JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 1008M:2024

STANDARD FOR SAFETY

Transfer Switch Equipment, Meter-Mounted

ANSI/UL 1008M-2024

SCC FOREWORD

National Standard of Canada

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UL Standard for Safety for Transfer Switch Equipment, Meter-Mounted, ANSI/CAN/UL 1008M

First Edition, Dated April 3, 2024

Summary of Topics

This is the First Edition of ANSI/CAN/UL 1008M, Standard for Transfer Switch Equipment, Meter-Mounted dated April 3, 2024.

The new requirements are substantially in accordance with Proposal(s) on this subject dated March 31, 2023 and February 16, 2024.

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ANSI/CAN/UL 1008M:2024

Standard for Transfer Switch Equipment, Meter-Mounted

First Edition

April 3, 2024

This ANSI/CAN/UL Safety Standard consists of the First Edition.

The most recent designation of ANSI/UL 1008M as an American National Standard (ANSI) occurred on April 3, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on April 3, 2024.

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ANNEX A – SAFETY MARKING TRANSLATIONS (Normative for Canada and Informative the United States)

Preface

This is the First Edition of ANSI/CAN/UL 1008M, Standard for Transfer Switch Equipment, Meter-Mounted.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 1008M Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Annex A is identified as Normative for Canada and Informative for the US. Informative text is for informational purposes only, and Normative text is considered to be mandatory.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted 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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This Edition of the Standard has been formally approved by the Technical Committee (TC) on Transfer Switch Equipment, TC 1008.

This list represents the TC 1008 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

TC 1008 Membership

Name	Representing	Interest Category	Region
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TC 1008 Membership Continued

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

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INTRODUCTION

1 Scope

1.1 These requirements cover automatic and non-automatic (manual) transfer switch equipment, operating at 600 V ac or less, intended for installation in a meter socket and used in non-hazardous locations in accordance with the National Electrical Code (NEC), NFPA 70, and the Canadian Electrical Code, Part I, CSA C22.1.

1.2 These devices are intended for use in other than life safety systems.

In the United States, these are intended for use in optional standby systems only and are not intended for use in Emergency or Legally Required Standby Systems (Life Safety Systems).

In Canada, these devices are for use in applications where loss of power is not considered safety critical.

These devices are intended for one of the following applications:

a) Permanent connection of a stationary generator to power a premise wiring system, where the generator is connected as a non-separately derived system, where the neutral (grounded circuit conductor) of the generator is not bonded to ground or the generator frame; or

b) Cord connection of a portable generator to power a premises wiring system, where the neutral (grounded circuit conductor) of the generator is not bonded to ground or the generator frame, and bonding of the neutral (grounded circuit conductor) to ground will occur:

1) In the United States, within the meter socket, or

2) In Canada, at the meter base or service box.

Note 1: In Canada, metering equipment may be connected on the supply side of the service box in some instances as outlined in the Canadian Electrical Code, Part I, Rule 6-402 (2). In the United States, installation of meter mounted transfer switches on the line side of the service disconnect is permitted by Section 230.82 of the National Electrical Code, NFPA 70.

Note 2: In Canada, emergency systems are identified as emergency power supplies. In the United States, this does not apply.

1.3 When these devices are connected between the meter mounting socket and the electric utility meter, and installed on the line side of the service disconnect, approval by the serving utility may be required before installation.

1.4 These requirements only cover transfer switches which are completely enclosed when installed in a meter socket in conjunction with the electrical utility meter.

1.5 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 Components

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.

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.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Referenced Publications

4.1 The following standards are referenced in this Standard, and portions of these referenced standards may be essential for compliance. Products covered by this standard shall comply with the referenced installation codes and standards noted in this clause 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.

4.2 Where reference is made to any Standards, such reference shall be considered to refer to the latest editions and revisions thereto available, unless otherwise specified.

