UL 1008

STANDARD FOR SAFETY

Transfer Switch Equipment

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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UL 1008
Ninth Edition

Transfer Switch Equipment

July 13, 2022

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ANSI/UL 1008-2022

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as “CSA Group”), and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and UL pages.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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."

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.

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.

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

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.

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.

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:

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.

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.

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:

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.

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.

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).

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.

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.

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.

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.

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.

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

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.

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.

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

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.

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.

6.19.19 Transfer equipment with separable single-pole connectors need not comply with 6.19.18 when the connector rating is greater than 60 A, and the transfer equipment is marked in accordance with 5.2.7.5 – 5.2.7.7.

6.19.20 Transfer switches provided with inlets rated 100 A or greater shall comply with one or more of the following:

a) Be provided with a disconnecting means that is mechanically interlocked such that the mating attachment connector(s) may not be inserted or removed unless the disconnecting means is in the open position; or

b) Be provided with inlets rated for disconnection under load; or

c) Be marked and provided with instructions in accordance with 5.2.7.13.

6.20 Inlets for generator connection

6.20.1 The requirements of 6.20.2 – 6.20.7 apply to enclosed multiple pole power inlets which are intended for use with transfer equipment to provide means for cord connection to a portable generator. These requirements do not apply to inlets consisting of single pole separable connectors. Enclosed inlet assemblies consisting of single pole separable connectors shall comply with Annex J.

6.20.2 The inlet shall be of a construction with male phase and neutral mating contacts. An inlet shall have a rating no less than the rating of the transfer switch to which it is intended to be connected.

6.20.3 The inlet shall have sufficient number of poles to accommodate the ground, neutral, and all ungrounded supply conductors in one connector.

6.20.4 The inlet shall be of a design such that the ground connection is the first connection made, and is the last connection to be opened when removing the connector.

6.20.5 The inlet shall be suitable for connection and disconnection under load.

6.20.6 The inlet shall be completely enclosed. When intended for outdoor use in wet locations, enclosures shall comply with all requirements for Type 3, 3R, 3S, 4, 4X, 6, or 6P enclosures, as detailed in 6.5, Enclosures, with the cord connector installed as well as with the connector withdrawn.

6.20.7 Enclosed power inlets shall comply with 5.2.7.10 and 5.2.7.11.

7 Performance Requirements

7.1 Operating mechanism

7.1.1 In Canada only, a transfer switch with identical power-switching mechanisms as found on an approved automatic transfer switch shall qualify as a manual transfer switch (electrically operated and/or externally manually operated) without additional testing. For the purpose of this requirement, identical power switching mechanisms are defined as mechanisms that provide identical speed of contact operation and sequencing times.

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

7.1.3 Other than as noted in 7.1.4, the operating mechanism shall be such that the load must be connected to either the normal or alternate source of supply, if one or both are available with sufficient

voltage and frequency to permit proper operation. This requirement does not preclude the use of service disconnect switches in transfer switches marked for service use, as opening of a service disconnect is considered to render the source unavailable. If intended for use with paralleled engine-generator sets, transfer to the generator source or sources may be inhibited until sufficient power for the connected load is available. Refer to 5.2.2.5.

7.1.4 In Mexico and the United States, in the case of a transfer switch limited to use on optional standby systems, the operating mechanism is allowed to disconnect both the normal and alternate supplies, regardless of supply availability, as long as this intentional neutral position is factory installed in the mechanism and this position can be reliably maintained.

In Canada, this requirement does not apply.

7.1.5 The mechanism of a transfer switch intended for use with paralleled engine-generator sets as indicated in 7.1.3 may be arranged to disconnect from the alternate source (generators) in the event of shut down of one or more of the paralleled engine-generator sets.

7.1.6 The operating mechanism of the normal and emergency contacts of an automatic transfer switch for use in emergency systems shall be electrically operated. Other than as noted in 7.1.7, the normal and emergency contacts of an automatic transfer switch intended for use in emergency systems shall be mechanically held in a closed position.

7.1.7 In Mexico and the United States, if a BCELTS is not mechanically held in the normal state, it shall default to the emergency state upon loss of normal power or control system failure. Once in the emergency state, the contacts of the BCELTS shall be mechanically held (for example, by spring force).

In Canada, this requirement does not apply.

7.1.8 A transfer switch that incorporates integral overcurrent protective devices in the main power circuits and that will not automatically transfer from one source to another as a result of the opening of one or more of these overcurrent devices shall be marked in accordance with 5.2.2.6.

7.1.9 An automatic transfer switch may be arranged with overlapping contacts to provide closed transition between synchronized supplies (i.e., one supply is closed before the other supply is opened).

7.1.10 A closed transition automatic transfer switch:

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

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

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

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

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

f) Shall be marked in accordance with 5.2.1.30; and

g) Shall be provided with:

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

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

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

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

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

7.1.11 Other than as noted in 7.1.12, a transfer switch provided with means to permit manual operation of the mechanism shall have such means externally operable.

7.1.12 A transfer switch having manual operating means provided for maintenance and servicing which are accessible only by opening the enclosure shall have all arcing parts, except the control circuit, shielded to protect the operator against arcing in the event of an inadvertent operation of the switch under load.

7.1.13 The manual operating means described in 7.1.12, including the control circuit, shall be so located with respect to other components that it is accessible for operation without subjecting the operator to the risk of electric shock or injury from adjacent moving parts. In addition, the switch shall be marked in accordance with 5.2.1.5.

7.1.14 A transfer switch having an external manual operating means that can permit opening or closing of the switch contacts at a speed slower than that caused by the automatic operating means shall comply with the requirements of 9.10.1.5.

7.1.15 A quick-make quick-break mechanism is considered to comply with 7.1.14 without further investigation.

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

7.1.17 If the means used to comply with 7.1.16 render the control circuit non-functional, audio or visual signals or equivalent means shall be provided to indicate the status of the control circuit.

7.1.18 The operating mechanism of open transition transfer switches shall be interlocked to reduce the possibility of simultaneous connection to both the normal and alternate supplies. Removal of doors or access panels shall not result in defeating the interlocking mechanism.

7.1.19 The interlock circuit wiring shall be factory connected and located entirely within the transfer switch enclosure. It shall be additionally protected from possible damage due to the operation of the transfer mechanism or during any servicing of the switch.

7.1.20 The electronic interlocking system described in 7.1.19 shall be evaluated to the requirements appearing in Annex A1, Item 10.

7.1.21 An alarm or test means shall be provided to indicate an inoperative condition of the interlocking system, if the failure analysis indicated in 7.1.20 results in showing that a single failure renders the system inoperative.

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

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

7.1.24 Remote test switches and their associated circuits for automatic transfer switches for use in emergency or legally-required systems shall be arranged such that they will not prevent a transfer to the alternate source in the event of loss of the normal source. This requirement shall be met under any condition of the remote test switch or the associated wiring resulting in a continuously closed, open, or intermittent state.

7.1.25 Other than as noted in 7.1.26 – 7.1.28, control circuits that are depended upon for the proper operation of a transfer switch shall be located wholly within the transfer switch enclosure and shall not have overload protective devices connected in them, but may have short-circuit and ground-fault protection.

7.1.26 The control circuit of a transfer switch shall have short-circuit protection and a disconnecting means suitable for the available current of the supply if the transfer switch is marked for service equipment use in accordance with 5.2.6.1.1 or 5.2.6.1.3 and its control circuit is connected ahead of the service-disconnecting means.

7.1.27 There may be provision for extending the control circuits from a transfer switch to an adjacent bypass/isolation switch or to (an) external engine-generator set(s), if a marking indicates that the control circuit wiring shall be in conduit. Refer to 5.2.1.11.

7.1.28 In Mexico and the United States, in a transfer switch limited to use on an optional standby system the control circuit may extend outside the enclosure if mis-operation of the circuit cannot result in asynchronous paralleling of the two sources.

In Canada, this requirement does not apply.

7.1.29 If an electrical motor on a drive mechanism is provided with overload protection, the motor shall be protected against locked-rotor burnout only. Refer to 9.11.5.

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

7.1.31 The normal supply voltage sensing circuit shall initiate transfer to the alternate supply for any value of normal supply voltage specified by the manufacturer. Refer to 5.2.2.1.

7.1.32 If voltage-frequency sensing circuits are provided to determine availability of the alternate supply, operation shall be effected within the marked limits specified by the manufacturer. Refer to 5.2.2.2.

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

7.1.34 With respect to 7.1.33, for automatic transfer switches for use in emergency or legally-required systems, the time delays shall be capable of being set such that the transfer is completed in 10 seconds or less. In Mexico and the United States, transfer times are not specified for transfer switches for use in optional standby systems.

Note: Local requirements can govern total system transfer time and could require transfer-switching times to be less than stated.

7.1.35 In Mexico and the United States, with respect to 7.1.34, for automatic transfer switches for use in optional standby systems, devices may be included to permit the load to be disconnected from both sources of supply simultaneously, provided that the transfer is automatically completed once the device has functioned as intended.

In Canada, this requirement does not apply.

7.1.36 If time-delayed transfer features are provided either from the normal to alternate source, alternate to normal source, or both, the transfers shall be within the marked limits specified by the manufacturer. Refer to 5.2.2.3.

7.2 Temperature rise

7.2.1 Transfer switches shall perform acceptably when subjected to a Temperature rise test as described in 9.8.

7.3 Dielectric properties

7.3.1 A transfer switch shall withstand the application of the test voltages specified in 9.9.

7.4 Ability to make and break under no-load, normal load, and overload conditions

7.4.1 Overload test

7.4.1.1 Transfer switch equipment shall be subjected to the Overload test as specified in 9.10.

7.4.2 Operational performance (endurance)

7.4.2.1 A transfer switch shall be subjected to the Endurance test as specified in 9.12.

7.5 Short-circuit tests

7.5.1 Short-time current rating test (optional)

7.5.1.1 A switch marked with a short-time current rating shall be tested under the conditions described in 9.15 and shall withstand the short-time current for the period specified.

7.5.2 Short-circuit withstand test

7.5.2.1 When tested under the conditions described in 9.13.3.5 – 9.13.3.25, a transfer switch shall withstand the marked short-circuit current rating at the associated maximum voltage until the overcurrent protective device(s) specified in 9.13.3.7 open or for a time duration as specified in 9.13.3.10.

7.5.3 Short-circuit closing test

7.5.3.1 When tested in accordance with 9.13.2.1 – 9.13.2.4, a transfer switch shall comply with the requirements in 9.13.3.1. Refer to 9.13.2.

8 Service Equipment Requirements

8.1 Service equipment for use in Mexico and the United States

8.1.1 General

8.1.1.1 Transfer switches marked for use as service equipment shall comply with 8.1.1.2 – 8.1.1.4 and 8.1.2 – 8.1.7.

8.1.1.2 The enclosure for a transfer switch marked for use as service equipment shall be in accordance with the enclosure requirements in Enclosures, 6.5, but in no case shall the enclosure 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.

8.1.1.3 The control circuit of a transfer switch shall have short-circuit protection and a disconnecting means suitable for the available current of the supply when the control circuit is connected on the line side of the service-disconnecting means.

8.1.1.4 Marking for service equipment shall be in accordance with 5.2.6.1.

8.1.2 Service-disconnecting means

8.1.2.1 Other than as noted in 8.1.2.3 and 8.1.2.4, a transfer switch marked for service equipment use shall be provided with readily accessible externally operable means to disconnect all ungrounded supply conductors of both the normal and the alternate sources under any condition of the normal and alternate supplies. The disconnecting means shall be manually operable by using a mechanical operating handle or an electrically operated switch.

8.1.2.2 The manually operable means required by 8.1.2.1 may be an electrically operated switch or electrically operated circuit breaker. The operating switch(es) for this means shall be readily accessible and externally operable. Electrically operated switches and circuit breakers shall also be capable of being mechanically operated. The means by which these devices are mechanically operated need not be externally operable when it complies with both (a) and (b).

a) All arcing parts, except the control circuit, shall be shielded to protect the operator against arcing.

b) Operation by hand does shall not subject the operator to the risk of electric shock or the risk of injury from adjacent moving parts.

Note: This may be accomplished by guarding live and moving parts only in the vicinity of the operating mechanism.

8.1.2.3 The disconnecting means for control circuit conductors need not be externally accessible when all of the following conditions are met:

a) The transfer switch is marked as shown in 5.2.6.1.13;

b) The transfer capability is disabled when both normal and alternate power disconnects are open;

c) The disconnecting means is accessible by opening the enclosure or removing a dead-front; and

d) The construction complies with 8.1.2.2 (a) and (b).

8.1.2.4 A transfer switch may be provided with a single disconnect, on the normal source only, when the alternate source is intended to be a feeder and the transfer switch is marked in accordance with 5.2.6.1.14.

8.1.2.5 Only the following equipment may be connected to the supply side of the service-disconnect means:

a) Instrument transformers (current and voltage) and load management devices;

b) Surge arresters and type 1 surge-protective devices;

c) Taps used only to supply circuits for standby power systems, if provided with service equipment and installed in accordance with requirements for service conductors;

d) Control circuits for power-operable service-disconnecting means, if suitable overcurrent protection and disconnecting means are provided; and

e) Ground-fault protection systems, if suitable overcurrent protection and disconnecting means are provided.

8.1.2.6 Transfer switches using circuit breakers as the transfer mechanism may use the circuit breaker(s) as the required service disconnect(s). In this case, the operating mechanism shall be such as to prevent automatic closing of the circuit breaker(s) when the service disconnect has been opened via manual means.

8.1.2.7 In a transfer switch intended for use as service equipment, having a service disconnect for both the normal and alternate supplies, each of the service disconnects shall be located in a separate compartment.

8.1.2.8 If any uninsulated live parts ahead of the service disconnect are located below any load terminal or below the neutral disconnect link, barrier(s) shall be provided to prevent a falling tool or other metal part from contacting them. The dimensions of openings in these barriers shall prevent the entry of a 1/2-inch diameter rod.

8.1.2.9 Removable barriers shall be marked in accordance with 5.2.1.28.

8.1.3 Grounding and bonding of neutral circuits

8.1.3.1 A transfer switch marked as being acceptable for use as service equipment shall have provision for connection of the grounding electrode conductor to the grounded service conductor. The size of the grounding electrode conductor shall be assumed to be in accordance with Table 14. A soldering lug or other connection means that depends upon solder is not acceptable.

8.1.3.2 Other than as noted in 8.1.3.3, when a neutral is provided, the provision for connection of the grounding electrode conductor mentioned in 8.1.3.1 shall be on the neutral.

8.1.3.3 The provision for connection of the grounding electrode conductor may be on the equipment grounding terminal assembly or equipment ground bus if the assembly complies with both of the following:

a) The main bonding jumper is a bus bar or wire; and

b) The main bonding jumper is connected directly from the neutral to the equipment grounding terminal assembly.

8.1.3.4 Other than as noted in 8.1.3.5, a transfer switch that is marked for service equipment use shall have a terminal for a grounded service conductor even though it has no provision for a load conductor to be connected to the grounded service conductor. If there is no provision for such a grounded load conductor, the grounded-service conductor terminal shall:

a) Accommodate a conductor of the same size as the main bonding jumper specified in Table 14;

b) Be bonded to the enclosure, or have provisions for being bonded; and

c) Be directly connected to the grounding electrode conductor terminal, or have provisions for being directly connected to the grounding electrode conductor terminal.

8.1.3.5 The terminals may be omitted if the transfer switch is marked as covered in 5.2.6.1.8.

8.1.3.6 A transfer switch marked as being acceptable for service equipment shall be provided with a main bonding jumper consisting of a separate screw, strap, or other means to bond the enclosure to the grounded circuit conductor of an alternating-current circuit, and the construction shall be such that when the bonding means is not used, the spacings given in Table 3 will exist. Unless the intended use and method of installation of the bonding means are obvious, instructions for its installation shall be provided.

8.1.3.7 If there is provision for a load conductor to be connected to the grounded-service conductor, a conductor or terminal connected to the grounded-service conductor shall be insulated from the enclosure as the unit is shipped from the factory.

8.1.3.8 Other than as noted in 8.1.3.9, the main bonding jumper shall be of copper or aluminum and shall have a cross sectional area as specified in Table 14.

8.1.3.9 Steel or brass screws may serve as the main bonding jumper only as indicated by footnotes a – d of Table 14.

8.1.4 Grounded load conductor disconnecting means

8.1.4.1 If a transfer switch has provision for the connection of a grounded load conductor and does not interrupt the grounded load conductor, other means shall be provided for disconnecting the grounded-service conductor from the load conductor.

8.1.4.2 The disconnecting means required in 8.1.4.1 may be a link or similar conducting piece constructed to make connection between two terminals, or it may be a terminal plate or stud provided with wire connectors.

8.1.4.3 A single-wire connector may be employed for the disconnecting means between the grounded load conductor and the grounded-service conductor, as well as the connection of the grounding electrode conductor, provided that the grounded load conductor can be removed without disturbing any other conductors.

8.1.4.4 If a disconnecting means as described in 8.1.4.2 is provided, there shall be provision for the separate connection of the grounded line and load conductors.

8.1.4.5 The grounding-electrode conductor terminal covered in 8.1.3.1 and the main bonding jumper covered in 8.1.3.2 shall connect to the neutral on the supply side of the service-disconnecting means for the neutral covered in 8.1.4.1.

8.1.5 Overcurrent protection

8.1.5.1 The following requirements shall apply:

a) Each ungrounded service conductor shall have overcurrent protection; and

b) The service-overcurrent device shall be an integral part of the service-disconnecting means or be located immediately adjacent thereto.

8.1.6 Ground-fault protection

8.1.6.1 Other than as noted in 8.1.6.2, 8.1.6.3, and 8.1.6.4, a transfer switch marked for use as service equipment for 3-phase, 4-wire, wye-connected services rated in excess of 1000 amps and 150 volts to ground shall be provided with ground-fault protection. The ground-fault sensing and relaying equipment provided shall operate to cause the service-disconnecting means to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amps.

8.1.6.2 If each service-disconnecting means rated 1000 amps or more 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 Test Requirements – Routine Tests, Section 10 and the transfer switch is marked as required by 5.2.6.1.10.

8.1.6.3 Ground-fault protection need not be provided for a transfer switch marked in accordance with 5.2.6.1.11.

8.1.6.4 Ground-fault protection need not be provided on that side of a transfer switch intended for connection to the alternate source, provided that the transfer switch is marked in accordance with 5.2.6.1.12

8.1.6.5 A transfer switch intended and marked for use as a disconnecting device in conjunction with Class I ground-fault sensing and relaying equipment shall have means to reduce the possibility of automatic opening (lockout) if the current in any phase exceeds 850 percent of the switch ampere rating unless tested in accordance with Item 2 of Table 21.

8.1.6.6 Compliance with the requirements specified in 8.1.6.1 anticipates that each service-disconnect device to which the requirement applies is provided with automatic tripping means for actuation by ground-fault sensing and relaying equipment that may although, it is not required to be, a part of the service-disconnect device.

8.1.6.7 Other than as specified in 8.1.6.2, 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.

8.1.6.8 If ground-fault protection is provided, although not required in 8.1.6.1, it shall comply with the requirements for the installation of ground-fault protection equipment as specified in these requirements.

8.1.6.9 A ground-fault protection system described as a zero-sequence type that employs a sensing element that encircles the neutral conductor, if any, and all ungrounded conductors of the protected circuit shall be installed in such a manner that the sensing element is located on the load side of any grounding or bonding connection to the neutral. It may be on the line or load side of the disconnecting device for the protected circuit.

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

8.1.6.11 A ground-fault protection system described as the ground return type that employs a single sensing element to detect the actual fault current shall be installed in such a manner that the sensing element detects any current that flows in the grounding electrode conductor, the main bonding jumper, and any other grounding connections within the equipment that may be made to the neutral. This requires that, except for these connections, the neutral be insulated from the noncurrent-carrying metal as covered in 6.3.1.21.

