UL 1008

STANDARD FOR SAFETY

Transfer Switch Equipment

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UL Standard for Safety for Transfer Switch Equipment, UL 1008

Ninth Edition, Dated July 13, 2022

Summary of Topics

This new edition of ANSI/UL 1008 dated July 13, 2022 includes the following changes:

- ***Marking Requirements***
- ***Scope of Annex J***
- ***Miscellaneous Updates***
- ***Table 2***
- ***Revised LSI Circuit Breaker Markings in Annex I***
- ***New Annex K for Arc Resistant Design***
- ***New Annex L for Electromagnetic Compatibility***
- ***Annex M for Cord Connected Transfer Switch Equipment***
- ***Marking/Instruction for Short Circuit Withstand Rating when Protected by Fuses***
- ***Revision of Requirements for Transfer Switches with Integral Inlets***
- ***Table 25***
- ***Changes to Align with the 2020 NEC***
- ***Revisions for Inlets Rated 100A and Greater for Compliance with the 2020 NEC***
- ***New Annex N for Combination Meter/Transfer Equipment Assemblies***

The new/revised requirements are substantially in accordance with Proposal(s) on this subject dated June 18, 2021 and January 21, 2022.

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NMX-J-672-ANCE
Third Edition

CSA Group
CSA C22.2 No. 178.1:22
Fourth Edition

Underwriters Laboratories Inc.
UL 1008
Ninth Edition

Transfer Switch Equipment

July 13, 2022

ANSI/UL 1008-2022

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This ANSI/UL Standard for Safety consists of the Ninth Edition. The most recent designation of ANSI/UL 1008 as an American National Standard (ANSI) occurred on July 13, 2022. 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 ANCE, CSA Group, and UL standard for Transfer Switch Equipment. It is the third edition of NMX-J-672-ANCE, the fourth edition of CSA C22.2 No. 178.1, and the ninth edition of UL 1008. This edition of NMX-J-672-ANCE supersedes the previous edition published on December 22, 2014 and revised on September 24, 2018. This edition of CSA C22.2 No. 178.1 supersedes the previous edition published on December 22, 2014 and revised on September 24, 2018. This edition of UL 1008 supersedes the previous edition published on December 22, 2014 and revised on September 24, 2018.

This harmonized standard was prepared by the Association of Standardization and Certification, (ANCE), CSA Group and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Subcommittee for Transfer Switches and the Council of the Harmonization of Electrotechnical Standards for 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.

The present Mexican Standard was developed by the CT CDI Control y Distribución Industrial from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the transfer switch manufacturers and users.

This standard was reviewed by the CSA Subcommittee on Automatic Transfer Switches, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with the 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 uses the IEC format, but is not based on, nor is it to be considered equivalent to, an IEC standard.

This standard is published as an equivalent standard for ANCE, CSA Group, and UL.

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.

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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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TRANSFER SWITCH EQUIPMENT

1 Scope

1.1 This standard applies to the following types of transfer switches that have a maximum rating of 1000 volts for use in non-hazardous locations, in accordance with Annex A1, Item 1:

a) Automatic transfer switches;

b) Manual or non-automatic transfer switches;

c) Closed transition transfer switches;

d) Hybrid transfer switches;

e) Transfer switches for fire pumps;

f) Bypass/isolating switches;

g) Softload transfer switches;

h) Transfer switches intended for use as service equipment;

i) Transfer switches intended for use in mobile/portable applications such as recreational vehicles, motor homes, camping trailers, and mobile health care facilities;

j) Inlet assemblies for transfer switch equipment;

k) Arc resistant transfer switch equipment;

l) Cord connected transfer switch equipment;

m) Combination meter/transfer equipment assemblies; and

n) In Mexico and the United States, branch circuit emergency lighting transfer switches (BCELTS).

In Canada, the requirements for BCELTS do not apply.

1.2 This standard specifically does not apply to:

a) Double-throw switches for use in optional standby systems;

b) Switches used in equipment manufactured in accordance with Annex A1, Item 9;

c) In Canada, manually operated generator transfer panels in accordance with Annex A1, Item 12.

d) Transfer switches rated over 1000 V;

e) Solid-state (static) transfer equipment;

f) Transfer switches for aircraft; and

g) Transfer switches for water craft.

1.3 These requirements apply to transfer switches and their associated control devices including voltage sensing relays, frequency sensing relays, time-delay relays, and the like.

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1.4 These requirements apply to completely enclosed transfer switches and to open types intended for mounting in other equipment such as switchboards.

1.5 These requirements apply to bypass/isolation switches used to manually select an available power source to feed load circuits and to provide for total isolation of an automatic transfer switch. These switches may be completely enclosed, enclosed with the transfer switch, or of the open type intended for mounting in other equipment. Refer to Annex D.

1.6 In Canada, automatic transfer switches built to the optional standby requirements of this standard are not permitted. In Mexico and the United States, this requirement does not apply.

1.7 These requirements cover enclosed inlets intended to facilitate connection of portable generators to transfer equipment.

1.8 This Standard contains annexes with requirements to cover the following:

a) Bypass/isolation switches (Annex D)

b) Transfer switches for fire pump service (Annex E)

c) Hybrid transfer switches (Annex F)

d) Softload transfer switches (Annex G)

e) Instrumentation and calibration of high capacity circuits (Annex H)

f) Sample markings (Annex I)

g) Inlet assemblies for transfer switch equipment (Annex J)

h) Arc resistant transfer switch equipment (Annex K)

i) Electromagnetic compatibility (EMC) requirements for transfer switches (Annex L)

j) Cord connected transfer switch equipment (Annex M)

k) Combination meter/transfer equipment assemblies (Annex N)

2 General Requirements

2.1 General

2.1.1 Automatic transfer switches for use in legally-required standby systems shall comply with the applicable requirements for transfer switches for use in emergency systems.

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

2.1.3 Legally-required standby systems are not recognized in Canada.

2.1.4 Bypass/Isolation switches may be located in the transfer switch enclosure, separately enclosed, or be of the open type intended for mounting in other equipment, and shall comply with the requirements of Annex D.

2.1.5 Transfer switches covered by this standard may employ solid-state devices only in control circuits or in power circuits of hybrid transfer switches complying with Annex F.

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2.1.6 In Canada, general requirements applicable to this standard are given in the latest edition of Annex A1, Item 11.

2.1.7 In this standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised, but not required; "may" is used to express an option or that which is permissible within the limits of the standard; and "can" is used to express possibility or capability. Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material. Notes to tables and figures are considered part of the table or figure and may be written as requirements. Legends to equations and figures are considered requirements. Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2.2 Kits, other than field-wiring kits

2.2.1 Transfer switches shall meet all the requirements of this standard with and without kits installed.

2.2.2 Kits shall be capable of being installed without custom tools, unless such tools (and instructions for their use) are furnished with each kit.

2.2.3 A barrier that is necessary because spacings would otherwise be less than required (or for any other reason) shall be securely attached to either the kit or the transfer switch.

2.3 Reference publications

2.3.1 For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved. For dated references to Standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the Standard was approved.

2.4 Units of measurement

2.4.1 The values given in SI (metric) units shall be normative. Any other values given shall be for information purposes only.

3 Definitions

3.1 BYPASS/ISOLATION SWITCH – An assembly intended for use with a transfer switch, that includes manual or non-automatic paralleling contacts and isolation contacts, that is used to select an available power source to feed load circuits, and to electrically isolate the transfer switch for inspection and maintenance.

3.2 CLASS 1 GROUND-FAULT PROTECTION DEVICE – A device that does not incorporate means to prevent opening of the disconnecting means at high levels of fault current and is intended for use with the following:

a) Circuit breakers,

b) Fused circuit breakers,

c) Fused switches having an interrupting rating not less than 12 times their ampere rating, or

d) Fused switches having integral means to prevent disconnecting at levels of fault current exceeding the contact interrupting rating of the switch.

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3.3 CONTROL CIRCUIT – Those circuits that sense and control the transfer from normal to alternate power sources.

3.4 EQUIVALENT – When applied to markings, a wording differing from that stated in a marking requirement that clearly and completely conveys the significant information.

3.5 EXTERNALLY OPERABLE – Readily accessible and capable of being operated without exposing the operator to live parts.

3.6 MONITORED SOURCE DEVIATION – A variation in the power source being monitored that signals the transfer switch to operate in its intended manner. Changes in voltage and frequency are typical variations that can be detected.

3.7 NORMAL SOURCE FAILURE – The loss or reduction of voltage supplied by the normal power source. It is one type of monitored source deviation.

3.8 READILY ACCESSIBLE – Capable of being reached for operation without the use of a tool. Provision for padlocking is not considered to require the use of a tool. Keyed latches are considered to require the use of a tool.

3.9 SERVICE-DISCONNECTING MEANS – A device that disconnects and isolates all ungrounded conductors to a building or other structure from the service entrance conductors. This disconnecting means may be a circuit breaker, switch, or drawout mechanism.

3.10 SERVICE EQUIPMENT – The necessary equipment usually consisting of a circuit breaker or switch and fuse and their accessories connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

3.11 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.

3.12 TRANSFER SIGNAL – The signal that is initiated by the monitored source deviation and signals the automatic transfer switch to operate.

3.13 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/isolation transfer switch – An assembly that includes a transfer switch, manual or non-automatic paralleling contacts, and isolation contacts that is used to select an available power source to feed load circuits and 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) Enclosed type transfer switch – A transfer switch provided within a complete enclosure.

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f) 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.

g) Manual transfer switch – A non-electrically operated transfer switch.

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

i) 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.

j) Open type transfer switch – A complete, assembled transfer switch without an enclosure.

k) 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.

l) Solid-state transfer switch – A transfer switch that incorporates solid-state power components as the switching means. (May also be identified as static or semiconductor transfer switch.)

m) Type A transfer switch – A transfer switch that does not employ integral overcurrent protective devices.

n) Type B transfer switch – A transfer switch that employs integral overcurrent protective device(s) on at least one source.

o) In Mexico and the United States, branch circuit emergency lighting transfer switch (BCELTS) – A device connected on the load side of branch circuit protection limited to transferring emergency lighting loads from the normal utility supply to a continuously available synchronous or asynchronous emergency supply. In Canada, this requirement does not apply.

3.14 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 Mexico and 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 Mexico and 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.

4 Characteristics

4.1 Summary of characteristics

4.1.1 Transfer switches shall be rated in volts and amperes, and the rating shall indicate whether the equipment is for direct or alternating current. The rating of alternating-current equipment shall include the number of phases and the frequency for both normal and alternate sources.

