



UL 977

STANDARD FOR SAFETY

Fused Power-Circuit Devices

UL Standard for Safety for Fused Power-Circuit Devices, UL 977

Fifth Edition, Dated April 30, 2012

Summary of Topics:

This reaffirmation of ANSI/UL 977 dated December 17, 2025 is issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated October 10, 2025.

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Fifth Edition

April 30, 2012

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through December 17, 2025.

The most recent designation of ANSI/UL 977 as a Reaffirmed American National Standard (ANS) occurred on December 17, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 977 on August 28, 1984. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover fused power-circuit devices to be employed in accordance with the National Electrical Code.

1.2 Fused power-circuit devices, as covered by these requirements, are considered to be either bolted pressure contact switches or high-pressure butt-type contact switches.

1.3 Bolted-pressure contact switches are devices in which the blade-jaw connections have an additional pressure or clamping action provided at both ends of the switch blades when the blades are in the fully closed position.

1.4 High-pressure butt-type contact switches are devices having butt-type contacts and a spring-charged mechanism.

1.5 These requirements do not apply to low-voltage AC power circuit protectors as covered by the Standard for Low Voltage AC Power Circuit Protectors Used in Enclosures, ANSI/IEEE C37.29, or to low-voltage AC integrally fused power circuit breakers as covered by the Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures, ANSI/IEEE C37.13.

1.6 Fused power-circuit devices may be manually or electrically operated and may incorporate electrical tripping means.

1.7 An electrically tripped device is one whose closing is performed manually or electrically but contact opening is performed by a release energized by a separate source of voltage.

1.8 A device with an electrical operator is one whose contact closing and opening is performed by electrical means.

1.9 Fused power-circuit devices have continuous current ratings of more than 600 A and voltage ratings of 600 V or less AC, DC, or both. Devices rated AC are intended for use on circuits having maximum available short-circuit currents of 100,000, 150,000, or 200,000 A (rms symmetrical). Devices rated DC are intended for use on circuits having maximum available short-circuit currents of 20,000, 50,000, 100,000, 150,000, or 200,000 A DC.

1.10 Fused power-circuit devices have provisions for mounting (or are intended to be used with upstream) Class L fuses or Class T fuses rated more than 600 A.

1.11 These requirements cover complete, enclosed fused power-circuit devices in which the switch is integral with the enclosure; open-type fused power-circuit devices intended for mounting in other equipment, such as switchboards or in a separately shipped enclosure; and enclosures intended for mounting open-type fused power-circuit devices.

1.12 These requirements also cover electrically tripped and/or operated devices that have been investigated to determine their acceptability for ground-fault protection when combined with ground-fault sensing and relaying equipment as follows:

- a) Switches for use with Class I ground-fault sensing and relaying equipment including those devices that are capable of interrupting 12 times their rated current or that have integral means intended to prevent disconnecting at levels of fault current exceeding the contact interrupting capability of the switch.

b) Switches for use with Class II ground-fault sensing and relaying equipment are capable of interrupting at 10 times their rated current and are for use in ground-fault protection systems where means intended to prevent disconnecting levels at fault current exceeding the contact interrupting capabilities of the switch are incorporated within the ground-fault sensing and relaying equipment.

1.13 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements to determine that the level of safety as originally anticipated by the intent of this standard is maintained. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard shall not be judged to comply with this standard. Where appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Components

2.1 A component of a product covered by this standard shall comply with the requirements for that component. See Appendix [A](#) for a list of standards covering components generally used in the products covered by this standard.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

3 Units of measurement

3.1 If a value for measurement is followed by a value in other units, the use or recognition of either value can be expected to provide equivalent results in the application of such requirements.

4 References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

CONSTRUCTION

5 General

5.1 A fused power-circuit device shall employ materials throughout that are acceptable for the particular application, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

5.2 The construction of a fused power-circuit device shall be such as to provide ample strength and rigidity.

5.3 All parts of a fused power-circuit device shall be properly assembled in place when shipped from the factory, except as noted in [5.4](#), [5.6](#), [5.7](#), [5.8](#), and [5.9](#).