CSA C22.1, *Canadian Electrical Code, Part 1*

CSA C22.2 No. 0.2, *Insulation Coordination*

CSA C22.2 No. 0.8, *Safety Functions Incorporating Electronic Technology*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 21, *Cord Sets and Power-Supply Cords*

CSA C22.2 No. 115, *Meter-Mounting Devices*

CSA C22.2 No. 144.1, *Ground-Fault Circuit-Interrupters*

CSA C22.2 No. 178.1, *Transfer Switch Equipment*

NEMA WD6, *Wiring Devices – Dimensional Specifications*

NEMA Z535.4, *Product Safety Signs and Labels*

NFPA-70, *National Electrical Code*

UL 414, *Meter Sockets*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 796, *Printed Wiring Boards*

UL 817, *Cord Sets and Power-Supply Cords*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment*

UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*

UL 943, *Ground-Fault Circuit-Interrupters*

UL 1008, *Transfer Switch Equipment*

5 Glossary

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

5.2 AUTOMATIC TRANSFER SWITCH (ATS) – 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 may 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.

5.3 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.

5.4 LEGALLY-REQUIRED STANDBY SYSTEMS – Those systems legally required by municipal, state, provincial or federal codes, or any governmental authority having jurisdiction, but not classified as essential for safety to human life.

5.5 NON-AUTOMATIC TRANSFER SWITCH – 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.

5.6 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, the term optional standby systems is not recognized.

CONSTRUCTION

6 General

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

7 Enclosure

7.1 A transfer switch shall be provided with an enclosure, which complies with the requirements of UL 414 or CSA C22.2 No. 115.

7.2 When provided, 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.

7.3 Marking and instructions on the exterior of the device shall be permanent. See 31.1.

7.4 Meter mounted transfer switches which are intended for outdoor use in wet locations shall comply with the requirements for Type 3, 3R, 3S, 4, or 4X enclosures, as detailed in the Enclosure Section of UL 414 or CSA C22.2 No. 115. Transfer switches intended for cord connection to portable generators, shall comply with these requirements with the cord connector installed as well as with the connector withdrawn.

7.5 Enclosures shall have provisions for padlocking or sealing by the serving utility, such that the enclosure may not be opened or removed without removing the utility company padlock or breaking the utility company seal. This requirement does not apply to enclosures (such as generator termination boxes) that contain only wiring or components that are not connected to the utility conductors with the transfer switch in any position.

8 Insulating Material

8.1 Material for the support of uninsulated live parts shall be porcelain, phenolic or cold molded composition, or other material acceptable for the support of such parts in accordance with UL 746C or CSA C22.2 No. 0.17, and shall be capable of withstanding the most severe conditions likely to be met in service.

8.2 Insulating material, including barriers between parts of opposite polarity (phase barriers) and material that may be subject to the influence of an arc formed by the opening of a switch, shall be acceptable 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 if such motion may adversely affect the intended performance of the equipment, or may affect the risk of fire and 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 if such motion may result in a reduction of spacings to less than those indicated in Section 18, Spacings. The security of contact assemblies shall be such as to provide the continued alignment of contacts.

9.3 Friction between surfaces is not acceptable 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 If the mechanism of a switching device is such that automatic operation of the transfer switch, or operation of a 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.

9.5 A transfer switch that is to be retrofitted to an existing meter socket shall be provided with a means to ensure that the system is tamper-resistant once installed onto the meter socket. A suitable tamper-resistant system may include but is not limited to: securing with tamper-resistant screws or the manufacture of the transfer switch and meter-mounting device (meter socket) as one complete assembly. Means shall be provided for the serving utility/supply authority to seal the equipment so that the meter cannot be removed without breaking the seal, in accordance with CSA C22.2 No. 115. For some constructions, this may require sealing the meter to the transfer switch, and also sealing the transfer switch to the meter socket.

10 Guarding and Accessibility of Live Parts

10.1 When the transfer switch is installed in a meter socket in conjunction with an electrical utility meter, there shall be no uninsulated live parts accessible once the meter is installed.

10.2 Inlets for connection of portable generators shall be of the type with male blades and shall be arranged such that they are not energized unless mated with the appropriate connector.

10.3 Connectors shall be of the multi-pole type, with enough poles to accommodate the ground/bond, neutral, and all ungrounded supply conductors.