4.1.2 Terminals for auxiliary circuits shall be rated in volts and amperes or volt-amperes.

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4.2 Ratings

4.2.1 The following standard voltage ratings are applicable to transfer switches, but other voltage ratings may be used.

a) AC – 120, 120/240, 127, 208Y/120, 220, 220Y/127, 240, 277, 347, 440, 440Y/254, 480, 480Y/277, 600, 600Y/347 V.

b) DC – 125, 125/250, 250 V.

4.2.2 Short-circuit characteristics – The short-circuit current ratings indicated in 5.2.3.1, 5.2.4.1, and 5.2.5.1 shall be determined using Table 25.

4.2.3 Other than as noted in 4.2.4 – 4.2.6, a switch shall not be marked with a short-circuit rating that exceeds the maximum short-circuit rating of any overcurrent device intended to be installed therein for that rating, or the remote main overcurrent protective device with which it is intended to be used for that rating, or any other component as covered by its marking or, for unmarked components, by the values in Table 6. In Canada, Table 6 is not applicable.

4.2.4 A branch circuit breaker connected to the load side of an integral main overcurrent protective device may have a short-circuit current rating less than the marked short-circuit current rating of the switch if the combination has been tested for such use.

4.2.5 If tested for such use, a branch circuit breaker, main circuit breaker, or both if provided, may have a short-circuit current rating less than the marked short-circuit current rating of the switch if the switch is marked in accordance with 5.2.5.1 for use at this short-circuit current rating only when connected to the load side of a separately installed main or feeder main overcurrent protective device having a short-circuit rating no less than that of the switch.

4.2.6 The switch short-circuit current rating may exceed the component short-circuit current rating marked on the device or in accordance with Table 6, if the marked or assumed short-circuit rating of the component is adequate for the assumed available short-circuit current at the component location as covered in 6.4.5 and 6.4.6. In Canada, Table 6 is not applicable.

4.2.7 Transfer switches are rated in amperes and are generally considered to be acceptable for total system transfer, which includes control of motors, electric-discharge lamps, electric-heating loads, and tungsten-filament lamp loads as referred to in 4.2.8.

4.2.8 A transfer switch intended for total system transfer as indicated in 4.2.7 is acceptable for the control of tungsten-filament lamp loads not exceeding 30 percent of the switch ampere rating unless the switch has been investigated for a higher percentage of lamp load and is marked as indicated in 5.2.1.7.

4.2.9 A transfer switch may be limited to use with one or more specific types of load if investigated accordingly and marked as indicated in 5.2.1.6.

4.2.10 In Mexico and the United States, BCELTS shall be rated only for the control of lighting loads, and shall be rated not greater than 20 amperes.

In Canada, this requirement does not apply.

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5 Product Information

5.1 Data requirements

5.1.1 Where applicable, the following information shall be given by the manufacturer:

a) Type of equipment;

b) Rated operational voltage;

c) Utilization category and rated operational current at the rated operational voltage;

d) Either the value of the rated frequency (i.e. 50 Hz), or the indication "D.C." (or the symbol ⎓);

e) Rated short-circuit making, breaking, and withstand capacities;

f) Number of main contact positions;

g) Monitored supply deviation and operating limits;

h) Operating sequence and time delays, and the position of time delays in the operating sequence; and

i) Special requirements.

5.2 Marking requirements

5.2.1 General

5.2.1.1 All markings shall be in the appropriate language for the country in which the transfer switch equipment will be installed. (Spanish for Mexico, English for the United States, English for Canada). A manufacturer may choose to utilize multiple languages on transfer switch equipment. Table 2 summarizes the marking requirements and their location. In Canada, danger, warning, and caution markings shall be in English and French.

Advisory Note: Markings in this standard may also be required in other languages to conform with the language requirements of the country where the product is to be used. In Canada, there are two official languages, English and French. Annexes B and C provide French and Spanish translations of the markings specified in this standard.

5.2.1.2 Transfer switches shall be plainly marked with:

a) The manufacturer's name, trademark, or similar identifier;

b) A distinctive catalog number (or equivalent);

c) The words "Transfer Switch"; and

d) A code to permit the month and year of manufacture to be determined.

5.2.1.3 A marking shall be molded, die-stamped, paint-stencilled, stamped or etched metal that is permanently secured, or indelibly applied lettering on a label secured by adhesive that is found to be acceptable for the application in accordance with Annex A1, Item 19. Ordinary usage of the equipment, including likely exposure to weather and other ambient conditions, handling, storage, and the like, is considered in the determination of the acceptability of the application.

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5.2.1.4 When the manufacturer produces or assembles transfer switch equipment at more than one factory, each finished item of equipment shall have a distinctive marking, which may be in code, by which it shall be identified as the product of a particular factory.

5.2.1.5 A transfer switch shall be marked "WARNING – more than one live circuit – disconnect all sources of supply before servicing" or equivalent wording for other than the signal word.

5.2.1.6 A transfer switch rated for control of a specific type of load shall be marked to indicate the type of load, such as "Resistive only" or "Tungsten only" or "Ballast only", or a combination of any of these markings. This marking shall appear adjacent to the marked current rating.

5.2.1.7 A transfer switch rated for total system transfer shall be marked with the statement "Suitable for total system transfer where the tungsten load does not exceed ___ percent of the switch rating." Refer to 4.2.8.

5.2.1.8 A transfer switch shall be marked "Continuous load current not to exceed xxx percent of switch rating." The xxx shall be either 80 or 100 based on the test current in accordance with 9.8.3.

5.2.1.9 Reference to Class H or K fuses shall not appear in the marking required in 5.2.5.4 and 5.2.5.5 if the indicated maximum rms symmetrical ampere rating is higher than 10,000 A.

5.2.1.10 Field-wiring terminals shall be marked and the equipment provided with a connection diagram to indicate the connections. In the United States, a connection diagram shall be located in accordance with Table 2.

In Canada and Mexico, this requirement does not apply.

5.2.1.11 For control circuits that are intended to be extended to a bypass/isolation switch or to (an) external engine-generator set(s) in accordance with 7.1.27, a marking shall be provided to indicate that conduit shall be employed between units. This protection is in addition to provisions for wiring methods for control circuits in applicable installation codes.

5.2.1.12 The transfer switch shall be provided with instructions for periodic testing. The location of such instructions shall be in accordance with Table 2.

5.2.1.13 If any terminal (refer to 5.2.1.18) is marked to indicate that aluminum wire may be used at that terminal (such as being marked with the symbol Al), and if such marking is visible under the conditions described in 5.2.1.14, the transfer switch shall be marked in accordance with 5.2.1.15, 5.2.1.16, or 5.2.1.17, whichever applies.

5.2.1.14 The term "visible" as used in 5.2.1.13 refers to a marking that will be visible when a front or trim has been removed, or is visible when a hinged cover of a component has been opened. A marking on a separately supplied connector or on a connector or part thereof that is likely to be removed or displaced during the wiring operation is considered to be visible.

5.2.1.15 With regard to 5.2.1.13, if, because of wiring space or other factors, no terminal of the transfer switch is acceptable for use with aluminum conductors, the transfer switch shall be marked "Use copper wire only", or equivalent.

5.2.1.16 If the wiring space and other factors are such that all terminals of the transfer switch are acceptable for use with aluminum conductors as well as with copper conductors, the transfer switch shall be marked "Use copper or aluminum wire", "Cu – Al", or "Al – Cu", or equivalent.

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5.2.1.17 If the wiring space and other factors are such that some terminals of the transfer switch are acceptable for use with aluminum conductors as well as with copper conductors, while the remainder of the terminals are acceptable for use with copper conductors only, the transfer switch shall be marked "Use copper wire only except at terminals _____" or equivalent. The marking shall positively identify the terminals that are acceptable for use with aluminum wire.

5.2.1.18 The word "terminal" as used in 5.2.1.13 – 5.2.1.17 signifies any terminal of the transfer switch, as well as a terminal of any component unit (circuit breaker, switch, and the like) that is installed or intended to be installed in the transfer switch and to which conductors shall be connected in the field.

5.2.1.19 With respect to 5.2.1.15, 5.2.1.16, and 5.2.1.17, any abbreviation designating copper shall be "Cu" or "CU" and any abbreviation designating aluminum shall be "A1" or "AL".

5.2.1.20 The characters in the markings described in 5.2.1.15 – 5.2.1.17 shall not be less than 2.4 mm (3/32 inch) in height.

5.2.1.21 Transfer switch equipment shall be marked where readily visible to indicate the required temperature of all field installed conductors.

5.2.1.22 When the temperature rise on the terminals as covered in Item 4 of Table 16 exceeds 50 °C (90 °F), transfer switch equipment shall be marked to indicate that when a cable is connected it shall employ 90 °C (194 °F) wire and that the size of the cable shall be determined based on the ampacity of wire rated 75 °C (167 °F). When transfer switch equipment is marked for use with aluminum or copper-clad aluminum conductors, there shall be a marking to indicate that the wire connectors shall be identified "AL9", "CU9AL", or "AL9CU".

5.2.1.23 The terminal assembly packages covered in 5.2.6.1.8 shall be marked with its identification, and manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified. The marking shall also include the wire size(s) and required tightening torques in accordance with 5.2.1.27 unless the value of tightening torque is included along with the transfer switch markings as covered in 5.2.6.1.8. Refer to 6.13.1.3 and 5.2.8.3.

5.2.1.24 An open-type device shall have markings to indicate the size of the ventilating openings required and the minimum spacings required between live parts and grounded metal when mounted, or a marking referring to a specific drawing, an information sheet, or installation instructions supplied by the manufacturer.

5.2.1.25 If ground-fault protection is provided, a marking shall be provided to indicate the circuit(s) protected. If a marking on the ground-fault sensing or relaying equipment is not visible from the front of the transfer switch with a cover removed, a separate marking such as on a wiring diagram shall be provided.

5.2.1.26 In a transfer switch with ground-fault protection, that part of the neutral bus for load termination shall be marked "WARNING – Do not connect grounding conductors to these or any other neutral terminals; doing so defeats ground-fault protection and may violate installation codes." The markings shall be located on or adjacent to the portion of the neutral for load terminals.

Note: In Canada it is not permitted to connect bonding or grounding conductors to the neutral other than in the service box compartment. See Service equipment for use in Canada (8.2) for further information.

5.2.1.27 With respect to the requirement in 6.13.2.7, a transfer switch shall be marked to indicate the specific tightening torque in N-m (in-lb or ft-lb) for each wire connector in the transfer switch that is intended for field-wiring. If different connectors are used for line or load, the specific torques to be applied to each connector shall be clearly indicated. The torque marking may be provided in a written format or pictorially.

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5.2.1.28 A removable barrier, as mentioned in 6.11.3 and 8.1.7.4, shall be marked to indicate that reinstallation is required.

