower plate. The longitudinal axes of the plates and the rod are to be in the same vertical plane. The specimens, the apparatus, and the surrounding air are to be in thermal equilibrium with one another and the surrounding air at a temperature of 24.0 ±8.0°C (75.2 ±14.4°F) throughout the test.

1600.2 The cable with the metal sheath under evaluation is to be tested in a continuous length of at least 36 inches or 915 mm, with this cable (test cable) being crushed at three points along that length. The points at which the test cable is to be crushed are to be measured and marked with chalk or another innocuous means on the test length before the test is begun. The first mark is to be placed 9 inches or 230 mm from one end of the test length and the two remaining marks are to be made at succeeding intervals of 9 inches or 230 mm down the length of the test cable.

1600.3 The test cable at the first mark is to be placed and held on the steel rod, with the longitudinal axis of the cable horizontal, perpendicular to the longitudinal axis of the rod, and in the vertical plane that laterally bisects the upper and lower plates and the rod. The upper steel plate is to be made snug against the cable. In a test using a dead weight(s) to crush the test cable, weight exerting the force determined in a separate test on the comparison cable (control) is to be placed gently on the upper plate. In a test using a compression machine, the upper plate is to be moved downward at the rate of 0.50 ±0.05 in/min or 10±1 mm/min thereby increasing the force on the test cable until the maximum level is reached at which

the comparison cable (control) resisted rupture in a separate test. That level of force is to be held constant for 60 s and is then to be reduced to zero by removing the dead weight(s) or, in the compression machine, by raising the upper steel plate at the rate of 0.50 ±0.05 in/min or 10 ±1 mm/min until the test cable is free.

1600.4 The test cable is to be advanced and crushed at each of the successive marks for a total of three crushes. The overall jacket or metal covering and the insulation on each conductor are to be examined at each of the three points at which the test cable was crushed. The test cable is not eligible for the 200 lbf or 890 N or 91 kgf reduced limit stated in the wire Standard for crushing the insulation on its conductors where the overall covering or any of the insulation is split, torn, cracked, or otherwise ruptured at any of the three points. Flattening of the jacket or the insulation, or both of these, without rupture is to be disregarded.

1600.5 IMPACT TEST – A solid rectangular block of steel 4-3/4 inches or 212 mm long by 3 inches or 76 mm wide by 5 inches or 127 mm high, with its upper face (4-3/4 inches by 3 inches or 212 mm by 76 mm) horizontal, is to be secured to a concrete floor, the building framework, or another solid support.

1600.6 An impact weight of 3 lb or 1.36 kgf is to be used. The impact weight is to consist of a solid steel cylinder having a diameter of 1-1/4 inches or 31.8 mm, with the edges of its lower face (the face that strikes the cable) rounded to a radius of 1/16 inch or 1.5 mm.

1600.7 The impact weight is to be supported with its lower face horizontal. A vertical line through the centers of gravity of the impact weight and the stationary block is to be coincident with a vertical line through the dimensional center of the lower face of the impact weight and the dimensional center of the upper face of the stationary block. A set of rails or other vertical guides is to constrain the impact weight and keep its lower face horizontal while the weight is falling and after it has struck the cable. The rails or other guides are not to interfere with the free fall of the impact weight. A means is to be at the top of the guides for releasing the impact weight to fall freely from any chosen height and strike the cable. The weight is to be kept from striking the cable more than once during each drop.

1600.8 The specimens, the apparatus, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 24.0 ±8.0°C (75.2 ±14.4°F) throughout the test.

1600.9 The cable with the metal sheath under evaluation is to be tested in a continuous length of at least 11 ft or 3.35 m, with ten strikes being made on that length of this cable (test cable). The points at which the test cable is to be struck are to be measured and marked with chalk or by another innocuous means on the test length before the test is begun. The first mark is to be placed 12 inches or 305 mm from one end of the test length and the nine remaining marks are to be made at succeeding intervals of 12 inches or 305 mm down the length of cable.

1600.10 Each of the insulated circuit conductors in the test cable is to be connected in series with a 3-W 120-V neon lamp to the energized conductor of a 2-wire 120-V 48 – 62 Hz grounded a-c supply circuit. The metal sheath in the test cable is to be connected to all parts of the impact apparatus, to earth ground, and to the grounded supply wire.

