26.5 Each pole of a snap switch rated as a 2-circuit, 3-circuit, or multicircuit switch may control a separate load at the full voltage rating of the switch. Each pole of a snap switch rated as a 240-volt, 2-pole switch may control a separate 120-volt load, and both may control both legs of a single 240-volt load. Each pole of a snap switch rated as a 240-volt, 3-pole switch may control a separate load not exceeding 139 volts, and the three poles may control the three legs of a 3-phase, 240-volt load.

26.6 A 240-volt or 250-volt snap switch used in a circuit involving more than 120 volts to ground shall be rated for such use as indicated by a double underlining under the voltage rating.

26.7 A switch shall not disconnect the grounded conductor of a circuit unless:

a) The switch simultaneously disconnects all conductors of the circuit, or

b) The switch is so arranged that the grounded conductor is not disconnected until the ungrounded conductors of the circuit have been disconnected.

26.8 Solid state switches shall comply with the requirements in this Standard. Mechanical and electromechanical switches shall comply with the applicable requirements for switches such as in Annex A, Ref. No. 37, or Annex A, Ref. No. 38.

26.9 Where a device switch or circuit breaker is mounted such that movement of the operating handle between the on position and off position results in one position being above the other position, the upper position shall be the ON position. This requirement does not apply to a switching device having more than one on position, a double throw switch, a rotationally operated switch, or a rocker switch.

27 Capacitors, Resistors, and Suppressors

27.1 Capacitors

27.1.1 The materials and construction of a capacitor, its case, or both shall be such that emission of flame from the enclosure of the device during malfunction of the capacitor does not occur. See 27.1.3.

27.1.2 The materials and construction of a capacitor or its case within a device shall be such that pressures capable of causing injury to persons do not develop in the capacitor in the event of malfunction of the capacitor or the circuit in which it is connected. See 27.1.3.

27.1.3 Compliance with the requirements described in 27.1.1 and 27.1.2 shall be determined by the Abnormal Tests specified in 52.

27.1.4 Under both normal and abnormal conditions of use, including internal shorting of the capacitor, a capacitor containing oil that is more combustible than askarel shall not result in a risk of fire or electric shock and shall be constructed to reduce the risk of expelling dielectric medium from the enclosure of the device. See 27.1.5 and 27.1.6.

27.1.5 With reference to the requirement in 27.1.4, a capacitor complying with the requirements for protected oil-filled capacitors in Annex A, Ref. No. 39, shall be constructed to reduce the risk of expelling the dielectric medium.

27.1.6 With reference to 27.1.4, a device having a capacitor other than that described in 27.1.5 shall be provided with:

a) A complete noncombustible bottom panel below the capacitor;

b) A ventilated, bottom-panel construction complying with 7.5.4.1; or

c) A ventilated, bottom-panel construction complying with the capacitor fault test described in 52.5.

27.1.7 A means such as a bleeder resistor shall be provided to drain the charge stored in a capacitor so that it does not provide a risk of electric shock. See 9.3.1.

27.1.8 Capacitors connected across an input ac circuit shall comply with the requirements for across-the-line capacitors in Annex A, Ref. No. 40.

27.2 Resistors

27.2.1 The assembly of a power resistor, such as a wire wound type requiring a separate support, shall be reliable. The resistor shall be prevented from loosening or rotating by a means other than friction between surfaces.

27.2.2 An assembly employing lock washers complies with the requirement in 27.2.1.

27.3 Suppressors

27.3.1 Suppressors shall be enclosed by housings of noncombustible, moisture-absorption-resistant material. If sheet steel is used, it shall be not thinner than 0.52 mm (0.02 inches).

27.3.2 The housing required by 27.3.1 may be dispensed with if a suppressor is mounted in an enclosure that affords protection equivalent to that of the housing.

28 Overcurrent Protective Devices

28.1 General

28.1.1 Supplementary overcurrent devices are not required unless specifically stated as such in other parts of this Standard or to reduce the risk of electric shock, fire, or injury to persons.

28.2 Supplementary protectors

28.2.1 Supplementary protectors shall not be used for overcurrent protection of circuits defined as ″branch circuits″ as defined in Annex A, Ref. No. 1.

28.2.2 Supplementary protection devices shall be in accordance with Annex A, Ref. No. 41. Supplementary protection devices that are user replaceable shall be accessible from outside the enclosure, or shall be located behind a hinged cover – see 7.2.1.

28.2.3 Except as indicated in 28.2.4, a supplementary protection device shall not be connected in the grounded (neutral) side of the line.