5.2.1.29 Marking required by 6.5.24 or the optional marking described in 6.5.26 shall be visible after installation and shall specify the environmental condition type number or numbers.

5.2.1.30 A transfer switch designed for closed transition (refer to 7.1.10) shall be marked, "Closed Transition Transfer Will Not Occur Unless Alternate And Normal Sources Are Synchronized".

5.2.1.31 With respect to 9.13.3.20, a marking indicating the type of bracing to be added to cables routed through the transfer switch between the point of entry and the incoming terminals shall be located on the switch or cabinet where it will be clearly visible after installation.

5.2.1.32 In Mexico and the United States, a transfer switch investigated for use in emergency systems or legally-required standby systems shall be marked "automatic transfer switch for emergency systems". In Canada, a transfer switch investigated for use in emergency systems shall be marked "automatic transfer switch".

5.2.1.33 In Mexico and the United States, transfer switches that comply only with the requirements for use in optional standby power systems shall be marked “TRANSFER SWITCH FOR USE ONLY IN OPTIONAL STANDBY SYSTEMS”. This marking may be preceded by the words “MANUAL”, “NON-AUTOMATIC”, or “AUTOMATIC”, as applicable.

In Canada, this requirement does not apply.

5.2.1.34 In Mexico and the United States, the marking "Suitable for Use in Other Spaces Used for Environmental Air (Plenums) in Accordance with Article 300 of the National Electrical Code" shall only be marked on equipment that has been evaluated in accordance with requirements for plenum rated equipment, as indicated in 6.5.29 and 6.5.31.

In Canada, the markings, "Suitable for Installation in a Compartment Handling Conditioned Air" shall only be marked on equipment that has been evaluated in accordance with requirements for plenum rated equipment, as indicated in 6.5.29 and 6.5.31.

Note: In Canada, equipment installed within a plenum is required to comply with the flame-spread rating and smoke developed classification requirements of the National Building Code of Canada.

5.2.1.35 In Canada only, a manual transfer switch shall be marked “CAUTION – Manual Transfer Switch – This Device Will Not Automatically Transfer To An Alternative Source”.

5.2.1.36 In Canada only, a manual transfer switch or an automatic transfer switch equipped with a manual means of operation shall be marked “WARNING – Verify The Condition of Power Source Prior to Manually Transferring. Manual Operation May Result in Out-Of-Phase Transfer When Both Sources Are Energized”.

5.2.1.37 For field installed bus connections, directions in the form of a permanent drawing or removable tag shall be provided and shall include at least the following information:

a) The recommended number and dimensions of bus bars intended for the connection;

b) The intended area of the connection;

c) The bolt pattern, if pre-drilled holes are provided; and

d) The recommended tightening torques if hardware is provided.

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5.2.2 Marking of adjustable and nonadjustable features

5.2.2.1 Other than as noted in 5.2.2.4, an automatic transfer switch shall be marked with the reduced normal supply voltage rating at which transfer to the alternate supply shall be initiated. Refer to 7.1.31.

5.2.2.2 Other than as noted in 5.2.2.4, an automatic transfer switch with frequency sensing shall be marked with the maximum frequency at which transfer to the alternate supply shall be always provided. Refer to 7.1.32.

5.2.2.3 Other than as noted in 5.2.2.4, an automatic transfer switch with time delay features shall be marked to indicate the delay time in transferring from "Normal to alternate" and from "Alternate to normal" supplies. Refer to 7.1.36.

5.2.2.4 With respect to the requirements of 5.2.2.1 – 5.2.2.3, an automatic transfer switch with adjustable features shall be marked to indicate the method to configure or verify configuration of the switch. This may be a marking that references a specific instruction manual.

5.2.2.5 An automatic transfer switch provided with features as specified in 7.1.3, for use with multiple engine-generator sets and that can remain simultaneously disconnected from both the normal and alternate sources until sufficient alternate power is available for the connected load, shall be marked, "TRANSFER TO GENERATOR SOURCE MAY BE DELAYED UNTIL ALL GENERATORS ON-LINE", or equivalent wording.

5.2.2.6 A transfer switch that will not automatically transfer from one source to the other as a result of the opening of an integral overcurrent device shall be marked with the statement "CAUTION – This switch will not transfer if overcurrent device opens due to fault." Refer to 7.1.8.

5.2.3 Markings for transfer switches tested with overcurrent protection

5.2.3.1 A transfer switch with integral overcurrent protection as specified in 9.13.3.7 shall be marked in accordance with 5.2.3.2 – 5.2.3.4. See Annex I for example markings.

5.2.3.2 A transfer switch tested per 9.13.3.9 and 9.13.2.2 and not per 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS", and the following:

> "This transfer switch is suitable for use in a circuit capable of delivering the short-circuit current for the maximum voltage marked below.
>
> When protected by a circuit breaker, the circuit breaker must include an instantaneous trip response that cannot be disabled.
>
> This transfer switch does not include short-time current ratings."

The sentences above shall be followed by a tabulation of the rated short-circuit current and voltage. See Annex I2, Example 1.

5.2.3.3 A transfer switch tested per 9.13.3.9, 9.13.2.2, and 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS," and the following:

> "This transfer switch is suitable for use in a circuit capable of delivering the short-circuit current for the maximum voltage marked below.
>
> When protected by a circuit breaker with a short-time trip response, the short-time response of the circuit breaker must be coordinated with the short-time current rating of the transfer switch as shown below."

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The sentences above shall be followed by two tabulations. The first tabulation shall include short-circuit current and voltage. The second tabulation shall include rated short-time current, voltage, and rated short-time duration. See Annex I3, Example 2.

5.2.3.4 The time duration for the short-time current shall be expressed in seconds and shall not exceed the duration for which the switch was tested.

5.2.4 Markings for transfer switches tested without overcurrent protective device

5.2.4.1 A transfer switch tested in accordance with 9.13.3.10 shall be marked per 5.2.4.2 – 5.2.4.4. See Annex I for example markings.

5.2.4.2 In the markings required by 5.2.4, the time duration for the short-time current and the short-circuit current shall be in seconds and shall not exceed the respective durations for which the switch was tested.

5.2.4.3 A transfer switch tested per 9.13.3.10 and 9.13.2.3 and not per 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS", and the following:

> "When protected by a circuit breaker, this transfer switch is suitable for use in a circuit capable of delivering the short-circuit current for the maximum time duration and voltage marked below.
>
> The circuit breaker must include an instantaneous trip response that cannot be disabled.
>
> The maximum clearing time of the instantaneous trip response must be equal to or less than the time duration shown for the marked short-circuit current.
>
> This transfer switch does not include short-time current ratings."

The above sentences shall be followed by a tabulation that includes the rated short-circuit current, voltage, and time duration. See Annex I4, Example 3.

5.2.4.4 A transfer switch tested per 9.13.3.10, 9.13.2.3, and 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS", and the following:

> "When protected by a circuit breaker, this transfer switch is suitable for use in a circuit capable of delivering the short-circuit current for the maximum time duration and voltage marked below.
>
> The circuit breaker must include an instantaneous trip response unless the available short-circuit current is less than or equal to the short-time rating of the transfer switch, and the circuit breaker includes a short-time trip response.
>
> The maximum clearing time of the instantaneous trip response must be equal to or less than the time duration shown for the marked short-circuit current.
>
> When protected by a circuit breaker with a short-time trip response, the short-time response of the circuit breaker must be coordinated with the short-time current rating of the transfer switch as shown below."

The above sentences shall be followed by two tabulations. The first tabulation shall include the rated short-circuit current, voltage, and time duration. The second tabulation shall include short-time current rating, voltage, and short-time duration. See Annex I6, Example 5.

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5.2.5 Markings for transfer switches for use with externally connected overcurrent protection devices

5.2.5.1 A transfer switch for use with an externally connected overcurrent protective device as specified in 9.13.3.7(c) shall be marked per 5.2.5.2 – 5.2.5.6.

5.2.5.2 A transfer switch tested with an externally connected circuit breaker in accordance with 9.13.3.9 and 9.13.2.2 and not in accordance with 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS WHEN USING SPECIFIC CIRCUIT BREAKERS" and the following:

> "When protected by a circuit breaker of the specific manufacturer, type and ampere rating as marked below, this transfer switch is suitable for use in circuits capable of delivering the short-circuit current at the maximum voltage marked."

The above sentence shall be followed by a tabulation which includes the short-circuit current and voltage ratings, manufacturer name, type designation, and current rating of the circuit breaker(s) to be used. See Annex I5, Example 4.

5.2.5.3 A transfer switch tested with an externally connected circuit breaker in accordance with 9.13.3.9, 9.13.2.2, and 9.15, shall be marked, "SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS WHEN USING SPECIFIC CIRCUIT BREAKERS", and the following:

> "When protected by a circuit breaker of the specific manufacturer, type, and ampere rating as marked below, this transfer switch is suitable for use in circuits capable of delivering the short-circuit current at the maximum voltage marked.
>
> When the circuit breaker has a short-time response, it shall be coordinated with the Short-Time Current rating of the transfer switch shown below."

The above sentences shall be followed by two tabulations. The first tabulation shall include the short-circuit current and voltage ratings, manufacturer name, type designation, and current rating of the circuit breaker(s) to be used. The second tabulation shall include the short-time current rating, voltage, and short-time duration. See Annex I7, Example 6. The time duration for the short-time current test shall be in seconds, is not limited, and shall not exceed the duration for which the switch was tested.

5.2.5.4 A transfer switch tested per 9.13.3.16, shall be marked, "SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS WHEN PROTECTED BY FUSES RATED 10KA OR LESS", and the following:

> "When protected by a fuse of the specific manufacturer, type, and ampere rating as marked below, this transfer switch is suitable for use in circuits capable of delivering the short-circuit current at the maximum voltage marked."

This sentence shall be followed by a tabulation that includes the short-circuit current and voltage ratings, and the manufacturer name, type designation, and current rating of the fuse(s) to be used. See Annex I8, Example 7.

5.2.5.5 A transfer switch tested per 9.13.3.13 – 9.13.3.14, shall be marked, "SHORT-CIRCUIT WITHSTAND/CLOSING RATING WHEN PROTECTED BY FUSES", and the following:

> "When protected by a fuse of the specific fuse class and maximum ampere rating as marked below, this transfer switch is suitable for use in a circuit capable of delivering the short-circuit current at the maximum voltage marked."

This sentence shall be followed by a tabulation that includes the short-circuit current and voltage ratings, and the fuse class and current rating of the fuse(s) to be used. See Annex I9, Example 8.