5.4 If a fused power-circuit device is acceptable for use without a neutral assembly as well as with such assembly, the neutral assembly need not be shipped from the factory with the switching unit provided that:

- a) The neutral assembly is shipped from the factory completely assembled with the necessary barriers and all other accessories that are required for its installation and use; and
- b) The neutral assembly and switch are marked in accordance with [50.12](#).

5.5 With reference to [5.4](#), hardware for mounting the neutral assembly must be furnished with that assembly but need not be assembled in place.

5.6 External operating handles need not be assembled in place but in place of such assembly, they are to be packaged and shipped with the switching unit.

5.7 When a fused power-circuit device without enclosure is shipped for assembly in a switchboard or similar equipment, the load fuse terminal assembly need not be mounted in place when all the following conditions are met:

- a) All poles of the load fuse terminal assembly are secured to a common base that can be installed as a single unit by a simple assembly operation;
- b) Assembly instructions and markings are provided;
- c) The construction is such that alignment of fuse mounts will be assured;
- d) Barriers or stops intended to prevent over-sized fusing will continue to be effective; and
- e) The load fuse terminal assembly is packaged and shipped with the switching unit.

5.8 If the proper operation or installation of an open type fused power-circuit device is dependent upon an insulating barrier, liner, shield or similar member being mounted on the device or elsewhere, the insulating barrier shall be provided with the device and a marking as specified in [50.29](#) shall be provided.

5.9 If a fused power-circuit device is intended for use with or without an accessory assembly, the assembly need not be shipped from the factory with the fused power-circuit device provided that:

- a) The fused power-circuit device is acceptable for use with or without the accessory.
- b) Each accessory is acceptable for the intended use.
- c) Installation instructions for the proper installation operation, and necessary adjustments are provided:
 - 1) With the accessory;
 - 2) With the fused power-circuit device; or
 - 3) The accessory is marked with reference to a specific installation instruction drawing unless the construction makes the installation obvious. If a filing, drilling, or cutting operation is involved the instructions include a caution statement, that such operation is to be accomplished only in the prescribed area.
- d) The installation of an accessory shall not require the use of a special tool, unless such a tool and instructions for its use are furnished with each accessory.
- e) A barrier that is necessary because spacing would otherwise be less than required, or for any other reason, is securely attached at the factory to either the fused power-circuit device or to the accessory to be installed.
- f) The accessory is an essentially complete unit and does not require detailed assembly in the field.

g) The accessory is provided with a marking in accordance with [50.30](#).

h) The fused power-circuit device is provided with a marking in accordance with [50.30](#).

6 Enclosure

6.1 General

6.1.1 An enclosure for a switch shall be of metal and shall be constructed so as to provide the required strength and rigidity. The enclosure shall have one or more of the type designations specified in [Table 6.1](#).

6.1.2 An enclosure is not required for a switching unit that is intended for installation in a switchboard or other enclosure.

6.1.3 Live parts shall be enclosed whether the switching unit is in the open or closed position.

6.1.4 An enclosure shall be provided with means for reliable mounting or support.

6.1.5 Unless the enclosure is of metal that will resist corrosion, both inside and outside surfaces shall be protected by painting, galvanizing, plating, or other equivalent means.

6.2 Rainproof enclosures

6.2.1 A Type 3R enclosure shall be constructed so that it withstands a simulated beating rain as described in the Water Spray Test, Section [29](#). Any opening associated with an opening handle shall be shielded from rain. Hinges and other attachments shall be resistant to corrosion. Metals shall not be used in such combinations as to result in galvanic action that affects adversely any part of the device. Any live part shall be located at least 12 inches (305 mm) above the mounting surface on concrete-pad-mounted equipment. See [50.28](#).

Table 6.1
Enclosure types

Type number	Intended use and description	Environmental construction and performance requirements
1	Indoor use primarily to provide a degree of protection against contact with the enclosed equipment.	Corrosion protection as specified in 6.1.5 , or the Rust Resistance Test described in the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50.
2	Indoor use to provide a degree of protection against limited amounts of falling water and dirt.	Corrosion protection as specified in 6.1.5 , or the Rust Resistance Test described in UL 50, and the Drip Test described in UL 50.
3R	Outdoor use to provide a degree of protection against falling rain, sleet, and external ice formation.	Protective coating as specified in 6.2.3 – 6.2.6 , the Water Spray Test described in Section 29 , and the Icing Test described in the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50.

