UL 1008A

STANDARD FOR SAFETY

Transfer Switch Equipment, Over 1000 Volts

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UL Standard for Safety for Transfer Switch Equipment, Over 1000 Volts, UL 1008A

Second Edition, Dated September 5, 2017

Summary of Topics

The revision of ANSI/UL 1008A dated May 10, 2023 includes the following changes in requirements:

– Revisions to Table 16 to align with UL 347 up to 15 kV.

– Updates to service equipment requirements to align with 2020 NFPA 70; 23.1.1, 23.1A, 32.1 and Figure 4.

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated January 6, 2023.

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UL 1008A
Second Edition

Transfer Switch Equipment, Over 1000 Volts

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This ANSI/UL Standard for Safety consists of the Second Edition including revisions through May 10, 2023. The most recent designation of ANSI/UL 1008A as an American National Standard (ANSI) occurred on May 10, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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PREFACE

This is the harmonized CSA Group, and ULSE standard for Transfer Switch Equipment – Over 1000 Volts. It is the First edition of CSA C22.2 No. 178.3, and the Second edition of UL 1008A. This edition of UL 1008A supersedes the First edition titled, Medium-Voltage Transfer Switches, published on March 30, 2012. This harmonized standard has been jointly revised on May 10, 2023. For this purpose, CSA Group and ULSE are issuing revision pages dated May 10, 2023.

This harmonized standard was prepared by the CSA Group and ULSE. The efforts and support of the Technical Harmonization Subcommittee, THSC 121A WG8, Transfer Switches over 750V, on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Subcommittee on High Voltage Transfer Switches, under the jurisdiction of the CSA Technical Committee on Industrial Products (TCIP) and the CSA Strategic Steering Committee on requirements for Electrical Safety (SCORES), and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of Harmonization

This standard is published as an equivalent standard for CSA Group and ULSE.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Reasons for Differences From IEC

There is no corresponding IEC standard.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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INTRODUCTION

1 Scope

1.1 These requirements cover automatic, non-automatic, and manual transfer switches, operating at voltages of greater than 1000 Vac, and intended for use in non-hazardous locations in accordance with Annex B, Item 1, the National Electrical Code, ANSI/NFPA 70, or the Canadian Electrical Code, CSA C22.1, Part 1, to provide for power as follows:

a) Automatic transfer switches for use in emergency systems in:

1) Emergency systems in accordance with the Standard for Emergency Electrical Power Supply for Buildings, CSA C282-15;

2) Health care facilities in accordance with Rule 24-304 of the Canadian Electrical Code (CEC) Part I;

3) Articles 517, Health Care Facilities, and 700, Emergency Systems, of the National Electrical Code, ANSI/NFPA 70 (refer to Annex B, Item 1); and

4) The Health Care Facilities Code, ANSI/NFPA 99, (refer to Annex B, Item 12).

Note: Transfer switches for optional standby systems are not recognized in Canada.

b) Transfer switches for use in optional standby systems in accordance with Article 702 of the National Electrical Code, ANSI/NFPA 70 (refer to Annex B, Item 1).

Note: Automatic transfer switches for optional standby systems are not recognized in Canada.

c) In legally required standby systems in accordance with Article 701 of the National Electrical Code, ANSI/NFPA 70(refer to Annex B, Item 1).

Note: Legally-required standby systems are not recognized in Canada.

d) Automatic transfer switches for use in accordance with the Standard for the Installation of Stationary Pumps for Fire Protection, ANSI/NFPA 20 or the Standard for Fire Pump Controllers, CSA C22.2 No. 263, (refer to Annex B, Item 2).

1.2 These requirements cover transfer switches rated greater than 1000 V to 46 kV.

1.3 These requirements cover transfer switches together with their associated control devices including, but not limited to, voltage sensing relays, frequency sensing relays, and time delay relays.

1.4 An automatic transfer switch as covered by these requirements is a device that automatically transfers a common load from a normal supply to an alternate supply in the event of failure of the normal supply, and automatically returns the load to the normal supply when the normal supply is restored. An automatic transfer switch can be provided with a logic control circuit that inhibits automatic operation of the device from either a normal to an alternate supply, or from an alternate to a normal supply when the switch reverts to automatic operation upon loss of power to the load.

1.5 A non-automatic transfer switch as covered by these requirements is a device, operated manually by a physical action, or electrically by a remote control, for transferring a common load between a normal and alternate supply.

1.6 These requirements only cover completely enclosed transfer switches.

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2 General Requirements

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the CSA or UL standards as appropriate for the country where the product is to be used.

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.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.5 In Canada, general requirements as indicated in the General Requirements – Canadian Electrical Code Part II, CSA C22.2 No. 0, (refer to Annex B, Item 3), are also applicable.

2.6 Transfer switches are rated in amperes and are considered to be acceptable for total system transfer, which includes control of motors, electric-heating loads, and transformer loads.

2.7 An automatic transfer switch for use in a legally required standby system shall comply with the requirements for a transfer switch for emergency systems.