1600.11 The impact weight is to be secured several cable diameters above the stationary steel block, and the test cable at the first mark is to be placed and held on the steel block, with the longitudinal axis of the cable horizontal and in the vertical plane containing the coincident vertical lines mentioned in 1600.7. The position of the impact weight is to be adjusted to place the lower face of the weight the same distance above the upper surface of the test cable as it was released from and resulted in contact in a separate test on the comparison cable (control). The impact weight is to be released from this height, is to fall freely in the guides, is to strike the test cable once, and is then immediately to be raised up to and secured at

the initial height. Note is to be taken and recorded of whether any or all of the neon lamps light during the impact indicating a momentary or other contact between the circuit conductors or between one or more of the circuit conductors and the metal sheath.

1600.12 The test cable is to be advanced to and impacted at each of the successive marks for a total of ten strikes. The test cable is not eligible for the 200 lbf or 890 N or 91 kgf reduced limit stated in the wire standard for crushing the insulation on its conductors where any lamp lights at more than two of the ten impact points.

1601 – 1609 *Reserved for Future Use*

MOISTURE ABSORPTION BY FIBROUS COVERINGS OTHER THAN TAPE

1610 Test

1610.1 The apparatus for this test is to consist of a desiccator containing anhydrous calcium chloride, a set of mandrels having diameters as indicated in Table 1610.1, a quick-damping balance accurate to 10 mg, and an agitated constant-temperature bath of tap water maintained at a temperature of 21.0 ±1.0°C (69.8±1.8°F). The bath is either to be fitted with a cover to keep out dust or is to be placed within a tight enclosure during the test. Where at any time the water becomes dirty or shows the presence of a surface film of dust or wax, it is to be replaced with fresh water.

1610.2 Before cutting a test specimen to size, the coil or other sample of the wire, cable, or assembly that is to be tested is to attain a room temperature of 21.0 ±1.0°C (69.8 ±1.8°F). Handling and flexing of samples to be tested are to be reduced to the absolute minimum required for conducting the test.

1610.3 A specimen 24 ±1/4 inches or 610 ±6 mm long is to be cut from the coil or other sample of wire, cable, or assembly and is to be bent around a mandrel of the diameter indicated in Table 1610.1 (single conductor) or in Table 1610.2 (multiple-conductor cable or assembly). For a 2 AWG or smaller wire and for a multiple-conductor cable or assembly for which the factor F in Table 1610.2 is 2 or 3, the maximum number of complete turns that fit on the mandrel are to be made around the mandrel with the wire tight on the mandrel, adjacent turns 1/8 – 1/4 inch or 3 – 6 mm apart, and with a 2– 2-1/2-inch or 50 – 60-mm straight length at each end of the specimen extending away from the mandrel. For wire sizes larger than 2 AWG and for a multiple-conductor cable or assembly for which the factor F in Table 1610.2 is 4.5, 6, 9, or 10, a half turn is to be made around the mandrel.

Table 1610.1
Mandrel diameters for moisture and cold-bend tests on single conductors

Size of conductor	Diameter of mandrel	
	inches	mm
14 AWG	0.313	8
13	0.350	9
12	0.375	9
11	0.415	11
10	0.563	14
9	0.585	15
8	0.688	17
7	0.740	19
6	1.250	32
5	1.305	33
4	1.375	35
3	1.458	37
2	1.563	40
1	2.688	68
1/0	2.875	73
2/0	3.000	76
3/0	3.250	83
4/0	3.500	89
250 kcmil	5.188	132
300	5.500	140
350	5.875	149
400	6.250	159
450	6.625	168
500	6.750	171
550	10.500	267
600	11.000	279
650	11.250	286
700	11.500	292
750	12.000	305
800	12.250	311
900	12.875	327
1000	13.500	343
1100	17.000	432
1200	17.250	438
1250	17.500	445

Table 1610.1 Continued on Next Page

Table 1610.1 Continued

Size of conductor	Diameter of mandrel	
	inches	mm
1300	17.750	451
1400	18.125	460
1500	18.500	470
1600	18.875	479
1700	19.375	492
1750	19.750	502
1800	19.875	505
1900	20.125	511
2000	20.500	521