10.4 Connectors shall have a rating no less than the portion of the transfer switch to which they are connected.

10.5 Connectors shall be suitable for connection and disconnection under load.

10.6 Transfer switches with inlets shall comply with 7.4.

10.7 Transfer switches with an inlet shall be marked in accordance with 30.13.

11 Current-Carrying Parts

11.1 Current-carrying parts shall meet the requirements of UL 414 or CSA C22.2 No. 115.

12 Power Circuit Connections

12.1 Transfer switch equipment shall be provided with blades and jaws for mating with a meter socket and an electrical utility meter. These blades and jaws shall comply with the requirements of UL 414 or CSA C22.2 No. 115.

12.2 Meter mounted transfer switches for connection to a portable generator shall be provided only with an integral inlet for cord connection of a portable generator. Flexible cord shall not be an integral part of the transfer switch. Field wiring terminals for connection of a portable generator are not allowed.

12.3 The integral inlet referenced in 12.2 shall be either:

a) A standard configuration flanged inlet in accordance with NEMA WD 6 or Diagram 2 of the Canadian Electrical Code, Part 1, or

b) A non-standard configuration when the transfer switch is also provided with a detachable cord set for connection of a portable generator as described in 12.4.

12.4 The cord set referenced in 12.3(b) shall be provided by the manufacturer of the transfer switch and shall have a connector to mate with the transfer switch inlet and a connector of a standard configuration in accordance with NEMA WD 6 or Diagram 2 of the Canadian Electrical Code, Part 1, for connection to the generator. The cord set shall comply with the requirements for outdoor cord sets in UL 817 or CSA C22.2 No. 21.

12.5 Meter mounted transfer switches for permanent connection to a stationary generator shall have provisions for permanent connection of wiring contained in appropriate flexible metal or non-metallic conduit in accordance with NFPA 70 or CSA C22.1. The use of non-flexible conduit is not permitted. Field wiring terminals shall comply with UL 1008/CSA C22.2 No. 178.1.

13 Internal Wiring

13.1 The internal wiring of transfer switches shall consist of general use wire or appliance wiring material acceptable for the particular application when considered with respect to the temperature and voltage and conditions of service to which the wiring is likely to be subjected.

13.2 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like, which may cause abrasion of the conductor insulation.

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

13.4 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.

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

13.6 An opening in a barrier through which factory installed wiring passes, or through which field installed wiring may pass, shall be provided with a bushing, or shall be formed so that there are no sharp edges with which conductors may come in contact.

13.7 A bushing employed as described in 13.6 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 acceptable for this bushing.

13.8 Insulated conductors supplied as part of meter-mounting devices that are intended for outdoor use shall be resistant to moisture-absorption.

14 Grounding and Bonding/Equipment Grounding

14.1 Transfer switches shall have provision for bonding/equipment grounding all dead metal parts that are exposed or that are likely to be touched by a person during adjustment or intended operation of the device, and that are likely to become energized.

14.2 Small, isolated (insulated) dead metal parts are not required to be bonded/equipment grounded.

14.3 A dead metal part is not considered likely to become energized if acceptable results are obtained during dielectric voltage withstand with the part connected to ground during the tests.

14.4 In the United States, the equipment grounding conductor and neutral (grounded circuit conductor) from the generator shall be bonded within the transfer switch enclosure to the neutral (grounded circuit conductor) of the normal supply circuit. The size of the bonding jumper conductor shall be based on the rating of the alternate supply circuit in accordance with the bonding jumper requirements in UL 1008.

14.5 The bonding conductor required by 14.4 shall be installed in the transfer switch and shall have provisions for connection to the neutral terminal of the meter socket.

14.6 In Canada, the bonding conductor and identified conductor (neutral/grounded circuit conductor) from the generator shall be bonded within the service equipment to the identified conductor of the normal supply circuit. A system bonding jumper shall also be installed in the transfer switch. The size of the system bonding jumper shall be based on the rating of the alternate supply circuit in accordance with the main bonding jumper requirements from CSA C22.2 No. 178.1.