2.8 Products covered by this standard shall comply with the referenced installation codes and standards noted in Annex B as appropriate for the country where the product is to be used. When the product is intended for use in more than one country, the product shall comply with the installation codes and standards for all countries where it is intended to be used.

3 Units of Measurement

3.1 The values given in SI (metric) units shall be normative other than for trade sizes. Any other values given shall be for information purposes only.

4 Reference Publications

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.

5 Definitions

5.1 For the purpose of this standard the following definitions apply.

5.2 ACCESSIBLE PART – A part located so that it can be contacted by a person, either directly or by means of a probe or tool during user servicing, or that is not recessed the required distance behind an opening.

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5.3 BARRIER – A partition for the insulation or isolation of electric circuits, for the isolation of electric arcs, or for isolation of moving parts or hot surfaces. In this respect, a barrier can serve as a portion of an enclosure or as a functional part.

5.4 BYPASS MODE – The mode where the load is supplied with power by switching device(s) other than the transfer switch.

5.5 CONTROL CIRCUIT – A circuit that carries electric signals directing the performance of a transfer switch. A control circuit does not carry main power current.

5.6 ENCLOSURE – That portion of a transfer switch that reduces the accessibility and unintentional contact of a part that may involve a risk of fire, electric shock, or injury to persons, or reduces the risk of propagation of flame, sparks, and molten metal initiated by an electrical disturbance occurring within.

5.7 GROUND (EARTH) – A conducting connection, whether intentional or accidental, by which an electric circuit or equipment is connected to the earth or to some conducting body of relatively large extent that serves in place of the earth.

Note: See Figure 2 for examples of the use of the terms "grounding" and "bonding", with corresponding terms for Canada.

5.8 ISOLATING DISTANCE (GAP) – The clearance between the line and load side contacts of the isolating means when in the open position.

5.9 ISOLATING MEANS (ISOLATING SWITCH OR DISCONNECTOR) – A mechanical switching device that provides, in the open position, isolating distance in the main circuit from the source of power. A drawout device in the test or disconnected position can serve as the isolating means.

5.10 LIVE PART – Denotes metal or conductive parts that, during intended use, have a potential difference with respect to ground or any other conductive part.

5.11 OPERATING DUTY CLASS – The minimum number of operations a transfer switch can be expected to perform over the life of the equipment. The three operating duty classes are:

a) Class A – 2000 operations.

b) Class B – 1000 operations.

c) Class C – 400 operations.

5.12 OPERATOR – Trained persons having familiarity with the construction and operation of the equipment, and the risks involved, including, but not limited to, persons who could periodically open a transfer switch enclosure to repair or maintain electrical or mechanical components.

5.13 PARTIAL DISCHARGE (PD) – localized electrical discharge that only partially bridges the insulation between conductors and which could or could not occur adjacent to a conductor.

Note 1: Partial discharges are in general a consequence of local electrical stress concentrations in the insulation or on the surface of the insulation. Generally, such discharges appear as pulses having durations of much less than 1 μs. More continuous forms can, however, occur, such as the so-called pulse-less discharges in gaseous dielectrics. This kind of discharge will normally not be detected by the measurement methods described in this standard.

Note 2: "Corona" is a form of partial discharge that occurs in gaseous media around conductors which are remote from solid or liquid insulation. "Corona" should not be used as a general term for all forms of PD.

Note 3: Partial discharges are often accompanied by emission of sound, light, heat, and chemical reactions.

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5.14 PARTIAL DISCHARGE EXTINCTION VOLTAGE U_e – Applied voltage at which repetitive partial discharges cease to occur in the test object, when the voltage applied to the object is gradually decreased from a higher value at which PD pulse quantities are observed. In practice, the extinction voltage U_e is the lowest applied voltage at which the magnitude of a chosen PD pulse quantity becomes equal to, or less than, a specified low value.

5.15 PARTIAL DISCHARGE INCEPTION VOLTAGE U_i – Applied voltage at which repetitive partial discharges are first observed in the test object, when the voltage applied to the object is gradually increased from a lower value at which no partial discharges are observed. In practice, the inception voltage U_i is the lowest applied voltage at which the magnitude of a PD pulse quantity becomes equal to or exceeds a specified low value.

5.16 POLLUTION DEGREE 1 – No pollution or only dry, nonconductive pollution occurs. The pollution has no influence.

5.17 POLLUTION DEGREE 2 – Normally, only nonconductive pollution occurs; however, temporary conductivity caused by condensation can be expected.

5.18 POLLUTION DEGREE 3 – Conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation that is expected.

5.19 PRIMARY CIRCUIT – Wiring and components that are conductively connected to the preferred or alternate source of supply or another branch circuit at the same voltage.

5.20 PRINTED-WIRING BOARD – The finished combination of a pattern of conductive paths either on, in, or both on and in (multilayer) a sheet of insulating material, including printed components, and the base material.

5.21 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist at any part when the potential between the part and earth ground or any other accessible part is greater than 42.4 V peak ac or 60 V dc, and the continuous current flow through a 1500 W resistor connected across the potential exceeds 5 mA.