6.2.2 A hole for conduit in a Type 3R enclosure shall be threaded unless it is entirely located below the lowest terminal lug or other live part within the enclosure or unless it accommodates a specific hub or closure fitting (see [50.27](#) and [50.28](#)). A threaded hole for conduit shall be reinforced to provide metal at least 1/4 inch (6.4 mm) thick. There shall be provision for drainage of the enclosure. A threaded hole for conduit shall be provided with a conduit end stop unless the thread is tapered.

6.2.3 A Type 3R sheet steel enclosure shall be protected against corrosion by one of the following coatings:

a) Hot-dipped, mill-galvanized sheet steel conforming with the coating Designation G90 in Table I of ASTM Designation A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of the zinc coating is permitted to be determined by any appropriate method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM Designation A90.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of coating shall be established by the metallic coating thickness test as indicated in the Metallic Coating Thickness Test, Section [41](#). An annealed coating shall comply with [6.2.4](#).

c) A zinc coating conforming with (1) or (2) below and with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint applied after forming on each surface. The acceptability of the paint is permitted to be determined by consideration of its composition or by corrosion tests when these are determined to be required.

1) Hot-dipped, mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in Table I of ASTM Designation A653/A653M-94, with no less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of zinc coating is permitted to be determined by any appropriate method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM designation A90.

2) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the metallic coating thickness test as indicated in the Metallic Coating Thickness Test, Section [41](#). An annealed coating shall also comply with [6.2.4](#).

d) A cadmium coating not less than 0.0010 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established by the metallic coating thickness test as indicated in the Metallic Coating Thickness Test, Section [41](#).

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the metallic coating thickness test as indicated in the Metallic Coating Thickness Test, Section [41](#), and the paint shall be as specified in (c).

f) Other finishes, including paints, special metal finishes, or combinations of the two are permitted to be accepted when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with item (a), indicate they provide equivalent protection. Among the factors which are taken into consideration when determining the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

6.2.4 An annealed coating on sheet steel that is bent or similarly formed or extruded or rolled at edge of holes after annealing shall be additionally painted in the affected area if the process damages the zinc coating.

6.2.5 If flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered to be damaged. Simple sheared or cut edges and punched holes are not required to be additionally protected.

6.2.6 When a Type 3R enclosure has any opening for passage of a wire or bus bar to a switchboard section or to a wireway, auxiliary gutter or busway, a gasket or other means shall be provided that is intended to prevent the entrance of water at such opening. When the opening is for attachment of a busway, the Type 3R enclosure and the busway are to be investigated together to determine that water does not enter along the bus bars.

7 Ventilation

7.1 A ventilating opening in an enclosure shall be so constructed and located that no flame or molten metal will be emitted during arcing that may normally be encountered during operation. See [32.3](#).

7.2 Unless the opening is remote from the arcing part, the requirement in [7.1](#) may require the interposing of a flame-retardant barrier between a ventilating opening and the possible source of arcing.

7.3 A ventilating opening in an enclosure shall have such size or shape, or shall be so covered by screening or by an expanded, perforated, or louvered metal panel that a test rod having the diameter specified in [7.4](#) will not enter the opening.

7.4 The test rod mentioned in [7.3](#) shall be 33/64 inch (13.1 mm) in diameter if the plane of the opening is less than 4 inches (102 mm) from an uninsulated live part, or 49/64 inch (19.4 mm) in diameter if the plane of the opening is 4 inches or more from such part.

7.5 A louver shall not be more than 12 inches (305 mm) in length.

7.6 The size, shape, and location of a ventilating opening shall be such as not to unduly weaken the overall enclosure.

7.7 The total area of enclosure material removed from a wall for the purpose of ventilation or for the insertion of a ventilating panel or screen together with total area of ventilating openings formed from the enclosure material shall not exceed 25 percent of the area of the entire surface of any wall in which such ventilating openings are located.

7.8 The area of any ventilating opening, as defined by the opening in the enclosure proper metal, shall not exceed 200 square inches (1290 cm²) if the ventilated closing panel is formed from material that has a thickness less than that of the enclosure proper metal. A ventilated closing panel of 0.053 inch (1.35 mm) or lighter steel or 14 AWG (2.08 mm²) or lighter steel wire mesh shall not be used to close an opening of more than 80 square inches (516 cm²). See [7.9](#) and [7.10](#).