14.7 In Canada, the system bonding jumper required by 14.6 shall be installed in the transfer switch.

Note: In the United States, the system bonding jumper shall be installed within the existing service equipment.

14.8 Units shall have provisions for connecting the bonding/equipment grounding conductor and identified conductor (neutral/grounded circuit conductor) from the generator to the bonding/equipment grounding conductor and identified conductor of the normal supply circuit within the service equipment. Units may have provisions for connection to the identified conductor terminal of the meter socket for units that do not meet the exception provided for in CSA C22.1, Rule 6-402 (2).

15 Operating Mechanism

15.1 General

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

15.1.2 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.

15.1.3 An automatic transfer switch shall be permitted to 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 and by voltage-frequency measurement. Unless the transfer switch is rated for switching fault currents, transfer under low supply voltage conditions shall be inhibited under short circuit conditions.

15.1.4 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 30.12.

15.1.5 A transfer switch provided with means to permit manual operation of the mechanism shall have such means externally operable without opening the enclosure.

15.1.6 A transfer switch having an external manual operating means that can permit opening or closing of the switch contacts at a rate of speed substantially slower than that caused by the automatic operating means shall be additionally investigated. See 23.3.

15.1.7 Means shall be provided to reduce the possibility of automatic operation during the manual transfer if automatic operation can result in risk of electric shock or injury to operating personnel.

15.1.8 If the means used to comply with 15.1.7 renders the control circuit non-functional, audible, or visual signals or equivalent means shall be provided to indicate the status of the control circuit.

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

15.1.10 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.

15.1.11 When an interlock system includes solid state components, the electric interlocking system shall be evaluated to the requirements of UL 991 or CSA C22.2 No. 0.8.

15.1.12 An alarm or test means shall be provided to indicate an inoperative condition of an interlocking system which includes solid state components, if the failure analysis indicated in 15.1.11 results in showing that a single failure renders the system inoperative.

15.1.13 The interlocking mechanism shall continue to operate in the intended manner at the conclusion of all applicable performance tests required in Sections 19 – 28. 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.

15.1.14 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.

15.1.15 Meter mounted transfer switches shall be constructed so that the neutral (grounded circuit conductor) is not switched. They shall be marked in accordance with 30.10.

15.1.16 Meter mounted transfer switches that transfer automatically shall comply with either:

a) The rating of the alternate supply circuit of the transfer switch shall be equal to the rating of the normal supply circuit; or

b) The transfer switch shall include a load management system that automatically manages the connected load, and the alternate source circuits shall have a rating sufficient to serve the connected load.

15.1.17 The alternate supply circuits of a meter mounted transfer switch that is only manually operated may have current ratings lower than those of the normal supply circuit.

15.2 Location and protection of transfer control circuits

15.2.1 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 protection (phase to phase and/or phase to ground). Supplementary protectors shall not be used for this protection.

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

15.2.3 To comply with 15.2.2 the overload protector shall not open during the endurance test described in Section 25.

15.2.4 Transfer switches may be provided with fuses or circuit breakers for protection of circuits and components internal to the transfer switch. These fuses or circuit breakers shall be located entirely within the transfer switch enclosure, such that they are not replaceable or resettable without removing the utility company padlock or seal.

16 Receptacles

16.1 Receptacles are not permitted.

17 Inlets for Cord Connection to a Portable Generator

17.1 Transfer switches intended for cord connection to a portable generator shall be provided with an integral inlet having male phase and neutral (grounded circuit conductor) connections and having a rating no less than the rating of the transfer switch to which it is connected.

17.2 An inlet shall have sufficient number of poles to accommodate the ground, neutral (grounded circuit conductor), and all ungrounded supply conductors in one connector.

17.3 An inlet shall be of a design such that the ground connection is the first connection made when inserting a plug and is the last connection to be opened when removing the plug.

17.4 An inlet shall be suitable for connection and disconnection under load.

17.5 An inlet shall be arranged such that the current carrying parts of the inlet are energized only when a mating attachment connector is connected to the inlet.