8.1.6.12 If the design of ground-fault sensing and relaying equipment necessitates a reset operation for restoring the equipment to functional status following operation due to a ground-fault or test, the design shall reduce the possibility of closing and maintaining contact of the disconnecting device to be controlled by the ground-fault sensing and relaying equipment until the reset operation is performed. The reset means may be incorporated in the disconnect device.

8.1.6.13 Overcurrent protection is not required for the operating coil (such as the shunt trip of a circuit breaker) used with ground-fault protection in which the coil is connected to the load side of the transfer switch.

8.1.6.14 The primary of a ground-fault protection control-circuit transformer may be connected on the line or load side of the main disconnect. The primary of the control circuit transformer shall be connected to two line-voltage parts (not to line and neutral). When connected to the line side of the main, a fused disconnect switch or circuit breaker acceptable for service equipment and providing overcurrent protection shall be installed ahead of the transformer or control circuit or both. Overcurrent protection is not required for the control circuit when wired to the load side of the main disconnect unless the control circuit wiring leaves the enclosure.

8.1.6.15 In equipment incorporating ground-fault protection of the ground-return type as described in 8.1.6.11, the main bonding jumper shall be factory connected to the neutral bus and to the enclosure or the ground bus.

8.1.6.16 A transfer switch having ground-fault protection shall be subjected to a factory test as described in Test Requirements – Routine Tests, Section 10, and shall be marked as specified in 5.2.1.25, 5.2.1.26, 5.2.6.1.9, and 5.2.6.1.10.

8.1.7 Guarding against inadvertent contact

8.1.7.1 Service equipment shall be constructed such that, with the service disconnect in the off position, no ungrounded uninsulated live part is exposed to inadvertent contact by persons while servicing any field connected load terminal, including a neutral load terminal, a branch circuit equipment grounding terminal, or the neutral disconnect link. The housing of the switching device is suitable to use as a barrier wall.

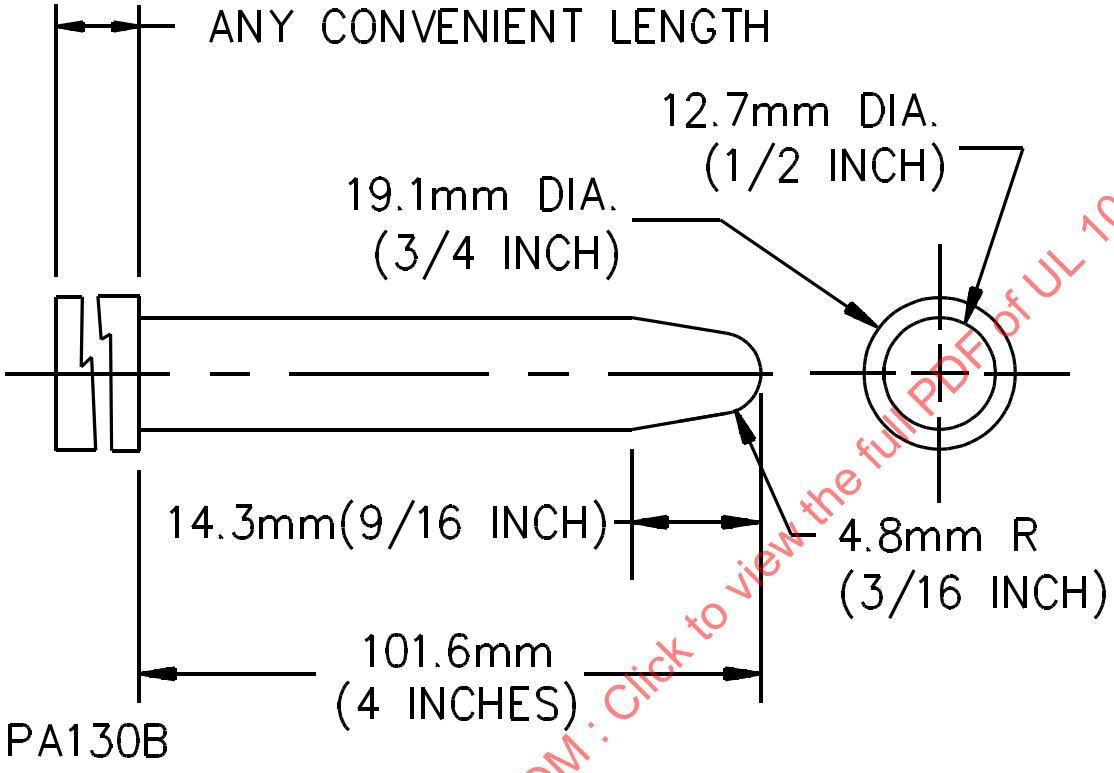
Note: In accordance with Annex A2, Ref. No. 11, an electrically safe work condition should be established prior to working on electrical equipment. Accessibility requirements do not endorse working on energized electrical equipment.

8.1.7.2 In a device having provision for the connection of a grounded service conductor, the disconnecting means referred to in 8.1.2.1 shall simultaneously interrupt the grounded conductor, or other means shall be provided for disconnecting the grounded service conductor from the interior wiring of the building.

8.1.7.3 Exposure to inadvertent contact is determined by use of the probe illustrated in Figure 8.1. If restriction to the line-side of the service disconnect is dependent on the installation of field installed service conductors, conductors sized in accordance with 6.13.1.4 shall be installed in the terminals when determining exposure to inadvertent contact. All live parts of the line side service terminal, including the connector body and pressure screw shall be evaluated.

Figure 8.1

Straight probe



8.1.7.4 Other than as described in 8.1.7.6, metal barriers provided to limit exposure to inadvertent contact shall:

a) Have a thickness not less than 0.032 inch (0.81 mm) if uncoated, not less than 0.034 inch (0.86 mm) if galvanized, and not less than 0.050 inch (1.27 mm) if aluminum; and

b) Be constructed so that it can be readily removed or repositioned, and then re-installed, without damaging the insulation of any insulated live part.

8.1.7.5 Other than as described in 8.1.7.6, nonmetallic barriers provided to limit exposure to inadvertent contact shall:

a) Comply with requirements for barriers used in conjunction with a minimum air space of 0.013 inch (0.33 mm); and

b) Be constructed so that it can be readily removed or repositioned, and then re-installed, to allow access to the terminal for servicing.

8.1.7.6 With reference to 8.1.7.4 and 8.1.7.5, factory installed barriers that limit access to factory installed wiring and terminations are not required to be constructed so that they can be removed or repositioned.

8.1.7.7 Equipment marked “Suitable for use as service equipment” may provide the protection from inadvertent contact in a field installable kit.

8.2 Service equipment for use in Canada

8.2.1 Transfer switch marking

8.2.1.1 A transfer switch marked for use as service equipment shall comply with 8.2.2 – 8.2.3.5.

8.2.2 Service-disconnecting means

8.2.2.1 Service-disconnecting means shall have provisions for the connection of 5.3 mm^2 (10 AWG) or larger conductors or be provided with wiring leads not smaller than 8.4 mm^2 (8 AWG).

8.2.2.2 Other than as noted in 8.2.2.3 – 8.2.2.5, a transfer switch marked for service equipment use in accordance with 5.2.6.2.1 shall be provided with an externally operable load rated service-disconnecting fused switch or circuit breaker to disconnect all ungrounded service conductors. The disconnecting means shall be manually operable by using a mechanical operating handle or an electrically operated switch.

8.2.2.3 The manually operable means required by 8.2.2.2 may be an electrically operated switch or electrically operated circuit breaker. The operating switch(es) for this means shall be externally operable. The electrically operated switch or circuit breaker shall also be capable of being mechanically operated to the open position from the exterior of the service box. The means by which these devices are mechanically operated need not be externally operable from outside the transfer switch enclosure when it complies with 8.2.2.4 and 8.2.2.5.

8.2.2.4 All arcing parts, except the control circuit, shall be shielded to protect the operator against arcing.

8.2.2.5 Operation by hand shall not subject the operator to the risk of electric shock or the risk of injury from adjacent moving parts. This shall be accomplished by guarding live and moving parts only in the vicinity of the operating mechanism.

8.2.2.6 The service-disconnecting means and its associated overcurrent devices shall be located in a separate compartment.

8.2.2.7 Associated equipment that must, by its operation, be connected to the line side of the main service-disconnect switch or circuit breaker, such as phase failure/phase reversal relays, may be installed in the service compartment. The circuits feeding this equipment shall be protected by overcurrent devices with the same interrupting ability as the main overcurrent device. There shall be a means for disconnecting the circuits ahead of these overcurrent devices. A circuit breaker or dead-front fuse assembly shall be deemed to satisfy this requirement.

8.2.2.8 Incoming service conductors shall be capable of being connected to the line side of the main switch or circuit breaker without passing through compartments or raceways containing conductors connected to the load side of the main switch or circuit breaker.

8.2.2.9 There shall be a means for locking and sealing the service-disconnecting switch or circuit breaker compartment to prevent access by unauthorized persons.

8.2.2.10 The handle of the service-disconnecting switch or circuit breaker shall be lockable in the off position.

8.2.2.11 A compartment provided for supply authority (utility) use shall be lockable or have provision for sealing, and shall be marked as specified in 5.2.6.2.2.

8.2.3 Grounding and bonding of neutral circuits

8.2.3.1 Equipment intended to function as service equipment on ac services involving a neutral shall have a neutral assembly located within the service equipment enclosure. The neutral assembly shall have an adequate number of suitable pressure-terminal connectors, clamps, or other acceptable means for connecting the following:

a) The incoming (grounded) neutral conductor;

b) The corresponding outgoing (load) conductor, where present;

c) The service-grounding conductor;

d) The bonding conductor to the enclosure; and

e) The bonding conductor to the service conduit (or the equivalent).

The connectors, clamps, etc., shall be grouped together and shall use pressure-type wire connectors for all field-made terminations. Terminal sizes shall be determined in accordance with Tables 16 and 41 of the Canadian Electrical Code, Part I. Where the neutral assembly is located within the service-disconnecting compartment, a second neutral assembly shall be installed outside the service-disconnecting compartment and within the service equipment enclosure. Where the neutral assembly is located within the service-disconnecting compartment, and where a neutral between the normal power supply source and the emergency power supply source is not interrupted in the transfer switch, a second neutral assembly shall be installed outside the service-disconnecting compartment and within the service equipment enclosure and shall be connected to the neutral assembly located in the service-disconnecting compartment by the conductor sized in accordance with Annex A1, Item 1.

Note: This requirement is intended for a transfer switch that is used with the generator which has a neutral, that is solidly interconnected with the neutral of the supply system in the transfer switch (i.e. where the neutral of the emergency generator is not grounded at the generator, and where a single connection to the grounding electrode is made at the service equipment in order to prevent the possibility of a ground fault at the emergency equipment from bypassing the ground fault protection sensor at the service equipment).

8.2.3.2 The bonding conductor connection specified in 8.2.3.1(d) may be omitted and a non-ferrous screw may be provided for bonding the enclosure to the neutral bar (convertible neutral). For transfer switches rated 125 Amp or less, the screw may be of corrosion resistant or plated steel. The screw shall be not smaller than:

a) No. 10 for switches rated 100 A or less;

b) 6.3 mm in diameter for switches rated over 100 A and up to and including 225 A; or

c) 7.9 mm in diameter for switches rated over 225 A and up to and including 400 A.

8.2.3.3 The neutral assembly specified in 8.2.3.1 shall be insulated from the enclosure, bonded to the enclosure before shipment, and marked in accordance with 5.2.6.2.3. The spacings between the neutral assembly and grounded metal parts shall be no less than that required for the line to neutral system voltage specified in Table 3 when the bond is removed.

8.2.3.4 Ground-fault protection, when provided, shall comply with Rule 14-102 of the Canadian Electrical Code, Part I.

Note: The Canadian Electrical Code, Part I, prohibits ground-fault protection in some circumstances, i.e., for circuits supplying fire pumps (Refer to E2.10 of this standard).

8.2.3.5 Marking for service equipment shall be in accordance with 5.2.6.2.

9 Test Requirements – General

9.1 General

9.1.1 Compliance with constructional requirements

9.1.1.1 To determine whether an automatic transfer switch is in compliance with 7.1.6, the device shall be mounted in its normal operating position. The device, with no load connected, shall be operated as follows:

a) The switch shall be electrically operated to close the normal supply contacts. After the contacts are closed, all voltage sources shall be disconnected. The normal source contact shall remain closed as determined by a continuity tester and

b) The switch shall be electrically operated to close the emergency supply contacts. After the contacts are closed, all voltage sources shall be disconnected. The emergency source contact shall remain closed as determined by a continuity tester.

9.1.1.2 In Mexico and the United States, to determine whether a BCELTS is in compliance with 7.1.7, the device shall be mounted in its normal operating position. The device, with no load connected, shall be operated as follows:

a) The switch shall be electrically operated to close the normal supply contacts. The normal source contact shall close as determined by a continuity tester and

b) After the normal supply contacts are verified to be closed, all voltage sources shall be disconnected. The normal supply contacts shall open and the emergency source contacts shall close and remain closed as determined by a continuity tester.

In Canada, this requirement does not apply.

9.2 Performance

9.2.1 Test sequences

9.2.1.1 The performance of transfer switch equipment shall be investigated by subjecting a representative device or devices in commercial form to the tests described in Table 15. The order of tests as far as applicable, shall be as indicated in Table 15 and, unless otherwise indicated, the various tests shall be conducted at the test frequency and at the test potential indicated in that table.

9.2.2 Samples

9.2.2.1 All tests shall be conducted on enclosed samples. One sample shall complete the overload, temperature, endurance, and dielectric voltage-withstand tests. A previously untested sample may be used for the withstand and closing tests. When multiple specific load uses are specified, additional samples may be used.

9.2.3 Temperature test

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

9.3 Overvoltage condition

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

9.3.2 To determine whether an operating coil complies with the requirement of 9.3.1, the coil shall be subjected to the increased voltage under operating conditions until the coil attains constant temperature.

9.4 Undervoltage condition

9.4.1 The coil of a phase-voltage sensing relay shall be capable of withstanding without damage 95 percent of its rated pull-in voltage for a minimum of 4 hours. Immediately following, the relay shall perform acceptably at its rated voltage and shall be capable of operating continuously at rated voltage without exceeding the maximum temperature rises specified in Table 16.

9.5 Operation on loss of supply voltage

9.5.1 To determine whether an automatic transfer switch complies with the requirements in 7.1.1 – 7.1.26, the switch shall be mounted in the intended manner and the normal and alternate supply terminals shall be connected to separate circuits of voltage and frequency in accordance with Table 15. The switch with no load connected shall be caused to operate by the following means:

a) Test switch; and

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

9.6 Operation on reduction of supply voltage

9.6.1 To determine whether an automatic transfer switch complies with the requirements in 7.1.1 – 7.1.26, the switch shall be mounted in the intended manner and the normal and alternate supply terminals shall be connected to separate circuits of voltage and frequency in accordance with Table 15. The switch with no load connected shall be caused to operate by low normal supply voltage.

9.6.2 In Mexico and the United States, a BCELTS that is not mechanically held in the normal state shall be additionally subjected to the following chatter performance test:

a) The BCELTS shall be connected to a normal source at rated voltage and an emergency source at rated voltage. The sources shall be 180° out of phase from one another.

b) A load shall be connected to the load terminals that complies with the requirements of 9.12.

c) The normal source voltage shall be decreased in 1 volt increments at a rate no faster than 1 volt per second.

1) If the BCELTS changes state from normal to emergency in one event (without chattering), the test shall be considered successful, and no further testing is required.

2) If the BCELTS changes state from normal to emergency and back to normal (i.e., "chatters"), the normal source voltage shall be adjusted to force the BCELTS to continuously chatter. The tests shall continue for a minimum of 60 minutes or until the

BCELTS stops chattering, whichever comes first. At the completion of the test, the BCELTS shall be completely operable and there shall be no evidence that the normal and emergency sources became cross-connected during the test.

In Canada, this requirement does not apply.

9.7 Transfer on availability of alternative voltage or voltage-frequency

9.7.1 To determine whether an automatic transfer switch complies with the requirements in 7.1.24 – 7.1.26, the switch shall be mounted in the intended manner and the normal and alternate supply terminals shall be connected to separate circuits of voltage and frequency in accordance with Table 15. The marked minimum operating values of voltage and frequency shall be verified by:

a) Increasing alternate supply frequency with voltage set at minimum marked operating voltage; and

b) Increasing the alternate supply voltage with frequency set at minimum marked operating frequency.

9.7.2 A closed-transition transfer switch shall be mounted in the intended manner and the normal and alternative supply terminals shall be connected to separate circuits of voltage and frequency in accordance with Table 15. The switch with no load connected shall be caused to attempt to operate under the following conditions:

a) Open-transition mode;

b) Closed-transition mode with sources in synchronization;

c) Closed-transition mode with sources not in synchronization with respect to voltage;

d) Closed-transition mode with sources not in synchronization with respect to frequency; and

e) Closed-transition mode with an external supply or shunt switch or equivalent method to simulate an extended parallel operation.

9.7.3 Operation of the closed-transition transfer switch shall comply with the requirements of 7.1.9.

9.8 Temperature rise test

9.8.1 When tested under the conditions described in 9.8.2 – 9.8.13, transfer switches shall not attain a temperature at any point high enough to constitute a risk of fire or to damage any materials employed in the device, and shall not show temperature rises at specific points greater than those indicated in Table 16.

9.8.2 For the temperature test the transfer switch shall be operated under normal conditions of its intended use and shall carry its test current continuously. Coils and heating elements shall be energized by a source of voltage as specified in Table 15. For other than a coil or heating element, any convenient voltage supply may be used as long as the specified current is caused to flow. The tests on all parts shall be made simultaneously, as the heating of one part may affect the heating of another part.

9.8.3 The test current shall be 100 percent of the rated current. A transfer switch incorporating integral overcurrent protective devices in the main power circuit may be tested at 80 percent of its rated current when marked accordingly. Refer to the marking in 5.2.1.8.

9.8.4 A transfer switch incorporating Class L fuses shall be tested with fuses installed and shall carry 100 percent rated current continuously without the fuses opening.

9.8.5 Other than as noted in 9.8.6, transfer switch equipment that has wiring terminals shall be connected with not less than 1.2 m (4 feet) of copper wire, per terminal. The wire size shall correspond to the rating of the transfer switch as given in 6.13.1.4. The wire type shall be a type which is suitable for field connection in accordance with Annex A1, Item 1. For a transfer switch rated 100 A or less the wire size shall also be based on the temperature rating of the wire as marked on the transfer switch. Where a dual temperature rating is marked, the test shall be conducted with wire based on the ampacity for 75 °C wire.

9.8.6 When there is only provision for the connection of bus bars to a transfer switch rated at 800 A or more, copper bus bars of the size shown in Table 17 and not less than 1.2 m (4 feet) in length shall be used. The spacing between multiple bus bars within each phase shall be 6.4 mm (1/4 inch) or less with no intentional wider spacing except as required at the individual terminals of the transfer switch.

9.8.7 Other than as noted in 9.8.8, for a device employing a fuseholder, a copper bar, copper tubing, or an equivalent material with negligible impedance instead of a fuse shall be used during the test.

9.8.8 A transfer switch incorporating Class L fuses shall be tested with fuses installed and shall carry 100 percent rated current continuously without the fuses opening.

9.8.9 Temperatures shall be measured by thermocouples consisting of wires no larger than 0.21 mm^2 (24 AWG) and no smaller than 0.05 mm^2 (30 AWG), applied to the hottest accessible parts. When thermocouples are used in determining temperatures in electrical equipment, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument shall be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire shall conform with the requirements for special thermocouples as listed in the table of limits of error of thermocouples in Annex A1, Item 17. The thermocouples and related instruments shall be accurate and calibrated in accordance with good laboratory practice.