5.22 RISK OF INJURY TO PERSONS – A condition that exists when stationary parts (such as sharp metal edges and projections), moving parts, falling objects, inadequate mechanical strength of material, or the physical instability of the equipment are such that injury to persons may result.

5.23 SECONDARY CIRCUIT – A circuit conductively connected to the secondary winding of an isolating power supply transformer.

5.24 SERVICING – Any form of servicing that can be performed by personnel other than those who are trained to maintain the unit. Some examples of user servicing are:

a) The installation of accessories.

b) The replacement of lamps and fuses, or the resetting of circuit breakers located in a user access area.

c) The making of routine operating adjustments necessary to adapt the unit for different intended functions.

d) Routine cleaning.

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5.25 SYNCHRONISM – The condition achieved when the two sources are in phase, at the same voltage and frequency, with a tolerance of ±10° on phase angle and ±5 percent on voltage and ±1 Hz on frequency.

5.26 TOOL – A hand-held implement, such as a wrench, screwdriver, or any other object that may be used during servicing, including a coin, key, or other object that can be used to operate a lock, screw latch, or similar fastening means.

5.27 TRANSFER SWITCH – A device for transferring one or more load conductor connections from one power source to another. Transfer switch types include:

a) Automatic transfer switch – A self-acting transfer switch.

b) Bypass transfer switch – An assembly that includes a transfer switch, a bypass means that is used to bypass the transfer switch, and an isolating means to electrically isolate the transfer switch for inspection and maintenance.

c) Closed transition transfer switch – An automatic transfer switch that is arranged with overlapping contacts to provide a make before break transfer operation between normal and alternative power sources that are actively or passively synchronized at the time of transfer. The two sources are paralleled for no more than 100 ms.

d) Delayed transition transfer switch – An open transition transfer switch with a position where the load is intentionally disconnected from both sources for a specified time period.

e) Hybrid transfer switch – A transfer switch that incorporates solid-state power components to bridge a power interruption during a mechanical break before make transfer operation. Upon completion of the transfer operation an air gap provides isolation between the sources.

f) Non-automatic transfer switch – An electrically operated transfer switch that is not self-acting.

g) Open transition transfer switch – A transfer switch that is arranged to provide a break before make transfer operation between normal and alternate power sources such that the load is intentionally disconnected from both sources.

h) Softload ATS – A transfer switch executing the transfer of power to the load from normal source to generator or generator to normal source while minimizing voltage and frequency fluctuations by actively synchronizing voltage, frequency, and phase-angle between normal source and generator sources and capable of paralleling the sources for greater than 100 ms while load is transferred.

5.28 TYPES OF SYSTEMS:

a) Emergency systems – Those systems legally required and classified as essential for safety to human life by municipal, state, provincial, or federal codes, or any governmental authority having jurisdiction. In Canada, emergency systems are identified as emergency power supplies.

b) Legally required standby systems in the United States – Those systems legally required by municipal, state, or federal codes, or any governmental authority having jurisdiction, but not classified as essential for safety to human life. In Canada, this requirement does not apply.

c) Optional standby systems in the United States – Those systems installed to provide an alternate source of power for structures for which a power outage could cause discomfort or interruption or damage to products or processes. In Canada, this requirement does not apply.

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CONSTRUCTION

6 General

6.1 Transfer switches shall employ materials throughout which are rated for the particular use, and shall be made and finished with the degree of uniformity and workmanship practicable in a well-equipped factory.

6.2 Transfer switch assemblies can consist of a single section, or of multiple sections, bolted or welded together into a single lineup of equipment. When consisting of multiple sections, all sections comprising the transfer switch assembly shall comply with these requirements.

7 Enclosure

7.1 A transfer switch shall be provided with an enclosure.

7.2 An enclosure shall comply with the requirements detailed in one of the following standards:

a) Standard for Medium-Voltage AC Contactors, Controllers, and Control Centers, UL 347 or the Standard for Medium-Voltage AC Contactors, Controllers, and Control Centres, C22.2 No. 253 (refer to Annex B, Item 14);

b) Standard for Metal-Clad Switchgear, IEEE C37.20.2, or the Standard for Switchgear Assemblies, CSA C22.2 No. 31 (refer to Annex B, Item 13); or

c) Standard for Metal-Enclosed Interrupter Switchgear, IEEE C37.20.3, or the Standard for Switchgear Assemblies, CSA C22.2 No. 31 (refer to Annex B, Item 15).

7.3 A ventilating opening in the top of the enclosure shall be covered by a hood or protective shield spaced above the opening to reduce the possibility of the entry of foreign material.

7.4 An enclosure may be marked with a type number or numbers indicating the external conditions for which it is rated. See Table 1. The marking may be on the inside or outside surface but shall be visible after installation. See 56.10.

7.5 An enclosure that complies with the requirements for more than one type of enclosure may have multiple designations.

7.6 An external operating means – such as those for a disconnect, a pilot device, or a resetting operation – mounted on or through an enclosure shall withstand the tests specified for the enclosure.