17.6 Meter mounted transfer switches intended to be supplied by a cord-connected portable generator shall be provided with integral branch circuit protection for the circuits that are supplied through the inlet or shall be marked in accordance with 30.9. The rating of the branch circuit protection shall not be greater than the rating of the inlet.

17.7 Meter mounted transfer switches intended for cord connection to a portable generator shall be marked in accordance with 30.9 and 30.11.

18 Spacings

18.1 General

18.1.1 Electrical spacings at the meter socket blades and jaws shall comply with UL 414 or CSA C22.2 No. 115.

18.1.2 Other than spacings on printed wiring boards, spacings in other portions of the transfer switch shall not be less than those required in UL 1008 or CSA C22.2 No. 178.1.

18.2 Spacings on printed wiring boards

18.2.1 The requirements of 18.2.2 – 18.2.4 do not apply to components that have been investigated to the appropriate component standards.

18.2.2 Clearances and creepage distances on printed wiring boards (other than printed wiring boards which are integral to previously investigated components) may be evaluated in accordance with the requirements in UL 840 or CSA C22.2 No. 0.2, as described in 18.2.4.

18.2.3 In conducting evaluations in accordance with the requirements in UL 840 or CSA C22.2 No. 0.2, the following guidelines shall be used:

a) For evaluating clearances:

1) Circuits connected to the utility supply shall be evaluated for Overvoltage Category IV. Circuits within the equipment which are located in the secondary of a transformer which is isolated from the utility supplied may be considered to be Overvoltage Category III;

2) The Phase-to-Ground Rated System Voltage used in the determination of Clearances shall be the equipment rated supply voltage rounded to the next higher value (in the table for determining clearances for equipment) for all points on the supply side of an isolating transformer or the entire product when no isolating transformer is provided. The measured clearance distance used in the evaluation of isolated secondary circuitry is able to be interpolated when the secondary voltage occurs between voltages in the supply voltage column;

3) To determine equivalence with current through air spacings requirements, an impulse test potential having a value as determined in UL 840 or CSA C22.2 No. 0.2, is to be applied.

b) For evaluation of creepages:

1) Any printed wiring board which complies with the requirements in UL 796 or CSA C22.2 No. 0.17, provides a Comparative Tracking Index (CTI) of 100, and when it complies with the requirements for Direct Support in UL 796, then it provides a CTI of 175;

2) Unless specified elsewhere in this standard, equipment shall be evaluated for pollution degree 3;

3) Printed wiring boards are evaluated as pollution degree 2 when adjacent conductive material is covered by any coating, such as a solder mask, which provides an uninterrupted covering over at least one side and the complete distance up to the other side of conductive material;

4) Printed wiring boards shall be evaluated as pollution degree 1 under one of the following conditions:

i) A coating which complies with the requirements for Conformal Coatings in UL 746C or CSA C22.2 No. 0.17; or

ii) At a specific printed wiring board location by application of at least a 1/32 in (0.79 mm) thick layer of silicone rubber or through potting, without air bubbles, in epoxy or potting material.

18.2.4 In a circuit involving potential of not more than 50 V, spacings may be 1/16 in (1.6 mm) through air and over surface, provided that insulation and clearances between the lower potential circuit and any higher potential circuit are in accordance with the requirements that are applicable to the higher potential circuit. Spacings are not specified for a circuit involving a potential of not more than 30 V and supplied by a primary battery or by a Class 2 transformer or by a combination of transformer and fixed impedance having output characteristics in compliance with those required for a Class 2 transformer.

PERFORMANCE

19 General

19.1 The performance of transfer switches shall be investigated by subjecting a representative device or devices in commercial form to the tests described in Sections 20 – 28. Unless otherwise indicated, the various tests shall be conducted at rated voltage.

19.2 All tests shall be conducted on enclosed samples. One sample is to complete the overload, temperature, endurance, and dielectric voltage-withstand tests. A previously untested sample may be used for the withstand and closing tests.

19.3 At the manufacturer's option, the temperature test may be conducted either after the endurance test or on a separate sample that has been previously subjected to an overload test.

19.4 Tests shall be conducted with the transfer switch mounted as intended in a certified commercially available meter base having the appropriate ratings.