Table 1610.2
Mandrel-diameter factor F for moisture and cold-bend tests on multiple-conductor cables and assemblies

Calculated diameter over the finished cable or assembly		Factor F by which the calculated diameter over the finished cable or assembly is to be multiplied to obtain the mandrel diameter
inches	mm	
0 – 0.375	0 – 9.52	2
0.376 – 0.500	9.53 – 12.70	3
0.501 – 0.750	12.71 – 19.05	4.5
0.751 – 1.125	19.06 – 28.58	6
1.126 – 1.500	28.59 – 38.10	9
over 1.500	over 38.10	10

1610.4 The specimen is to be removed from the mandrel without disturbing its form and is to be placed in the desiccator over anhydrous calcium chloride at a temperature of 21.0 ±1.0°C (69.8 ±1.8°F) for at least 18 h. It is then to be removed from the desiccator and weighed to the nearest 10 mg. The weight is to be recorded as W.

1610.5 The specimen is then to be immersed in the tap-water bath, with 1 ±1/8 inch or 25 ±3 mm of each end of the coil or 180° bend projecting above the surface of the water. After 24 h of immersion, the specimen is to be removed from the bath, shaken vigorously for 5 s to remove adherent moisture and weighed again 2 min after removal from the bath. This weight is to be recorded as W_1. All fibrous coverings other than tape are then to be removed from the full length of the specimen. The conductor(s), insulation, and any tape are then to be weighed. In the case of an assembly for use in armored cable, any overall fibrous covering and any fibrous covering on the individual wires are to be taken together in one test and a second test is to be made on only the fibrous covering on the individual wires. This weight is to be recorded as W_2.

1610.6 The moisture absorbed by the specimen is not to be adjusted for the portion of the specimen projecting above the water. The percentage of absorption is to be calculated (to 0.1 percent) by means of the expression

$$\frac{100(W_1 - W)}{W - W_2}$$

1611 – 1629 *Reserved for Future Use*

FALLING PARTICLES AND DRIPPING FROM FIBROUS-COVERED WIRE AND CABLE

1630 Test

1630.1 A 7-inch or 180-mm specimen of the finished fibrous-covered wire or cable is to be secured in a horizontal position above the floor of a full-draft circulating-air oven for 7 h at the rated temperature of the wire or cable ±1.0°C (±1.8°F). The saturant, finish, and any lubricant comply where, with a clean sheet of aluminum foil or white paper covering the entire floor of the oven for the 7 h, drippings or particles or drippings and particles do not fall from the wire or cable onto the paper or foil.

1631 – 1669 *Reserved for Future Use*

ARCING OF TYPE HPN CORD

1670 Flame Test

1670.1 One end of a sample length of finished Type HPN cord having two circuit conductors with or without one grounding conductor is to be cut off, with the face of the cut end flat and perpendicular to the longitudinal axis of the cord. The cord is to be laid out straight and flat on a horizontal, electrically nonconductive, noncombustible surface, with 4 inches or 100 mm of the cord at the cut end extending beyond the edge of the supporting surface. The circuit conductors at the end of the cord opposite the cut end are to be connected to a 120 V 48 – 62 Hz sinusoidal or nearly sinusoidal rms branch-circuit supply that has a 15-A fuse or circuit breaker, and has a capacity that enables short circuiting of the circuit to cause the fuse or circuit breaker to open. Any grounding conductor is not to be connected.

1670.2 A Tirrill, Bunsen, or similar appropriate gas burner having a vertical barrel that has an inside diameter of 3/8 inch or 9.5 mm and extends 4 inches or 102 mm above the air inlets is to be lit and adjusted for a steady flame with an overall height of 1-1/2 inches or 38 mm with the temperature at its tip 816°C (1500°F) or higher as measured using a chromel-alumel (nickel-chromium and nickel-manganese-aluminum) thermocouple. With its barrel vertical, the burner is to be placed under the free end of the cord with the tip of the blue inner cone touching the flat underside of the cord at a point that is midway between the conductors and 1/2 inch or 13 mm from the cut end. The flame is to be applied for 120 s and then removed. The cord does not comply where arcing occurs between the conductors during application of the flame or where the fuse or circuit breaker opens.