7.7 Marking and instructions on the exterior of an enclosure shall be permanent. See 58.1.

7.8 When marked with an enclosure type number, an enclosure shall be subjected to the tests specified in Table 1, and shall comply with the construction requirements applicable to an enclosure of the type number or numbers with which it is marked.

7.9 Outdoor enclosures shall comply with the Method for the Weatherproofing Test for Outdoor Switchgear from the Standard of Common Requirements for High Voltage Power Switchgear Rated Above 1000 V, IEEE C37.100.1 (refer to Annex B, Item 16), in addition to tests required for all enclosure type ratings marked on the enclosure.

7.10 Hinged doors and covers that provide access to live parts shall be constructed such that they open to no less than 90 degrees from the closed position. This requirement does not preclude the use of a wind

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strap, chain, or similar attachment that normally prevents opening to 90 degrees, if it can be readily detached or moved to allow the door to open to no less than 90 degrees.

8 Insulating Material

8.1 Material for the support of uninsulated live parts operating at voltages of 1500 V and below shall be porcelain, phenolic or cold molded composition, or other material suitable for the support of such parts in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or the Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17, (refer to Annex B, Item 5), and shall be capable of withstanding the most severe conditions likely to be met in service.

8.2 Material for the support of uninsulated live parts operating at voltages above 1500 V shall comply with the Dielectric Voltage-Withstand Test, 41, and the Impulse Withstand Test, 52.

8.3 Insulating material, including barriers between parts of opposite polarity (phase barriers) and material that could be subject to the influence of an arc formed by the opening of a switch, shall be rated for the particular application.

9 Mounting of Parts

9.1 All parts of transfer switches shall be securely mounted in position and prevented from loosening or turning when such motion could adversely affect the intended performance of the equipment, or could affect the risk of fire and shock or injury to persons incident to the operation of the equipment.

9.2 Uninsulated live parts other than pressure wire connectors, shall be secured to their supporting surfaces so that they will be prevented from turning or shifting in position when such motion could result in a reduction of spacings to less than those indicated in Table 5. The security of contact assemblies shall be such as to provide the continued alignment of contacts.

9.3 Friction between surfaces is not permitted as a means to prevent turning, loosening, or shifting of a part as required in 9.1 and 9.2, but a lock washer, properly applied, may be accepted.

9.4 External handles and pushbuttons (if applicable) shall be located in accordance with the following:

a) Control and transfer switch handles and pushbuttons shall be located in a readily accessible location at an elevation above the equipment mounting surface not in excess of 2 m (79 inches).

b) Operating handles requiring more than 222 N (50 lbf) to operate shall not be located higher than 1.67 m (66 inches) in either the open or closed position.

c) Operating handles for infrequently operated devices, such as isolating means reset devices, drawout fuses, or fused transformer primary disconnects need not comply with (a) and (b).

9.5 In determining compliance with 9.4, measurements shall be made to the centre of the handle grip with the handle in the highest possible position. Where the handle grip is not clearly defined, it shall be considered to be at a point 76 mm (3 inches) in from the end of the handle.

9.6 When the mechanism of a switching device is such that automatic operation of the transfer switch, or operation of remote or automatic tripping devices will permit sudden movement of an operating handle, the motion of the handle shall be restricted or the handle shall be guarded to prevent injury to persons in the vicinity of the handle.

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10 Guarding and Accessibility of Live Parts

10.1 Energized uninsulated parts of control circuits operating at greater than 30 V that are mounted on doors shall be guarded or enclosed to reduce the risk of unintentional contact when the door is opened for maintenance of equipment or removal of drawout equipment.

10.2 When access is required to a compartment that contains energized parts operating at 1000 V and above, barriers shall be provided to:

a) Keep from unintentional contact with energized parts.

b) Keep tools or other equipment from being dropped on energized parts.

10.3 Barriers shall be provided to protect against contact with live parts of adjacent functional units.

10.4 Any barrier intended to be removed during routine maintenance or servicing shall be marked in accordance with 56.9.

11 Current-Carrying Parts

11.1 A current-carrying part shall have mechanical strength and current-carrying capacity for the service, and shall be of metal that is rated for the particular application.

11.2 When parts are held together by screws, a threaded part shall have no fewer than two full, clean-cut threads engaged. When the screw does not extend all the way through a threaded part, the taper or lead and the first full thread shall be disregarded in a determination of the number of threads engaged.

12 Field Wiring Terminals for Control Circuits

12.1 Transfer switches shall be provided with terminals for the connection of each control circuit conductor intended to be field installed. The terminals shall be sized to accommodate conductors having an ampacity equal to or greater than the current rating of the circuit for which they provide connection, and shall comply with the requirements in the Standard for Terminal Blocks, UL 1059, or the Standard for Terminal Blocks, C22.2 No. 158 (refer to Annex B, Item 17).

12.2 Sizes of field-installed conductors for circuits operating below 1000 V shall be determined in accordance with Table 2.

12.3 A wiring terminal without a marked wire size range shall hold the next larger size conductor than that specified in 12.2, unless the equipment is marked to indicate the wire size to be used in accordance with 56.20.