9.8.10 The primary (preferred) method of measuring the temperature of a coil is the resistance method as specified in 9.8.12, but temperature measurements by either the thermocouple or resistance method are acceptable, except that the thermocouple method shall not be employed for a temperature measurement at any point at which supplementary insulation is employed.

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

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

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

where

ΔT is the temperature rise,

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

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

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

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

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

9.8.13 Unless the resistance can be measured with the device energized, the value of R at shutdown shall be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time may be plotted and extrapolated to give the value of R at shutdown.

9.9 Dielectric voltage-withstand test

9.9.1 A transfer switch device shall be capable of withstanding for a minimum of 1 minute without breakdown the application of 1000 Vac plus twice maximum rated voltage at a frequency in accordance with Table 15:

a) Between uninsulated live parts and the enclosure with the switch alternately closed to each supply source;

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

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

d) Between uninsulated live parts of different circuits;

e) Between terminals of normal source and alternate source with the switch in the normal supply position; and

f) Between terminals of normal source and alternate source with the switch in the alternate supply position.

9.9.2 With reference to 9.9.1, a transformer, a coil, an electronic part, or a similar device normally connected between lines of opposite polarity shall be disconnected from one side of the line during the test described in 9.9.1(b).

9.9.3 To determine whether a transfer switch complies with the requirements in 9.9.1, the device shall be tested by means of a 500 VA or larger capacity transformer, the output voltage of which can be varied. The waveform of the voltage shall approximate a sine wave. The applied potential shall be increased gradually from zero to the required test value, and shall be held at that value for a minimum of 1 minute. The increase in the applied potential shall be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter in the output circuit of the test transformer.

9.10 Overload test

9.10.1 General

9.10.1.1 Overload tests consist of making and breaking specified levels of current, at a rate of operation and for a number of operations based on the rating of the transfer switch.

9.10.1.2 The required test current and power factor for the overload test shall be determined using Table 18.

9.10.1.3 The required number of operations and rate of operation shall be determined using Table 19. One cycle of operation is defined as making and breaking the required test current on both the normal and alternate contacts.

9.10.1.4 The minimum on time in each contact position shall be 0.167 second, unless automatic tripping of the overcurrent device occurs.

9.10.1.5 If a transfer switch has manual operating means that can cause slow opening or closing of the contacts as mentioned in 7.1.14, the last number of operations of the overload test shall be performed at the slowest manual operation possible. The number of manual operations shall be determined using Table 20.

Note: Also refer to 7.1.12.

9.10.2 Sample arrangement

9.10.2.1 The transfer switch under test shall be mounted as intended in service. Open type devices shall be tested in an enclosure having dimensions equal to or smaller than the minimum dimensions specified in the installation instructions as specified by the manufacturer.

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

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

9.10.2.4 A transfer switch having a ventilated enclosure shall have a cotton pad indicator at least 1/2 inch (12.7 mm) thick attached to the outside of the enclosure. The pad shall cover all louvers or other openings.

9.10.2.5 An automatic transfer switch shall be operated through a test switch that will simulate normal source failure. A non-automatic transfer switch shall be operated using its externally mounted manual operating means, or electrically, if so equipped.

9.10.2.6 A transfer switch intended for use on circuits having one conductor grounded shall be tested with the enclosure connected to the grounded conductor through a 30-A nontime-delay Class RK5 or K5 cartridge fuse, having a voltage rating not less than the rating of the transfer switch. If the switch is intended for use on other types of circuits, the enclosure shall be connected through the fuse mentioned above to the live pole least likely to strike to ground. This connection shall be made with 10 AWG copper wire, having a length of 1.2 – 1.8 m (4 – 6 feet).

9.10.3 Test circuit

9.10.3.1 Alternating-current interrupting tests shall be made using a test circuit with a frequency in accordance with Table 15. Transfer switches with DC ratings shall be tested on a DC test circuit.

9.10.3.2 Other than as noted in 9.10.3.3, the test circuit shall have a closed-circuit voltage between 100 and 110 percent of the test potential indicated in Table 15.

9.10.3.3 For a transfer switch rated more than 100 A, the closed-circuit voltage may be between 85 and 100 percent of the test potential indicated Table 15, if the open-circuit voltage is adjusted to be as much above the required test potential as the closed-circuit voltage is below the required test potential, or 110 percent of the required test potential, whichever is less.

9.10.3.4 The overload test or tests shall cover the conditions of maximum voltage, power, and current interrupted.

9.10.3.5 The test for a 3-phase rating shall be considered to cover the same device for single-phase at the same rating.

9.10.3.6 During the test, both the normal and alternate source terminals shall be connected to the test source. The alternate source shall be displaced 120 electrical degrees from the normal source for a 3 phase supply or 180 electrical degrees for a single-phase supply.

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

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

where:

PF is the power factor,

E is the closed-circuit phase voltage, and

I is the phase current.

9.10.4 Assessment of test results

9.10.4.1 At the conclusion of the Overload test, the transfer switch shall comply with 9.10.4.2 – 9.10.4.6.

9.10.4.2 There shall be no ignition of the cotton indicator pad required in 9.10.2.4.

9.10.4.3 The ground fuse required in 9.10.2.6 shall not have opened.

9.10.4.4 There shall have been no electrical or mechanical malfunction of the transfer switch.

9.10.4.5 The transfer switch shall be capable of successfully completing the test sequence as outlined in 9.2.1.

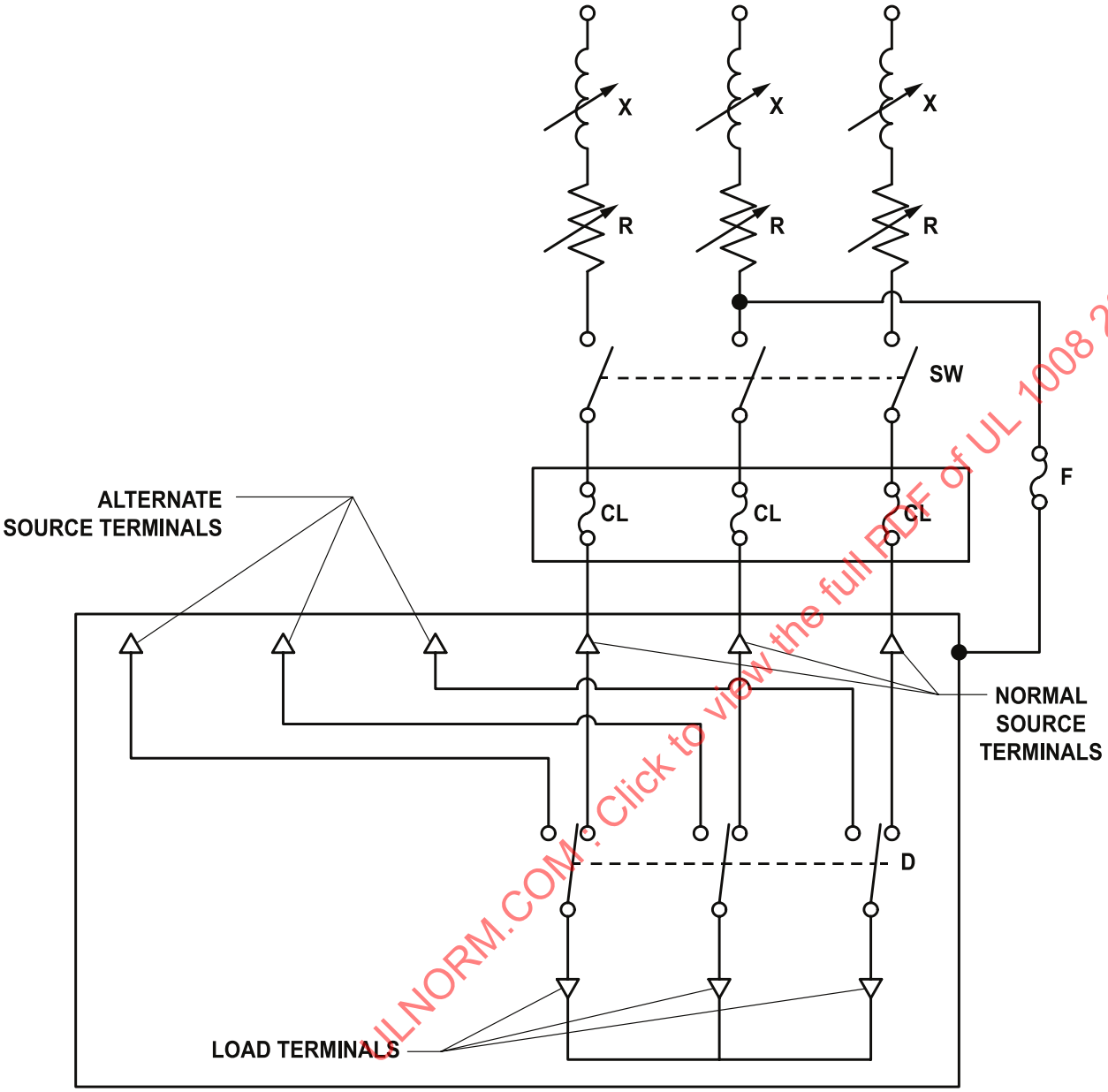
9.10.4.6 The interlocking mechanism shall continue to operate in the intended manner. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections shall not become loose, parts shall not rotate, and the like.

9.11 Contact opening test

9.11.1 A transfer switch intended for use with fuses and marked for use with ground-fault protection that is electrically operated or that has an electrical tripping mechanism shall be capable of being operated electrically to break levels of current as indicated in Table 21. The number of operations shall be three for a poly-phase unit and five for a single-phase unit. All required operations shall be made using the same test sample, and the contacts may be serviced, but not replaced, after each operation. The test shall be conducted at the rated voltage of the switch with the switch connected as shown in Figure 9.1, except that the current-limiting fuses shall be omitted.

Figure 9.1

Circuit for Withstand and Closing Tests



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Legend

Supply – Rated voltage 3-Phase

X – Variable tap air-core reactor

R – Variable resistor

SW – Closing switch – may be located as shown or ahead of limiting impedance

F – Enclosure fuse

D – Device under test

CL – Protective fuses if used

9.11.2 The test-circuit power factor shall be 0.40 – 0.50 for currents of 10,000 A or less, 0.25 – 0.30 for currents of more than 10,000 to 20,000 A, and 0.20 or less for currents greater than 20,000 A. Lower power factors may be used if agreeable to those concerned.

9.11.3 If a transfer switch incorporates fuseholders in the normal or emergency supply, dummy fuses shall be installed in the switch for the contact-opening test. If the fuse mounting means are located in or near the arcing zone of the switch, the dummy fuses shall closely resemble the proper fuse in physical configuration.

9.11.4 At the conclusion of the test, the device shall be in operable condition or capable of being put into operable condition by resetting of trip devices. The fuse indicated in 9.10.2.6 and connected to indicate arc-over to the enclosure or grounded metal shall not have opened.

9.11.5 The overload protector referenced in 7.1.29 shall not open during the test.

9.11.6 The interlocking mechanism shall continue to operate in the intended manner. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections shall not become loose, parts shall not rotate, and the like.

9.11.7 The dielectric voltage-withstand test described in Dielectric voltage-withstand test, 9.9, shall be repeated following the contact opening test.

9.12 Endurance test

9.12.1 The conditions for the endurance test shall be the same as conditions for the overload test as indicated in 9.10. The test current, number of operations, and rate of operation shall be in accordance with Table 22, Table 23, and Table 24.

9.12.2 If tungsten-filament lamps are used as the load, the load shall be made up of the smallest possible number of 500-W lamps, or of larger lamps if agreeable to those concerned. One or two lamps smaller than the 500-W size shall be used if necessary to make up the required load. Only one set of contacts (normal or alternate) are required to perform on tungsten-filament lamp load if the construction of both sets of contacts is identical and the transfer switch has additional ratings.

9.12.3 With regard to 9.12.2, the circuit shall be such that the peak value of the inrush current will be reached in 1/240 of a second after the circuit is closed, and the inrush current shall be ten times the normal current.

9.12.4 A synthetic load may be used in place of tungsten-filament lamps, and may consist of noninductive resistors if they are so connected and controlled that a portion of the resistance is shunted during the closing of the switch under test. A synthetic load may also consist of a non-inductive resistor or resistors, connected in parallel with a capacitor.

9.12.5 If a synthetic load is used in place of tungsten-filament lamps, it shall be equivalent to a tungsten-filament lamp load on the test circuit in question, and the inrush current shall not be less than ten times the normal current in any case.

9.12.6 There shall be no electrical or mechanical malfunction of the device under test. The interlocking mechanism shall continue to operate in the intended manner. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections shall not become loose, parts shall not rotate, and the like.

9.12.7 At the conclusion of the Endurance test, the Dielectric voltage-withstand test, 9.9, shall be conducted.

9.13 Short-circuit test

9.13.1 General

9.13.1.1 In Mexico and the United States, instrumentation and calibration of high capacity circuits shall be performed in accordance with the procedures in Annex H. In Canada, Annex H is informative and represents one acceptable method of calibrating the short-circuit test.

9.13.2 Rated short-circuit making capacity (closing)

9.13.2.1 The transfer switch subjected to the Rated short-circuit capacity (withstand) test in 9.13.3.1 shall also be subjected to a short-circuit closing test. The short-circuit closing test shall be conducted on same set of contacts used in the short-circuit withstand test. Test procedures and conditions for the closing test shall be as described in 9.13.3.7 – 9.13.3.33. The transfer switch shall be closed on the circuit.

9.13.2.2 When an overcurrent protective device as described in 9.13.3.7 is used to conduct the short-circuit closing test, the test circuit closing switch (see Figure 9.1) shall be used to apply the test voltage to the circuit before the transfer switch is closed and until after the overcurrent device interrupts the current.

9.13.2.3 When the short-circuit closing test is conducted for a time duration as described in 9.13.3.10, the test circuit closing switch shown in Figure 9.1 shall be used to apply the test voltage to the circuit before the transfer switch is closed. The test circuit closing switch shall remain closed until current passes through the transfer switch for the time duration marked on the transfer switch as specified in 9.13.3.12. A separate main device (see Figure 9.2) may be used to terminate the test when all of the following conditions are met:

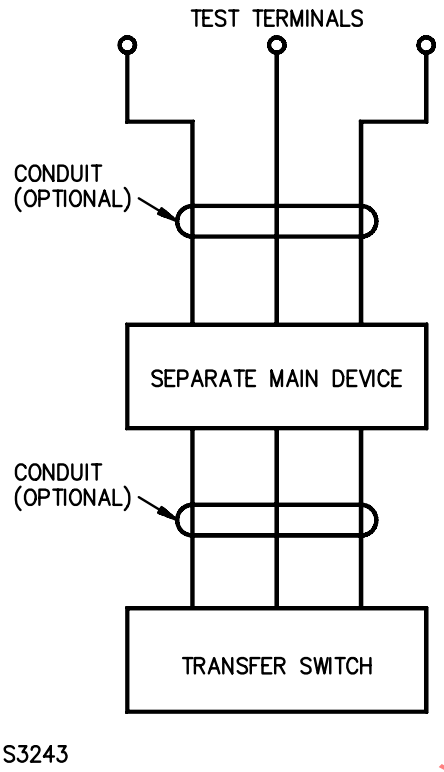
a) The available rms symmetrical current shall be determined at the line terminals of the separate main device;

b) The available rms symmetrical current shall be 10 percent higher than the required test current; and

c) If the separate main device is a current limiting circuit breaker or fuse, the point where it is considered current limiting shall be greater than the required test current.

Figure 9.2

Line connection for tests



9.13.2.4 The test current shall be the same as that used in the withstand test.

9.13.3 Rated short-circuit capacity (withstand)

9.13.3.1 At the conclusion of the withstand test, the transfer switch shall meet the criteria in 9.13.3.2 – 9.13.3.4 as applicable.

9.13.3.2 For transfer switches intended for emergency systems or legally-required standby systems, the switch shall be capable of being operated by its intended means as demonstrated by (a) – (e).

a) It shall be possible to operate the transfer switch to the opposite source (close the switch onto the source which was not subjected to the short-circuit withstand and short-circuit closing test) by the electrical means.

b) For transfer switches with a manual operator, it shall be possible to operate the transfer switch to the untested source. This operation shall be possible by using the manual operator only, without any additional tools, levers, or the like.

c) For transfer switches with both manual and electrical operation, compliance with (a) above shall be demonstrated prior to demonstration of (b) above.

d) The contacts of the untested source side of the switch shall be undamaged during the test. For the purpose of this requirement, any pitting, welding, fracturing, or deformation of the contacts or contact arms is considered to be an indication of damage. If there is any evidence of damage to the contacts of the untested source side, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8, with the test current passing through the contacts of the untested source side.

e) There shall be no continuity between the normal and alternate source terminals with the switch operator in any position. Continuity between the terminals of the tested source and the load terminals is not required.

9.13.3.3 In Mexico and the United States, for transfer switches intended for optional standby systems only, the transfer switch shall be capable of being operated by its intended means as demonstrated by (a) – (e) below:

a) For electrically operated devices, it shall be possible to operate the transfer switch to the off position, if provided by the electrical means. If no off position is provided, it shall be possible to operate the transfer switch to the untested source (close the switch onto the source which was not subjected to the short-circuit withstand and short-circuit closing test) by the electrical means.

b) For transfer switches with a manual operator, it shall be possible to operate the transfer switch to the off position, if provided. If no off position is provided, it shall be possible to operate the transfer switch to the untested source. This operation shall be possible by using the manual operator only, without any additional tools, levers, or the like.

c) For transfer switches with both manual and electrical operation, compliance with (a) above shall be demonstrated prior to demonstration of (b) above.

d) There shall be no continuity between the normal and alternate source terminals with the switch operator in any position. Continuity between either set of source terminals and the load terminals is not required.

e) If the transfer switch can be moved to the untested source such that there is continuity between any of the untested source side terminals and any of the load terminals, the transfer switch shall comply with (1) and (2) below:

1) There shall be continuity on all phases, including any contacts which switch the grounded circuit conductor (the neutral).

2) All the contacts of the untested source side of the switch shall be undamaged during the test. For the purpose of this requirement, any pitting, welding, fracturing, or deformation of the contacts or contact arms is considered to be an indication of damage. If there is any evidence of damage to these contacts of the untested source side, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8, with the test current passing through the contacts of the untested source side.

In Canada, this requirement does not apply.

9.13.3.4 For all transfer switches, (a) – (g)

a) The fuse mentioned in 9.13.3.28 shall not open;

b) There shall be no breakage of the switch base to the extent that the integrity of the mounting of live parts is impaired;

c) The door shall be prevented by its latch, without bolt or lock installed therein, from opening;

d) No conductor shall have pulled out of a terminal connector and there is no damage to the conductor insulation or the conductor;

e) For a plug in or draw out unit, the point of contact shall be the same both mechanically and electrically as before the test;

f) The interlocking mechanism shall continue to operate in the intended manner. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections shall not become loose, parts shall not rotate, and the like; and

g) The transfer switch shall comply with the requirements in the Dielectric voltage-withstand test, 9.9, except that the test potential shall be twice the rated voltage of the switch, but not less than 900 V.

9.13.3.5 Other than as noted in 9.13.3.6, the tests specified in this clause shall be performed on both the normal source and alternate source circuits.

9.13.3.6 If the construction of the normal and alternate source circuits are representative of each other, the test need be conducted on only one circuit.