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5.2.5.6 A branch circuit emergency lighting transfer switch that does not contain integral fuses and is tested per 9.13.3.13, 9.13.3.14, 9.13.3.15, or 9.13.3.16, and not tested per 9.15, 9.13.2.2, or 9.13.3.10 shall be marked with the following:

> "This transfer switch must be protected by required fuses. When protected by a fuse of the specific fuse class and maximum ampere rating as marked below, this transfer switch is suitable for use in a circuit capable of delivering the short-circuit current at the maximum voltage marked."

This sentence shall be followed by a tabulation that includes the short-circuit current and voltage ratings, and the fuse class and current rating of the fuse(s) to be used. See Annex I9, Example 8.

5.2.6 Markings for service equipment

5.2.6.1 Markings for service equipment

Note: In Mexico and the United States, these requirements are applicable. In Canada, these requirements are not applicable.

5.2.6.1.1 A transfer switch that is intended for use as service equipment and does not have the neutral bonded at the factory shall be marked "Suitable for use as service equipment".

5.2.6.1.2 A transfer switch marked, "Suitable for use as service equipment" shall be provided with a marking "Service Disconnect" in the form of a pressure-sensitive label, which is in an envelope or on a card, with instructions to apply the label near the disconnect handle if the equipment is used as service equipment.

5.2.6.1.3 A transfer switch that is intended for service equipment use and that has the neutral bonded at the factory shall be marked "Suitable only for use as service equipment".

5.2.6.1.4 If a transfer switch is marked "Suitable only for use as service equipment", the service-disconnecting means for the ungrounded service conductors shall be marked "Service disconnect". The disconnecting means for the grounded service conductor need not be marked.

5.2.6.1.5 The marking "Service disconnect" identifying the service-disconnecting switch required in 5.2.6.1.4 shall appear on or adjacent to the switch handle.

5.2.6.1.6 If the construction is as described in 6.3.1.10 and the spacings do not comply with the requirements in Table 3 when the bonding device is removed, the transfer switch enclosure shall be marked "Bonded Neutral – Remove bonding device for test purposes only" or with equivalent instructions.

5.2.6.1.7 The marking required in 5.2.6.1.1 shall be an integral part of the marking containing the manufacturer's name or trademark and the electrical rating, unless it is an integral part of other required marking on the switch.

5.2.6.1.8 If the terminals mentioned in 8.1.3.5 are required, but are not supplied with the transfer switch, the transfer switch shall be marked with a catalog number of a kit including the terminals – or information stating the wire size of terminals required – and instructions for assembly in the enclosure.

5.2.6.1.9 If a transformer providing control voltage for ground-fault protection is connected to the line side of the service disconnect, this disconnect may be marked as the "Service Disconnect", but the transfer switch shall be marked in accordance with 5.2.6.1.13.

5.2.6.1.10 If the ground-fault protection sensors or relaying equipment or both are located in a separate enclosure as covered in 6.16.3 or 8.1.6.2, the transfer switch shall be marked with the manufacturer's

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name and catalog number of the ground-fault protection equipment, and with instructions covering the interconnections.

5.2.6.1.11 A transfer switch not providing ground-fault protection in accordance with 8.1.6.3 shall be marked "Suitable For Use As Service Equipment Only When Supplying A Continuous Industrial Process", or "Suitable For Use As Service Equipment Only When Supplying Fire Pumps". Equivalent wording may be used.

5.2.6.1.12 A transfer switch not providing ground-fault protection for the alternate source in accordance with 8.1.6.4 shall be marked, "Does not provide ground-fault protection for alternate source" or with equivalent wording.

5.2.6.1.13 In accordance with 5.2.6.1.9 or 8.1.2.3, a transfer switch that is intended for use as service equipment shall be marked "DANGER" and the following or equivalent "Risk of Electric Shock – This service disconnect does not disconnect control or instrument circuits."

5.2.6.1.14 A transfer switch constructed in accordance with 8.1.2.4 shall be marked "Suitable for use as service equipment – NORMAL source only. An additional disconnect must be readily available for the alternate source, unless the alternate source is an accessible generator and can be readily shut down".

5.2.6.2 Markings for service equipment

Note: In Canada, these requirements are applicable. In Mexico and the United States, these requirements are not applicable.

5.2.6.2.1 A Type B transfer switch that is suitable for use as service equipment shall be marked "SUITABLE FOR USE AS SERVICE EQUIPMENT" and "PEUT ÊTRE UTILISÉ COMME APPAREILLAGE DE BRANCHEMENT" or "SUITABLE ONLY FOR USE AS SERVICE EQUIPMENT" and "PEUT SEULEMENT ÊTRE UTILISÉ COMME APPAREILLAGE DE BRANCHEMENT".

5.2.6.2.2 A compartment in a transfer switch that is intended for supply authority use shall be permanently marked "COMPARTMENT FOR SUPPLY AUTHORITY USE" and "RÉSERVE AU DISTRIBUTEUR D'ÉLECTRICITÉ".

5.2.6.2.3 Transfer switches intended for service use and constructed in accordance with 8.2.3.3 shall be provided with a temporary tag, instruction sheet, or the equivalent indicating how the bond shall be removed when not used as service equipment where bonding by means of the grounded service conductor is prohibited by the Canadian Electrical Code, Part I (i.e., "Where electrical inspection authorities require the neutral assembly to be disconnected from the enclosure, ...").

5.2.6.2.4 Transfer switches intended for service use shall be marked "Service disconnect" adjacent to the handle of the service-disconnect switch or circuit breaker.

5.2.6.2.5 When the service disconnect operating handle or pushbutton is located behind an exterior door, the enclosure shall be marked, "Service disconnect inside". This marking shall be visible with the door closed.

5.2.7 Markings for transfer switches with inlets

5.2.7.1 Transfer equipment with an inlet that does not have integral branch circuit overcurrent protection in the circuit supplied by the inlet shall be marked to indicate that external branch circuit overcurrent protection shall be provided. The marking shall include the maximum current rating for this branch circuit overcurrent protection.

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5.2.7.2 When provided with an inlet, transfer equipment that does not switch the neutral conductor shall be marked to indicate it is suitable only for use with generators that do not have the neutral bonded to ground or the generator frame.

5.2.7.3 When provided with an inlet, transfer equipment that does switch the neutral conductor shall be marked to indicate it is suitable only for use with generators having the neutral bonded to ground or the generator frame.

5.2.7.4 Transfer switches with inlets shall be marked "Not for indoor use", and shall be provided with installation instructions. The installation instructions shall clearly indicate proper location of an attached generator in order to mitigate carbon monoxide hazards. When required by 6.19.12, the transfer switch shall be also marked "For use in a weather protected area only".

5.2.7.5 Transfer equipment provided with single pole separable connectors that are not mechanically interlocked shall be marked to indicate that connections to the inlets shall be made by qualified personnel only.

5.2.7.6 Transfer equipment provided with single pole separable connectors that are not mechanically interlocked shall be marked to indicate the proper order of connection and disconnection. This marking shall read as follows:

WARNING

Risk of Electric Shock

Plug connection should be in the following order:

1) Equipment grounding conductor connectors,

2) Grounded circuit conductor connectors, and

3) Ungrounded conductor connectors.

Disconnection should be in the reverse order

5.2.7.7 The marking required by 5.2.7.5 and 5.2.7.6 shall be located adjacent to the inlets.

5.2.7.8 A transfer switch incorporating an inlet assembly shall be marked "DANGER – Risk of Electric Shock" and the following or equivalent "Do not start the generator until all connectors are connected or made to be inaccessible. Any terminal may be energized when any cable is connected. De-energize cables at the generator prior to connecting or removing any connectors". This marking shall be located so as to be visible during connection and removal of the connectors.

5.2.7.9 A transfer switch incorporating an inlet assembly shall be marked to say:

a) That installation of the temporary wiring shall be performed according to the applicable electrical installation codes.

b) That all temporary cables shall be suitable for hard usage, in wet or outdoor applications.

c) That strain relief shall be provided for a connection with a vertical unsupported length of 2 meters or more.

5.2.7.10 Enclosed inlets for cord connection of generators shall be marked “For power inlet only. Not for use as an outlet.” This marking shall be located so as to be visible before inserting the connector into the inlet.

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5.2.7.11 Enclosed inlets shall be provided with instructions or markings stating: “When used to power a structure, this inlet must be used in conjunction with a transfer switch”.

5.2.7.12 Transfer equipment and inlet assemblies using single-pole inlets shall be marked with the following adjacent to the inlets:

“DANGER – Risk of electric shock – Do not connect or disconnect when energized”.

5.2.7.13 When required by 6.19.20 c), transfer switches provided with inlets rated 100 A or greater shall be marked “Generator must be installed within line of sight of the inlets” and shall be provided with instructions that the transfer switch is only suitable for use in supervised industrial installations where a space is permanently dedicated for locating the portable generator, and this space is within sight of the inlets.

5.2.8 Markings for kits

5.2.8.1 Identification of the kits that can be installed in transfer switches shall be located in accordance with Table 2.

5.2.8.2 A kit, or its smallest unit package, shall be marked with its catalog number (or equivalent) and the name or trademark of the manufacturer.

5.2.8.3 Information on the range of conductor sizes that the connector in a connector kit is intended to accommodate shall be marked on, or included as a separate sheet with, one of the following:

a) The kit;

b) The kit container or package;

c) The main device; or

d) The main device enclosure.

5.2.8.4 Unless it is obvious how a kit shall be installed, assembly instructions shall be provided, either as part of the kit, or as part of the transfer switches, and shall include the following:

a) A clear identification of the individual parts, components, and subassemblies;

b) Schematics or wiring diagrams, if applicable; and

c) Information that describes all aspects of assembly.

5.2.8.5 The parts and components of a kit shall be identified, if necessary, in a manner that ensures proper matching with the assembly instructions.

5.3 Instructions for installation, operation, and maintenance

5.3.1 To provide for system performance testing, each ground-fault relay or apparatus incorporating a ground-fault relay or its functions shall be provided with information sheets describing system testing instructions, and with a test form. The form shall include a space for the date the test was performed and the results, and shall state that the form should be retained by those in charge of the building's electrical installation in order to be available to the authority having jurisdiction. The instructions shall include the following items and shall basically prescribe only that information necessary to perform the tests. The instructions shall be separate and apart from any more elaborate test detail that the manufacturer may wish to provide. The instructions shall specify that:

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a) The interconnected system shall be evaluated in accordance with the manufacturer's detailed instructions, and that this evaluation shall be undertaken by qualified personnel.

b) The proper location of the sensors around the bus of the circuit to be protected shall be determined. This can be done visually, with knowledge of which bus is involved.

c) The grounding points of the system shall be verified to determine that ground paths do not exist that would bypass the sensors. The use of the high-voltage testers and resistance bridges may be suggested.

d) A simulated fault current shall be generated by a coil around the sensors, by means of a separate test winding in the sensor, or by equivalent means. The reaction of the circuit-interrupting device shall be observed for correct response.

e) The results of the test shall be recorded on the test form provided with the instructions.