7.9 The steel wires of a screen of a ventilating opening shall not be smaller than 16 AWG (1.31 mm²) if the screen openings are 1/2 square inch (3.23 cm²) or less in area, and not smaller than 12 AWG (3.31 mm²) for larger screen openings. A supplementary screen of smaller openings may be additionally provided. The supplementary screen is not to be considered in the evaluation of the ventilating opening screen.

7.10 Except as noted in [7.11](#), perforated sheet steel and sheet steel expanded mesh shall not be less than 0.042 inch (1.07 mm) thick or 0.045 inch (1.14 mm) if zinc coated if the mesh openings or perforations are 1/2 square inch (3.23 cm²) or less in area, and shall be not less than 0.080 inch (2.03 mm) thick or 0.084 inch (2.13 mm) if zinc coated for larger openings.

7.11 Where the indentation of a guard or enclosure will not alter the clearance between uninsulated live parts and grounded metal, so as to affect performance adversely or reduce spacings below the minimum values given in [Table 20.1](#) and [Table 20.2](#), 0.020 inch (0.51 mm) minimum expanded steel mesh, 0.023 inch (0.58 mm) if zinc coated, may be employed; see [7.7](#).

8 Sheet-Metal Enclosures

8.1 A sheet-metal enclosure shall employ metal not less than 0.108 inch (2.74 mm) thick if of uncoated steel and not less than 0.111 inch (2.82 mm) thick if of a zinc-coated steel. A sheet aluminum enclosure shall employ metal not less than 0.122 inch (3.10 mm) thick. The grade and thickness of aluminum employed shall be such that the enclosure will have mechanical strength and rigidity at least that of an enclosure formed of 0.108 inch sheet steel.

9 Doors and Covers

9.1 Any door, front, or cover shall be provided with means for holding it securely in place.

9.2 A door or cover intended to give access to fuses shall be hinged, sliding, or similarly attached in a manner intended to prevent its being removed.

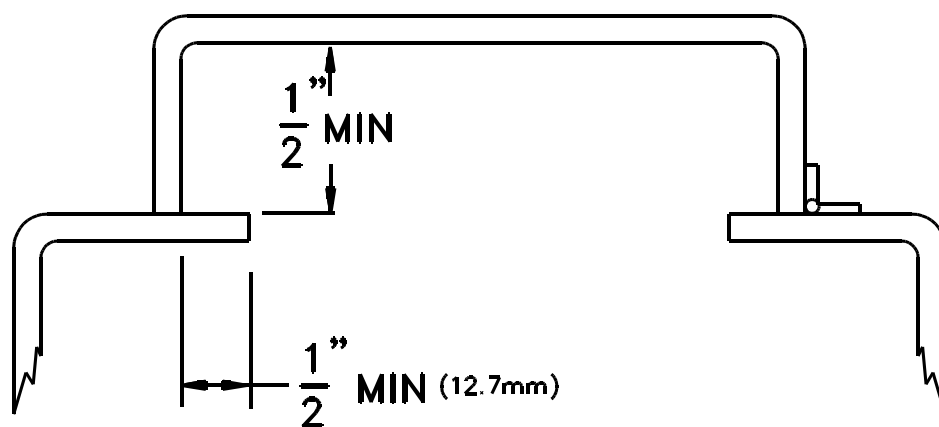
9.3 The thickness of a sheet-metal door, front cover, or auxiliary door shall not be less than that indicated for the enclosure.

9.4 A flat door or cover shall shut closely against a 1/4 inch (6.4 mm) rabbet or the equivalent on all sides – except that if a piano type hinge is used, the rabbet may be omitted in the area of the hinge.