28.2.4 Additional protection in the grounded side of the supply circuit is allowed when the protection simultaneously disconnects all grounded and ungrounded conductors of the supply circuit.

28.2.5 Where the device has provision for connection of a grounded neutral conductor, individual single-pole circuit breakers may be used as the protection for each ungrounded conductor of a 3-wire single-phase circuit or for each ungrounded conductor of a 4-wire, 3-phase circuit, when no conductor involves a potential to ground in excess of 150 volts. See 74.15.

28.3 Thermal links

28.3.1 Non-resettable thermal links incorporated as overcurrent protection shall comply with the applicable requirements in Annex A, Ref. No. 42.

28.4 Fuses

28.4.1 Fuses used for overcurrent protection shall be plug fuses or cartridge fuses. Plug fuses shall be Edison base or Type S fuses and shall comply with 28.4.2. Cartridge fuses shall be Class CC, G, H, J, K, RK1, RK5, or T, and shall comply with 28.4.3.

28.4.2 Plug fuses shall comply with Annex A, Ref. No. 43 and Ref. No 44. The fuseholder shall comply with Annex A, Ref. No. 46.

28.4.3 Cartridge fuses shall comply with Annex A, Ref. No. 43 and additionally, the Standard based on fuse class in accordance with Annex A, Ref. Nos. 47 and 49. Fuseholders shall comply with Annex A, Ref. No. 45 and additionally, the Standard based on fuse class in accordance with Annex A, Ref. No. 48.

28.4.4 For plug fuses and cartridge fuses, except as indicated in 28.4.5, a disconnecting means shall be provided on the supply side of each fuse. The disconnecting means shall be such that each individual circuit can be independently disconnected from the source of supply.

28.4.5 For service replaceable fuses, the disconnecting means can be the circuit breaker in the building installation. If so used, no additional disconnecting means is necessary, provided that manufacturer's service instructions inform the service personnel to disconnect power to the unit prior to changing the fuse.

28.4.6 A device shall be constructed so that fuses will be readily accessible when the disconnecting means is opened so that the fuse may be replaced without the service personnel or user inadvertently contacting live parts.

28.4.7 If a Type S fuseholder, or Edison base fuseholder with or without a Type S adapter, is used, the line connection shall be made to the center contact.

28.4.8 A fuse and fuseholder shall have a voltage and current rating not less than those for the circuit in which they are connected. Plug fuses are not allowed in a circuit rated more than 125 volts or 125/250 volts, 3-wire.

28.4.9 Fuses shall be located in all ungrounded conductors.

28.4.10 A device shall be marked in accordance with 74.8 when it is provided with overcurrent protection consisting of an interchangeable fuse that is accessible to the user, whether the user is instructed to change the fuse or not.

28.5 Circuit breakers

28.5.1 Circuit breakers incorporated as overcurrent protection shall comply with the applicable requirements in Annex A, Ref. No. 74.

29 Transformers

29.1 General

29.1.1 A transformer coil, unless inherently moisture resistant, shall be treated with an insulating varnish and baked, or otherwise impregnated to exclude moisture or acid vapor. Film coated magnet wire is moisture resistant for this case.

29.1.2 A thermal cutoff or other device employed to reduce the risk of fire or electric shock due to overheating of a transformer during abnormal operation shall comply with the requirements applicable to such a device in addition to the applicable requirements in this Standard. For example, a thermal cutoff shall comply with the applicable requirements in this Standard and those Annex A, Ref. No. 42.

29.1.3 A transformer used to supply a signal circuit where the outlet is accessible to the user shall have its primary winding electrically isolated from its secondary winding and shall be constructed as specified in 29.2.1 – 29.2.7 so that there is no electrical connection - under normal and overload conditions - between the primary and secondary windings, between the primary winding and the core, or between separate adjacent secondary windings, where such connection results in a risk of fire or electric shock.

29.1.4 With reference to the requirement in 29.1.3, a transformer complying with the requirements in any of the following Standards complies with this requirement:

a) Annex A, Ref. No. 50 and Ref. No. 51;

b) Annex A, Ref. No. 52; or

c) Annex A, Ref. No. 27.

29.2 Coil insulation

29.2.1 A transformer winding including the start, all taps, finish, and crossover leads up to the point where insulated leads are provided shall be constructed, when used, as specified in Table 18.