5.3.2 A branch circuit emergency lighting transfer switch that does not contain integral fuses and is tested per 9.13.3.13, 9.13.3.14, 9.13.3.15, or 9.13.3.16, and not tested per 9.15, 9.13.2.2, or 9.13.3.10, shall be marked with the following: “This transfer switch must be protected by fuses.” Where such external fuses are shown in a schematic installation diagram, each fuse shall be called out on the diagram as “Required Fuse”. Where such fuses are mentioned in in the installation text, such fuses shall be described as “required”. The installation instructions shall include all of the above information.

6 Construction Requirements

6.1 Materials

6.1.1 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 quality of work practicable in a well-equipped factory.

6.2 Intended for service equipment

6.2.1 A transfer switch intended for use as service equipment shall comply with the applicable requirements for service equipment and be marked in accordance with 5.2.6.

6.3 Clearance and creepage distances

6.3.1 General

6.3.1.1 Other than as noted in 6.3.1.2, the spacing in transfer switches shall not be less than those indicated in Table 3.

6.3.1.2 The spacings indicated in Table 3 do not apply across switching contacts.

6.3.1.3 Spacings in a component used in power circuits, such as industrial control equipment, nonautomatic circuit-interrupters and the like within a transfer switch, shall comply with the requirements applicable to that component, except that the spacings to the overall enclosure (other than inherent spacings) and spacings between individual components, shall comply with Table 3.

6.3.1.4 The spacings in a component device (such as a snap switch, lampholder, and the like) supplied as part of a transfer switch, other than in a power circuit, shall be not less than the minimum spacings required for the component device or the spacings indicated in Table 3, whichever are smaller.

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6.3.1.5 In Canada, except in the zone of the arc, knife switches and fuseholders shall have at least the spacings specified in Table 4, provided that, in the case of fuseholders, the fuses are not so close together as to cause inconvenience when they are being inserted or removed by hand.

In Mexico and the United States, this requirement does not apply.

6.3.1.6 In Canada, special components used in equipment where the short-circuit capacity of the circuit in which they are connected is limited by overcurrent devices with ratings not exceeding the ratings of the special component devices and ratings of 10 A or less at 375 V or less, or 5 A or less at 376 to 750 V, may have spacings less than those required by Table 3, but the spacings shall be not less than those required by Table 4.

In Mexico and the United States, this requirement does not apply.

Note: Current limitation by means other than overcurrent devices is subject to investigation.

6.3.1.7 In Canada, Table 4 spacings shall be the subject of investigation in devices connected in circuits where:

a) The power is limited by a transformer, rectifier, voltage divider, or a similar device (excluding overload devices and fuses); and

b) The short-circuit limit between conductors or between conductors and ground is 1500 V·A or less; and

c) A fire hazard will not result from a short-circuit.

For the purposes of this requirement, the short-circuit volt-ampere limit shall be the product of the open-circuit volts and the short-circuit amperes (the root-mean-square [rms] values in an ac circuit).

In Mexico and the United States, this requirement does not apply.

6.3.1.8 The application of Table 3 shall be based on the following:

a) The voltage from a live part, other than the neutral, to grounded dead metal equals the line-to-line voltage of the system.

b) The voltage from a neutral live part on an insulated neutral to grounded dead metal equals the line-to-neutral voltage of the system.

c) Spacings at a fuseholder shall be measured with a fuse in place, the fuse being of the maximum standard dimensions – including the maximum projections for assembly screws and rivets. Dimensions of fuses and fuseholders are given in the requirements for fuses and fuseholders.

6.3.1.9 Terminals and other parts identified for connection to the grounded conductor of a circuit shall be considered uninsulated live parts unless such parts are mounted directly on or in permanent electrical connection with grounded dead metal.

6.3.1.10 If the connection mentioned in 6.3.1.9 is solely by means of a screw, strap, or other bonding device that can be readily removed and is not depended upon to perform a mechanical function, the transfer switch shall:

a) Comply with the requirement in Table 3 when the bonding device is removed, or

b) In Mexico and the United States, be marked as described in 5.2.6.1.6. In Canada, this requirement does not apply.

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6.3.1.11 In a circuit involving potential of not more than 50 V, spacings at field-wiring terminals may be 3.2 mm (1/8 inch) through-air and 6.4 mm (1/4 inch) over-surface, and spacings elsewhere may be 1.6 mm (1/16 inch) through-air and over-surface, provided that insulation and clearances between the low-potential circuit and any high-potential circuit are in accordance with the requirements that are applicable to the high-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.

6.3.1.12 In 6.3.1.13 – 6.3.1.18, the liner or barrier referred to is insulating material that separates uninsulated live parts of opposite polarity, or separates an uninsulated live part and a grounded dead-metal part – including the enclosure – where the through-air spacing between the parts would otherwise be less than the required value.

6.3.1.13 A barrier or liner that comprises the sole separation:

a) Shall be of material acceptable for supporting an uninsulated live part, except that a barrier between the enclosure and an uninsulated part electrically connected to a grounded circuit conductor (neutral) may be of fiber; and

b) Shall be not less than 0.71 mm (0.028 inch) thick, unless a lesser thickness is found to be acceptable for the particular application.

6.3.1.14 A barrier or liner used in conjunction with an air space shall be not less than 0.71 mm (0.028 inch) thick, unless a lesser thickness is found to be acceptable for the particular application or the barrier is used in conjunction with an air space of one-half or more of the required spacings as described in 6.3.1.16 and 6.3.1.17.

6.3.1.15 If the barrier mentioned in 6.3.1.14 is of material, other than fiber, that is not acceptable for the support of uninsulated live parts, the air space shall be acceptable for the particular application.

6.3.1.16 Other than as noted in 6.3.1.17, a barrier or liner used in conjunction with an air space of one-half or more of the required through-air spacing may have a thickness of not less than 0.33 mm (0.013 inch) if it is:

a) Of material acceptable for supporting uninsulated live parts,

b) Of adequate strength if exposed or otherwise likely to be subjected to physical damage,

c) Reliably held in place, and

d) So located that it will not be adversely affected by operation of the equipment in service.

6.3.1.17 With respect to 6.3.1.16, insulating material having a thickness less than 0.33 mm (0.013 inch) may be accepted if it is found to be acceptable for the particular application.

6.3.1.18 In measuring between an uninsulated live part and a bushing installed at a knockout, it shall be assumed that a bushing having the dimensions indicated in Table 5, but without a locknut inside the enclosure, is in place.

6.3.1.19 Other than as noted in 6.3.1.20, a pressure wire connector shall be prevented by a restraint, such as a shoulder or boss, from turning so as to reduce spacings to values less than those required. A lock washer alone is not acceptable for this purpose.

6.3.1.20 The means to prevent turning required by 6.3.1.19 need not be provided if spacings are not less than the minimum acceptable values:

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a) When the lug or connector and any lug or connector of opposite polarity have each been turned 30 degrees toward the other, and

b) The lug or connector has been turned 30 degrees toward other opposite-polarity live parts and toward grounded dead metal parts.

6.3.1.21 In Mexico and the United States, other than as noted in 6.3.1.22, when a neutral is factory bonded to the ground bus or enclosure, all conductive parts connected to the neutral shall comply with the following:

a) The parts shall be insulated from the ground bus and enclosure, and

b) The parts shall be provided with a minimum of 3.2 mm (1/8 inch) spacing through-air and over-surface to the enclosure.

In Canada, this requirement does not apply.

6.3.1.22 The requirement of 6.3.1.21 does not apply to the following parts that will not interfere with the operation of the ground-fault protection system if they were to contact the enclosure:

a) For zero sequence type ground-fault protection and residual type ground-fault protection, any neutral part on the line side of the neutral sensing means; and

b) For ground return type ground-fault protection, any neutral part on the ground side of the sensing means.

6.3.2 Printed-wiring board assemblies

6.3.2.1 In Mexico, clearances and creepage distances provided on printed-wiring board assemblies may be less than indicated in Table 3, but not less than 0.8 mm (1/32 inch) provided the board is coated or encapsulated and an investigation is conducted to determine the acceptability of the coating or encapsulation. The investigation shall include temperature and humidity conditioning, preceded and followed by dielectric voltage-withstand tests. Flammability tests shall also be conducted on the combination of the coating or encapsulation and the board. In the United States and Canada, clearances and creepage distances provided on printed-wiring board assemblies may be less than indicated in Table 3, provided that they comply with 6.3.2.2 – 6.3.2.7.

6.3.2.2 All printed-wiring board assemblies shall be considered to be Pollution Degree 3 except as noted in 6.3.2.3 and 6.3.2.4.

6.3.2.3 Pollution Degree 2 shall be considered to exist on a printed-wiring board where a coating provides an uninterrupted covering of the conductive material for at least one of two conductive materials and covers the entire space between the two conductive materials for which the spacing is being evaluated.

6.3.2.4 Pollution Degree 1 shall be considered to exist on a printed-wiring board where a coating that complies with Annex A1, Item 20, is provided.

6.3.2.5 A printed-wiring board or other solid insulation shall be considered to be Material Group IIIb (CTI of 100 to 175) without further investigation. For printed-wiring boards or other solid insulation of Material Groups I, II, or IIIa, the requirements of Annex A1, Item 7, shall apply.

6.3.2.6 For those areas of printed-wiring boards in Pollution Degree 3, clearances and creepage distances shall be no less than the values in Annex A1, Item 20.

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6.3.2.7 For those areas of printed-wiring boards where Pollution Degree 1 or 2 are provided by a coating, creepage distances shall be no less than the values in Annex A1, Item 21. The existence of recurring voltages shall be evaluated in accordance with Annex A1, Item 20.

6.4 Components

6.4.1 Except as indicated in 6.4.2, a component of a product covered by this standard shall comply with the requirements for that component. Refer to Annex A2 for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL standards as appropriate for the country where the product is to be used.

6.4.2 A component is not required to comply with a specific requirement of the component standard if it:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

6.4.3 A component shall be used in accordance with its established rating and its intended conditions of use. Polymeric materials which have been determined to be acceptable for use at 600 V are considered to be acceptable for use up to 1000 V when the complete assembly complies with all performance requirements of this standard.

6.4.4 In Mexico and the United States, a component not marked with a short-circuit current rating shall be considered rated for use in a circuit having a maximum short-circuit current as shown in Table 6.

In Canada, this requirement does not apply.

6.4.5 The short-circuit current available in the secondary circuit of a transformer rated 10 kVA or less shall be considered to be 5000 amperes or less.