20 Normal Operation Test

20.1 Automatic transfer switches shall be capable of operating in their acceptable manner, for all conditions of their marked intended performance. Other than the test described in 20.3, devices rated 50/60 Hz may be tested at either frequency. Devices with frequency ratings other than 50/60 Hz shall be tested at each rated frequency.

20.2 The normal supply voltage sensing circuit shall initiate transfer to the alternate supply for any value of normal supply voltage specified by the manufacturer. See 30.3.

20.3 If voltage-frequency sensing circuits are provided to determine availability of the alternate supply, operation shall be affected within the marked limits specified by the manufacturer. For devices with multiple frequency ratings (including devices rated 50/60 Hz) this testing shall be conducted at each rated frequency. See 30.4.

20.4 If time delayed transfer features are provided either from the normal to alternate source, alternate to normal source, or both, the transfers shall be within the marked limits specified by the manufacturer. See 30.5.

20.5 To determine whether an automatic transfer switch complies with the requirements in 20.1 – 20.4, the switch is to be mounted in the intended manner and the normal and alternate supply terminals are to be connected to separate circuits of rated voltage and frequency. The switch with no load connected is to be caused to operate by the following means:

a) Test switch;

b) Interrupting and then restoring, in turn each conductor of the normal supply;

c) Low normal supply voltage; or if a voltage-frequency sensing is provided, the operating values of voltage and frequency may be determined by:

1) Increasing alternate supply frequency with voltage set at minimum specified operating voltage; and

2) Increasing the alternate supply voltage with frequency set at minimum specified operating frequency, or by any other equivalent method.

21 Overvoltage Test

21.1 The coil of an electromagnet shall be capable of withstanding 110 % of the rated voltage for the maximum time it is normally energized in service without damage.

21.2 To determine whether an operating coil complies with the requirement of 21.1 the coil is to be subjected to 110 % of rated voltage under operating conditions until the coil attains constant temperature.

21.3 Test frequency shall be at rated frequency. For devices rated 50/60 Hz, tests may be conducted at either frequency.

22 Undervoltage Test

22.1 The coil of a phase-voltage sensing relay shall be capable of withstanding without damage 95 % of its rated pull-in voltage for 4 h. Immediately following, the relay shall perform acceptably at its rated voltage and shall be capable of operating continuously at rated voltage without exceeding the maximum temperature rises specified in Table 24.1.

22.2 Test frequency shall be at rated frequency. For devices rated 50/60 Hz, tests may be conducted at either frequency.

23 Overload Test

23.1 Transfer switch equipment shall perform in an acceptable manner, as intended by the manufacturer, when subjected to an overload test consisting of the number of operations specified in Table 23.1, controlling a test current of six times rated current for ac rated devices, and 10 times rated current for dc rated devices. The power factor of the circuit shall be 0.5 or less for ac testing, and a noninductive dc load shall be used for dc rated circuits.

Table 23.1
Overload Test

Switch rating, amperes	Number of cycles of operation	Rate of operation[a]
0 – 300	50	1 per minute
301 – 400	50	1 per 2 minutes
401 – 600	50	1 per 3 minutes
601 – 800	50	1 per 4 minutes
801 – 1600	50	1 per 5 minutes
1601 – 2500	25	1 per 5 minutes
2501 and above	3	1 per 5 minutes

[a] May be conducted at a faster rate if agreeable to those concerned.

23.2 If a transfer switch has manual operating means that can cause slow opening or closing of the contacts as mentioned in 15.1.6, the last number of operations of the overload test, as indicated in Table 23.2, shall be performed at the slowest manual operation possible.

Table 23.2
Slow-Opening Contact Evaluation

Switch rating in amperes	Number of manual operations
0 – 1600	5
1601 – 2500	3
2501 and over	1

23.3 A cycle is defined as making and breaking the required test current on both the normal and alternate contacts. During the test, the alternate source shall be displaced 120 electrical degrees from the normal source for a 3 phase supply or 180 electrical degrees for a single phase supply.