13 Internal Wiring

13.1 General

13.1.1 Insulated conductors shall be suitable for the service intended with respect to voltage, temperature, and grouping. The temperature rating of conductors shall be not less than 90 °C unless shown suitable with appropriate temperature rise testing. Conductors shall be insulated for the highest voltage normally occurring between such conductors unless wires are grouped so as to segregate the several voltages.

Conductors shall not be smaller than 0.205 mm^2 (24 AWG) except when used for wiring of printed circuit boards and interconnecting wiring between electronic modules and subassemblies.

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13.1.2 Support for internal wiring. Internal wiring shall be supported or secured so as not to come in contact with:

a) Bare live parts of opposite polarity;

b) Bare live parts of other circuits;

c) Sharp or abrasive surfaces;

d) Heat-producing components such as transformers, power resistors, fuse bodies, semiconductor devices; or

e) Moving parts.

A bare conductor, including pigtails and coil leads, shall be supported so that the spacings required elsewhere in this standard will be maintained, unless covered by suitable insulating sleeving or tubing.

13.1.3 All joints and connections shall be mechanically secure and shall provide effective electrical contact without strain on connections and terminals.

13.1.4 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands restrained by cupped washers or the equivalent to provide connections.

13.1.5 A splice shall be provided with insulation equivalent to that of the wires involved.

13.2 Barriers defining wireways

13.2.1 A sheet steel barrier shall not be less than 1.35 mm (0.053 inch) thick, when uncoated and not less than 1.42 mm (0.056 inch) thick when galvanized, unless the configuration of the barrier is such to provide strength and rigidity at least equal to a flat sheet of steel having the same dimensions as the barrier and of the required thickness.

13.2.2 A nonmetallic barrier shall not be less than 6.4 mm (1/4 inch) thick unless it is located where it will not be subject to mechanical abuse during installation and maintenance. All nonmetallic barriers shall be constructed so as to have adequate physical strength and rigidity.

13.2.3 Routing through a metal barrier: A hole through which insulated wires pass in a sheet metal barrier within the enclosure of the equipment shall be provided with a smooth, well-rounded bushing or shall have smooth, well-rounded surfaces upon which the wires may bear, to reduce the risk of abrasion of the insulation.

13.2.4 If conductors greater than 5.26 mm^2 (10 AWG) of an alternating-current circuit pass through a wall or partition of metal having magnetic properties, all of the conductors of the circuit, including the neutral, shall be run through the same opening. The conductors may pass through individual openings in a wall or partition of metal having magnetic properties if:

a) The openings are connected by slots cut in the metal wall; or

b) During the temperature test, temperatures are recorded on interposed metal to determine that conductor insulation is not adversely affected. The conductors may be run through individual openings in an insulating block used to cover an opening in the metal wall sufficiently large for all the conductors of the circuit if no metal bracket, brace, or the like, is placed across the insulating material between the conductors. See Figure 1.

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13.2.5 A bushing employed as described in 13.2.3 shall be of glass, ceramic, hard fiber, phenolic composition, cold-molded composition, or other polymeric material which has been investigated and found suitable for the application. Rubber, neoprene, and similar materials are not permitted for this bushing.

13.3 Wiring in circuits below 1000 V

13.3.1 Wires shall be of multi-stranded, flexible, or extra-flexible construction where they make connection to electrical equipment mounted on a hinged door. These conductors shall be cabled, routed, secured, and protected so that they will not be damaged during the opening and closing of the door or cover or during the movement of a drawout unit. If the flexing section of the wiring could come in contact with grounded metal parts, that portion of the wiring shall be given additional protection with wrappings of tape or the equivalent or enclosed in nonmetallic flexible tubing or conduit.

13.3.2 Cord-connected control circuit devices shall be provided with the correct length, size, and type of hard-service or junior hard-service flexible cord (such as Type S, and SJ) or the equivalent, that is suitable for use at the temperature and voltage involved, terminating with an attachment plug.

13.4 Wiring in circuits operating at 1000 V and higher

13.4.1 Wiring in circuits operating at 1000 V and higher shall be sized in accordance with Table 3. Wiring smaller than that shown in Table 3 is permitted when tested in accordance with the Temperature Test, 39. Conductors in sizes 53.5 mm^2 (1/0 AWG) and larger may be run in parallel if the arrangement is such as to provide equal division of total current among all conductors involved.

13.4.2 For equipment operating above 7200 V, instruments, meters, relays, secondary control devices, and their wiring shall be isolated by grounded metal barriers from the primary circuit elements, with the exception of short lengths of wire such as at instrument transformer terminals and secondary disconnecting devices.

14 Isolation

14.1 Isolating means

14.1.1 A transfer switch shall be provided with an isolating means for each source. Each isolating means shall consist of no more than two devices per source. If two isolating devices are required for a source, the transfer switch shall be marked in accordance with 56.21. Each device shall be externally- operable, and gang-operated. Each device shall have position indication. The isolating means shall be capable of interrupting the no-load current of the control-circuit transformer in accordance with the Switching Capacity Test – Isolating Means, 49, unless interlocked to prevent such operation. The isolating means may be any one of the following:

a) Three-pole isolating switch;

b) Drawout contactor that may or may not include fuse assembly; or

c) Drawout circuit breaker.