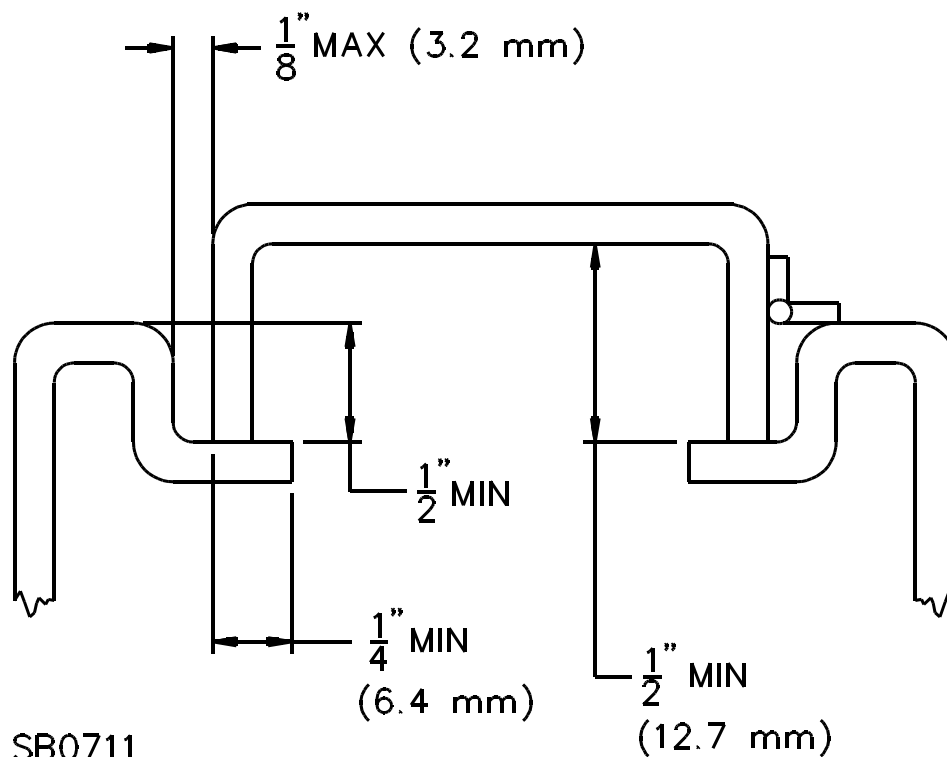
9.5 The flanges of the flanged door or cover shall fit closely with the outside walls of the enclosure proper and shall be not less than 1/2 inch (12.7 mm) in depth.

9.6 A combination of flange and rabbet is acceptable. Typical acceptable constructions are illustrated in [Figure 9.1](#).

Figure 9.1
Flanged-door construction



SB0710



SB0711

10 Hinges

10.1 Door hinges shall be of metal, of strong and durable design. A leaf of a hinge shall be securely fastened at two or more points to the enclosure or trim and to the door or cover.

10.2 At least two hinges shall be provided for each hinged door or a continuous piano-type hinge may be used.

10.3 Except as noted in [10.4](#), hinges shall be spaced not more than 30 inches (762 mm) apart. Hinges shall be located not more than 4 inches (102 mm) from each end of a door. All hinge spacings shall be measured from the center of hinges.

10.4 On a steel flanged type door 45 inches (1.14 m) high or less, two hinges not more than 36 inches (914 mm) apart and not more than 5 inches (127 mm) from the ends of the door are acceptable.

11 Latches

11.1 A latch or a hand-operated captive screw shall be provided for each door, and shall be positive in action and of substantial design and construction; except that ordinary screw fasteners may be used in place of a latch in the case of an enclosure that has a hinged cover, but where the contemplated use of the device is such that hinges are not required on the cover.

11.2 A door more than 48 inches (1.22 m) long on the hinged side shall have at least two fastening means. Acceptable examples are a two-point or three-point latch operated by a single knob or handle, two or more spring latches, one knob-operated latch and one spring latch, or two or more hand operated captive screws as a fastening means.

11.3 A spring latch consisting of a strip of steel spot welded or riveted to the wall of an enclosure and cooperating with a slot in the cover shall be so formed and attached that it will engage the edge of the cover slot away from the wall or shall otherwise be acceptable for the particular application.

11.4 A knob, door handle, or equivalent means shall be provided for opening a door.

11.5 With respect to [11.4](#), a captive screw or other fastening which is readily grasped is considered an equivalent means.