Table 18
Transformer insulation

	Insulation required	Type of insulation
1.	Insulation between the primary wires of opposite polarity and between secondary wires of opposite polarity having a potential greater than 30 volts, rms (42.4 volts peak)	a, b, c, or d
2.	Insulation between the primary and any secondary winding	a, b, c, or d
3.	Insulation between any winding or lead connections and dead metal parts	b, c, d, e, f, or g
4.	Insulation between the crossover leads and (1) the turns of a different winding, (2) the metal enclosure of a unit, or (3) the core	a, d, e, g, or h

a. Electrical grade paper that is waxed or otherwise treated to retard the absorption of moisture and that has a total thickness of not less than 0.71 mm (0.028 inch); polyethylene terephthalate film, not less than 0.178 mm (0.007 inch) thick; or aramid paper, not less than 0.203 mm (0.0085 inch) thick.

b. A thermoplastic or thermoset coil form not less than 0.71 mm (0.028 inch) thick.

c. A material having a thickness less than 0.71 mm (0.028 inch) is used only when it is equivalent to note a or b and the material has a minimum dielectric breakdown strength of 5000 volts for the thickness used as determined by the test described in Tests on Transformer Insulating Materials, 69.

d. Using spacings specified in Table 19 in place of the specified insulation is not prohibited.

e. Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.33 mm (0.013 inch) when used in conjunction with an air spacing of one-half that specified in note d.

f. Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.71 mm (0.028 inch) where the insulation is in contact with the enclosure.

g. A material having a thickness less than that specified in notes e and f is not prohibited where it is equivalent to notes e and f and the material has a minimum dielectric breakdown strength of 2500 volts for the thickness used for note e and 5000 volts for the thickness used for note f as determined by the test described in 51.

h. Any type and thickness of insulation in addition to the magnet wire coating, or a through air spacing less than that specified in Table 19 is not prohibited from being used between a crossover lead and the winding to which it is connected when the construction complies with either of the following:

1) 1. The coil withstands the applicable dielectric withstand potential described in 51.3.1 and 51.3.2. The potential shall be applied between the coil leads with the crossover lead cut at the point where it enters the inner layer.

2) 2. The coil withstands the induced potential described in 51.5.2 and 51.5.5.

Table 19
Spacings within a transformer

Minimum spacing through air and over surface, mm (inch)	
Potential involved, volts	**Between any uninsulated live part and an uninsulated live part of opposite polarity, or the core[a]**
0 – 50	1.2 (3/64)
Greater than 50 to 125	1.6 (1/16)
Greater than 125 to 250	2.4 (3/32)
Greater than 250 to 600	6.4 (1/4)
NOTE – This table applies only to transformers that are treated with an insulating varnish and baked or otherwise impregnated. [a] Includes turns of a coil having a magnet wire coating.	

29.2.2 Insulating material, such as outer-wrap and crossover-lead insulation, employed to reduce the risk of live parts from becoming accessible through openings in the outer enclosure in accordance with Protection of Users - Accessibility and User Servicing, 8, shall comply with note (a) or (c) of Table 18.

29.2.3 A flanged bobbin-wound transformer shall be constructed so as to maintain physical separation between the primary and secondary windings. Physical separation accomplished by employing a 3-flange bobbin for winding the primary and secondary windings adjacent to each other is allowed. As an alternative, a telescoping bobbin construction, with each section containing an individual winding, shall be used where the primary winding is wound over the secondary winding or the secondary winding over the primary winding. The bobbin insulation shall comply with note (a), (b), (c), or (d) of Table 18.

29.2.4 A 2-flange bobbin having the primary winding wound over the secondary winding or the secondary winding wound over the primary with the primary winding insulated from the secondary winding by means of tape insulation meets the intent of 29.2.3 when:

a) The tape insulation complies with note (a) or (c) of Table 18;

b) The tape insulation provides a continuous overlap on the bobbin flange;

c) The transformer complies with the tests described in the Flanged Bobbin Transformer Abnormal Test, 53; and

d) The transformer complies with the induced potential tests described in 51.5.

29.2.5 A 2-flange bobbin having the primary winding wound over the secondary winding or the secondary winding wound over the primary with the primary winding insulated from the secondary winding by means of tape insulation meets the intent of 29.2.3 when:

a) The tape insulation complies with note (a) or (c) of Table 18,

b) The coils are layer wound, and

c) All windings have end turns that are retained by a positive means and the spacing between end margins of the primary and secondary windings comply with item (d) of Table 18.

29.2.6 A transformer complying with the requirements in either Annex A, Ref. No. 50 and Ref. No. 51 or Annex A, Ref. No. 27 or Annex A, Ref. No. 52 complies 29.2.3.