9.13.3.7 When an overcurrent protective device is used to conduct the test specified in 9.13.3.1, it shall be one of the types defined in (a) – (c) below, based on the markings on the transfer switch (refer to 5.2.3.1 or 5.2.5.1):

a) The integral circuit breaker provided in the transfer switch, if such circuit breaker is part of the design;

b) The maximum ampere rated fuse that can be inserted if integral fuseholders are provided; or

c) An externally connected circuit breaker or fuses, as marked on the transfer switch. The ampere rating of such circuit breakers or fuses shall not be less than 125 percent of the transfer switch ampere rating unless the circuit breaker is listed for operation at 100 percent of its rating, in which case its rating shall not be less that the transfer switch rating. Additional, externally connected circuit breakers may be added to the markings as specified in 5.2.5.1 based on an evaluation using the data from the short-circuit withstand test specified in 9.13.3.1 and the short-circuit closing test specified in 9.13.2. The investigation shall be conducted in compliance with items (1) – (3) below:

1) The duration of time that current passes through the contacts of the switch shall be measured from the short-circuit withstand and short-circuit closing test data. The shortest duration shall be selected from the evaluation.

2) The circuit breaker(s) intended for addition the markings, as selected at the transfer switch manufacturer's discretion, shall be evaluated by use of the published time-current curve for each submitted circuit breaker.

3) The circuit breaker time-current characteristic shall be evaluated in the instantaneous trip region at the current measured for the short-circuit withstand and short-circuit closing tests. If the circuit breaker maximum clearing time, at this current on the time-current characteristic, is less than or equal to the shortest test duration as determined in (1), the circuit breaker is acceptable for addition to the markings as specified in 5.2.5.1.

9.13.3.8 When an externally connected circuit breaker as described in 9.13.3.7(c) is used to conduct the short-circuit withstand test specified in 9.13.3, and the short-circuit closing tests as specified in 9.13.2, the adjustable instantaneous trip setting, if present, shall be adjusted to the maximum setting.

9.13.3.9 When an overcurrent protective device as described in 9.13.3.7 is used to conduct the withstand test, with the transfer switch in the fully closed position, the test voltage shall be applied to the circuit using the test closing switch (see Figure 9.1) until after the overcurrent device interrupts the current. For a magnetically held transfer switch, the magnet shall be held closed electrically.

9.13.3.10 When the test specified in 9.13.3 is conducted for a time duration, with the transfer switch in the fully closed position, the test circuit closing switch (see Figure 9.1) shall be used to apply the test

voltage to the circuit for the time duration as specified in 9.13.3.12. For a magnetically held transfer switch, the magnet shall be held closed electrically. For transfer switches rated over 100 A, a separate main device as shown in Figure 9.2 shall not be used to conduct the test. For transfer switches rated 100 A or less, a separate main device, (see Figure 9.2), may be used to terminate the test, when all of the following conditions are met:

a) The available rms symmetrical current shall be determined at the line terminals of the separate main device;

b) The available rms symmetrical current shall be 10 percent higher than the required test current; and

c) If the separate main device is a current limiting circuit breaker or fuse, the point where it is considered current limiting shall be greater than the required test current.

9.13.3.12 For a time duration test, the test current shall pass through the transfer switch for at least the time duration shown in Table 25. In addition to this time duration test, any other time durations may be tested, including those less than the minimum time duration, but shall be one of the values in Table 27. The transfer switch markings shall be as specified in 5.2.4.1. The marked time duration shall be equal to the duration used during the test.

9.13.3.13 If fuses are used for tests at current levels greater than 10,000 A, a fuse shall be installed in each conductor. The fuse may be external to the switch as shown in Figure 9.1. Other than as noted in 9.13.3.14, each of the fuses shall be of such characteristics that, when tested on a single phase circuit having an available current of not less than the short-circuit rating of the transfer switch, the peak let-through current and maximum clearing I^2t would be not less than the corresponding values specified in the requirements for the class of fuse [J, L, T, or R(RK-5)] and the current and voltage ratings of the fuse intended for use with the device being tested. To obtain the required values of these characteristics, it can be necessary to employ a fuse of a different class or having a current rating higher than that of the fuse specified for use with the device. The values of I_p and I^2t shall be determined at the voltage rating of the fuse, or, with the concurrence of those concerned, the determination of I_p and I^2t may be made at the voltage rating of the transfer switch.

9.13.3.14 The fuse referred to in 9.13.3.13 may be any Class J, L, T, or R(RK-5) fuse without regard to its peak let-through current and maximum clearing I^2t if the test current is below the point (threshold value of the fuse) where the fuse is considered to be current limiting.

9.13.3.15 If a transfer switch has a maximum withstand rating higher than 20 times the switch ampere rating, and if the fuse specified for the test is considered to be current limiting above 20 times the switch rating, the transfer switch shall be subjected to withstand tests:

a) At the maximum withstand rating with fuses in accordance with 9.13.3.13, and

b) At 20 times the switch ampere rating with fuses in accordance with 9.13.3.14.

A separate sample may be used for the second test.

9.13.3.16 If fuses are used for tests at current levels of 10,000 A or less, they shall comply with the limits specified for high-interrupting-capacity Class RK-5 fuses. The fuses, if external, shall be connected as described in 9.13.3.13.

9.13.3.17 A transfer switch intended for use on an alternating-current system shall be tested with alternating current at a frequency in accordance with Table 15 on a circuit as indicated in Figure 9.1. The test shall be performed in accordance with the following:

a) The open-circuit voltage of the power-supply circuit shall not be less than the maximum rated voltage of the switch;

b) Except as noted in (c), the available short-circuit rms symmetrical current in amperes at the test source terminals shall not be less than that shown in Table 25;

c) The available short-circuit current for a transfer switch incorporating circuit breakers shall not be greater than the marked interruption current rating of the breaker;

d) The test source circuit shall include the necessary measuring equipment and the fuse-mounting means if necessary;

e) The power factor of the circuit shall be determined using Table 25; and

f) The test source terminals shall be included in the circuit for the connections described in 9.13.3.19. In determining the available short-circuit current of the circuit, these terminals as well as the fuse-mounting means shall be short-circuited in each instance by bus bars.

9.13.3.18 The reactive components of the impedance in the line shown in Figure 9.1 may be paralleled if of the air-core type, but no reactance shall be connected in parallel with resistances, except that an air-core reactor(s) in any phase may be shunted by resistance as determined in accordance with Annex H, H5.20.

9.13.3.19 For the performance of the test, the line terminals of the switch shall be connected to the corresponding test circuit terminals by the conductor or conductors described in 9.8.5. Lengths shall be in accordance with 9.13.3.25 – 9.13.3.27 and as specified in Annex H, H2.4. The load terminals shall be similarly connected to a short-circuiting bus bar.

9.13.3.20 Other than as noted in 9.13.3.21 – 9.13.3.24, separate short-circuit tests shall be conducted with copper cable and with compact aluminum cable. The cable shall enter the line end of the enclosure at a point that provides the maximum length of unsupported cable within the enclosure. The line terminals shall be wired and tightened to the torque that was used in the investigation of the terminals in accordance with Annex A1, Item 4. There shall be no bracing of the cable inside the enclosure unless the design includes instructions for bracing the conductors as covered in 5.2.1.31. The provision for bracing may be provided with the transfer switch. Bracing hardware not provided as part of the switch shall be available to the installer. A cable shall be braced as it leaves the enclosure on the supply side.

9.13.3.21 The sample shall be tested with copper cable when the transfer switch is restricted to use with copper cable in accordance with 5.2.1.15.

9.13.3.22 The sample shall be tested with aluminum or copper cable when the short-circuit current rating divided by the number of cables per phase results in a current of 50,000 A per cable or less.

9.13.3.23 A transfer switch that does not have provision for wire connection shall be connected with bus bars in accordance with Table 17.

9.13.3.24 When the short-circuit test current rating is greater than 50,000 A per conductor, the test sample shall be tested with either compact aluminum or copper cable when the type of cable used for the short-circuit test has a lower pull out force than the untested cable material.

9.13.3.25 The total length of rated phase conductor or conductors in the test circuit shall not exceed 2.4 m (8 feet) per conductor unless the excess length is included in the test circuit calibration as specified in Annex H, Test Circuit Calibration, Section H2.

9.13.3.26 In a transfer switch provided with integral fuseholders, the supply conductor shall be connected to the terminals of the transfer switch. The test fuses specified in 9.13.3.13 shall be installed in the fuseholder. When the size of the test fuse is such that it cannot fit in the fuseholder, an external fuseholder shall be used. The external fuseholder shall be inserted:

a) Between the load side of the transfer switch and the shorting bar; or

b) On the line side of the transfer switch.

When external fuses are used, a copper bus or tube (dummy fuse) shall be installed in each fuseholder of the transfer switch. The combined length of the supply conductor and of all other conductors, other than the conductors on the load side of the switch, shall be part of the calibrated circuit or shall be in accordance with 9.13.3.25.

9.13.3.27 When a separate main device is used, the method of line connection shall be as shown in Figure 9.2. In the case of a separate fusible main, fuses shall be installed in an external fuseholder. The main device terminals shall be connected by a conductor in accordance with 9.13.3.25. The combined length of each conductor (line, external fuseholder, and connections between the separate main device and transfer switch) shall not exceed the length permitted by 9.13.3.25.

9.13.3.28 The enclosure shall be connected through a 30 A, non-delay-type cartridge fuse to the line lead of the pole least likely to arc to the enclosure. The fuse shall have a voltage rating not less than the rated voltage of the equipment being tested. This connection shall be made on the load side of the limiting impedance by a 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 meters (4 – 6 feet) long. Refer to Figure 9.1.

9.13.3.29 With the switch in the fully closed position, the test circuit shall be closed on the switch. For magnetically operated devices, the magnet shall be held closed electrically.

9.13.3.30 A three-phase transfer switch shall be tested on a three-phase circuit.

9.13.3.31 A single-phase transfer switch, including a design employing adjacent poles of a three-phase construction, shall be tested on a single-phase circuit.

9.13.3.32 Closing for the withstand test on a single-phase circuit shall be controlled so that the closing angle with respect to the zero point of the supply voltage is within +10 degrees.

9.13.3.33 A transfer switch having any of the neutral construction features described in (a) – (c) below shall be subjected to a line-to-neutral short-circuit withstand test as specified in 9.13.3.34 and 9.13.3.35. This test shall be in addition to the line-to-line short-circuit withstand test:

a) A switched neutral of different construction than a power pole;

b) A neutral bus that is spaced closer to a line bus than the spacing between adjacent line buses; or

c) A different means of support for the neutral bus.

9.13.3.34 The line-to-neutral short-circuit withstand test in 9.13.3.33 shall be conducted on the neutral pole or bus and the nearest phase pole or bus.

9.13.3.35 The line-to-neutral short-circuit withstand test in 9.13.3.33 shall be conducted at the marked line-to-neutral voltage. The short-circuit current shall be the same as that used in the line-to-line test.

9.14 Dielectric voltage-withstand test (following short-circuit withstand or closing tests)

9.14.1 A transfer switch that has been subjected to the withstand test and to the closing test shall comply with the requirements in the Dielectric voltage-withstand test, 9.9, except that the test potential shall be twice the rated voltage of the switch, but not less than 900 V.

9.15 Short-time current rating test – optional

9.15.1 General

9.15.1.1 At the conclusion of the Short-Time Current Rating Test, the transfer switch shall comply with 9.15.1.2 – 9.15.1.7.

9.15.1.2 The switch shall comply with items (a) – (g) below:

a) It shall be possible to operate the transfer switch to the opposite source (close the switch onto the source which was not subjected to the Short-time current rating test specified in 9.15.1.1 and short-time closing test specified in 9.15.2.16) by the electrical means, if provided.

b) For transfer switches with a manual operator, it shall be possible to operate the transfer switch to the untested source. This operation shall be possible by using the manual operator only, without any additional tools, levers, or the like.

c) For transfer switches with both manual and electrical operation, compliance with (a) above shall be demonstrated prior to demonstration of (b) above.

d) The contacts of the untested source side of the switch shall be undamaged during the test. For the purpose of this requirement, any pitting, welding, fracturing, or deformation of the contacts or contact arms is considered to be an indication of damage. If there is any evidence of damage to the contacts of the untested source side, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8, with the test current passing through the contacts of the untested source side.

e) There shall be no continuity between the normal and alternate source terminals with the switch operator in any position. Continuity between the terminals of the tested source and the load terminals is required.

f) For devices provided with an "off" position, it shall be possible to operate the transfer switch to the off position. In the off position, there shall be no continuity between any line terminal and the load.

g) The interlocking mechanism shall continue to operate in the intended manner. In addition, all wiring connections shall be examined to determine that there has been no adverse effect – for example, connections shall not become loose, parts shall not rotate, and the like.

9.15.1.3 The fuse mentioned in 9.15.2.11 shall not open.

9.15.1.4 There shall be no breakage of the switch base to the extent that the integrity of the mounting of live parts is impaired.

9.15.1.5 The door shall be restricted by its latch, without bolt or lock installed therein, from opening.

9.15.1.6 No conductor shall have pulled out of a terminal connector, and there shall not be any damage to the conductor insulation or the conductor.

9.15.1.7 For a plug-in or draw-out unit, the point of contact shall be the same both mechanically and electrically as before the test.

9.15.2 Tests conducted on both normal and alternate source circuits

9.15.2.1 Other than as noted in 9.15.2.2, the tests specified in 9.15.2.3 – 9.15.2.19 shall be performed on both the normal source and alternate source circuits.

9.15.2.2 If the construction of the normal and alternate source circuits are representative of each other, the test is only required on one circuit.

9.15.2.3 A transfer switch intended for use on an alternating current system shall be tested with alternating current at a frequency in accordance with Table 15. The circuit shall be as indicated in Figure 9.1. The test shall be performed in accordance with the following:

a) The open circuit voltage of the power supply shall not be less that the maximum rated voltage of the switch;

b) The available short-time rms symmetrical current in amperes at the test source terminals shall not be less than the short-time current rating, as specified by the manufacturer, for the device under test;

c) The test source circuit shall include the required measuring equipment;

d) The power factor of the circuit shall be 0.40 – 0.50 for currents of 10,000 A or less, 0.25 – 0.30 for currents of 10,001 – 20,000 A, and 0.20 or less for currents greater than 20,000 A. Lower power factors may be used if agreeable to those concerned; and

e) The test source terminals shall be included in the circuit for the connections described in 9.15.2.5. In determining the available short-circuit current of the circuit, these terminals shall be short-circuited by bus bars.

9.15.2.4 The reactive components of the impedance may be paralleled in the line shown in Figure 9.1 if of the air-core type. No reactance shall be connected in parallel with the resistance, except that an air-core reactor in any phase may be shunted by resistance as determined in accordance with Annex H, H5.20.

9.15.2.5 For the performance of the test, the line terminals of the switch shall be connected to the corresponding test circuit terminals by the conductor or conductors described in 9.8.5. Lengths shall be in accordance with 9.13.3.25 – 9.13.3.27 and as specified in Annex H, H2.4. The load terminals shall be similarly connected to a short-circuiting bus bar.

9.15.2.6 Other than as noted in 9.15.2.7 – 9.15.2.10, separate short-circuit tests shall be conducted with copper cable and with compact aluminum cable. The cable shall enter the line end of the enclosure at a point that provides the maximum length of unsupported cable within the enclosure. The line terminals shall be wired and tightened to the torque used in the investigation of the terminals in accordance with Annex A1, Item 4. There shall be no bracing of the cable inside the enclosure unless the design includes instructions for bracing the conductors as covered in 5.2.1.31. The provision for bracing may be provided with the transfer switch. Bracing hardware not provided as part of the switch shall be available to the installer. A cable shall be braced as it leaves the enclosure on the supply side.

9.15.2.7 The representative transfer switch shall be tested with copper cable when the transfer switch is restricted to use with copper cable in accordance with 5.2.1.15.

9.15.2.8 The representative transfer switch shall be tested with aluminum or copper cable when the short-circuit current rating divided by the number of cables per phase results in a current of 50,000 A per cable or less.

9.15.2.9 A representative transfer switch that does not have provision for wire connection shall be connected with bus bars in accordance with Table 17.

9.15.2.10 When the short-circuit test current rating is greater than 50,000 A per conductor, the representative transfer switch shall be tested with either compact aluminum or copper cable when the type of cable used for the short-circuit test has a lower pull out force than the untested cable material.

9.15.2.11 The enclosure shall be connected through a 30 A, non-delay-type cartridge fuse to the line lead of the pole least likely to arc to the enclosure. The fuse shall have a voltage rating not less than the rated voltage of the equipment being tested. This connection shall be made on the load side of the limiting impedance by a 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 meters (4 – 6 feet) long. Refer to Figure 9.1.

9.15.2.12 For the test specified in 9.15.1.1, the transfer switch contacts shall be closed. The test circuit closing switch shown in Figure 9.1 shall then be used to apply the test voltage to the circuit. The test circuit closing switch shall remain closed until current passes through the transfer switch continuously for the rated time duration. A separate main device (see Figure 9.2) shall not be used to conduct the test.

9.15.2.13 A three-phase transfer switch shall be tested on a three-phase circuit.

9.15.2.14 A single-phase transfer switch, including a design employing adjacent poles of a three-phase construction, shall be tested on a single-phase circuit.

9.15.2.15 When the test in 9.15.2.12 is conducted on a single-phase circuit, it shall be controlled so that the closing angle with respect to the zero point of the supply voltage is within +10 degrees.

9.15.2.16 The transfer switch subjected to the short-time withstand test in 9.15.1.1 shall also be subjected to a short-time closing test. The short-time closing test shall be conducted on the same set of contacts used in the short-time withstand test. The conditions shall be the same as for the short-time withstand test. The test circuit-closing switch shown in Figure 9.1 shall be used to apply the test voltage to the circuit before the transfer switch is closed. The test circuit-closing switch shall remain closed until current passes through the transfer switch continuously for the time duration intended for marking. A separate main device as shown in Figure 9.2 shall not be used to conduct the test.

9.15.2.17 A transfer switch that has been subjected to the tests in 9.15.1.1 and 9.15.2.16 shall comply with the requirements in the Dielectric voltage-withstand test, 9.9, except that the test potential shall be twice the rated voltage of the switch, but not less than 900 V.

9.15.2.18 Using the contacts subjected to the tests described in 9.15.1.1 and 9.15.2.16, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8. The test current shall be passed through the contacts without maintenance, and the temperature rise shall not exceed the values given in Table 16, increased by 10 °C or 18 °F.

9.15.2.19 The transfer switch markings shall be marked as specified in 5.2.3.3, 5.2.3.4, 5.2.4.4, or 5.2.5.3. The marked time duration shall be equal to lowest time duration measured in either the short-time withstand test or the short-time closing test.

9.16 Receptacle withstand test

Note: In Mexico and the United States, these requirements apply. In Canada, these requirements do not apply.

9.16.1 Other than as noted in 9.16.2 and 9.16.3, a receptacle provided as part of a transfer switch shall be tested as specified in 9.16.5 – 9.16.7 and shall comply with the requirements as specified in 9.16.4.

9.16.2 A non-GFCI type receptacle in a transfer switch marked with a short-circuit current rating of 10,000 amperes or less is not required to be tested if the overcurrent protective device ahead of the receptacle has a minimum short-circuit rating of 10,000 amperes.

9.16.3 A GFCI-type receptacle with a marked short-circuit current rating of 5,000 or 10,000 amperes in a transfer switch having the same short-circuit rating is not required to be tested if the overcurrent protective device ahead of the receptacle has a minimum short-circuit current rating of 5,000 or 10,000 amperes, respectively.

9.16.4 Upon completion of the tests specified in 9.16.3 – 9.16.7:

a) A transfer switch shall comply with the withstand requirements specified in 9.13.3.1;

b) The cord shall not be visibly damaged and, after removing the shorting pressure wire connector, the cord shall withstand a 900-volt potential applied between the individual conductors;

c) A GFCI-type receptacle, if included, shall either open the circuit when the test button is pushed or at the completion of the short-circuit test, have permanently opened the circuit; and

d) A GFCI-type receptacle, if included, shall withstand a 900-volt potential applied between the line and load sides after opening as specified in (c).