23.4 Devices rated both 3 phase and single phase shall be tested using 3 phase and also using single phase. Separate samples may be used for the 3 and single phase tests.

23.5 The minimum on time in each contact position is to be 1/6 second (ten electrical cycles based on a 60-Hz source), unless automatic tripping of the overcurrent device occurs.

23.6 All sensing and control relays shall be energized at their rated voltage and the relay contacts shall make and break their intended load.

23.7 Time delay, undervoltage, and frequency sensitive relays and the like may be bypassed to facilitate testing of the main power circuit contacts.

23.8 The transfer switch shall be operated through a test switch that will simulate normal source failure.

23.9 There shall be no electrical or mechanical malfunction of the device.

23.10 Alternating-current interrupting tests are to be made at the maximum rated frequency.

23.11 The overload test(s) are to cover the conditions of maximum voltage, power, and current interrupted.

23.12 Reactive components of the load employed may be paralleled if of the air-core type but no reactances are to be connected in parallel with resistances, except that an air-core reactor in any phase may be shunted by resistance (R_{SH}) the loss in which is approximately 1 % of the total power consumption in that phase calculated in accordance with the following formula:

$$R_{SH} = 100\left(\frac{1}{PF} - PF\right)\frac{E}{I}$$

in which:

R_{SH} is the shunt resistance,

PF is the power factor,

E is the closed-circuit phase voltage, and

I is the phase current.

23.13 A transfer switch intended for use on circuits having one conductor grounded shall be tested with the enclosure connected to the grounded conductor through a 30-A nontime delay fuse, having a voltage rating not less than the rating of the transfer switch. This connection is to be made with a minimum 10 AWG copper wire, having a length of 4 – 6 ft (1.2 – 1.8 m). The ground fuse shall not open during the test.

24 Temperature Test

24.1 In the United States, the meter base used for conducting the Temperature Test shall be calibrated before each temperature test in accordance with Section SA4, Heating Test, of UL 414. The correction factor obtained during this calibration shall be used during the temperature test on the transfer switch.

In Canada, this requirement does not apply.

24.2 In the United States, transfer switches incorporating a socket for intended for installation of a meter shall be subjected to the Heating Test in UL 414. In Canada, they shall be subjected to the Temperature, Contact Endurance, and Temperature (repeated) tests from CSA C22.2 No 115.

24.3 Transfer switches when tested under the conditions described in 24.4 – 24.12 shall not attain a temperature at any point high enough to constitute a risk of fire or to damage any materials employed in the device, and shall not show temperature rises at specific points greater than those indicated in Table 24.1.

24.4 For the temperature test the transfer switch is to be operated under intended use conditions and is to carry its test current continuously. A low-potential source of supply may be used for temperature tests on parts other than coils, which shall be tested at rated voltage. The tests on all parts shall be made simultaneously as the heating of one part may affect the heating of another part.

24.5 The test current shall be 100 % of the rated current. Test frequency shall be at rated frequency. For devices rated 50/60 Hz, the test may be conducted at either frequency.

Table 24.1
Maximum Acceptable Temperature Rises

Materials and compounds	°C	(°F)
1. Buses, Connecting Joints, Moving or hinge contacts		
Where both mating surfaces are copper	30	(54)
Where one mating surface is copper and the other is silver, tin or equivalent	50	(90)
Where both mating surfaces are silver, tin, or the equivalent	65	(117)
2. Field-wiring terminals:		
Bare copper or bare copper alloy	50	(90)
Silver, Nickel, or Tin coated	65	(117)
3. Class 90 insulation systems and parts in contact with Class 90 insulation:		
Thermocouple method	50	(90)
Resistance method	70	(126)
4. Class 105 insulation systems and parts in contact with Class 105 insulation		
Thermocouple method	65	(117)
Resistance method	85	(153)
5. Class 130 insulation systems and parts in contact with Class 130 insulation:		
Thermocouple method	85	(153)
Resistance method	105	(189)
6. Parts subject to contact by personnel		
Parts handled by operator in normal course of duty	50[a]	(90[a])
Parts accessible to operator during normal course of duty	70[a]	(126[a])

[a] Limits shown are total temperature limits. For maximum allowable rise, subtract test ambient from total limit shown.