14.1.2 Each isolating means indicated in 14.1.1, shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. One pole of the disconnecting means may disconnect a permanently grounded conductor, provided that the disconnecting means is so constructed that the pole in the grounded conductor cannot be opened without disconnecting all conductors of the circuit in the same operation.

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14.1.3 The isolating means shall provide visible evidence of an isolating gap in the circuit adequate for the operating voltage.

14.1.4 To comply with 14.1.3, the isolating gap or a mechanically operated indicator shall be visible through a viewing pane or by opening a door when the isolating gap is open. The mechanical indicator shall be actuated by the movement of the actual isolating switch, the shutter of a drawout assembly, or the like. The action of the mechanical indicator shall not be dependent on the movement of the operating handle or mechanism alone. Where the isolating means consists of a drawout type device, the presence of the drawout device in the test or disconnected position provides the required visible evidence.

14.1.5 The power-circuit isolating means shall be interlocked as indicated in Interlocking, 21.

14.1.6 The power-circuit isolating means shall have provision for being padlocked in the open position.

14.1.7 All switch blades shall be de-energized when the switch is in the open position, unless the switch must necessarily be energized from both sides (such as bus ties or loop sectionalizing configurations). Such switches may have energized blades in the open position when:

a) Barriers or enclosures are installed over the switches for protection against contact with the energized switch blades; and

b) The switch is marked in accordance with 56.12.

14.1.8 In Canada, the transfer switch shall be marked in accordance with 56.19.

In the United States, this requirement does not apply.

14.2 Isolation of circuits

14.2.1 Wiring operating at 1000 V and higher shall not be routed or bundled with wiring operating at below 1000 V.

14.2.2 For equipment operating above 7200 V, instruments, meters, relays, secondary control devices, and their wiring shall be isolated by grounded metal barriers from the primary circuit elements, with the exception of short lengths of wire such as at instrument transformer terminals and secondary disconnecting devices.

15 Grounding and Bonding

15.1 Terms

15.1.1 The grounding and bonding terms are identified in Figure 2. The terms used in this standard are in accordance with the UL column in Figure 2. The corresponding Canadian Electrical Code (CEC) terms are also provided for information.

15.2 Grounding of exposed metal parts

15.2.1 An enclosure shall have provision for permanent and effective grounding of exposed non-current-carrying metal parts. The means for grounding shall consist of a ground bus or ground stud with provisions for the mounting of pressure terminal connectors acceptable for use with conductors of the size indicated in Table 4. At all points of connection between the ground bus or the equipment grounding conductor and the assembly, any nonconductive coating, such as paint, shall be removed or penetrated to provide a good electrical connection. Bolts or screws engaging at least two full threads in the penetrated metal shall be considered to have provided adequate penetration.

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15.2.2 There shall be provision for permanently and effectively grounding a metal plate that covers uninsulated live parts. All dead metal parts that are likely to be touched by persons and are likely to become energized shall be grounded.

15.2.3 If the above requirements cannot be visually verified, the grounding provisions shall be tested in accordance with the Enclosure Ground Integrity Test, 53.

15.2.4 In Canada, provision for bonding shall also comply with the Standard for Bonding of Electrical Equipment, CSA C22.2 No. 0.4 (refer to Annex B, Item 6).

In the United States, this requirement does not apply.

15.3 Ground bus

15.3.1 A ground bus shall be provided for all transfer switch assemblies.

15.3.2 The ground bus shall be of equivalent cross-sectional area to the conductors shown in Column 2 or 3 of Table 4. Splice bars shall be provided for field splicing sections as needed.

15.4 Provision for ground termination

15.4.1 Transfer switch assemblies shall include one of the following provisions for the termination of the grounding conductor associated with each incoming or outgoing circuit, or provision for field installation of wire connectors suitable for that purpose:

a) For each circuit, a suitable stud or bolt mounted on the grounding bus or transfer switch assembly structure, together with a standard complement of hardware to secure a suitable wire connector (the connector need not be furnished);

b) For each circuit, a wire connector, located either on the grounding bus or elsewhere on the transfer switch assembly structure; or

c) For each circuit, a termination pad with drilling in accordance with the Standard for Electric Power Connection for Substations, ANSI NEMA CC 1 (refer to Annex B, Item 11).

15.4.2 There shall be provisions for grounding the shields of field-installed shielded conductors.

15.5 Grounding of drawout elements

15.5.1 The metal frame of a drawout element (if provided) shall be grounded in the test and connected positions and in all locations between these positions.

15.5.2 When in the test position, all dead metal parts that are likely to be touched by persons and are likely to become energized shall be grounded. A dead metal part shall be considered likely to become energized if the part contains or encloses live parts above 50 V.