29.2.7 With reference to note (c) in 29.2.4, the Flanged Bobbin Transformer Abnormal Test, 53, is not required when the transformer is supplied from an LVLE circuit, or a limited energy circuit, or complies with the requirements in 28.2.

30 Printed Wiring Boards

30.1 Except as indicated in 30.1.1, a printed-circuit board shall comply with the requirements in Annex A, Ref. No. 53, and shall be classed V-1 in accordance with the requirements in Annex A, Ref. No. 16.

30.1.1 A printed wiring board located outside an enclosure, such as in an external control circuit, and located in a LVLE circuit or a limited-energy circuit shall be classed as minimum V-2.

30.2 A resistor, capacitor, inductor, or other part that is mounted on a printed-circuit board to form a printed-circuit assembly shall be secured so that it does not become displaced and cause a risk of electric shock or fire by a force that is capable of being exerted on it during assembly, intended operation, or servicing of the power supply.

30.3 Further evaluation shall be conducted for a barrier or a partition that is part of the device assembly and that provides mechanical protection and electrical insulation of a component connected to the printed-circuit board.

31 Insulating Materials

31.1 An insulating material used for supporting live parts and a barrier material shall be moisture-resistant and not be adversely affected by the temperature and stresses to which it is subjected under conditions of use.

31.2 Insulating material shall be judged with respect to the application for which it is to be used. Materials such as mica, some molded compounds, and certain refractory materials are usually used for the sole support of live parts. When an investigation is required to determine whether a material is capable of being used, such investigation shall be conducted in accordance with Annex A, Ref. No. 21. Consideration shall be given to the material's mechanical strength, resistance to hot wire ignition, resistance to high-current-arc ignition, resistance to high-voltage-arc ignition, dielectric strength, insulation resistance, and heat-resistant qualities, in both the aged and unaged conditions; the degree to which the material is enclosed; and any other feature affecting the risk of fire, electric shock, hazardous energy levels, or injury to persons. All factors shall be taken into account with respect to conditions of actual service.

31.3 Ordinary vulcanized fibers used for insulating bushings, washers, separators, and barriers shall not be the sole support for uninsulated live parts.

31.4 A sensor such as a current transformer, transducer, or similar device shall be provided with insulation that has been evaluated for the maximum voltage and temperature involved in its application, while taking into account the presence of other circuits.

32 Protection of Service Personnel

32.1 The requirements in 32 apply only to service personnel who find they must reach over, under, across, or around uninsulated electrical parts or moving parts to make adjustments or measurements while the device is energized.

32.2 Live parts shall be so arranged and covers so located as to reduce the risk of electric shock or exposure to energy hazardous parts while covers are being removed and replaced.

32.3 An uninsulated live part involving a risk of electric shock or exposure to hazardous energy shall be located, guarded, or enclosed so as to reduce the risk of unintentional contact by service personnel adjusting or resetting controls, or similar action or performing mechanical service functions with the equipment energized, such as adjusting the setting of a control with or without marked dial settings, resetting a trip mechanism, or operating a manual switch.

32.4 Live parts involving a risk of electric shock, or exposure to hazardous energy, located on the back side of a door or cover shall be either guarded or insulated to reduce the risk of unintentional contact of the live parts by service personnel.

32.5 A component that requires examination, resetting adjustment, servicing, or maintenance while energized shall be so located and mounted with respect to other components and with respect to grounded metal parts that it is accessible for electrical service functions without subjecting the service person to the risk of electric shock or exposure to hazardous energy levels. Access to a component shall not be impeded by other components or by wiring.

32.6 For an adjustment that is to be made with a screwdriver or similar tool when the device is energized, 32.5 requires that protection be provided so that the risk of inadvertent contact with adjacent uninsulated live parts involving a risk of electric shock is reduced, taking into account that misalignment of the tool with the adjustment means is capable of resulting where an adjustment is attempted. This protection shall be provided by locating the adjustment means away from uninsulated live parts or by a guard that reduces the risk of the tool contacting uninsulated live parts.

32.7 A live relay frame or similar device involving a risk of electric shock or exposure to hazardous energy levels and that is capable of being mistaken for dead metal shall be guarded to reduce the risk of unintentional contact by the service person or be marked in accordance with 74.16.

32.8 Moving parts that can cause injury to service personnel that must be in motion during service operations that do not involve the moving parts shall be so located or protected that unintentional contact with the moving parts is not likely.