1671 – 1679 *Reserved for Future Use*

1680 Broken-Strands Test

1680.1 For each test, the specimen is to be 40 inches or 1 m long and is to be taken from a length of the finished cord containing two circuit conductors with or without a grounding conductor. Both ends of each circuit conductor are to be bared for electrical connection. Any grounding conductor is to be present and disregarded. A commercially available strain-relief bushing for the type and size of cord being tested is to be assembled to the cord as intended at a point 24 inches or 610 mm from one end of the specimen.

1680.2 By means of the bushing, the specimen is to be secured in a flexing machine with the 24-inch or 610-mm end of the cord hanging vertically below the bushing. The circuit conductors are to be connected in series with one another, a lamp or other device to signal breakage of a circuit conductor, and a 48 – 62 Hz, 24-V rms supply circuit that operates at a current not exceeding 200 mA. A weight exerting the force indicated in Table 1680.1 is to be secured to the cord at a point 8-1/2 inches or 215 mm below the bushing.

Table 1680.1
Weight for strand-breaking flexing

AWG size of circuit conductors	Weight		
	lbf	N	gf
18	2	8.9	907
17	2.5	11.1	1134
16	3	13.3	1361
14	4	17.8	1814
12	5	22.2	2268

1680.3 The machine is to flex the cord edgewise at the point of exit of the cord from the bushing. The flexing is to be by simple harmonic motion at a rate at or near 12 cycles per minute. Each cycle is to consist of flexing the cord from its original vertical position to a horizontal position 90° to one side, back through 180° from that position to a similar horizontal position to the other side, and then back to the original vertical position. The circuit conductors in the cord are to remain in the same vertical plane throughout the flexing. The flexing is to continue until all of the strands of one circuit conductor break as indicated by the lamp or other signal device. Breakage of a circuit conductor is to stop the flexing machine.

1680.4 The strain-relief bushing is to be removed and the specimen is to be examined for damage to the insulation. Where there is any splitting, cracking, or other visible damage to the insulation or where any strand(s) extend through the insulation, the specimen is to be discarded and a new specimen is to be prepared, flexed until one circuit conductor breaks, and examined for damage to the insulation. For this flexing procedure, the weight attached to the cord is to be reduced (steps of 4 ozf, 1.1 N, or 113 gf typically are convenient) to result in the flexing breaking a circuit conductor without any visible damage to the insulation.

1680.5 The undamaged specimen is to be wrapped with four single layers of bleached cheesecloth that is 2 inches or 50 mm wide, runs 14 – 15 yd/lb or 26 – 28 m^2/kg, and has what is known in the trade as a count of 32 by 28 (a square 1 inch on a side has 32 threads in one direction and 28 threads in the other direction or a square 1 cm on a side has 13 threads in one direction and 11 threads in the other direction). The cheesecloth is to be tight on the specimen, centered over the break in the circuit conductor, and held

in place by a strain-relief bushing that is larger than the one indicated in 1680.1 (see Table 1680.2 for some appropriate cord/bushing combinations). The bushing is to be assembled to the cheesecloth-wrapped cord at a point 1/4 inch or 5 mm from the break in the circuit conductor.

Table 1680.2
Combinations of cord and bushing

Cord construction	Typical bushing[a]
18/2, 18/3, 16/2	SR-4K-1
16/3	SR-5W-1
14/2, 14/3 smaller dimensions	SR-33-1
14/2, 14/3 larger dimensions	SR-34-2

[a] The specific bushings shown are not required. These particular bushings are mentioned as a guide because the selection of bushings is difficult and these have been used successfully in a number of tests. Different bushings are to be used where required by the dimensions of the cord being tested and the layering of cheesecloth over the cord. The designations shown are for Heyco bushings made by the Heyman Manufacturing Company of Kenilworth, New Jersey 07033.

1680.6 By means of the bushing, the specimen is to be secured in a vertical sheet-metal bracket. As shown in Figure 1680.1, the longitudinal axis of the specimen is to be horizontal at the point at which the bushing passes through the vertical surface of the bracket. The cheesecloth-wrapped break in the circuit conductor is to be in front of the bracket.