12 Operating Mechanism

12.1 General

12.1.1 The construction of the operating mechanism shall be such as to provide strength and rigidity. Screws and nuts serving to attach operating parts to crossbars or other movable members shall be staked, upset, or otherwise locked in position to keep them from loosening under the jars of continued use.

12.1.2 Unless a switch is intended for electrical operation only, an operating handle shall be provided. An operating handle of conducting material shall be in electrical connection with the enclosure or shall be so constructed that when mounted in the conventional manner it will be grounded.

12.1.3 A metal rod using the wall of the box as a bearing is considered to be in electrical connection with the enclosure.

12.1.4 An electrically operated switching mechanism shall be provided with means for manually opening without opening the enclosure. If a manual closing means is provided for normal operation, it shall be possible to close the switching unit with all enclosure covers closed.

12.1.5 A special tool that cannot be left in place with the door closed and that is to be used for maintenance purposes only is exempted from complying with [12.1.4](#).

12.1.6 An electrically operated mechanism shall be such that the operation shall be completed should loss of power occur during any portion of the closing or opening operations where the switch blades have started to move.

12.1.7 The operating mechanism of an electrically tripped fused power-circuit device shall be such that at the moment when the switch contacts close, the operating mechanism shall immediately be in a condition to open the switch contacts by the electrical tripping means without further operation, manual or otherwise.

12.1.8 A fused power-circuit device having an electrical operator shall have means to disconnect the energy from the operator after the operator has performed its intended function.

12.1.9 If the open or closed condition of the switching unit is indicated by the position of the operating handle, there shall be definite open and closed positions for the handle, and the construction of the operating mechanism shall be such that the handle cannot be left at or near the open position when the switching unit contacts are closed. See [50.18](#).

12.1.10 If a switch handle is operated vertically, the "on" handle position shall be the up position.

Exception: Double-throw switches need not comply with this requirement.

12.1.11 A handle or other member that indicates the position of the switch blades or contacts (closed or open) shall be so constructed that the door, front, or cover cannot be secured in place in the intended manner with the handle or member indicating open while the switch blades or contacts are in the closed position.

12.1.12 The mechanism of an electrically tripped or electrically operated switch shall be so arranged that electrical operation will not result in an injury to persons in the vicinity of the switch due to sudden movement of an external part such as a manual operating handle.

12.1.13 There shall be provision for locking a fused power-circuit device in the open position without opening the enclosure, and there may be a provision for locking a manual device in the closed position.

12.1.14 Except for bearings and the like, whose protection is impractical, all metal parts unless of corrosion-resistant material shall be galvanized, painted, or otherwise protected against corrosion.

12.1.15 Metal parts that are zinc-coated or cadmium-plated, painted, or enameled are considered to be acceptably protected against corrosion.

12.1.16 Means shall be provided for mechanically applying contact pressure at both ends of a contacting member when the member has reached the end of its travel in the closing direction.

12.1.17 A separate door or cover that gives access to fuses shall be interlocked with the operating mechanism so that the door or cover is held closed when the device is in the closed position. Provision shall be made for defeating an interlock while the device is in the closed position.

12.1.18 If the removal of the operating handle— in the closed position – permits opening of the separate door or cover noted in [12.1.17](#), such removal may be considered as being an acceptable defeating means.

12.2 Electrical operators

12.2.1 An electrical operator shall be acceptable for the particular application, and shall be capable of handling its maximum intended load without introducing any electrical risk or risk of injury to persons.

12.2.2 A winding shall be such as to resist the absorption of moisture and shall be formed and assembled in a workmanlike manner.

12.2.3 With reference to the requirement in [12.2.2](#), film-coated wire is not required to be additionally treated to resist absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials should be provided with impregnation or otherwise treated to resist moisture absorption.

12.2.4 Means shall be provided that is intended to prevent the electrical operator from functioning during manual operation if electrical operation can result in an electrical risk or risk of injury to operating personnel.

13 Ground Fault Protection

13.1 A fused power-circuit device rated 1000 A or more that is marked for service equipment use, and is intended to operate on a solidly grounded wye service of more than 150 V to ground but not exceeding 600 V phase-to-phase, shall be provided with ground-fault protection. The ground-fault sensing and relaying equipment provided shall operate to cause the fused power-circuit device to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 A.