9.16.5 The attachment plug shall be wired with 254 mm (10 inches) per terminal of the cord of wire gauge as specified in Table 26 and inserted into the receptacle as intended in service. At the end of the attachment plug, the cord connectors shall be joined in a pressure wire connector rated for the size of conductors involved.

9.16.6 The branch circuit overcurrent protective device, consisting of either a fused switch or a circuit breaker, and all the main overcurrent devices, integral or separate, shall be in the fully closed position. The test circuit shall be closed on the switch by an external switching means.

9.16.7 All switches and overcurrent protective devices, integral or separate, shall be in the fully closed position. The attachment plug, wired with the maximum-sized cord, shall close the circuit by being mechanically inserted into the receptacle.

9.17 Strength of insulating base and support tests

9.17.1 General

9.17.1.1 The insulating base of a transfer switch shall not be damaged when wire connectors securing short lengths of conductors of rated ampacity are torqued to 110 percent of the value marked on the transfer switch.

9.17.1.2 Damage is considered to have occurred if the base insulating material cracks or rotates; bosses, recesses, or other means to prevent turning do not perform their intended function; straps or bus bars bend or twist; or members move at electrical joints. Minor chipping or flaking of brittle insulating material is acceptable if the performance is not otherwise impaired. Momentary flexing of metallic members without permanent deformation is acceptable.

9.17.2 Strain relief tests for leads

9.17.2.1 In order to determine compliance with 6.13.3.3, there shall not be any breakage, damage, or loosening of any component that is detrimental to the use of the switch, including, but not limited to the terminals, strain relief, field-wiring leads, conduit, and similar items, when tested as required in 9.17.2.2.

9.17.2.2 A lead shall be exposed to a direct pull increased gradually to a minimum of 156 N (35 lbf) and maintained at that value for a minimum of 5 minutes. If factory attached conduit is provided, the free end of the conduit shall be fixed with the force applied to the lead.

10 Test Requirements – Routine Tests

Note: In Mexico and the United States, these requirements apply. In Canada, these requirements do not apply.

10.1 Ground-fault protection

10.1.1 Other than as noted in 10.1.2, a factory test shall be conducted on each transfer switch incorporating ground-fault protection equipment to determine that the ground-fault sensing and protective equipment functions. The primary of the control transformer, if any, shall be energized at 57 percent of its voltage rating. The relay may be set for any convenient pick-up value. Following this test, with simulated ground-fault current no longer flowing, an attempt shall be made to close the main switch or circuit breaker without pushing any reset button. If the switch or breaker stays closed, the simulated ground-fault current shall be reapplied, and the ground-fault protection system shall function.

10.1.2 When conducting the test in 10.1.1, the applied voltage may be approximately rated voltage if the particular combination of transformer, ground-fault sensing and relaying equipment, and disconnecting means has been previously tested at 57 percent of rated voltage.

TABLES

Table 1
Short-Circuit Rating – RMS Symmetrical Amperes

5,000
7,500
10,000
14,000
18,000
22,000
25,000
30,000
35,000
42,000
50,000
65,000
85,000
100,000
125,000
150,000
200,000

Table 2
Marking Locations

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
5.2.1.2(a)	Manufacturer name or trademark	B	B
5.2.1.2(b)	Catalog number	B	B
5.2.1.2(c)	The words "Transfer Switch"	B	B
5.2.1.2(d)	Date code	B	B
5.2.1.4	Factory identification	B	V
5.2.1.5	WARNING – More than one live circuit. Disconnect all sources of supply before servicing.	A	B
5.2.1.6	Type of load	B	B
5.2.1.7	Total System transfer	B	B
5.2.1.8	80 or 100 percent current rating	B	B
5.2.1.10	Connection diagram	B	B
5.2.1.11	Use of conduit required between units	B	B
5.2.1.12	Instructions for periodic testing	B	B
5.2.1.13 – 5.2.1.20	Type of wire (Cu and/or Al)	B	B
5.2.1.21 – 5.2.1.22	Temperature rating of conductors	B	B
5.2.1.23	Terminal kit markings	G	G
5.2.1.24	Ventilation requirements	–	B or E
5.2.1.25	Ground-fault circuit protection	B and E	B and E
5.2.1.26	Neutral bus markings	I	I
5.2.1.27	Tightening torque for terminals	B	B
5.2.1.28	Replacement of barriers	F	F
5.2.1.29	Environmental markings	B	B
5.2.1.30	Closed transition transfer	B	B
5.2.1.31	Cable bracing	B	B
5.2.1.32	Automatic transfer switch for emergency systems	B	B
5.2.1.33	Optional Standby only	B	B
5.2.1.34	Plenum rating	B	B
5.2.1.35	Manual Transfer Switch	B	B
5.2.1.36	Verify condition of power source before manual transfer	B	B
5.2.1.37	Field installed bus connections	J	J
5.2.2.1	Transfer voltage	B	B
5.2.2.2	Transfer frequency	B	B
5.2.2.3	Transfer delay time	B	B
5.2.2.4	Adjustment and configuration instructions	B or E	B or E
5.2.2.5	Transfer delayed until generators are on-line	B	B
5.2.2.6	Transfer switch does not transfer if overcurrent device opens	B	B
5.2.3.1	Short-circuit rating for integral overcurrent protection	B	B

Table 2 Continued on Next Page

Table 2 Continued

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
5.2.4.1	Short-circuit rating without integral overcurrent protection	B	B
5.2.5.1	Short-circuit rating (specific overcurrent device)	B	B
5.2.6.1.1, 5.2.6.1.7	Suitable for use as service equipment	B	B
5.2.6.1.2	Separate service disconnect label	C	C
5.2.6.1.3	Suitable only for use as service equipment	B	B
5.2.6.1.4, 5.2.6.1.5	Service disconnect	H	H
5.2.6.1.6	Bonded neutral – Remove bonding device for test purposes only	B	B
5.2.6.1.8	Required terminals	B	B
5.2.6.1.9	Service disconnect with transformer connected to line side	H	H
5.2.6.1.10	Connection of ground-fault protection	B and E	B and E
5.2.6.1.11	Service equipment without ground-fault protection	B	B
5.2.6.1.12	No ground-fault protection for alternate source	B	B
5.2.6.1.13	Service disconnect does not disconnect control and instrument circuits	H	H
5.2.6.1.14	Service disconnect – NORMAL source only	D	D
5.2.6.2.1	Suitable for use as service equipment	B	B
5.2.6.2.2	Compartment for Supply Authority use	B	B
5.2.6.2.3	Bonded neutral	B	B
5.2.6.2.4	Service Disconnect	H	H
5.2.6.2.5	Service Disconnect Inside	A	NA
5.2.7.1	External branch overcurrent protection	B	B
5.2.7.2	Unswitched neutral	B and E	B and E
5.2.7.3	Switched neutral	B and E	B and E
5.2.7.4	Not for indoor use	B and E	B and E
5.2.7.5	Single pole separable connectors	B	B
5.2.7.6	Order of connection	B	B
5.2.7.8	Generator connection	B	B
5.2.7.9	Temporary wiring	B	B
5.2.7.10	Inlets	A	NA
5.2.7.11	Use with a transfer switch	K	NA
5.2.7.12	Disconnection while energized	L	L
5.2.7.13	Generator installed in sight of inlets	A	NA
5.2.8.1	Kit identification	K	K
5.2.8.2	Kit catalog number	G	G
5.2.8.3	Connector kit conductor size	G	G
5.2.8.4	Kit installation instructions	G	G
5.2.8.5	Kit parts and components identification	G	G
5.3.1	Instructions for ground-fault testing	D	D
D14.1	Bypass/isolation operating instructions	A	A

Table 2 Continued on Next Page

Table 2 Continued

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
D14.3	Parts energized in isolation mode	A	A
E6.1	Fire pump power transfer switch	B	B
E6.6	Open all disconnecting means	A	A

In this table, references provided to original clauses indicate that the full clause and any national deviations are applicable. Where specific different marking requirements are contained in national deviations, those national deviation clauses are separately referenced in the table. Where the national deviation replaces the original clause, only the national deviation clause is referenced in the table. Those original clauses not considered to be applicable are not referenced in the table.

[a] This is a brief summary of marking requirements. For complete details, see the specific requirement reference.

[b] For marking locations identified below, "A" is the highest order of location, and "I" is the lowest order of location. At the option of the manufacturer, a higher order of location category may be used. Location "J" is not part of the order of locations.

[c] For the purpose of location of markings, a device which, upon installation, completes an overall enclosure (such as a device mounted to a junction box), shall be considered an enclosed device.

A. Marking shall be visible when the enclosure cover is on and the door is closed.

B. Marking shall be visible:

1) When the enclosure cover is removed or the door is open;

2) When other devices are mounted nearby as intended;

3) When devices are installed side by side with intended clearances; and

4) Without being obscured by attachments such as disconnect switch operating handles.

C. Marking is on a separable, self-adhesive permanent label that is shipped with the device in an envelope or on a card.

D. Marking is on the device or separate sheet provided with the device.

E. Marking is in instructional manual shipped with the device. A marking on the device refers to the specific instruction manual.

F. Marking is provided on the removable barrier.

G. Marking is provided on the kit or shipped separately with the kit.

H. Marking is on or immediately adjacent to the service-disconnect handle and is visible after installation.

I. Marking is on or adjacent to the neutral bus.

J. Marking is on a permanent drawing which is visible after installation or is on a removable tag attached to the bus.

K. Information shall be marked on the transfer switch or in instructions provided with the transfer switch.

L. Marking is adjacent to the inlets and visible when the connectors are being installed and removed.

Table 3
Minimum Acceptable Spacings in millimeters (inches)

Potential involved, in volts		Power circuits rated 400 A maximum and control circuits					
		51 – 150		151 – 300		301 – 1000	
Between any uninsulated live part and an uninsulated live part of opposite polarity	Through air or oil	3.2[a]	(1/8)[a]	6.4	(1/4)	9.5	(3/8)
	Over surface[d,e]	6.4	(1/4)	9.5	(3/8)	12.7	(1/2)
Between any uninsulated live part and an uninsulated grounded part, other than the enclosure, or exposed metal part	Through air or oil	3.2[a]	(1/8)[a]	6.4	(1/4)	9.5	(3/8)
	Over surface[d,e]	6.4	(1/4)	9.5	(3/8)	12.7	(1/2)
Between any uninsulated live part and the walls of a metal enclosure, including	Shortest distance[d,e]	12.7	(1/2)	12.7	(1/2)	12.7	(1/2)

Table 3 Continued on Next Page

Table 3 Continued

fittings for conduit or armored cable							
Potential involved, in volts		**Power circuits rated over 400 A**					
		50 – 150		**151 – 300**		**301 – 1000**	
Between any uninsulated live part and an uninsulated live part of opposite polarity	Through air or oil	12.7	(1/2)	19.1	(3/4)	25.4	(1)
	Over surface[d,e]	19.1	(3/4)	31.8	(1-1/4)	50.8	(2)
Between any uninsulated live part and an uninsulated grounded part, exposed metal part, or walls of a metal enclosure, including fittings for conduit or armored cable[b]	Through air or oil	12.7	(1/2)	19.1	(3/4)	25.4[c]	(1)[c]
	Over surface[d,e]	12.7	(1/2)	12.7	(1/2)	25.4	(1)

[a] The spacing between wiring terminals of opposite polarity and the spacing between a wiring terminal and a grounded part shall not be less than 6.4 mm (1/4 inch) if short-circuiting or grounding of such terminals can result from projecting strands of wire.

[b] For the purpose of this requirement, a metal piece attached to the enclosure shall be considered a part of the enclosure if deformation of the enclosure is likely to reduce spacings between the metal piece and uninsulated live parts.

[c] A through-air spacing of not less than 12.7 mm (1/2 inch) is acceptable:

1) At the main terminals, and

2) Between grounded dead metal and the neutral of a 277/480 V, or 347/600 V, 3-phase, 4-wire transfer switch.

[d] In measuring over-surface spacings, any slots, grooves, and the like, 0.33 mm (0.013 inch) wide or less in the contour of insulating material shall be disregarded.

[e] An air space of 0.33 mm (0.013 inch) or less between a live part and an insulating surface shall be disregarded and the part shall be considered in contact with the insulating material when measuring spacings.

Table 4
Minimum Spacings for Live Parts of Special Components

	Minimum spacing between bare parts of opposite polarity and between bare live parts and grounded metal parts[a], mm		
Type of spacing	51 – 150 V	151 – 375 V	376 – 750 V
Through-air	1.6	1.6	4.8
Over-surface	1.6	3.2	9.4
To enclosure (through-air and over-surface)[b]	6.4	6.4	12.7

[a] Metal parts that are likely to be grounded when the special component is installed shall be considered to be grounded metal parts.

[b] If a special component has a metal enclosure, it shall be protected by the outer enclosure of the complete equipment unless spacings meet the requirements of Table 3.

NOTES:

1 – In Mexico and the United States, this requirement is applicable.

2 – In Canada, this requirement does not apply.

3 – Spacings for equipment rated at voltages below 51 V are not specified in this table, but are subject to investigation.

Table 5
Bushing Dimensions

Trade size of conduit SI (inch)	Overall diameter		Height	
	mm	(in)	mm	(in)
16 (1/2)	25.4	(1.00)	9.5	(0.38)
21 (3/4)	31.4	(1.23)	10.7	(0.42)
27 (1)	40.5	(1.59)	13.1	(0.51)
35 (1-1/4)	49.2	(1.94)	14.3	(0.56)
41 (1-1/2)	56.0	(2.20)	15.1	(0.59)
53 (2)	68.7	(2.70)	15.9	(0.63)
63 (2-1/2)	81.8	(3.22)	19.1	(0.75)
78 (3)	98.4	(3.88)	20.6	(0.81)
91 (3-1/2)	112.7	(4.44)	23.8	(0.94)
103 (4)	126.2	(4.97)	25.4	(1.00)
N/A (4-1/2)	140.9	(5.55)	27.0	(1.06)
129 (5)	158.0	(6.22)	30.2	(1.19)
155 (6)	183.4	(7.22)	31.8	(1.25)

Table 6
Assumed Maximum Short-Circuit Current Ratings for Unmarked Components

Component	Short-circuit current rating, kA
1. Circuit breaker (including GFCI type)	5
2. Clock-operated switch	5
3. Fuseholder	10
4. Luminaire (circuit) internal	5
5. Miniature fuse	10[a]
6. Plug fuse	10
7. Industrial control equipment	
a. Auxiliary device	5
b. Motor controllers or switches (other than mercury tube type)	5
8. Meter socket base	10
9. Receptacle (GFCI type)	2
10. Receptacle (other than GFCI type)	10
11. Snap switch	5
12. Terminal block	10
13. Thermostat	5

NOTES:

1. In Mexico and the United States, this requirement is applicable.

2. In Canada, this requirement does not apply.

[a] The use of these fuses is limited to 125-volt circuits that do not leave the transfer switch.

Table 7
Thickness of Sheet Metal for Enclosures – Carbon Steel or Stainless Steel

Without supporting frame[a]				With supporting frame or equivalent reinforcement[a]				Minimum acceptable thickness, uncoated	
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length[c]			
cm	(inches)	cm	(inches)	cm	(inches)	cm	(inches)	mm	(inches)
10.2	(4.0)	Not limited		15.9	(6.25)	Not limited		0.51[d]	(0.020)[d]
12.1	(4.75)	14.6	(5.75)	17.1	(6.75)	21.0	(8.25)		
15.2	(6.0)	Not limited		24.1	(9.5)	Not limited		0.66[d]	(0.026)[d]
17.8	(7.0)	22.2	(8.75)	25.4	(10.0)	31.8	(21.5)		
20.3	(8.0)	Not limited		30.5	(12.0)	Not limited		0.81	(0.032)
22.9	(9.0)	29.2	(11.5)	33.0	(13.0)	40.6	(16.0)		
31.8	(12.5)	Not limited		49.5	(19.5)	Not limited		1.07	(0.042)
35.6	(14.0)	45.7	(18.0)	53.3	(21.0)	63.5	(25.0)		
45.7	(18.0)	Not limited		68.6	(27.0)	Not limited		1.35	(0.053)
50.8	(20.0)	63.5	(25.0)	73.7	(29.0)	91.4	(36.0)		
55.9	(22.0)	Not limited		83.8	(33.0)	Not limited		1.52	(0.060)
63.5	(25.0)	78.7	(31.0)	88.9	(35.0)	109.2	(43.0)		
63.5	(25.0)	Not limited		66.0	(39.0)	Not limited		1.70	(0.067)
73.7	(29.0)	91.4	(36.0)	104.1	(41.0)	129.5	(51.0)		
83.8	(33.0)	Not limited		129.5	(51.0)	Not limited		2.03	(0.080)
96.5	(38.0)	119.4	(47.0)	137.2	(54.0)	167.6	(66.0)		
106.7	(42.0)	Not limited		162.6	(64.0)	Not limited		2.36	(0.093)
119.4	(47.0)	149.9	(59.0)	172.7	(68.0)	213.4	(84.0)		
132.1	(52.0)	Not limited		203.2	(80.0)	Not limited		2.74	(0.108)
152.4	(60.0)	188.0	(74.0)	213.4	(84.0)	261.6	(103.0)		
160.0	(63.0)	Not limited		246.4	(97.0)	Not limited		3.12	(0.123)
185.4	(73.0)	228.6	(90.0)	261.6	(103.0)	322.6	(127.0)		

[a] See 6.4.1.3 of Annex A1, Item 2.

[b] The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] "Not limited" applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

[d] Steel sheet for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.81 mm (0.032 inch) thick.

Table 8
Thickness of Sheet Metal for Electrical Enclosures – Aluminum, Copper, or Brass

Without supporting frame[a]				With supporting frame or equivalent reinforcement[a]				Minimum acceptable thickness, uncoated	
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length[c]			
cm	(inches)	cm	(inches)	cm	(inches)	cm	(inches)	mm	(inches)
7.6	(3.0)	Not limited		17.8	(7.0)	Not limited		0.58[d]	(0.023)[d]
8.9	(3.5)	10.2	(4.0)	21.6	(8.5)	24.1	(9.5)		
10.2	(4.0)	Not limited		25.4	(10.0)	Not limited		0.74	(0.029)
12.7	(5.0)	15.2	(6.0)	26.7	(10.5)	34.3	(13.5)		
15.2	(6.0)	Not limited		35.6	(14.0)	Not limited		0.91	(0.036)
16.5	(6.5)	20.3	(8.0)	38.1	(15.0)	45.7	(18.0)		
20.3	(8.0)	Not limited		48.3	(19.0)	Not limited		1.14	(0.045)
24.1	(9.5)	39.2	(11.5)	53.3	(21.0)	63.5	(25.0)		
30.5	(12.0)	Not limited		71.1	(28.0)	Not limited		1.47	(0.058)
35.6	(14.0)	40.6	(16.0)	76.2	(30.0)	94.0	(37.0)		
45.7	(18.0)	Not limited		106.7	(42.0)	Not limited		1.91	(0.075)
50.8	(20.0)	63.5	(25.0)	114.3	(45.0)	139.7	(55.0)		
63.5	(25.0)	Not limited		152.4	(60.0)	Not limited		2.41	(0.095)
73.7	(29.0)	91.4	(36.0)	162.6	(64.0)	198.1	(78.0)		
94.0	(37.0)	Not limited		221.0	(87.0)	Not limited		3.10	(0.122)
106.7	(42.0)	134.6	(53.0)	236.2	(93.0)	289.6	(114.0)		
132.1	(52.0)	Not limited		312.4	(123.0)	Not limited		3.89	(0.153)
152.4	(60.0)	188.0	(74.0)	330.2	(130.0)	406.4	(160.0)		

[a] See 6.4.1.3 of Annex A1, Item 2.