1680.7 The bared ends of the broken circuit conductor are to be connected in series with a variable resistor, an a-c ammeter of applicable range, overcurrent protection, and a 48 – 62 Hz supply circuit of 120 ±2 V as shown in Figure 1680.1. A 120-V neon lamp is to be connected either in parallel with the broken circuit conductor, or in parallel with the variable resistor. The lamp acts as an indicator of the circuit being opened (lamp lit where in parallel with the broken conductor, lamp dark where in parallel with the resistor) and closed (lamp dark where in parallel with the broken conductor, lamp lit where in parallel with the resistor) in the specimen as the specimen is flexed. The unbroken circuit conductor and any grounding conductor are to be present and are not to be in the circuit.

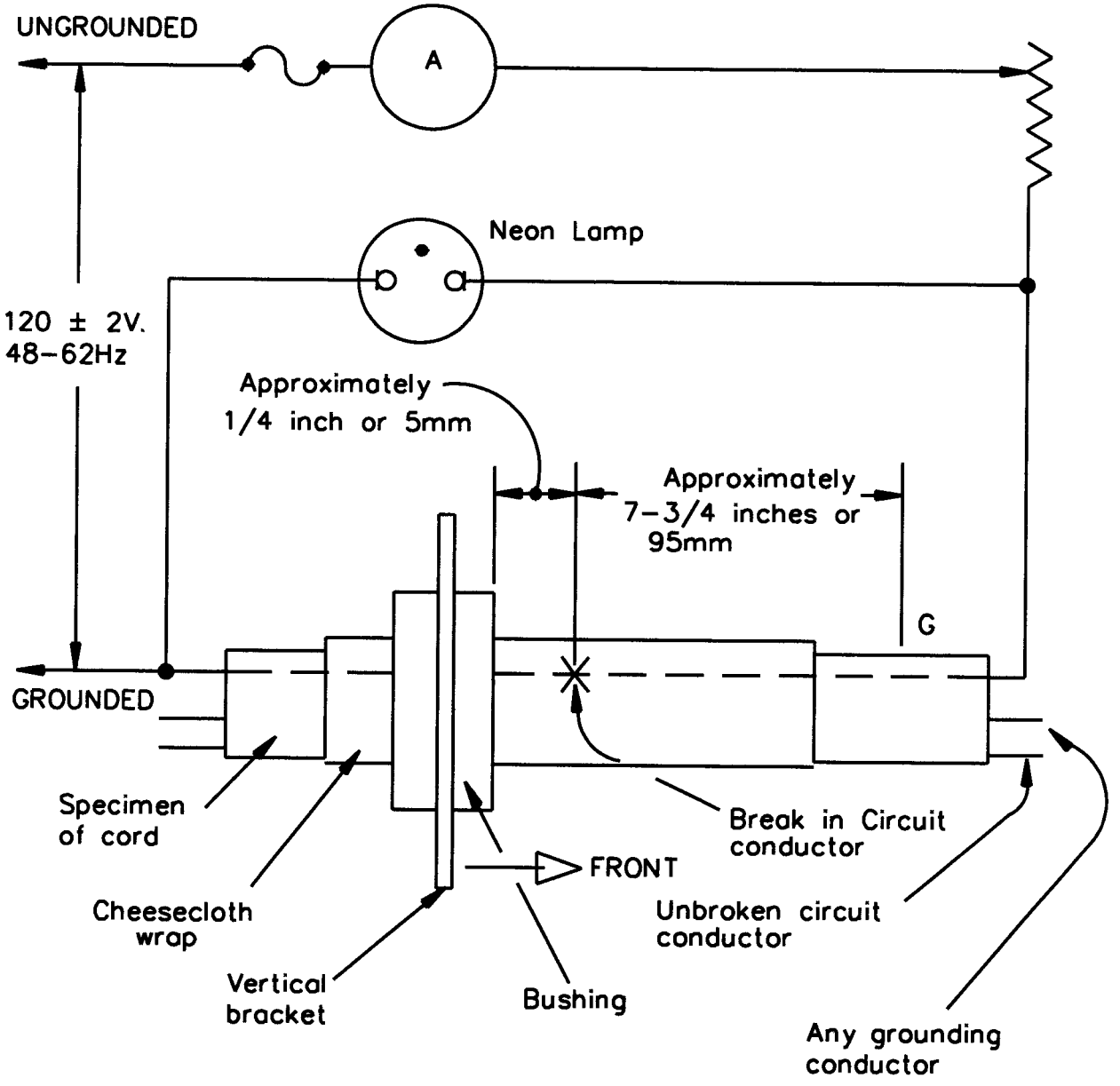
1680.8 The variable resistor is to be adjusted to result in the current indicated in Table 1680.3 flowing in the broken circuit conductor.