15.6 Grounding of instrument and control circuits

15.6.1 The metal cases or frames of instrument transformers, instruments, meters, relays, and similar equipment shall be considered adequately grounded when mounted directly on the grounded metal structure. When not mounted directly on the grounded metal structure, metal cases shall have a grounding conductor of at least 3.31 mm^2 (12 AWG) copper or equivalent.

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15.6.2 Secondary circuits of internally mounted current and potential transformers shall be grounded. The grounding conductor for secondary circuits of current and potential transformers and for instrument cases shall not be smaller than 3.31 mm^2 (12 AWG) copper or equivalent.

15.7 Grounding and bonding of neutral circuits for service entrance transfer switches

15.7.1 Service entrance transfer switches shall comply with the grounding and bonding requirements of 23.2 or 24.2 as appropriate.

16 Operating Mechanism

16.1 General

16.1.1 The operating mechanism of a transfer switch shall be constructed to provide reliable and positive electrical and mechanical performance under all conditions of intended operation.

16.1.2 Provision shall be made to reduce the possibility of adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

16.1.3 An automatic transfer switch shall incorporate the required control equipment to initiate transfer from the normal supply to the alternate supply upon the interruption of any or all phases of the normal supply.

16.1.4 An automatic transfer switch may be additionally controlled by equipment to provide a time delay in either or both directions of transfer. Equipment may initiate transfer under low normal voltage conditions or by voltage-frequency measurement.

16.1.5 A transfer switch that incorporates integral overcurrent protective devices in the main power circuits and that will not automatically transfer from one source to another as a result of the opening of one or more of these overcurrent devices shall be marked in accordance with 56.4.6.

16.1.6 An automatic transfer switch may be arranged to provide closed transition between synchronized supplies. A closed transition automatic transfer switch:

a) Shall always transfer in an open transition mode on loss of power;

b) Shall not transfer in closed transition mode if synchronization is not achieved;

c) Shall permit an open transition when synchronization is not achieved;

d) Shall be provided with electrical interlocks to prevent closing of both sources simultaneously when operating in open transition mode;

e) May be provided with a user selectable mode of operation (open or closed transition). The status of the operator selection shall not prevent the transfer switch from transferring in open transition mode on loss of the connected source;

f) Shall be marked in accordance with 56.11; and

g) Shall be provided with:

1) A control circuit arranged to permit closed transition only when synchronization is achieved;

2) A protective device to inhibit closed transition when synchronization is not achieved (at a minimum, a synchronizing check relay);

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3) Circuitry to detect and provide an alarm to indicate failure to achieve synchronization;

4) Circuitry to prevent the sources from being paralleled for more than 100 ms; and

5) Additional circuitry to detect an extended parallel operation time (greater than 100 ms) and cause one or both sources to be disconnected to remove the condition. The time to disconnection may be adjustable up to 500 ms.

16.1.7 A transfer switch provided with means to permit manual operation of the mechanism shall have such means externally operable without opening the enclosure. When the transfer switch consists of circuit breakers within switchgear complying with the Standard for Metal-Clad Switchgear, IEEE C37.20.2, or the Standard for Switchgear Assemblies, CSA C22.2 No. 31, manual operation of the circuit breakers need not be externally operable. Refer to Annex B, Item 13).

16.1.8 When a transfer switch is provided with a means to permit manual operation of the mechanism, the speed and force of this operation shall be independent of the action of the person.

16.1.9 Means shall be provided to reduce the possibility of automatic operation during the manual transfer, when automatic operation can result in risk of electric shock or injury to the operator.

16.1.10 When the means used to comply with 16.1.9 renders the control circuit non-functional, audible or visual signals or equivalent means shall be provided to indicate the status of the control circuit.

16.1.11 Operation of an overcurrent protection system shall not cause a switching device to interrupt an overcurrent greater than the rated interrupting current of the switching device or initiate a transfer.

16.1.12 Unless the transfer switch is rated for switching fault currents, transfer under low supply voltage conditions shall be inhibited under short-circuit conditions.

16.1.13 Undervoltage transfer initiation shall be blocked when an overcurrent is sensed.

16.2 Transfer switch operator interlocks

16.2.1 The operating mechanism of open transition switches shall be interlocked to reduce the possibility of simultaneous connection to both the normal and alternate supplies.

16.2.2 The interlock circuit wiring shall be factory connected and located entirely within the transfer switch enclosure. It shall be additionally protected from possible damage due to the operation of the transfer mechanism or during any servicing of the switch. Where transfer equipment consists of multiple sections of equipment, provisions shall be made for field connection of the interlock circuit wiring, and detailed instructions for this connection shall be provided.

16.2.3 When an interlock system includes solid-state components, the electric interlocking system shall be evaluated to the requirements of the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 (refer to Annex B, Item 18).

16.2.4 An alarm or test means shall be provided to indicate an inoperative condition of an interlocking system which includes solid-state components, when the failure analysis indicated in 16.2.3 results in showing that a single failure renders the system inoperative.

16.2.5 The interlocking mechanism shall operate in the intended manner at the conclusion of all tests, as specified in the Performance section of this document for the particular type of transfer switch construction. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections should not become loose, parts should not rotate, and the like.