[b] The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] "Not limited" applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

[d] Sheet copper, brass, or aluminum for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.74 mm (0.029 inch) thick.

Table 9
Minimum Material Characteristics for the Direct Support of Uninsulated Live Parts

Flame Class[e]	RTI Elec	HWI[b]	HAI[b]	CTI[c,d]
HB	Note a	30 (PLC 2)	60 (PLC 1)	175 (PLC 3)
V-2	Note a	30 (PLC 2)	30 (PLC 2)	175 (PLC 3)
V-1	Note a	15 (PLC 3)	30 (PLC 2)	175 (PLC 3)
V-0	Note a	7 (PLC 4)	15 (PLC 3)	175 (PLC 3)

[a] The electrical RTI value of a material shall be determined in accordance with Annex A1, Item 6, by test or by use of the generic RTI table. This material characteristic is dependent upon the minimum thickness at which the material is being used and shall not be exceeded during the Temperature rise test, 9.8.

[b] The HAI and HWI value of a material shall be determined by test in accordance with Annex A1, Item 5. This material characteristic is dependent upon the minimum thickness at which the material is being used.

[c] The CTI value of a material shall be determined by test in accordance with Annex A1, Item 7. This material characteristic shall not be dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a CTI value, the material is evaluated as having the same CTI value found for the greater thickness.

[d] A material without a CTI value or with a CTI value greater (worse) than the value required by Table 9, shall have a proof tracking index of 175 as determined by the end-product proof tracking test specified in Annex A1, Item 7.

[e] See Annex A1, Item 3 for flame test requirements.

Table 10
Ampacity of Insulated Conductors

Wire size		60 °C (140 °F)		75 °C (167 °F)	
mm²	AWG or kcmil	Copper	Aluminum	Copper	Aluminum
0.20	24	2	–	–	–
0.32	22	3	–	–	–
0.52	20	5	–	–	–
0.82	18	7	–	–	–
1.3	16	10	–	–	–
2.1	14	15	–	15	–
3.3	12	20	15	20	15
5.3	10	30	25	30	25
8.4	8	40	30	50	40
13.3	6	55	40	65	50
21.2	4	70	55	85	65
26.7	3	85	65	100	75
33.6	2	95	75	115	90
42.4	1	110[a]	85[a]	130	100
53.5	1/0	125	100	150	120
67.4	2/0			175	135
85.0	3/0			200	155
107.2	4/0			230	180
127	250			255	205
152	300			285	230
177	350			310	250
203	400			335	270
253	500			380	310

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Table 10 Continued

Wire size		60 °C (140 °F)		75 °C (167 °F)	
mm²	AWG or kcmil	Copper	Aluminum	Copper	Aluminum
304	600			420	340
355	700			460	375
380	750			475	385
405	800			490	395
456	900			520	425
507	1000			545	445
633	1250			590	485
760	1500			625	520
887	1750			650	545
1010	2000			665	560

[a] If the transfer switch is marked to indicate that 75 °C (167 °F) wire shall be used at the terminal, the acceptable current is 130 A for a copper conductor and 100 A for an aluminum conductor.

NOTES

1. For a multiple-conductor at a terminal, the value shall be multiplied by the number of conductors that the terminal accommodates [53.5 mm² (1/0 AWG) or larger].

2. These values of ampacity apply only when not more than 3 conductors are intended to be field installed in the conduit. When 4 or more conductors, other than a neutral that carries the unbalanced current, are intended to be installed in a conduit (which is possible because of the number of conduit hubs provided in an outdoor switch, because the number of wires in certain poly-phase systems, or other reasons) the ampacity of each of those conductors shall be 80 percent of the value given in the table when 4 – 6 conductors are involved, 70 percent of that value when 7 – 24 conductors are involved, and 50 percent of that value if 43 or more conductors are involved.

Table 11
Minimum Width of Gutter and Wire-Bending Space in millimeters (inches)[a]

Size of wire		Wires per pole									
mm²	(AWG or MCM)	1		2		3		4		5	
2.1 – 5.3	(14 – 10)	Not specified									
8.4 – 13.3	(8 – 6)	38.1	(1 1/2)	–		–		–		–	
21.2 – 26.7	(4 – 3)	50.8	(2)	–		–		–		–	
33.6	(2)	63.5	(2 1/2)	–		–		–		–	
42.4	(1)	76.2	(3)	–		–		–		–	
53.5 – 67.4	(1/0 – 2/0)	88.9	(3 1/2)	127	(5)	178	(7)	–		–	
85.0 – 107	(3/0 – 4/0)	102	(4)	152	(6)	203	(8)	–		–	
127	(250)	114	(4 1/2)	152	(6)	203	(8)	254	(10)	–	
152 – 177	(300 – 350)	127	(5)	203	(8)	254	(10)	305	(12)	–	
203 – 253	(400 – 500)	152	(6)	203	(8)	254	(10)	305	(12)	356	(14)
304 – 355	(600 – 700)	203	(8)	254	(10)	305	(12)	356	(14)	406	(16)
380 – 456	(750 – 900)	203	(8)	305	(12)	356	(14)	406	(16)	457	(18)
507 – 633	(1000 – 1250)	254	(10)	–		–		–		–	
760 – 1010	(1500 – 2000)	305	(12)	–		–		–		–	

Note – Products manufactured for use in Canada may use the values in Annex A1, Item 16. In Mexico and the United States, this requirement does not apply.

[a] The table includes only those multiple – conductor combinations that are likely to be used. Combinations not mentioned may be given further consideration.

Table 12
Minimum Wire-Bending Space at Terminals in inches

Wire size,		Wires per terminal (pole)[a]							
AWG or MCM		1		2		3		4 or more	
		mm	in	mm	in	mm	in	mm	in
2.1 – 5.3	14 – 10	Not specified		–		–		–	
8.4	8	38.1	1-1/2	–		–		–	
13.3	6	50.8	2	–		–		–	
21.2	4	76.2	3	–		–		–	
26.7	3	76.2	3	–		–		–	
33.6	2	88.9	3-1/2	–		–		–	
42.4	1	114	4-1/2	–		–		–	
53.5	0	140	5-1/2	140	5-1/2	178	7	–	
67.4	2/0	152	6	152	6	191	7-1/2	–	
85.0	3/0	165 (152)	6-1/2 (6)	165 (152)	6-1/2 (6)	203	8	–	
107	4/0	178 (152)	7 (6)	191 (152)	7-1/2 (6)	216 (203)	8-1/2 (8)	–	
127	250	216 (165)	8-1/2 (6-1/2)	216 (165)	8-1/2 (6-1/2)	229 (203)	9 (8)	254	10
152	300	254 (178)	10 (7)	254 (178)	10 (7)	279 (254)	11 (10)	305	12
177	350	305 (229)	12 (9)	305 (229)	12 (9)	330 (254)	13 (10)	356 (305)	14 (12)
203	400	330 (254)	13 (10)	330 (254)	13 (10)	356 (279)	14 (11)	381 (305)	15 (12)
253	500	356 (279)	14 (11)	356 (279)	14 (11)	381 (305)	15 (12)	406 (330)	16 (13)
304	600	381 (305)	15 (12)	406 (330)	16 (13)	457 (381)	18 (15)	483 (406)	19 (16)
355	700	406 (330)	16 (13)	457 (381)	18 (15)	508 (432)	20 (17)	559 (483)	22 (19)
380	750	432 (356)	17 (14)	483 (406)	19 (16)	559 (483)	22 (19)	610	24 (21)
405	800	457	18	508		508	22	610	24
456	900	483	19	559		610	24	610	24
507	1000	508	20	–		–		–	
633	1250	559	22	–		–		–	
760 – 1010	1500 – 2000	610	24	–		–		–	

[a] Wire-bending space may be reduced to the number shown in parentheses under the following conditions:

1. Only removable wire connectors receiving one wire each are used (there may be more than one removable wire connector per terminal), and

2. The removable wire connectors can be removed from their intended location without disturbing structural or electrical parts other than a cover, and can be reinstalled with the conductor in place.

Table 13
Wiring Space

Maximum size of wire or cable involved		Minimum width and depth of wiring space		Minimum area in square millimeters (square inches) required for multiple wires based on factor of 2.5											
				Two wires		Three wires		Four wires		Five wires		Six wires		Seven wires	
mm^2	AWG / MCM	mm	(inch)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)
3.3	12	9.5	(3/8)	90	(0.14)	135	(0.21)	181	(0.28)	226	(0.35)	271	(0.42)	316	(0.49)
5.3	10	9.5	(3/8)	148	(0.23)	219	(0.34)	297	(0.46)	368	(0.57)	439	(0.68)	516	(0.80)
8.4	8	12.7	(1/2)	277	(0.43)	413	(0.64)	548	(0.85)	690	(1.07)	826	(1.28)	968	(1.50)
13.3	6	15.9	(5/8)	400	(0.62)	600	(0.93)	800	(1.24)	1000	(1.55)	1200	(1.86)	1400	(2.17)
21.2	4	19.1	(3/4)	516	(0.80)	774	(1.20)	1032	(1.60)	1290	(2.00)	1548	(2.40)	1806	(2.80)
26.7	3	19.1	(3/4)	587	(0.91)	877	(1.36)	1174	(1.82)	1465	(2.27)	1755	(2.72)	2052	(3.18)
33.6	2	22.2	(7/8)	665	(1.03)	1000	(1.55)	1329	(2.06)	1665	(2.58)	2000	(3.10)	2329	(3.61)
42.4	1	25.4	(1)	877	(1.36)	1316	(2.04)	1755	(2.72)	2194	(3.40)	2632	(4.08)	3071	(4.76)
53.5	1/0	25.4	(1)	1000	(1.55)	1503	(2.33)	2000	(3.10)	2503	(3.88)	3006	(4.66)	3503	(5.43)
67.4	2/0	25.4	(1)	1155	(1.79)	1729	(2.68)	2310	(3.58)	2884	(4.47)	3458	(5.36)	4039	(6.26)
85	3/0	28.6	(1-1/8)	1342	(2.08)	2006	(3.11)	2684	(4.16)	3348	(5.19)	4013	(6.22)	4690	(7.27)
107	4/0	31.8	(1-1/4)	1561	(2.42)	2342	(3.63)	3123	(4.84)	3903	(6.05)	4684	(7.26)	5465	(8.47)
127	250	34.9	(1-3/8)	1910	(2.96)	2865	(4.44)	3819	(5.92)	4774	(7.40)	5729	(8.88)	6684	(10.36)
152	300	38.1	(1-1/2)	2206	(3.42)	3310	(5.13)	4413	(6.84)	5516	(8.55)	6619	(10.26)	7716	(11.96)
177	350	38.1	(1-1/2)	2458	(3.81)	3690	(5.72)	4916	(7.62)	6148	(9.53)	7381	(11.44)	8606	(13.34)
203	400	41.3	(1-5/8)	2967	(4.60)	4045	(6.27)	5394	(8.36)	6742	(10.45)	8090	(12.54)	9439	(14.63)
253	500	44.5	(1-3/4)	3174	(4.92)	4761	(7.38)	6348	(9.84)	7835	(12.14)	9523	(14.76)	11110	(17.22)
304	600	47.6	(1-7/8)	3852	(5.97)	5781	(8.96)	7703	(11.94)	9632	(14.93)	11561	(17.92)	13484	(20.90)
355	700	50.8	(2)	4310	(6.68)	6465	(10.02)	8619	(13.36)	10774	(16.70)	12929	(20.04)	15083	(23.38)
380	750	50.8	(2)	4542	(7.04)	6813	(10.56)	9084	(14.08)	11355	(17.60)	13626	(21.12)	15896	(24.64)
406	800	54.0	(2-1/8)	4768	(7.39)	7155	(11.09)	9535	(14.78)	11923	(18.48)	14310	(22.18)	16690	(25.87)
456	900	57.2	(2-1/4)	5219	(8.09)	7826	(12.13)	10439	(16.18)	13045	(20.22)	15652	(24.26)	18264	(28.31)
507	1000	57.2	(2-1/4)	5658	(8.77)	8484	(13.15)	11316	(17.54)	14142	(21.92)	16968	(26.30)	19800	(30.69)
633	1250	63.5	(2-1/2)	7116	(11.03)	10677	(16.55)	14232	(22.06)	17794	(27.58)	21355	(33.10)	24910	(38.61)

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Table 13 Continued

Maximum size of wire or cable involved		Minimum width and depth of wiring space		Minimum area in square millimeters (square inches) required for multiple wires based on factor of 2.5											
				Two wires		Three wires		Four wires		Five wires		Six wires		Seven wires	
mm^2	AWG / MCM	mm	(inch)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)	mm^2	(in^2)
760	1500	69.9	(2-3/4)	8219	(12.74)	12329	(19.11)	16439	(25.48)	20548	(31.85)	24658	(38.22)	28768	(44.59)
	1750	73.0	(2-7/8)	9323	(14.45)	13981	(21.67)	18645	(28.90)	23303	(36.12)	27961	(43.34)	32626	(50.57)
1010	2000	79.4	(3-1/8)	10348	(16.04)	15523	(24.06)	20697	(32.08)	25871	(40.10)	31045	(48.12)	36219	(56.14)

Table 14
Size of Grounding Electrode Conductors and Main Bonding Jumper

Ampere rating not exceeding	Size of main bonding jumper (minimum)[e,g,h]		Cross section of main bonding jumper in square inches (mm^2) (minimum)[e,g]				Size of grounding electrode conductor (minimum)	
	Copper	Aluminum	Copper		Aluminum		Copper	Aluminum
90	8 AWG	6 AWG	0.013[a]	(8.4)[a]	0.021[a]	(13.5)[a]	8 AWG	6 AWG
100	6	4	0.021[a]	(13.5)[a]	0.033[a]	(21.3)[a]	6	4
125	6	4	0.021[a]	(13.5)[a]	0.033[a]	(21.3)[a]	6	4
150	6	4	0.021[b]	(13.5)[b]	0.033[b]	(21.3)[b]	6	4
200	4	2	0.033[b]	(21.3)[b]	0.052[b]	(33.5)[b]	4	2
225	2	0	0.052[c,d]	(33.5)[c,d]	0.083[c,d]	(53.5)[c,d]	2	0
400	0[f]	3/0[f]	0.083[d,f]	(53.5)[d,f]	0.132[d,f]	(85.2)[d,f]	0[f]	3/0[f]
500	0	3/0	0.083	(53.5)	0.132	(85.2)	0	3/0
600	2/0	4/0	0.105	(67.7)	0.166	(107)	2/0	4/0
800	2/0	4/0	0.105	(67.7)	0.166	(107)	2/0	4/0
1000	3/0	250 MCM	0.132	(85.2)	0.196	(126)	3/0	250 MCM
1200	250 MCM	250	0.177	(114)	0.196	(126)	3/0	250
1600	300	400	0.236	(152)	0.294	(190)	3/0	250
2000	400	500	0.294	(190)	0.353	(228)	3/0	250
2500	500	700	0.353	(228)	0.515	(332)	3/0	250
3000	600	750	0.412	(266)	0.589	(380)	3/0	250
4000	750	1000	0.589	(380)	0.810	(523)	3/0	250

[a] A 4.2 mm diameter (No. 8) or larger brass or 4.8 mm diameter (No. 10) or larger steel screw may be used.

[b] A 4.8 mm diameter (No. 10) or larger brass or steel screw may be used.

[c] A 4.8 mm diameter (No. 10) or larger brass screw may be used.

[d] A 6.4 mm diameter (1/4 inch) or larger brass or steel screw may be used.

[e] The cross section may be reduced to 12.5 percent of the total cross section of the largest main service conductor(s) of the same material (copper or aluminum) for any phase on service equipment rated 1200 A and above. This applies when the cross section of the service conductors is limited by the wire terminal connectors provided.

[f] When the ampere rating is 400 and the wire terminal connectors for the main service conductors are acceptable for two 3/0 AWG copper or two 250 MCM aluminum conductor, but will not accept a 600 MCM conductor, these values may be reduced to 33.5 mm^2 (2 AWG – 0.052 in^2) copper or 53.5 mm^2 (0 AWG – 0.083 in^2) aluminum.

[g] For service equipment rated 1200 A or more that has wiring terminals intended to connect service conductor wires sized larger than 600 MCM copper or 750 MCM aluminum, the cross section of the main bonding jumper shall be at least 12.5 percent of the total cross section of the largest main service conductor(s) of the same material (copper or aluminum) for any phase.

[h] These are also sizes for the grounded service conductor of 8.1.3.2.

Table 15
Voltage and Frequency for Tests

Test	Voltage rating of device and corresponding test potential in volts[a]					Test frequency
	110 – 120	127	220 – 240	440 – 480	550 – 600	
Normal operation (9.5, 9.6, 9.7, D4)	120	127	240	480	600	d
Overvoltage ac or dc	132	139.7	264	528	660	e
Undervoltage	Refer to 9.4.1					e
Overload[b]	120	127	240	480	600	Max rated
Temperature[c]	120	127	240	480	600	e
Endurance[b]	120	127	240	480	600	Max rated
Dielectric voltage-withstand	Refer to 9.9					e
Withstand	120	127	240	480	600	Max rated
Circuit closing	120	127	240	480	600	Max rated
Contact opening in Mexico and the United States. In Canada, this requirement is not applicable.	120	127	240	480	600	Max rated
Dielectric voltage-withstand	Refer to 9.12.7					e

[a] If the rating of the device does not fall within any of the indicated voltage ranges, it shall be tested at its rated voltage. The overvoltage test shall be conducted at 110 percent of rated voltage.

[b] Refer to 9.10.3.2 and 9.10.3.3.

[c] If a manufacturer supplies transformer or magnet coils for various voltage ratings within specified ranges (for example, 110, 115, or 120 V), and if a coil is supplied for the maximum voltage rating of each range, tests may be conducted on representative coils within each range based on the marked voltage ratings of the coils selected for testing. Unless a coil is provided for the maximum voltage rating for each range, tests shall be conducted on all coils at the potential indicated in the table.

[d] For normal operation tests, test frequency shall be at rated frequency. For devices rated 50/60 Hz, tests other than described in 9.7 may be conducted at either frequency. For devices with multiple frequency ratings the test described in 9.7 shall be conducted at each rated frequency.

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

Table 16
Maximum Acceptable Temperature Rises

Materials and compounds	°C	°F
1. Knife-switch blades and contact jaws	30	54
2. Fuse clips	30[a]	54
3. Rubber- or thermoplastic-insulated conductors[b,c]	35	63
4. Field-wiring terminals:[d]		
Equipment marked for use with 60 °C or 60/75 °C wire[f]	50	90
Equipment marked for use with 90 °C wire	60[e]	108
5. Class 90 (Class 0) insulation systems		
Thermocouple method	50	90
Resistance method	70	126
6. Connecting straps and buses	65	117
7. Class 105 (Class A) insulation systems		
Thermocouple method	65	117

Table 16 Continued on Next Page

Table 16 Continued

Materials and compounds	°C	°F
Resistance method	85	153
8. Class 130 (Class B) insulation systems		
Thermocouple method	85	153
Resistance method	105	189
9. Class 105 (Class A) insulation systems on a single-layer series coil with exposed surfaces either uninsulated or enameled:		
Thermocouple method	90	162
10. Phenolic composition[b]	125	225
11. Fiber employed as electrical insulation[b]	65	117
12. Urea composition[b]	75	135
13. Melamine[b]	125	225
14. The softening point of any sealing compound minus 15 °C (27 °F)	(Refer to 6.9.2)	

[a] Applicable only to devices for use with Class H fuses when tested with dummy fuses installed.

[b] The limitations on insulating materials do not apply to a material or compound that has been certified or approved and has special heat resistance properties.

[c] For standard insulated conductors other than those specified in Item 3 of Table 16, reference shall be made to Annex A1, Item 1. The maximum allowable temperature rise in any case is 25 °C (45 °F) less than the allowable temperature limit of the wire in question.