Table 1680.3
Current in the broken circuit conductor

AWG size of circuit conductors in cord	RMS current in amperes
18	10.0 ±0.5
16	15.0 ±0.5
14	20.0 ±0.5
12	30.0 ±0.5

1680.9 While the current is flowing, the specimen is to be grasped 7-3/4 inches or 197 mm from the break in the circuit conductor (point G in Figure 1680.1). Without physically straining the insulation, the cord is to be moved back and forth to result in the circuit being opened and closed at the break in the circuit conductor as indicated by the neon lamp lighting and going dark. Each cycle of make and break is to take 3 – 4 s. The test is to be discontinued after 20 cycles of opening and closing the circuit.

Figure 1680.1
Arcing circuit



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1680.10 Where the insulation is perforated as evidenced by flaming, glowing, or charring of the cheesecloth, the test is to be stopped. Perforation in 20 or fewer cycles constitutes noncompliance.

1680.11 Where 20 cycles is not completed on an unperforated specimen because contact is no longer made between the broken ends of the circuit conductor, that specimen is to be discarded and the test is to be repeated with a new specimen.

1681 – 1689 *Reserved for Future Use*

DURABILITY OF INDELIBLE-INK PRINTING

1690 Test

1690.1 Two straight 300-mm or 12-inch specimens of the single- or multiple-conductor construction are to be cut from a sample length of any convenient size of the finished wire or cable on which the ink printing is being evaluated. The specimens are to be handled minimally and are not to be wiped, scraped, or otherwise cleaned in any way.

1690.2 One of the specimens is to be aged in a circulating-air oven that complies with 420.8 and 420.9, including 100 – 200 fresh-air changes per hour, operating for the time and at the temperature specified for the insulation or jacketing material whose outer surface is printed, and is then to be removed from the oven and kept in still air to cool to room temperature for 60 min before being tested. The one remaining specimen is to rest for at least 24 h in still air at 23.0 ±5.0°C (73.4 ±9.0°F) before being tested.

1690.3 The test is to be made using a weight whose lower face is machined to a flat, rectangular surface measuring 25 mm by 50 mm or 1 inch by 2 inches. The height of the weight is to be uniform to ensure even distribution of the weight throughout the area of the lower face. Clamps or other means are to be provided for securing to the lower face of the weight a layer of craft felt (composition not specified) that is 1.2 mm or 0.047 inch thick. Without the felt in place, the weight and the means for securing the felt to the weight are to exert 450 ±5 g or 1 lbf ±0.2 ozf or 4.45 ±0.06 N on a specimen. It is appropriate to use the felt for several tests; however, the felt is to be replaced as soon as the fibers flatten or become soiled. While not in use, the weight is to be stored resting on one of its surfaces that is not covered with felt. The apparatus and the specimens are to be in thermal equilibrium with the surrounding air at a temperature of 23.0 ±5.0°C (73.4 ±9.0°F) throughout the test. Each specimen is to be placed on a solid, flat, horizontal surface with the printing up and at the center of the length of the specimen. The ends of each specimen are to be bent around supports or otherwise secured to keep the printed area of the insulation or jacket from rotating out from under the weight.

1690.4 The felted surface of the weight is to be placed on the printed area of a specimen with the felted surface horizontal and with the 50-mm or 2-inch dimension of the felted surface parallel to the length of the specimen. With the weight so resting on the specimen, the felt is to be slid lengthwise by hand along the printed area of the specimen for a total of three cycles. Each cycle is to consist of one complete back-and-forth motion covering the entire length of the specimen. The three cycles of rubbing are to be completed at an even pace, taking a total time of 5 – 10 s. The procedure is to be repeated on the second specimen. Where the printing is illegible on either of the two specimens, the ink printing on the wire or cable does not comply.