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16.2.6 The mechanism and interlocking means shall be constructed to reduce the possibility of transfer in either direction in the event of welding of one or more contacts in the power circuit or one contact in the control circuit.

16.3 Location and protection of transfer control circuits

16.3.1 When a transfer switch is marked for service equipment use, and the control circuit is connected on the line side of the service disconnecting means, the control circuit shall have short-circuit protection and a disconnecting means suitable for the available current of the supply.

16.3.2 Control circuits may extend from a transfer switch to an external engine-generator set, when a marking indicates that the control circuit wiring is to be in conduit. See 56.7.

16.3.3 Other control circuits that are depended upon for the proper operation of a transfer switch shall be located wholly within the transfer switch enclosure and shall not have overload protective devices connected in them, but may have short-circuit and ground-fault protection. In a transfer switch consisting of multiple vertical sections, the control circuits may be in any vertical section of a continuous lineup of sections.

16.3.4 When an electrical motor on a transfer switch drive mechanism is provided with overload protection, the motor shall be protected against locked-rotor burnout only.

16.3.5 To be in compliance with 16.3.4, the overload protector shall not open during the Mechanical Endurance Tests, 40.

16.4 Transfer switches for emergency use

16.4.1 The operating mechanism and control circuit shall be such that the load cannot remain simultaneously disconnected from both the normal and alternate supplies when either or both supplies are available with voltage and frequency sufficient to permit proper operation. When intended for use with paralleled engine generator sets, transfer to the generator source or sources may be inhibited until sufficient power for the connected load is available. See 56.4.5.

16.4.2 The mechanism of a transfer switch intended for use with paralleled engine-generator sets as indicated in 16.4.1 may be arranged to disconnect from the alternate source (generators) in the event of shutdown of one or more of the paralleled engine-generator sets.

16.4.3 The operating mechanism of the normal and emergency contacts of an automatic transfer switch for use in emergency systems shall be electrically operated.

16.4.4 The normal and emergency contacts of an automatic transfer switch intended for use in emergency systems shall be mechanically held in a closed position.

16.4.5 At least one manually operated dead front test switch shall be provided to simulate loss of the normal supply, or provision shall be made for the connection of a remote test switch or switches.

16.4.6 Circuits for the remote test switches required in 16.4.5 for automatic transfer switches shall be arranged so that shorting or opening of the circuit or test switch does not reduce the possibility of transfer to the alternate source in the event of loss of the normal source.

16.4.7 An auxiliary contact shall be provided for remote indication that the transfer switch is non-functional under any of the following conditions:

a) Any control switch is set to a position that prevents automatic operation.

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b) The transfer switch is in bypass mode.

c) An isolating means is open such that the transfer switch is non-functional.

d) Operation of a protective device has rendered the transfer switch non-functional.

17 Overcurrent and Ground-Fault Protection

17.1 Overcurrent protection

17.1.1 Transfer switches constructed using switching devices other than medium voltage circuit breakers shall be provided with overcurrent protection that is effective in all modes of operation, including bypass mode when provided. Transfer switches constructed using medium voltage circuit breakers shall be provided with overcurrent protection included in the transfer switch assembly or shall be marked to indicate the overcurrent protection that is to be provided on the line (supply) side of the transfer switch assembly in accordance with 56.22.

17.1.2 The operation of the overcurrent protection system shall not cause a switching device to interrupt an overcurrent greater than the rated interrupting current of the switching device.

Note: For transfer switches incorporating a switching device and a power fuse in combination, the rated interrupting rating current in this clause refers to the switching device alone, and not the rating of the power fuse nor the combination rating. For contactors investigated to the requirements of the Standard for Medium-Voltage AC Contactors, Controllers, and Control Centers, UL 347, or the Standard for Medium-Voltage AC Contactors, Controllers, and Control Centres, C22.2 No. 253 (refer to Annex B, Item 14), the rated interrupting current is the making and breaking capacity of the contactor.

17.1.3 For transfer switches constructed using switching devices other than medium voltage circuit breakers, the overcurrent protection system shall inhibit a transfer operation above 600 percent of the transfer switch continuous current rating. The setting at which the overcurrent system inhibits transfer may be adjustable to a lower value. The overcurrent protection system shall include an external trip signal for coordinating the transfer switch with an upstream protective device.

17.2 Ground-fault protection

17.2.1 Ground-fault protection is not required. However, when provided, it shall comply with 17.2.2 and with (a) – (d) as follows:

a) The ground-fault protection system shall open all ungrounded conductors of the faulted circuit.

b) The maximum setting of the ground-fault protection shall be 1200 A.

c) The maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 A.

d) Equipment shall be provided with instructions for field testing of the ground-fault protection system.

17.2.2 Operation of a ground fault protection system shall not cause a switching device to interrupt a ground fault greater than the rated interrupting current of the switching device or initiate a transfer.

18 Receptacles

18.1 When 15 A or 20 A, 125 V receptacles are provided, they shall be of the Class A GFCI type or otherwise Class A GFCI protected.

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