Exception No. 1: If the fused power-circuit device is provided with a shunt trip that is acceptable for use with ground fault protection, the ground-fault sensors or relaying equipment or both may be in a separate enclosure if the combination is found acceptable and the fused power-circuit device is marked as covered in [50.34](#).

Exception No. 2: Ground-fault protection need not be provided if a device is marked in accordance with [50.35](#).

13.2 Compliance with the requirements specified in [13.1](#) anticipates that the fused power-circuit device to which the requirement applies is provided with automatic tripping means for actuation by ground-fault sensing and relaying equipment that may, although not required, be a part of the fused power-circuit device.

13.3 The short-circuit withstand rating of the ground-fault sensing and relaying equipment shall be equal to or greater than the short-circuit withstand rating of the fused power-circuit device.

13.4 Ground-fault sensing and relaying equipment that is not a part of the fused power-circuit device shall be mounted in the fused power-circuit device enclosure and be connected to the fused power-circuit device and power source, if any. The rating of the control circuit shall be compatible with that of the sensing and relaying components.

13.5 If ground-fault protection is provided, though not required by [13.1](#), it shall comply with the requirements for the installation of ground-fault protection equipment as specified in these requirements.

13.6 A ground fault protection system, described as a zero-sequence type, that employs a sensing element that encircles the neutral conductor, if any, and all ungrounded conductors of the protected circuit

shall be installed in such a manner that the sensing element is located on the load side of any grounding or bonding connection to the neutral. It may be on the line or load side of the fused power-circuit device for the protected circuit.

13.7 A ground-fault protection system, described as the residual type, that combines the outputs of separate sensing elements for the neutral, if any, and each ungrounded conductor shall be installed in such a manner that the neutral sensing element is located on the load side of any grounding or bonding connection to the neutral. The ungrounded conductor sensors may be on the line or load side of the fused power-circuit device for the protected circuits.

13.8 A ground-fault protection system, described as the ground-return type, that employs a single sensing element to detect the actual fault current shall be installed in such a manner that the sensing element detects any current that flows in the grounding-electrode conductor, the main bonding jumper, and any other grounding connections within the equipment that may be made to the neutral. This will require that, except for these connections, the neutral be insulated from the noncurrent-carrying metal as covered in [20.3](#).

13.9 If the construction of ground-fault sensing and relaying equipment is such that a reset operation is required to restore the equipment to functional status following operation due to a ground fault or test, the construction shall be such that closing and maintaining contact of the fused power-circuit device to be controlled by the ground-fault sensing and relaying equipment will not occur until the reset operation is performed.

13.10 Overcurrent protection is not required for the operating coil of a fused power-circuit device where the coil is connected on the load side of the disconnecting switch of the fused power-circuit device as covered in [13.11](#).

13.11 The primary of a ground-fault protection control-circuit transformer may be connected to the line or load side of the fused power-circuit device. The primary of the control-circuit transformer shall be connected to two line voltage parts, not line and neutral. When connected to the line side of the fused power-circuit device, overcurrent protection of not more than 300 percent shall be installed ahead of the transformer or control circuit or both. Overcurrent protection is not required for the control circuit when wired to the load side of the fused power-circuit device, unless the control circuit wiring leaves the enclosure. A fuse shall be Class CC, G, T, R or J. A fuse or circuit breaker shall have a current-interrupting rating not less than that of the fused power-circuit device.

13.12 The secondary circuit of a control power transformer shall be grounded under any of the following conditions if the circuit extends or may extend beyond the equipment in which the transformer is mounted:

- a) When the secondary is less than 50 V and the transformer supply is over 150 V to ground or the transformer supply at any voltage is ungrounded.
- b) When the secondary is 50 V or greater and the secondary circuit can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 V.

13.13 If a transformer secondary is required to be grounded in accordance with [13.12](#), a main bonding jumper shall be factory connected to the transformer secondary and to the enclosure or ground bus. The size of the connection to the transformer secondary shall be not less than 14 AWG (2.1 mm²) copper or 12 AWG (3.3 mm²) aluminum or have equivalent respective cross-sectional area.

13.14 In fused power-circuit devices incorporating ground-fault protection of the ground return type as described in [13.8](#), the main bonding jumper shall be factory connected to the neutral bus and to the enclosure or the ground bus.