[d] The temperature on a wiring terminal or lug is measured at the point that will be contacted by the insulation of a conductor installed as in actual service.

[e] Refer to 5.2.1.22 for information on the marking required for devices for which the maximum temperature rise recorded on its terminals exceeds 50 °C (90 °F).

[f] Equipment marked for use with 60 °C or 60/75 °C wire may use 90 °C conductors provided the size shall be determined based on the ampacity of wire rated 75 °C.

Table 17
Size of Copper Bus Bar Connections for Temperature Test

Device rating amperes	Bus bars per terminal	
	Number	Size in mm (inches)
800	1	6.4 by 76 (1/4 by 3)
1200	1	6.4 by 102 (1/4 by 4)
1600	2	6.4 by 76 (1/4 by 3)
2000	2	6.4 by 102 (1/4 by 4)
2500	2	6.4 by 127 (1/4 by 5)
	Or 4	6.4 by 76.2 (1/4 by 2-1/2)
3000	4	6.4 by 102 (1/4 by 4)
4000	4	6.4 by 127 (1/4 by 5)
5000	6	6.4 by 127 (1/4 by 5)
6000	6	6.4 by 152 (1/4 by 6)

Table 18
Method of Determining Test Current for Overload Tests on Transfer Switches

Device used for	Device rated in amperes	Power test current	Power factor
Motor loads or total system load	a-c	6 times rated current	0.40 – 0.50
	d-c	10 times rated current	a
Incandescent lamp control or resistive load[a]	a-c	1.5 times rated current	0.75 – 0.80
	d-c	1.5 times rated current	a
Electric-discharge-lamp control	a-c	3 times rated current	0.40 – 0.50

[a] Noninductive resistive load.

Table 19
Overload Test – Number of Cycles and Rate of Operation

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

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

Table 20
Slow-Opening Contact Evaluation

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

Table 21
Contact Opening – Current Multiplier

Type of switch	Test current
Electrically operated	10 times rated[a]
Electrically tripped	10 times rated

[a] May be six times rated current if the time required to open the switch with the electrical operator is not less than 1-1/2 seconds after initiation by the electrical operator. Need not be performed if the test in 9.10 is conducted at six times rated current.

Table 22
Method of Determining Test Current for Endurance Tests

Device used for	Rated Type of Current	Test current	Power factor
Total system load, motor load or	a-c	See Table 23	0.75 – 0.80
	d-c	See Table 23	a
Resistive loads	a-c	Rated current	a
	d-c	Rated current	a
Incandescent lamp control	a-c	Rated current[c]	b
	d-c	Rated current[c]	b

[a] Noninductive resistive load.

[b] The load shall consist of tungsten-filament lamps or a load having equivalent characteristics. See 9.12.2 and 9.12.5.

[c] The test cycle shall be 1 second "on" and 59 seconds "off". A controller may be operated at a rate of more than 1 cycle per minute if synthetic loads are used or if a sufficient number of banks of lamps controlled by a commutator are employed so that each bank will cool for at least 59 seconds between successive applications of current.

Table 23
Endurance Test Cycles

Switch rating	Rate of operation[a,b]	Number of cycles of operations		
		With current[c]	Without current	Total
0 – 300	1 per minute	6000	–	6000
301 – 400	1 per minute	4000	–	4000
401 – 800	1 per minute	2000	1000	3000
801 – 1600	1 per 2 minutes	1500	1500	3000
1601 and above	1 per 4 minutes	1000	2000	3000

[a] May be conducted at a faster rate if agreeable to those concerned. However, not faster than one operation per minute for tungsten ratings unless synthetic load is employed.

[b] The indicated number of cycles of operation per minute applies only to that part of the test with current. When no current is used, the switch may be operated at any convenient speed representative of intended operation.

[c] For transfer switches rated for total system transfer, motor loads, or electric-discharge lamp loads, the test shall be conducted for one half of the specified number of operations at 200 percent of rated current and for one half of the specified number of operations at 100 percent of rated current.

Table 24
Endurance Test Cycles for Optional Standby Systems Other Than Emergency and Legally-Required

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

NOTES :

1. In Mexico and the United States, this requirement is applicable.

2. In Canada, this requirement does not apply.

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

[b] The test shall be conducted at 100 percent of rated current.

Table 25
Available Short-Circuit Current

Switch rating	Minimum short-circuit current in amperes[a]	Power factor[b]	Time duration test time in seconds, minimum[c]
100 A or less	5,000	0.40 – 0.50	0.008
101 – 400 A	10,000	0.40 – 0.50	0.025
401 A – 1000 A	20 times rating, but not less than 10,000 A	0.25 – 0.30	0.050
1001 A and greater	20 times rating	0.20 or less	0.050

[a] This value may be higher at the option of the manufacturer. The value shall be one of the acceptable values shown in Table 1.

[b] When a switch is tested for a short circuit rating higher than the required minimum, the power factor shall be no greater than that shown in this table for the higher short-circuit rating for which the transfer switch is being tested. At the option of the manufacturer, the power factor for any test may be lower than required by this table.

[c] Test times are minimum values for the time duration test for Type A transfer switches in accordance with 9.13.3.12. In addition to the minimum value test, any other time durations may be tested at the option of the manufacturer but shall be one of the values shown in Table 27.

Table 26
Wire Size for Attachment Plug Test Leads

Rating of receptacle accommodating attachment plug, amperes	Single-phase test leads				3-Phase test leads			
	Minimum		Maximum		Minimum		Maximum	
	mm^2	(AWG)	mm^2	(AWG)	mm^2	(AWG)	mm^2	(AWG)
15	0.82	(18)	2.1	(14)	0.82	(18)	2.1	(14)
20	0.82	(18)	3.3	(12)	0.82	(18)	3.3	(12)
30	1.3	(16)	5.3	(10)	0.82	(18)	8.4	(8)
40	3.3	(12)	8.4	(8)	3.3	(12)	13.3	(6)
50	3.3	(12)	13.3	(6)	3.3	(12)	21.1	(4)

Note – Type SJ cord for sizes 18 – 10 AWG and Type SO cord for 8 AWG and larger.

Table 27
Acceptable Short-Circuit Current Time Durations in Seconds

0.008
0.017
0.025
0.033
0.050
0.067
0.083
0.100

Annex A1
(Normative)

Normative references

Item	CANADA	MEXICO	UNITED STATES
1	CSA C22.1 – Canadian Electrical Code Part I	NOM-001-SEDE, Electrical Installations (Utility)	ANSI/NFPA 70, National Electrical Code
2	CSA C22.2 No 94.1 – Enclosures for Electrical Equipment, Non-Environmental Considerations	NMX-J-235/1-ANCE, Enclosures for electrical equipment, Non-Environmental considerations	UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations
3	CSA C22.2 No 0.17 – Evaluations of Properties of Polymeric Materials	NMX-J-565/3-ANCE, Safety requirements – Flammability of plastic materials for parts in devices and appliances – Test methods	UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
4	CSA C22.2 No. 65 – Wire Connectors and Tables D6 and D7 of the Canadian Electrical Code Part I	NMX-J-543-ANCE, Wire Connectors – Specifications and test methods	UL 486A-486B, Wire Connectors
5	CSA C22.2 No 0.17 – Evaluations of Properties of Polymeric Materials	NMX-J-565/7-ANCE, Safety Requirements – High-current arc resistance to ignition – Test method	UL 746A, Polymeric Materials – Short Term Property Evaluations
6	CSA C22.2 No 0.17 – Evaluations of Properties of Polymeric Materials	Not applicable	UL 746B, Polymeric Materials – Long Term Property Evaluations
7	CSA C22.2 No 0.17 – Evaluations of Properties of Polymeric Materials	Not applicable	UL 746C, Polymeric Materials – Use in Electrical Equipment Evaluations
8	Not applicable	Not applicable	UL 796, Printed wiring boards
9	CSA C22.2 No. 141 – Unit equipment for emergency lighting	Not applicable	UL 924, Emergency Lighting and Power Equipment
10	CSA C22.2 No. 0.8 – Safety Functions Incorporating Electronic Technology	Not applicable	UL 991, Tests for Safety-Related Controls Employing Solid-State Devices
11	CAN/CSA C22.2 No. 0 – General Requirements – Canadian Electrical Code Part II	Not applicable	Not applicable
12	CSA C22.2 No. 178.2 – Requirements for Manually Operated Generator-Transfer Panels	Not applicable	Not applicable
13	CSA C22.2 No 94.2 – Enclosures for Electrical Equipment, Environmental Considerations	NMX-J-235/2-ANCE, Enclosures – Enclosures for electrical equipment – Part 2: Specific requirements – Specifications and test methods	UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
14	CSA C22.2 No 0.17 – Evaluations of Properties of Polymeric Materials – Ball pressure test	Not applicable	ASTM E28-67, Test Method for Softening Point by Ring-and-Ball Apparatus
15	CSA C22.2 No 144.1 – Ground-fault Circuit Interrupters	NMX-J-520-ANCE, Ground-fault Circuit Interrupters – Specifications and test method	UL 943, Ground-fault Circuit-Interrupters
16	CSA C22.2 No. 0.12 – Wiring Space and Wire Bending Space in Enclosures for Equipment rated 750 Volts or less	Not applicable	Not applicable
17	Not applicable	Not applicable	ANSI/ASTM E230/E230M, Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
18	IEEE C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated On A Symmetrical Current Basis	Not applicable	ANSI/IEEE C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated On A Symmetrical Current Basis

Item	CANADA	MEXICO	UNITED STATES
19	CSA C22.2 No. 0.15 – Adhesive Labels	NMX-J-515-ANCE, Distribution and control equipment – Safety general requirements – Specifications and test methods	UL 969, Marking and Labeling Systems
20	CSA C22.2 No 0.2 – Insulation Coordination	Not applicable	UL 840, Insulation Coordination including Clearances and Creepage Distances for Electrical Equipment
21	CSA C22.2 No 0.5 – Threaded Conduit Entries	NMX-J-235/1-ANCE, Enclosures for electrical equipment, Non-Environmental Considerations	UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations
22	CSA C22.2 No. 263 – Fire Pump Controllers	Not applicable	UL 218, Fire Pump Controllers
23	CSA C22.2 No. 4 – Enclosed and Dead-front Switches	NMX-J-162-ANCE, Desconectadores – Desconectadores en gabinete y de frente muerto – Especificaciones y métodos de prueba	UL 98, Enclosed and Dead-front Switches
24	CSA C22.2 No. 5 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures	NMX-J-266-ANCE, Electrical products – Molded case circuit breakers – Specifications and test methods	UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
25	Not applicable	Not applicable	UL 2043, Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
26	CSA C22.2 No. 14 – Industrial Control Equipment	NMX-J-235/1-ANCE, Enclosures for electrical equipment, Non-environmental considerations, NMX-J-235/2-ANCE, Enclosures for electrical equipment, Environmental considerations	UL 508, Industrial Control Equipment
27	CSA C22.1 – Canadian Electrical Code Part I	ANSI/NFPA 20, Installation of Centrifugal Fire Pumps	ANSI/NFPA 20, Installation of Centrifugal Fire Pumps
28	CSA C22.2 No. 0.22 – Evaluation methods for arc resistance ratings of enclosed electrical equipment	IEEE C37.20.7, Guide for Testing Switchgear Rated up to 52 kV for Internal Arcing Faults	IEEE C37.20.7, Guide for Testing Switchgear Rated up to 52 kV for Internal Arcing Faults
29	CSA C22.2 No. 115 – Meter mounting equipment	UL 414, Meter Sockets	UL 414, Meter Sockets

Annex A2
(informative)

Informative References

Item	CANADA	MEXICO	UNITED STATES
1	CSA C22.2 No. 107.3 – Uninterruptible power systems	Not applicable	UL 1778, Uninterruptible Power Systems
2	CSA C22.2 No. 14 – Industrial Control Equipment	NMX-J-515-ANCE, Distribution and control equipment – Safety general requirements – Specifications and test methods	UL 508, Industrial Control Equipment
3	CSA C22.2 No. 0.4 – Bonding of Electrical Equipment	Not applicable	Not applicable
4	CSA C22.2 No. 248.14 – Low-Voltage Fuses – Part 14: Supplemental Fuses	NMX-J-009/248/14-ANCE, Low voltage fuses – Part 14: Supplemental fuses	UL 248-14, Low-Voltage Fuses – Part 14: Supplemental Fuses
5	CSA C22.2 No. 107.1 – Power conversion equipment	Not applicable	UL 1012, Power Units Other than Class 2
6	CAN/CSA C22.2 No. 248.7 – Low Voltage Fuses – Part 7: Class H Renewable Fuses	NMX-J-009/248/7-ANCE, Low voltage fuses – Part 7: Class H renewable fuses	UL 248-7, Low-Voltage Fuses – Part 7: Class H Renewable Fuses
7	CSA C282 – Emergency Electrical Power Supply for Buildings	Not applicable	Not applicable
8	CSA Z32 – Electrical Safety and Essential Electrical Systems in Health Care Facilities	Not applicable	ANSI/NFPA 99, National Fire Protection Association Standard for Health Care Facilities
9	NBCC National Building Code of Canada	Not applicable	Not applicable
10	ANSI Z535.4-2007 – American National Standard for Product Safety Signs and Labels	ANSI Z535.4-2007 – American National Standard for Product Safety Signs and Labels	ANSI Z535.4-2007 American National Standard for Product Safety Signs and Labels
11	CSA Z462 – Workplace Electrical Safety	Not applicable	NFPA 70E, Standard for Electrical Safety in the Workplace

Annex B
(informative)

French Translation of Markings

Clause	English	French
5.2.1.2(c)	Transfer Switch	Commutateur
5.2.1.5	WARNING – more than one live circuit – disconnect all sources of supply before servicing.	AVERTISSEMENT – Plus d'un circuit sous tension – débrancher toutes les sources d'alimentation avant d'entreprendre le dépannage
5.2.1.6	Resistive only	Résistance seulement
5.2.1.6	Tungsten only	Tungsten seulement
5.2.1.6	Ballast only	Ballast seulement
5.2.1.7	Suitable for total system transfer where the tungsten load does not exceed ___ percent of the switch rating.	Convient à la commutation de la charge totale d'un circuit si la charge de tungstène ne dépasse pas de __ pourcent le courant nominal du commutateur.
5.2.1.8	Continuous load current not to exceed xxx percent of switch rating	Le courant de charge continu ne doit pas dépasser de xxx pourcent le courant nominal du commutateur
5.2.1.15	Use copper wire only	Utiliser des fils en cuivre uniquement
5.2.1.16	Use copper or aluminum wire	Utiliser des fils en cuivre ou en aluminium
5.2.1.16	Cu – Al	Cu – Al
5.2.1.16	Al – Cu	Al – Cu
5.2.1.17	Use copper wire only except at terminals _____	Utiliser des fils en cuivre uniquement, sauf aux bornes
5.2.1.19	Cu	Cu
5.2.1.19	CU	CU
5.2.1.19	Al	Al
5.2.1.19	AL	AL
5.2.1.22	AL9	AL9
5.2.1.22	CU9AL	CU9AL
5.2.1.22	AL9CU	AL9CU
5.2.1.26	WARNING – Do not connect grounding conductors to these or any other neutral terminals; doing so defeats ground-fault protection and may violate installation codes.	AVERTISSEMENT – Ne pas raccorder les conducteurs de mise à la terre à ces bornes ou à d'autres bornes neutres; un tel raccordement annulera la protection contre les fuites à la terre et serait contraire aux codes d'installation.
5.2.1.30 G5.2.2	Closed Transition Transfer Will Not Occur Unless Alternate And Normal Sources Are Synchronized.	Le transfert à transition fermée ne se produira pas si les sources normales et auxiliaires ne sont pas synchronisées.
5.2.1.32	Automatic transfer switch for emergency systems	Commutateur automatique
5.2.2.3	Normal to alternate	Normal -auxiliaire
5.2.2.3	Alternate to normal	Auxiliaire- normal
5.2.2.5	TRANSFER TO GENERATOR SOURCE MAY BE DELAYED UNTIL ALL GENERATORS ON-LINE	LE TRANSFERT VERS LA GÉNÉRATRICE PEUT ÊTRE RETARDÉ JUSQU'À CE QUE TOUTES LES GÉNÉRATRICES SOIENT EN LIGNE
5.2.2.6	CAUTION – This switch will not transfer if overcurrent device opens due to fault.	ATTENTION – Ce commutateur n'effectuera pas de transfert si le dispositif de protection contre les surintensité s'ouvre en raison d'un défaut.
5.2.3.2	SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS 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 shall not include a short-time trip response. This transfer switch does not include short-time current ratings.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT Ce commutateur convient aux circuits capables d'acheminer un courant de court-circuit à la tension maximale indiquée plus bas. Si la protection est assurée par un disjoncteur, le disjoncteur ne doit pas être à déclenchement rapide. Ce commutateur n'est pas évalué pour les courants nominaux de courte durée.