6.4.6 The short-circuit current available on the load side of a 15 ampere current-limiting circuit breaker or Class CC, G, J, RK1, RK5, or T fuse shall be considered to be 5000 amperes. In a single phase 120-volt circuit, the short-circuit current available on the load side of a 20 ampere circuit breaker or Class CC, G, J, RK1, RK5, or T fuse shall be considered to be 10,000 amperes or less.

6.5 Enclosures

6.5.1 Other than as noted in 6.5.2 – 6.5.5, an enclosure provided shall comply with Annex A1, Items 2 and 13.

6.5.2 If a product is identified for use in Canada, the enclosure shall comply with Annex A1, Item 1.

6.5.3 An enclosure having maximum dimensions as shown in Table 7 or Table 8 may have minimum thicknesses per Table 7 or Table 8.

6.5.4 For a transfer switch intended for use as service equipment, the enclosure thickness shall not be less than 1.35 mm (0.053 inch) if of uncoated steel, 1.42 mm (0.056 inch) if of zinc-coated steel, and 1.91 mm (0.075 inch) if of aluminum.

6.5.5 The enclosure of a transfer switch may be provided with ventilating openings. Ventilation openings shall comply with the requirements in 6.5.6 – 6.5.23. In Mexico and the United States, transfer switches rated less than 400 A may not be provided with ventilating openings.

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6.5.6 A ventilating opening shall be designed and located so that no flame or molten metal is emitted during arcing normally encountered during acceptable performance of the Overload test described in 7.4.1, the withstand test described in Rated short-circuit making capacity (withstand) in 9.13.3, and the closing test described in Rated short-circuit making capacity (closing) in 9.13.2.

6.5.7 Unless the opening is remote from the arcing part, the requirement in 6.5.13 necessitates the interposing of a barrier between a ventilating opening and a possible source of arcing such as a switch, fuse, and the like, as noted in 6.5.8 – 6.5.12.

6.5.8 The barrier required by 6.5.7 shall be of such dimensions and so located that straight lines drawn from any arcing part past the edge of the barrier define an area at the plane of the opening 6.4 mm (1/4 inch) beyond the edges of the opening.

6.5.9 Other than as noted in 6.5.10, a sheet steel barrier required by 6.5.7 shall not be less than 1.35 mm (0.053 inch) thick if uncoated and not less than 1.42 mm (0.056 inch) thick if zinc-coated.

6.5.10 The barrier required by 6.5.7 may be of steel of less thickness than required by 6.5.9, provided that its strength and rigidity is not less than that of a flat sheet of steel having the same dimensions as the barrier and having the specified thickness.

6.5.11 Other than as noted in 6.5.12, a nonmetallic barrier required by 6.5.7 shall not be less than 6.4 mm (1/4 inch) thick and shall be supported to maintain position of the barrier with respect to the openings.

6.5.12 The thickness of a nonmetallic barrier required by 6.5.7 may be less than 6.4 mm (1/4 inch) required by 6.5.11, if the barrier is so located and supported that it is not subject to mechanical abuse during transfer switch installation.

6.5.13 A ventilating opening in an enclosure shall have such size or shape, or shall be so covered by screening or by an expanded, perforated, or louvered metal panel, that a test rod having the diameter specified in 6.5.14 will not enter the opening.

6.5.14 The test rod mentioned in 6.5.13 shall be 13.1 mm (33/64 inch) in diameter if the plane of the opening is less than 102 mm (4 inches) from an uninsulated live part, or 19.4 mm (49/64 inch) in diameter if the plane of the opening is 102 mm (4 inches) or more from such parts.

6.5.15 A louver shall not be more than 305 mm (12 inches) long.

6.5.16 The size, shape, and location of a ventilating opening shall not unduly weaken the overall enclosure.

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

6.5.18 The 25 percent limitation required in 6.5.17 may be exceeded provided that means of reinforcement, such as stiffeners, are employed and the enclosure complies with the comparative deflection test of Annex A1, Item 2.

6.5.19 The area of an opening covered by a louvered, perforated, or expanded metal panel that is thinner than the enclosure, shall not exceed 0.129 m^2 (200 in^2). A ventilated closing panel of 1.35 mm (0.053 inch) if uncoated, 1.42 mm (0.056 inch) if zinc-coated or thinner steel or wire mesh of 1.63 mm diameter (14 AWG) or smaller wire shall not be used to enclose an opening of more than 0.052 m^2 (80 in^2).

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6.5.20 The wires of a screen of a ventilating opening shall not be smaller than 1.29 mm diameter (16 AWG) if the screen openings are 323 mm^2 (1/2 in^2) or less in area, and not smaller than 2.05 mm diameter (12 AWG) for larger screen openings. A supplementary screen of smaller openings may be additionally provided. The supplementary screen shall not be considered in the evaluation of the ventilating opening screen.

6.5.21 Other than as noted in 6.5.22, perforated sheet steel and sheet steel employed for expanded-metal mesh shall not be less than 1.07 mm (0.042 inch) thick if uncoated, or 1.14 mm (0.045 inch) thick if zinc-coated, if the mesh openings or perforations are 323 mm^2 (1/2 in^2) or less in area, and shall be not less than 2.03 mm (0.080 inch) thick if uncoated or 2.13 mm (0.084 inch) thick if zinc-coated for larger openings.

6.5.22 Where the indentation of a guard or enclosure cannot alter the clearance between uninsulated live parts and grounded metal so as to affect performance adversely or reduce spacings below the minimum values in Table 3, 0.51 mm (0.020 inch) if uncoated or 0.58 mm (0.023 inch) if zinc-coated expanded metal mesh may be employed. Refer to 6.5.19.

6.5.23 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.

6.5.24 An enclosure shall be constructed, tested, and marked as per Annex A1, Items 2 and 13. The marking may be on the inside or outside surface, but shall be visible after installation. Refer to 5.2.1.29. Devices intended only for use in Canada and provided with a general purpose enclosure as permitted by Annex A1, Item 1, need not be marked with a type rating.

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

6.5.26 An enclosure marked Type 3, 3S, 4, 4X, 6, or 6P may additionally be marked "Raintight" or "Rainproof". An enclosure marked Type 3R may additionally be marked "Rainproof". Refer to 5.2.1.29.

6.5.27 A device covering an opening in an enclosure or forming a portion of an enclosure shall meet the requirements specified for the enclosure with the device installed.

6.5.28 Marking and instructions on the exterior of an enclosure shall be permanent. Refer to 5.2.1.3.

6.5.29 Other than as noted in 6.5.30, equipment with nonmetallic enclosures and other non-metallic discrete objects, intended to be installed in air-handling spaces shall additionally comply with the requirements in the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.

6.5.30 The requirement 6.5.29 does not apply to the following:

a) Air filters, wire insulation, paint applied for corrosion protection, or tubing of material equivalent to one of the types of wire insulation permitted by this standard;

b) Gaskets forming air or water seals between metal parts;

c) Miscellaneous small parts such as insulating bushings, resilient or vibration mounts, wire ties, clamps, or labels, having a total exposed surface area not exceeding 25 in^2 (161.29 cm^2); or

d) An adhesive that, when tested in combination with the specific insulating material, complies with the requirement.

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6.5.31 Metallic enclosure surfaces are suitable for use in air handling ducts and plenums without further investigation.

6.6 Connections for wiring systems

6.6.1 If knockouts are provided in the enclosure of transfer switches, they may be of any size; but at least two of them (or more when multiple conduits are involved) shall be so located that the installation of bushings will not result in spacings between live parts and bushings of less than the minimum requirements in Clearance and creepage distances, 6.3, when they are reamed for the size of conduit required for the maximum number and gauge of wires necessitated by the switch rating.

6.6.2 In Mexico and the United States, a conduit hub in an enclosure shall be threaded and shall have a wall thickness before threading not less than that of the corresponding trade-size of rigid conduit. A conduit hub shall not depend upon friction alone to prevent its turning, and shall be capable of withstanding the specified torque applied to a short length of rigid conduit threaded into the hub in the intended manner, without turning in the enclosure and without stripping of any threads. The enclosure shall be securely (rigidly) mounted or supported. For the 21 (3/4 inch) and smaller trade sizes, the applied torque shall be 90 N·m (800 pound-inches); for the 27, 35, and 41 (1, 1-1/4, and 1-1/2 inch) trade sizes, 113 N·m (1000 pound-inches); and for the 53 (2 inch) and larger sizes, 181 N·m (1600 pound-inches).

In Canada, this requirement does not apply.

6.6.3 In Mexico and the United States, a tapped hole for the attachment of threaded rigid conduit shall be provided with:

a) An end-stop, or shall be so located that a standard bushing may be attached to the end of the conduit;

b) A tapered thread in equipment for outdoor use, if not provided with an end stop; and

c) At least three full threads when tapped all the way through the wall of an enclosure, or with at least 3-1/2 full threads and a smooth, well-rounded inlet hole having a diameter approximately the same as the internal diameter of a standard bushing to provide protection for the conductors equivalent to that provided by such a bushing.

In Canada, this requirement does not apply.

6.6.4 In Canada, the requirements for connections for wiring systems are contained in Annex A1, Items 11 and 21.

In Mexico and the United States, this requirement does not apply.

6.6.5 When conduit is supplied at the factory, the type, size (based on conduit fill and wire ampacity calculation), length and fittings shall comply with the requirements of Annex A1, Item 1.

6.6.6 If leads are provided and brought out through factory-attached conduit, a conduit fitting shall be provided at the free end of the conduit, or the conductor insulation at the free end of the conduit shall be protected from the sharp edges of the conduit during shipping by means of a tape wrap, a fiber bushing secured in place, or the equivalent.

6.6.7 Other than as noted in 6.6.8 and 6.6.9, if a conduit is supplied, access shall be provided to enable tightening of the locknut of the conduit or conduit fitting.

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6.6.8 With respect to 6.6.7, access to the fitting or locknut is not required if the conduit opening is threaded and complies with Annex A1, Item 21.

6.6.9 With respect to 6.6.7, access to the fitting or locknut is not required if a conduit hub is installed.

6.7 Corrosion protection

6.7.1 Iron and steel parts other than bearings and so forth, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

6.7.2 The requirement of 6.7.1 applies to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to parts such as washers, screws, bolts, and the like, if any damage of such unprotected parts would not be likely to result in the equipment being affected adversely. Parts made of stainless steel (properly polished or treated, if necessary) do not require additional protection against corrosion. Bearing surfaces should be of such materials and construction to resist binding due to corrosion.