24.6 For a device employing a fuseholder, a copper bar, copper tubing, or an equivalent material with negligible impedance, instead of a fuse, is to be used during the test.

24.7 The thermocouple method consists of the determination of temperature by the application of thermocouples to the hottest accessible parts.

24.8 The resistance method consists of the determination of the temperature of a copper or aluminum winding by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature, according to the formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which

Δt is the temperature rise,

R is the resistance of the coil at the end of the test,

r is the resistance of the coil at the beginning of the test,

t_1 is the room temperature in °C at the beginning of the test,

t_2 is the room temperature in °C at the end of the test, and

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

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

24.10 The temperature readings are to be obtained by means of thermocouples and an indicating instrument. A temperature is considered to be constant when three successive readings, taken at intervals of 10 % of the previous elapsed duration of the test, but not less than 10-minute or more than 20-minute intervals, indicate that stable conditions have been reached.

24.11 The primary (preferred) method of measuring the temperature of a coil is the resistance method; but temperature measurements by either the thermocouple or resistance method are acceptable, except that the thermocouple method is not to be employed for a temperature measurement at any point at which supplementary insulation is employed.

24.12 Temperatures are to be measured by thermocouples consisting of wires no larger than 24 AWG (0.21 mm^2) and no smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument are to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire is to comply with the requirements listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ASTM E230/E230M. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice.

25 Endurance Test

25.1 A transfer switch shall perform as intended when subjected to an endurance test controlling a test current at a rate and number of cycles described in Table 25.1. AC rated devices shall be tested with a power factor of 0.8 or less.

Table 25.1
Endurance Test Cycles for Standby Switches

Switch rating	Rate of operation[a,b]	Number of cycles of operations		
		With current[c]	Without current	Total
0 – 300	1 per minute	4000	2000	6000
301 – 400	1 per minute	1000	3000	4000
401 – 600	1 per minute	1000	2000	3000
601 – 1600	1 per 2 minutes	500	2000	2500
1601 – 2500	1 per 4 minutes	500	2000	2500
2501 and above	1 per 4 minutes	250	1250	1500

[a] Conducting the test at a faster rate is not prohibited if agreeable to those concerned however, not faster than one operation per minute for tungsten ratings unless synthetic load is employed.

[b] The indicated number of cycles of operation per minute applies only to that part of the test with current. When no current is used, the switch is not prohibited from being operated at any convenient speed representative of intended operation.

[c] The test shall be conducted at 100 % of rated current.

25.2 The conditions for the endurance test shall be the same as conditions for the overload test as indicated in Section 23, Overload Test.

26 Dielectric Voltage-Withstand Test

26.1 A transfer switch device shall be capable of withstanding for one minute without breakdown the application of a sinusoidal potential of 1000 V rms plus 2 times maximum rated voltage. Devices rated 50 Hz, 60 Hz, or 50/60 Hz shall be tested at a frequency of 48 – 62 Hz. The potential shall be applied:

a) Between live parts and metallic foil wrapped tightly around the enclosure with the switch alternately closed to each supply source;

b) Between terminals of opposite polarity with the switch in the normal supply position;

c) Between terminals of opposite polarity with the switch in the alternate supply position;

d) Between uninsulated live parts of different circuits;

e) Between terminals of normal source and alternate source with switch in both normal and alternate supply positions; and

f) Between all source terminals and any isolated circuit if such circuit exits the transfer switch enclosure, with the switch in both normal and alternate supply positions.

26.2 With reference to 26.1, a transformer, a coil, or a similar device connected between lines of opposite polarity is to be disconnected from one side of the line during test in 26.1 (b) and (c).

26.3 To determine whether a transfer switch complies with the requirements in 26.1, the device is to be tested by means of a 500 VA or larger capacity transformer, the output voltage of which can be varied. The waveform of the voltage is to approximate a sine wave. The applied potential is to be increased gradually from zero to the required test value and is to be held at that value for one minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter in the output circuit of the test transformer.