33 Electronic Protection Circuits

33.1 When circuit analysis or test results indicate that single component failure affects the ability of an electronic or solid-state circuit to perform its back-up, limiting, or other safety related function intended to reduce the risk of fire, electric shock, or injury to persons the circuit shall comply with the requirements in Annex A, Ref. No. 36, including environmental and stress tests applicable to the intended usage of the end-product. When such circuits employ a microprocessor executing software to perform the safety-related function, the software shall comply with the requirements in Annex A, Ref. No. 54.

33.2 When it is determined that environmental tests are required, the protection control shall be subjected to the following tests in accordance with the method described in Annex A, Ref. No. 36:

a) Transient Overvoltage Test;

b) Ramp Voltage Test;

c) Electromagnetic Susceptibility Tests;

d) Electrostatic Discharge Test;

e) Thermal Cycling Test;

f) Humidity Test; and

g) Effects of Shipping and Storage Test.

Before and after each test, the control shall be checked for normal operation.

33.3 The following test parameters shall be used in the investigation of the control covered by 33.1 for compliance with Annex A, Ref. No. 36:

a) Electrical supervision of critical components;

b) Visibility or audibility as a trouble indicator for an electrical supervision circuit;

c) A field strength of 3 volts per meter (0.91 volts per foot) shall be used for the Radiated EMI Test; and

d) Exposure Class H5 shall be used for the Humidity Test.

33.4 The following test parameters shall be used in the investigation of the circuit employing software covered by 33.1 for compliance with Annex A, Ref. No. 54:

a) The requirements for Software Class 1 shall be applied, and

b) A failure in the software during its intended operation does not affect compliance under the following conditions:

1) There is no loss of protective function as specified by the manufacturer, or

2) The EV supply equipment is de-energized such that there is no longer a risk.

34 Cord Reels

34.1 For EV supply equipment provided with a cord reel, the cord reel shall comply with Annex A, Ref. No. 55.

34.2 If the EV supply equipment is provided with hooks, or similar means, for manually winding a cord for storage, whether it is the flexible power cord or the EV cable, the requirement in 34.1 does not apply. The wound cord shall be subjected to temperature rating verification by temperature measurements on the cord during the Temperature Test, 49, with 2/3 of the cord length wound as intended.

35 Luminaires

35.1 Electric vehicle supply equipment provided with an external luminaire shall comply with the requirements specified in 35.2 – 35.5. The luminaire shall comply with the applicable requirements in Annex A, Ref. No. 56.

35.2 Luminaires provided as part of the electric vehicle supply equipment shall be provided with overcurrent protection in accordance with Overcurrent Protective Devices, 28, unless as indicated in 35.3.

35.3 Except as indicated in 35.3.1, a luminaire supplied by the same source as the electric vehicle supply equipment shall be provided with a switch rated 20 A minimum on the supply side of the overcurrent protection.

35.3.1 A switch is not required to be provided if the overcurrent protection can only be accessed after power is removed or if the access panel, cover, or door, is provided with an interlock.

35.4 A luminaire supplied by a separate source from the electric vehicle supply equipment need not be provided with a switch and overcurrent protection when the electric vehicle supply equipment is marked in accordance with 74.18.

35.5 With reference to 35.4, the electric vehicle supply equipment shall be marked in accordance with 74.17.

PROTECTION OF USERS AGAINST INJURY

36 General

36.1 Where the operation or user maintenance of a device involves a risk of injury to persons, means shall be provided to reduce the risk.

36.2 For the purpose of the requirements described in 36.3 – 36.6, the words “injury to persons” are in reference to physical harm to persons other than the physiological effects of electric shock.

36.3 When judging a product with respect to the requirement in 36.1, reasonably foreseeable misuse of the device shall be a factor.

36.4 A functional attachment that is made available or specified by the manufacturer for use with the basic device shall be included in the evaluation of the device. Unless the manufacturer specifies the use of two or more attachments at the same time, only one attachment at a time shall be evaluated with the device.

36.5 Whether a guard, a release, an interlock, or similar device is required and whether such a device is to be used shall be determined from an investigation of the complete device, its operating characteristics, and the risk of injury to persons resulting from a cause other than gross negligence. The investigation shall include evaluating the results of breakdown or malfunction of any component; not more than one component at a time, unless one event contributes to another. Where the investigation shows that breakdown or malfunction of a particular component results in a risk of injury to persons, that component shall be investigated for reliability.

36.6 Specific constructions, tests, markings, guards, and similar specifications are detailed for some common constructions. Specific features and products not covered herein shall be examined and tested to determine whether they are to be used for the purpose.

37 Sharp Edges

37.1 An enclosure, a frame, a guard, a handle, or similar device shall not have sharp edges that constitute a risk of injury to persons in normal maintenance and use.