6.8 Insulating materials

6.8.1 Other than as noted in 6.8.2 – 6.8.5, a material that is used for the direct support of an uninsulated live part shall be porcelain, unfilled phenolic, or cold molded composition, or shall comply with the Relative Thermal Index (RTI), Hot Wire Ignition (HWI), High-Current Arc Resistance to Ignition (HAI), and Comparative Tracking Index (CTI) values indicated in Table 9. A material is in direct support of an uninsulated live part when:

a) It is in direct physical contact with the uninsulated live part; and

b) It serves to physically support or maintain the relative position of the uninsulated live part.

6.8.2 In Mexico and the United States, materials may either have no HWI values or may have HWI values higher (worse) than those required by Table 9 if the materials comply with the end-product Abnormal Overload Test in accordance with Annex A1, Item 7.

In Canada, this requirement does not apply.

6.8.3 In Mexico and the United States, materials may either have no HAI values or may have HAI values higher (worse) than those required by Table 9 if the materials comply with the end-product Arc Resistance Test in accordance with Annex A1, Item 7.

In Canada, this requirement does not apply.

6.8.4 Materials that are more than 12.7 mm (1/2 inch) away from arcing contacts are not required to comply with the HAI requirements.

6.8.5 In Mexico and the United States, materials may either have no CTI values or may have CTI values higher (worse) than the CTI required by Table 9 if the materials comply with the end-product Arc Resistance Test in accordance with Annex A1, Item 7.

In Canada, this requirement does not apply.

6.8.6 In the United States, a printed-wiring board shall comply with the requirements in Annex A1, Item 8.

In Canada and Mexico, this requirement does not apply.

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6.8.7 A printed-wiring board shall have a flammability rating of V-0, V-1, or V-2.

6.8.8 A printed-wiring board shall comply with the direct support requirements in 6.8.1.

6.9 Bases

6.9.1 Other than as noted in 6.9.2, a live screwhead or nut on the underside of a base designed for surface mounting shall be counter-sunk not less than 3.2 mm (1/8 inch) in the clear, and covered to a depth of not less than 3.2 mm (1/8 inch) with a waterproof, insulating sealing compound.

6.9.2 If the screw or nut is prevented from loosening by being staked or upset, by a lock washer, or by other means, it may be insulated from the mounting surface by material other than sealing compound or by providing a spacing from the mounting surface not less than that indicated in Table 3.

6.9.3 The sealing compound mentioned in 6.9.1 shall not melt at a temperature 15 °C (27 °F) higher than its operating temperature, and not less than 90 °C (194 °F) in any case.

6.9.4 A determination of the softening point of a sealing compound shall be made in accordance with Annex A1, Item 14.

6.10 Mounting of parts

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

6.10.2 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 can result in a reduction of spacings to less than those indicated in Table 3. The security of contact assemblies shall be such as to provide the continued alignment of contacts. Refer to 6.3.1.19.

6.10.3 Friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part as required in 6.10.1 and 6.10.2. A lock washer, properly applied, may be accepted at connections other than pressure wire connectors.

6.11 Guarding and accessibility of live parts

6.11.1 Other than as noted in 6.11.2, energized uninsulated live parts of control circuits 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.

6.11.2 Uninsulated live parts of control circuits that operate at less than 30 V and are supplied in accordance with 6.3.1.11 need not be so guarded or enclosed.

6.11.3 Any barrier intended to be removed during routine maintenance or servicing shall be marked in accordance with 5.2.1.28.

6.12 Current-carrying parts

6.12.1 A current-carrying part shall have mechanical strength and current-carrying capacity for the service, and shall be of silver, a silver alloy, copper, a copper alloy, aluminum, or other metal that is acceptable for the particular application.

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6.12.2 If parts are held together by screws, a threaded part shall have no fewer than two full, clean-cut threads engaged. If 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.

6.13 Field-wiring terminals

6.13.1 General

6.13.1.1 Other than as noted in 6.13.1.2, transfer switches shall be designed for connection of supply conductors, load conductors, and external signal/control circuit conductors by the means specified in 6.13.1.4 – 6.13.2 as applicable. 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. Power terminals shall be sized to accommodate conductors having an ampacity equal to or greater than the current rating of the overcurrent device specified for use with the transfer switch.

6.13.1.2 Terminal connectors for field connection (line or load) are not required to be provided when all the following conditions are met:

a) Other than bonding terminations, the transfer switch is intended to be terminated with field-wiring larger than 10 AWG. Bonding kits may be provided for all sizes of conductors.

b) Connector and bonding kits that will properly accommodate conductors suitable for the ampere rating of the device are made available by the transfer switch manufacturer.

c) Kits shall comply with 6.13.1.3.

6.13.1.3 The wire connector kits and bonding kits (in the form of either individual terminals or an assembly) shall be constructed so that:

a) Installation can be easily accomplished without special tools;

b) Live parts are suitably supported after being assembled;

c) Reliable connections to terminal pads can be achieved;

d) The grounding terminal means are readily accessible when the transfer switches are mounted as in service, and are not connected directly to a neutral (when provided);

e) Each kit can be installed without disassembly of factory-assembled parts (other than those parts normally disassembled for installation and wiring);

f) Spacings will be maintained when the kit is installed;

g) Fastening devices such as studs, nuts, bolts, washers, and similar parts, as required for an effective installation, shall either be provided as part of the component terminal assembly, or be mounted on or separately packaged with the transfer switch; and

h) Marking is provided in accordance with 5.2.1.23.

6.13.1.4 Other than as noted in 6.13.1.5, with reference to conductor ampacity in 6.13.1.1, sizes of field installed conductors shall be determined as follows. For current specified in Table 10:

a) 75 °C (167 °F) ampacity shall be used for 53.5 mm^2 (1/0 AWG) or larger conductors; and

b) 60 °C (140 °F) ampacity shall be used for 42.2 mm^2 (1 AWG) or smaller conductors.

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6.13.1.5 When the switch is marked for use with 75 °C wire in accordance with 5.2.1.21, conductor ampacity shall be based on 75 °C ampacity for all conductors.

6.13.1.6 Other than as noted in 6.13.1.7 and 6.13.1.8, the terminal (pressure wire connector) provided shall be the same type as employed during the short-circuit test.

6.13.1.7 Alternate wire connectors may be used in a transfer switch without conducting a short-circuit test when the short-circuit current let-through divided by the number of conductors per phase results in a current of 50,000 A RMS (70,700 A peak) per conductor or less, and the short-circuit current rating of the transfer switch is 100,000 A RMS maximum.

6.13.1.8 Alternate wire connectors may be used in a transfer switch in which the short-circuit current rating per conductor is greater than 50,000 A without conducting a short-circuit test providing the short-circuit current rating of the transfer switch is 100,000 A maximum, and the following conditions are met:

a) The number of conductors per lug is equal to or greater than the number of conductors as tested; and

b) The average pullout force – in accordance with Annex A1, Item 4 – of three samples of the alternate wire connector is equal to or greater than the average pullout force of three samples of the wire connectors used in the short-circuit test.

6.13.1.9 Pressure wire connectors shall be employed for 8.4 mm^2 (8 AWG) and larger conductors. For 5.3 mm^2 (10 AWG) and smaller wires, the parts to which wiring connections are made shall consist of clamps or binding screws with terminal plates having upturned corners or the equivalent to hold the wires in position.

6.13.2 Wire-binding screws

6.13.2.1 A wire-binding screw or stud of a wiring terminal shall not have more than 0.80 mm pitch (32 threads per inch) and shall not be smaller than M5 (No. 10), except that an M4 (No. 8) copper-alloy machine screw may be used at a terminal intended only for the connection of a 2.1 mm^2 (14 AWG) conductor. The terminal shall be provided with upturned corners, a cupped washer, or the equivalent capable of retaining a 2.1 mm^2 (14 AWG) solid conductor even though the screw or nut becomes slightly loose.

6.13.2.2 Except as noted in 6.13.2.5, a terminal plate for a wire-binding screw shall not be less than 1.27 mm (0.050 inch) thick.

6.13.2.3 No fewer than two full threads of a wire-binding screw shall engage in the metal terminal plate.

6.13.2.4 A terminal plate for a wire-binding screw may have the metal extruded at the tapped hole to provide at least two full threads, if the thickness of the unextruded metal is not less than the pitch of the thread.

6.13.2.5 A terminal plate for a wire-binding screw not less than 0.76 mm (0.030 inch) thick may be used if the tapped threads have equivalent mechanical strength.

6.13.2.6 A pressure wire connector provided with or specified for use with a transfer switch shall comply with Annex A1, Item 4.

6.13.2.7 The tightening torque for a field-wiring terminal shall be as specified by the transfer switch manufacturer and shall be marked as required by 5.2.1.27. Other than as noted in 6.13.2.8, the specified tightening torque shall not be less than 90 percent of the value employed in the static heating test as

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specified in the standard in Annex A1, Item 4 for that wire size corresponding to the ampere rating of the transfer switch.

6.13.2.8 With respect to 6.13.2.7, torque value may be less than 90 percent if the connector is investigated in accordance with the lesser assigned torque value in Annex A1, Item 4.

6.13.3 Factory provided leads for field-wiring

6.13.3.1 The requirements described in 6.13.3.2 – 6.13.3.6 apply to leads provided at the factory for wiring in the field.

6.13.3.2 The field-wiring leads of a transfer switch shall be sized in accordance with Table 10.

6.13.3.3 A field-wiring lead shall be provided with strain relief. The strain relief shall reduce transmittal of forces due to compression, tension, or rotation of the leads of terminals, splices, or wiring within the switch. The strain relief shall reduce the likelihood of displacement that can result in:

a) Mechanical damage to the leads;

b) Exposure of the leads to a temperature higher than its rated temperature;

c) Reduction of spacings that force the lead to contact other than intended live parts; or

d) Other detrimental effects.

6.13.3.4 The strain relief mentioned in 6.13.3.3 shall withstand the stress of normal handling without damage to itself or the equipment. Refer to Strain relief tests for leads, 9.17.2.

6.13.3.5 Green coloring with or without one or more yellow stripes and white or gray coloring shall not be used for the covering of a conductor unless intended for connection to grounding and grounded conductors, respectively.

6.13.3.6 The free length of a wiring lead shall be as required for the application, but not less than 15.2 cm (6 inches) in length.

6.13.4 Bus bar type field connections for transfer switches

6.13.4.1 Field connections for transfer switches may be made with bus bars in accordance with 6.13.4.2 – 6.13.4.4.

6.13.4.2 The transfer switch enclosure shall be provided with a covered access opening allowing sufficient room to make the connections.

6.13.4.3 The bus bars shall be plated with silver, nickel, or a similar material over the intended area of connection as indicated in 5.2.1.37(b).

6.13.4.4 Directions for the intended means of connection shall be provided in accordance with 5.2.1.33.

6.14 Internal wiring

6.14.1 Insulated conductors shall be of types suitable for the service with respect to voltage, temperature, and grouping. The temperature rating shall be not less than 90 °C unless investigation shows that a lower temperature rating is satisfactory. These requirements shall apply only to wiring furnished on or in equipment as part of the equipment itself.

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6.14.2 All conductors in an assembly intended for use in a complete enclosure shall be insulated for the highest voltage normally occurring between such conductors unless the wires are grouped so as to segregate the several voltages.

6.14.3 Wires shall be of multi-stranded, flexible, or extra-flexible construction where they connect to electrical equipment mounted on a hinged door. If the flexing section of the wiring is liable to come into contact with grounded metal parts, that portion of the wiring shall be given additional protection with wrappings of tape (or equivalent) or enclosed in non-metallic flexible tubing or flexible conduit.

6.14.4 Supplementary insulation, such as coated-fabric or extruded thermoplastic insulating tubing, shall not be adversely affected physically or electrically by the temperature to which it may be subjected in service.

6.14.5 Wires shall be supported or secured, or otherwise run in suitable wireways, to prevent their coming into contact with moving parts or resting on sharp edges or projections that could abrade the insulation. Wireways shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like, which can cause abrasion of the conductor insulation. Holes in sheet-metal walls through which insulated wires pass shall be provided with a bushing if the wall is 1.06 mm (0.042 inch) or less thick. Holes in walls thicker than 1.06 mm (0.042 inch) shall have smooth, well-rounded edges.

6.14.6 Internal wiring shall not be in contact with components operating above the temperature rating of the wire insulation, bare live parts of opposite polarity, or bare live parts of other circuits.

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

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

6.14.9 Soldered joints and taps in conductors shall be both mechanically and electrically secure before solder is applied. Non-corrosive soldering fluxes only shall be used. Joints or splices made in or between insulated conductors at other than suitable rigid terminal points need not be enclosed to a greater degree than is required for the conductors being joined, but shall be covered in a suitable manner with insulation equivalent to or better than the insulators on the conductors themselves with regard to voltage, thermal, and other characteristics; and located so that they will be accessible for maintenance and service without disturbing the wiring of the equipment.

6.15 Grounding and bonding

Note: The term “grounding” as used in this clause relates to “bonding” in Canada.

6.15.1 Transfer switches shall have provision for 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.

6.15.2 Small, isolated (insulated) dead metal parts are not required to be grounded.

6.15.3 The provision of a knockout or other opening in a metal enclosure for the connection of armored cable, conduit, metal raceway, or the like is acceptable as means for grounding.

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6.16 Ground-fault protection

6.16.1 When ground-fault protection is provided on a transfer switch not marked for use as service equipment, it shall comply with 6.16.2 – 6.16.5. (See Section 8 for Service Equipment Requirements.)

6.16.2 The ground-fault sensing and relaying equipment provided shall operate to cause the disconnecting means to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amps.

6.16.3 If the disconnecting means is provided with a shunt trip that is acceptable for use with ground-fault protection, the ground-fault sensors or relaying equipment or both may be in a separate enclosure if the combination is found acceptable when tested in accordance with 10.1 and the transfer switch is marked as required by 5.2.6.1.10.

6.16.4 Other than as specified in 6.16.3, ground-fault sensing and relaying equipment that is not a part of the disconnect device shall be mounted in the transfer switch enclosure and be connected to the disconnect device and power source, if any. The rating of the disconnect device control circuit shall be compatible with that of the sensing and relaying components.

6.16.5 A ground-fault protection system shall comply with 8.1.6.9 – 8.1.6.16.

6.17 Receptacles

6.17.1 When receptacles having a 15A or 20A configuration, rated 150 Vac or less, are provided, they shall be of the GFCI type or otherwise GFCI protected.

6.17.2 Markings on the enclosure shall be in accordance with Annex A1, Item 15.

6.18 Wiring spaces

6.18.1 There shall be ample space within the enclosure of a transfer switch for the installation of all wires and cables to be employed, based on the ampere rating of the transfer switch. Refer to Table 11, Table 12, and Table 13.

6.18.2 The arrangement of the wiring space shall be such that the normal and alternate supply conductors can be kept separated.

6.18.3 For a transfer switch the wire-bending space at the line and load terminals shall be as specified in Table 12 for the conductor size that corresponds with the maximum ampere rating of the transfer switch.

6.18.4 The wire-bending space from a connector to any barrier or other obstruction that is part of a transfer switch shall be as specified in Table 11.

6.18.5 If a wire is restricted by barriers or other means from being bent in a 90-degree or S bend from the terminal to any usable location in the wall of the enclosure, the distance shall be measured from the end of the barrier or other obstruction.

6.18.6 The distance mentioned in 6.18.3 and 6.18.4 shall be measured in a straight line from the edge of the wire terminal closest to the wall in a direction perpendicular to the box wall or barrier. The wire terminal shall be turned so that the axis of the wire opening in the connector is as close to perpendicular to the wall of the enclosure as it can assume without defeating any reliable means provided to prevent its turning, such as a boss, shoulder, walls of a recess, multiple bolts securing the connector, or the like. A barrier, shoulder, or the like shall be disregarded when the measurement is being made if it does not reduce the

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radius to which the wire must be bent. If a terminal is provided with one or more connectors for the connection of conductors in multiple, the distance shall be measured from the wire opening closest to the wall of the enclosure. If the connectors for a circuit are fixed in position – for example, by the walls of a recess – so that they are turned toward each other, the distance shall be measured at the wire opening nearest to the wall in a direction perpendicular to the wall.

6.18.7 The clear wiring space, independent of all projections, obstructions, or interference from moving parts of a switching mechanism:

a) Shall not be smaller in width or in depth than the values indicated in Table 13;

b) Shall be acceptable for the wiring of the device; and

c) Shall not be smaller in total area than 250 percent of the total cross-sectional area of the maximum number of wires that can be used in such space.

6.18.8 In determining whether or not a wiring space complies with the requirement of 6.18.7, consideration shall be given to the actual size of wires which will be used in that space; but it shall be assumed that wires smaller than 3.3 mm^2 (12 AWG) will not be used. In computing the area of a wiring space, consideration shall be given to all the available space which can be used properly for the placement of wires. Minimum areas of the more common multiple-wire connections are given in Table 13.

6.18.9 An operating mechanism and its relation to the wiring space shall be such that it will not cause damage to wires with which it can come in contact during its operation. Wiring space and other compartments intended to enclose wires shall be smooth and free from sharp edges, burrs, fins, and the like which might damage the conductor insulation.

6.18.10 A transfer switch intended to be installed with one or more sets of conductors, lines or load or both passing into the enclosure at the same end shall have ample space for them to pass from their terminals to the point of entrance.

6.19 Transfer switches with integral inlets for portable generator connection

6.19.1 The requirements in 6.19.2 – 6.19.20 are applicable to transfer equipment that is provided with an integral multiple pole inlet or with single-pole separable connectors for cord connection to a portable generator.

6.19.2 Connectors rated 60 A or less, shall be multi-pole types. Connectors rated greater than 60 A may be of single-pole type.

6.19.3 An integral multiple pole inlet or single-pole separable connector shall be of a construction with male phase and neutral mating contacts and shall have a rating no less than the rating of the portion of the transfer switch to which it is connected.

6.19.4 An integral multiple pole inlet shall have sufficient number of poles to accommodate the ground/bond, neutral, and all ungrounded supply conductors in one connector.

6.19.5 When single-pole separable connectors are provided, they shall be of the locking type, and there shall be a sufficient number to accommodate the ground, neutral, and all ungrounded supply conductors, and these connectors shall be grouped together. The connector arrangement shall be phase connectors (A, B, C or LI, L2), neutral connector when provided, and ground/bond connector. The phase arrangement on a three-phase system shall be A, B, C from front to back, top to bottom, or left to right, and the phase arrangement on a single-phase system shall be L1, L2 from front to back, top to bottom, or left to right as viewed from the front of the automatic transfer switch.

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6.19.6 An integral multiple-pole inlet shall be of a design such that the ground/bond connection is the first connection made when connecting the mating connector and is the last connection to be opened when removing the mating connector.

6.19.7 An integral multiple pole inlet shall be rated for connection and disconnection under load. Transfer switches with single-pole inlets shall be marked in accordance with 5.2.7.12.

6.19.8 Other than as noted in 6.19.9, a multi-pole or separable single-pole inlet shall be arranged such that the current-carrying parts of the inlet are energized only when the mating attachment connector is connected to the inlet.

6.19.9 For separable single-pole inlets, 6.19.8 applies only upon connection of all of the connectors for all phases. The marking of 5.2.7.8 shall be provided.

6.19.10 Separable single-pole inlets may be paralleled only when the cable size for the connector is equal to or greater than 1/0 AWG. Multi-pole connectors shall not be used in parallel.

6.19.11 Transfer equipment with an inlet which is intended for outdoor use in wet locations shall comply with the requirements for Type 3, 3R, 3S, 4, 4X, 6, or 6P enclosures, as detailed in Annex A1, Item 13, with the cord connector installed as well as with the connector withdrawn.

6.19.12 Transfer equipment in a Type 1, 2, 5, 12, 12K, or 13 enclosure with an inlet, or transfer equipment with an inlet not rated for use in outdoor applications when a connector is installed shall be marked as specified in 5.2.7.4.

6.19.13 Transfer equipment with an inlet shall be provided with branch circuit type overcurrent protection for the circuits supplied through the inlet, or shall be marked in accordance with 5.2.7.1. The rating of the overcurrent protection shall not be greater than the rating of the inlet. Where multiple inlets are connected in parallel, the rating of the overcurrent protection shall be not greater than the sum of the ratings of the inlets.

6.19.14 When provided with an inlet, transfer equipment that does not switch the neutral conductor shall be marked in accordance with 5.2.7.2.

6.19.15 When provided with an inlet, transfer equipment that switches the neutral conductor shall be marked in accordance with 5.2.7.3.

6.19.16 Transfer equipment with a multiple-pole inlet or with single-pole separable connectors shall comply with 5.2.7.4.

6.19.17 Separable single-pole connectors shall be color coded. The connector for the ground/bond conductor shall be green and the connector for the neutral/grounded conductor shall be white. The connector of each phase shall be identified by a unique color that shall not be white or green.

6.19.18 Other than as noted in 6.19.19, single-pole separable connectors shall be mechanically interlocked in such a manner that mating connectors must be connected in the following sequence and disconnected in the reverse order:

a) Equipment-grounding conductor connection;

b) Then grounded-circuit conductor connection, if provided; and

c) Then ungrounded conductor connections.

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