Clause	English	French
5.2.3.3	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS 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.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT ET COURANTS NOMINAUX DE COURTE DURÉE Ce commutateur convient aux circuits capables d'acheminer un courant de court-circuit à la tension maximale indiquée plus bas. Si la protection est assurée par un disjoncteur à déclenchement rapide, le déclenchement du disjoncteur doit être coordonné au courant de courte durée du commutateur indiqué plus bas.
5.2.4.3	SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS 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 and shall not include 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. This transfer switch does not include short-time current ratings.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT S'il est protégé par un disjoncteur, ce commutateur convient aux circuits capables d'acheminer un courant de court-circuit pendant la durée et à la tension maximales indiquées plus bas. Le disjoncteur doit être à déclenchement instantané sans déclenchement rapide. Le temps de coupure maximal pour le déclenchement instantané doit être égal ou inférieur à la durée indiquée pour le courant de court-circuit. Ce commutateur n'est pas évalué pour les courants de courte durée.
5.2.4.4	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS 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.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT ET COURANTS NOMINAUX DE COURTE DURÉE S'il est protégé par un disjoncteur, ce commutateur convient aux circuits capables d'acheminer un courant de court-circuit pendant la durée et à la tension maximales indiquées plus bas. Le disjoncteur doit être à déclenchement instantané sauf si le courant de court-circuit est inférieur ou égal au courant nominal de courte durée du commutateur, et si le disjoncteur est à déclenchement rapide. Le temps de coupure maximal pour le déclenchement instantané doit être égal ou inférieur à la durée indiquée pour le courant de court-circuit. Si la protection est assurée par un disjoncteur à déclenchement rapide, le déclenchement du disjoncteur doit être coordonné au courant de courte durée du commutateur indiqué plus bas.
5.2.5.2	SPECIFIC CIRCUIT BREAKER MANUFACTURER AND TYPE LISTING 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.	FABRICANT DU DISJONCTEUR ET TYPE Ce commutateur, s'il est protégé par un disjoncteur dont le nom du fabricant, le type et le courant nominal sont indiqués plus bas, convient aux circuits capables d'acheminer un courant de court-circuit à la tension maximale indiquée plus bas.
5.2.5.3	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS WHEN USING SPECIFIC CIRCUIT BREAKERS 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.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT ET COURANTS NOMINAUX DE COURTE DURÉE POUR DES DISJONCTEURS SPÉCIFIQUES Ce commutateur, s'il est protégé par un disjoncteur dont le nom du fabricant, le type et le courant nominal sont indiqués plus bas, convient à des circuits capables d'acheminer un courant de court-circuit à la tension maximale indiquée plus bas. Si le disjoncteur est à déclenchement rapide, le déclenchement doit être coordonné au courant de courte durée du commutateur indiqué plus bas.
5.2.5.4	SPECIFIC FUSE MANUFACTURER AND TYPE LISTING	FABRICANT DU FUSIBLE ET TYPE

Clause	English	French
	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.	Ce commutateur, s'il est protégé par un fusible dont le nom du fabricant, le type et le courant nominal sont indiqués plus bas, convient à des circuits capables d'acheminer le courant de court-circuit à la tension maximale indiquée.
5.2.5.5	SHORT-CIRCUIT WITHSTAND/CLOSING RATING WHEN PROTECTED BY 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.	COURANTS NOMINAUX DE RÉSISTANCE AU COURT-CIRCUIT ET DE FERMETURE DE CIRCUIT SI LA PROTECTION EST ASSURÉE PAR DES FUSIBLES Ce commutateur, s'il est protégé par un fusible dont la classe et le courant nominal sont indiqués plus bas, convient à un circuit capable d'acheminer le courant de court-circuit à la tension maximale indiquée.
5.2.5.6	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.	Ce commutateur de transfert doit être protégé par les fusibles requis. Lorsqu'il est protégé par un fusible de la classe de fusible spécifique et de l'ampérage maximal indiqué ci-dessous, ce commutateur de transfert convient à une utilisation dans un circuit capable de fournir le courant de court-circuit à la tension maximale indiquée.
5.2.6.2.1	Suitable for use as service equipment	Peut être utilisé comme appareillage de branchement
5.2.6.2.4	Service Disconnect	Sectionneur
5.2.6.2.1	Suitable only for use as service equipment	Utiliser uniquement comme appareillage de branchement
5.2.6.2.2	COMPARTMENT FOR SUPPLY AUTHORITY USE	RÉSERVE AU DISTRIBUTEUR D'ÉLECTRICITÉ
5.2.7.4	Not for indoor use	Ne pas utiliser à l'intérieur
5.2.7.4	For use in a weather protected area only	Utiliser uniquement dans un endroit protégé des intempéries
5.2.7.6	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.	Risque de choc électrique Le raccordement devrait être effectué dans l'ordre qui suit: 1) Conducteur de mise à la terre de l'appareillage 2) Conducteur du circuit mis à la terre 3) Conducteurs non mis à la terre La mise hors tension doit se faire dans l'ordre inverse.
5.2.7.8 F5.5	DANGER – Risk of Electric Shock	DANGER – Risque de choc électrique
5.2.7.8	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	Ne pas mettre la génératrice en marche avant que tous les connecteurs soient connectés ou rendus inaccessibles. N'importe quelle borne peut être mise sous tension si un câble est raccordé. Débrancher les câbles à la génératrice avant de brancher ou de débrancher les connecteurs
5.2.1.35	CAUTION – Manual Transfer Switch – This Device Will Not Automatically Transfer To An Alternative Source	ATTENTION – Commutateur manuel – Ce dispositif ne transfert pas automatiquement une charge vers une source auxiliaire
5.2.1.36	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	AVERTISSEMENT – Vérifier l'état de la source d'alimentation avant un transfert manuel. Une opération manuelle peut entraîner un transfert déphasé si les deux sources sont sous tension
E6.1	Fire Pump Power Transfer Switch	Commutateur pour pompe d'incendie
E6.3	Not suitable for use with a generator as the alternate source	Ne convient pas à une génératrice servant de source d'appoint
E6.4	Not suitable for use with a generator as the primary source	Ne convient pas à une génératrice servant de source principale
E6.5	Suitable for use only with utility supply on both sources	Convient uniquement à l'alimentation de service pour les deux sources
F5.2	Hybrid Transfer Switch	Commutateur hybride
F5.4	WARNING – Capacitor Circuit – Wait 5 Minutes After Opening, Then Verify Capacitors Are Discharged Before Handling	AVERTISSEMENT – Circuit du condensateur – Attendre 5 minutes après l'ouverture, puis vérifier que les condensateurs sont déchargés avant de manipuler

Clause	English	French
F5.5	ISOLATE USING DISCONNECT SWITCHES ON BOTH THE LINE SIDE AND LOAD SIDE OF THE FUSE BEFORE REPLACEMENT	ISOLER AU MOYEN DES SECTIONNEURS CÔTÉ SECTEUR ET CÔTÉ CHARGE DU FUSIBLE AVANT DE REMPLACER
G5.2.1(a)	Softload Transfer Switch	Commutateur pour charge souple
G5.2.2	Transfer Between Sources May be Gradual. Transfer Time May Exceed 100 msec	Le transfert entre les sources peut être graduel. La durée du transfert peut dépasser 100 ms

Annex C
(informative)

Spanish Translation of Markings

Clause	English	Spanish
5.2.1.2(c)	Transfer Switch	Transferencia
5.2.1.5	WARNING – more than one live circuit – disconnect all sources of supply before servicing.	ADVERTENCIA – Más de un circuito vivo – Desconecte todas las fuentes de suministro antes de servicio
5.2.1.6	Resistive only	Sólo resistencia
5.2.1.6	Tungsten only	Sólo tungsteno
5.2.1.6	Ballast only	Sólo balastro
5.2.1.7	Suitable for total system transfer where the tungsten load does not exceed ___ percent of the switch rating.	Adecuado para transferencia completa cuando la carga de tungsteno no exceda ___ por ciento del valor nominal del equipo
5.2.1.8	Continuous load current not to exceed xxx percent of switch rating	La corriente continua de la carga no debe exceder xxx por ciento del valor nominal del equipo
5.2.1.15	Use copper wire only	Usar únicamente conductores de cobre
5.2.1.16	Use copper or aluminum wire	Usar conductores de cobre o aluminio
5.2.1.16	Cu – Al	Cu – Al
5.2.1.16	Al – Cu	Al – Cu
5.2.1.17	Use copper wire only except at terminals _____	Usar únicamente conductores de cobre excepto en las terminales ____
5.2.1.19	Cu	Cu
5.2.1.19	CU	CU
5.2.1.19	Al	AL
5.2.1.19	AL	AL
5.2.1.22	AL9	AL9
5.2.1.22	CU9AL	CU9AL
5.2.1.22	AL9CU	AL9CU
5.2.1.26	WARNING – Do not connect grounding conductors to these or any other neutral terminals; doing so defeats ground-fault protection and may violate installation codes.	ADVERTENCIA – No conecte conductores puestos a tierra a estas terminales o a cualquier otra terminal para el neutro; ya que de hacerlo merma la protección contra falla a tierra e incluso puede violar lo establecido por la norma oficial de instalaciones eléctricas.
5.2.1.30 G5.2.2	Closed Transition Transfer Will Not Occur Unless Alternate And Normal Sources Are Synchronized.	No se presenta una transferencia con transición cerrada a menos que se sincronicen las fuentes alterna y normal.
5.2.1.32	Automatic transfer switch for emergency systems	Transferencia automática para sistemas de emergencia
5.2.2.3	Normal to alternate	Normal a alterno
5.2.2.3	Alternate to normal	Alterno a normal
5.2.2.5	TRANSFER TO GENERATOR SOURCE MAY BE DELAYED UNTIL ALL GENERATORS ON-LINE	LA TRANSFERENCIA A LA FUENTE DEL GENERADOR PUEDE RETRASARSE HASTA QUE TODOS LOS GENERADORES ESTÉN EN LÍNEA
5.2.2.6	CAUTION – This switch will not transfer if overcurrent device opens due to fault.	PRECAUCIÓN – Este equipo no realiza la transferencia si el dispositivo contra sobrecorriente se abre debido a una falla.
5.2.3.2	SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS 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 shall not include a short-time trip response.	AGUANTE DE CORTOCIRCUITO Y VALORES NOMINALES DE CIERRE Esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito para la tensión máxima indicada a continuación. Cuando esté protegida con un interruptor automático, el interruptor no debe incluir una respuesta de disparo de corta duración.

Clause	English	Spanish
	This transfer switch does not include short-time current ratings.	Esta transferencia no incluye corrientes nominales de corta duración.
5.2.3.3	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS 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.	AGUANTE DE CORTOCIRCUITO/CORRIENTES NOMINALES DE CIERRE Y CORTA DURACIÓN Esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito para la tensión máxima indicada a continuación. Cuando esté protegida con un interruptor automático con respuesta de disparo de corta duración, esta respuesta debe coordinarse con la corriente nominal de corta duracón de la transferencia como se muestra a continuación.
5.2.4.3	SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS 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 and shall not include 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. This transfer switch does not include short-time current ratings.	AGUANTE DE CORTOCIRCUITO Y VALORES NOMINALES DE CIERRE Cuando esté protegida con un interruptor automático, esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito para la tensión y duración de tiempo máxima indicada a continuación. El interruptor automático debe incluir una respuesta instantánea de disparo y no debe tener una respuesta de disparo de corta duración. El tiempo máximo de liberación de la respuesta instantánea de disparo debe ser igual o menor que la duración de tiempo de la corriente de cortocircuito marcada. Esta transferencia no incluye corrientes nominales de corta duración.
5.2.4.4	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS 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.	AGUANTE DE CORTOCIRCUITO/CORRIENTES NOMINALES DE CORTA DURACIÓN Y CIERRE Cuando esté protegida con un interruptor automático, esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito para la tensión y duración de tiempo máxima indicada a continuación. El interruptor automático debe incluir una respuesta instantánea de disparo a menos que la corriente de cortocircuito disponible sea menor o igual que el valor nominal de corta duración de la transferencia, y el interruptor automático incluya una respuesta de disparo de corta duración. El tiempo máximo de liberación de la respuesta instantánea de disparo debe ser igual o menor que la duración de tiempo de la corriente de cortocircuito marcada. Cuando esté protegida con un interruptor automático con respuesta de disparo de corta duración, esta respuesta debe coordinarse con la corriente nominal de corta duración de la transferencia como se muestra a continuación.
5.2.5.2	SPECIFIC CIRCUIT BREAKER MANUFACTURER AND TYPE LISTING 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.	INTERRUPTOR AUTOMÁTICO DE UN FABRICANTE EN ESPECÍFICO Y TIPO Cuanto esté protegida con un interruptor automático de un fabricante en específico, del tipo y corriente nominal como se muestra a continuación, la transferencia es adecuada para utilizarse en circuitos capaces de liberar la corriente de cortocircuito a la tensión máxima marcada.
5.2.5.3	SHORT-CIRCUIT WITHSTAND/CLOSING AND SHORT-TIME CURRENT RATINGS WHEN USING SPECIFIC CIRCUIT BREAKERS 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.	AGUANTE DE CORTOCIRCUITO/CORRIENTES NOMINALES DE CIERRE Y CORTA DURACIÓN CUANDO SE UTILIZAN INTERRUPTORES AUTOMÁTICOS ESPECÍFICOS Cuando esté protegida con un interruptor automático de un fabricante en específico, del tipo y corriente nominal como se muestra a continuación, esta transferencia es adecuada para utilizarse en un

Clause	English	Spanish
		circuito capaz de liberar la corriente de cortocircuito a la tensión máxima marcada.
	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.	Si el interruptor automático tiene una respuesta de corta duración, debe coordinarse con la corriente nominal de corta duración de la transferencia mostrada a continuación.
5.2.5.4	SPECIFIC FUSE MANUFACTURER AND TYPE LISTING 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.	FUSIBLE DE UN FABRICANTE EN ESPECÍFICO Y TIPO Cuando esté protegida con un fusible de la clase específica y corriente nominal máxima como se muestra a continuación, esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito a la tensión máxima marcada.
5.2.5.5	SHORT-CIRCUIT WITHSTAND/CLOSING RATING WHEN PROTECTED BY 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.	AGUANTE DE CORTOCIRCUITO/VALOR NOMINAL DE CIERRE CUANDO SE PROTEGE CON FUSIBLES Cuando esté protegida con un fusible de la clase específica y corriente nominal máxima como se muestra a continuación, esta transferencia es adecuada para utilizarse en un circuito capaz de liberar la corriente de cortocircuito a la tensión máxima marcada.
5.2.5.6	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.	Este equipo de transferencia debe protegerse por los fusibles que se requieren. Cuando se protege por un fusible de la clase específica y corriente máxima asignada como se especifica más adelante, este equipo de transferencia es apropiado para uso en un circuito capaz de entregar la corriente de corto circuito a la tensión máxima que se especifica en el marcado.
5.2.6.1.1 5.2.6.2.1	Suitable for use as service equipment	Adecuada para utilizarse como equipo de acometida
5.2.6.1.2 5.2.6.1.4 5.2.6.2.4	Service Disconnect	Desconexión de la acometida
5.2.6.1.3 5.2.6.2.1	Suitable only for use as service equipment	Adecuada para utilizarse únicamente como equipo de acometida
5.2.6.1.6	Bonded Neutral – Remove bonding device for test purposes only	Neutro unido – Retirar el dispositivo de unión únicamente para pruebas
5.2.6.1.11	Suitable For Use As Service Equipment Only When Supplying A Continuous Industrial Process	Adecuada para utilizarse como equipo de acometida únicamente cuando se alimenta un proceso industrial continuo
5.2.6.1.11	Suitable For Use As Service Equipment Only When Supplying Fire Pumps	Adecuada para utilizarse como equipo de acometida únicamente cuando se alimentan bombas contra incendio
5.2.6.1.12	Does not provide ground-fault protection for alternate source	No proporciona protección contra falla a tierra para fuentes alternas
5.2.6.1.13	DANGER	PELIGRO
5.2.6.1.13	Risk of Electric Shock – This service disconnect does not disconnect control or instrument circuits	Riesgo de choque eléctrico – Esta desconexión de acometida no desconecta circuitos de instrumento o control
5.2.6.1.14	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	Adecuada para utilizarse como equipo de acometida – Únicamente fuente NORMAL. Para la alterna debe tenerse disponible una desconexión adicional.
5.2.7.4	Not for indoor use	No destinado para uso en interiores
5.2.7.4	For use in a weather protected area only	Para utilizarse únicamente en un área con clima controlado
5.2.7.6	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.	Riesgo de choque eléctrico La conexión debe realizarse en el orden siguiente: La conexión debe realizarse en el orden siguiente: 1) Conectadores del conductor puesto a tierra del equipo

Clause	English	Spanish
	Disconnection should be in the reverse order.	2) Conectadores del conductor del circuito puesto a tierra, y 3) Conectadores del conductor no puesto a tierra. La desconexión debe realizarse en el orden inverso.
5.2.7.8 F5.5	DANGER – Risk of Electric Shock	PELIGRO – Riesgo de choque eléctrico
5.2.7.8	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.	No encienda el generador hasta después de realizar todas las conexiones o aislarlas. Cualquier terminal puede estar energizada al conectar los cables. Desenergize los cables en el generador antes de conectar o retirar cualquier conectador.
5.2.1.33	TRANSFER SWITCH FOR USE ONLY IN OPTIONAL STANDBY SYSTEMS	TRANSFERENCIA PARA UTILIZARSE ÚNICAMENTE EN SISTEMAS DE RESERVA LEGALMENTE REQUERIDOS
5.2.1.33	MANUAL	MANUAL
5.2.1.33	NON-AUTOMATIC	NO AUTOMATICA
5.2.1.33	AUTOMATIC	AUTOMATICA
E6.1	Fire Pump Power Transfer Switch	Transferencia para alimentar bombas contra incendio
E6.3	Not suitable for use with a generator as the alternate source	No adecuada para utilizarse con un generador como fuente alterna
E6.4	Not suitable for use with a generator as the primary source	No adecuada para utilizarse con un generador como fuente primaria
E6.5	Suitable for use only with utility supply on both sources	Adecuada para utilizarse únicamente con alimentación de la compañía suministradora en ambas fuentes
F5.2	Hybrid Transfer Switch	Transferencia híbrida
F5.4	WARNING – Capacitor Circuit – Wait 5 Minutes After Opening, Then Verify Capacitors Are Discharged Before Handling	ADVERTENCIA – Circuito capacitor – Espere 5 min después de abrir, enseguida cerciórese de que los capacitores estén descargados antes de tocarlos
F5.5	ISOLATE USING DISCONNECT SWITCHES ON BOTH THE LINE SIDE AND LOAD SIDE OF THE FUSE BEFORE REPLACEMENT	AISLAR UTILIZANDO DESCONECTADORES EN AMBOS LADOS, LINEA Y CARGA, DEL FUSIBLE ANTES DEL REEMPLAZO
G5.2.1(a)	Softload Transfer Switch	Transferencia suave
G5.2.2	Transfer Between Sources May be Gradual. Transfer Time May Exceed 100 msec	La transferencia entre las fuentes puede ser gradual. La duración de la transferencia puede ser mayor que 100 ms

Annex D
(normative)

Bypass/Isolation Switches

D1 Scope

D1.1 These requirements cover bypass/isolation switches that can be used to manually select an available power source to feed load circuits and to provide for total isolation of an automatic transfer switch.

D1.2 Bypass/isolation switches are rated in amperes and are 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 this standard.

D1.3 Bypass/isolation switches may be of different types and include:

a) Load break contacts;

b) Overlapping contacts; or

c) Combination of (a) and (b).

D2 Construction – General

D2.1 Construction requirements pertaining to enclosure, corrosion protection, insulating material, bases, mounting of parts, current-carrying parts, wiring, terminals, grounding, and spacings shall be in accordance with Construction Requirements, Section 6.

D2.2 Bypass/isolation switches shall be provided with interlocks to prevent connection of two sources simultaneously. Refer to 7.1.15 – 7.1.20.

D2.3 In addition to D2.2, bypass/isolation switches with overlapping contacts shall be provided with interlocking means to prevent the opening of non-load-break contacts under load.

D2.4 The operating handles shall be externally operated (dead-front) and arranged so that one person can perform the bypass and isolation functions through the operation of a maximum of two handles. The equipment shall have provision for locking in the isolation position. The requirement for a maximum of two handles is not applicable in Canada.

D2.5 Bypass/isolation switches shall be constructed so that the associated automatic transfer switch can be completely isolated from all power sources and loads, including control circuitry. Other than as noted in D2.6, means shall be provided to make power available to the control circuit of the transfer switch for testing purposes and the isolation arrangement shall prevent the transfer switch from being closed on a power source or a load in the isolation position.

D2.6 Power may be available for position-indicator lights, interlock solenoids, engine-start contacts, or equivalent accessories in the transfer-switch compartment when the equipment is in the isolation mode, providing the equipment is marked to so indicate. Refer to D14.3.

D2.7 A pilot light or other visual indication shall be provided to indicate that the bypass/isolation switch is in the bypass or isolation position and that the associated automatic transfer switch is nonfunctional.

D2.8 When the bypass/isolation switch is in the isolation position and the source of supply to the load is transferred from one source to another:

a) Neither power source nor the load shall be connected, momentarily or otherwise, to the associated transfer switch, and

b) Any degree of control circuit isolation (refer to D2.5), provided at the time of transfer, shall be maintained. No momentary connections of other control circuits, or disconnection, shall occur which results in connecting power to these circuits, in the transfer switch.

D2.9 In Canada, a voltage free contact shall be provided for remote annunciation to indicate that the bypass switch is in the bypass position.

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

D3 Performance – General

D3.1 The performance of bypass/isolation switches shall be investigated by subjecting a representative sample or samples in commercial form to the tests described in Sections D4 – D12. Unless otherwise indicated, the various tests shall be conducted at the test frequency and at the test potential indicated in Table 15.

D3.2 Bypass/isolation switches shall be subjected to the tests specified in D4 – D12. The order of tests shall, as applicable, follow the order specified in Table D3.1. One sample shall complete the overload, temperature, endurance, and dielectric voltage-withstand tests, in that order. Alternatively, the temperature test may be performed following the overload and endurance tests. A previously untested sample may be used for the withstand and closing tests. When multiple specific load uses are specified, additional samples may be used. All tests shall be conducted on enclosed samples.

Table D3.1
Test Sequence for Bypass/Isolation Switches

Test	Type of switch		
	A Load-break contacts	B Overlapping contacts	C Combination of A and B
Normal Operation Test, Section D4	X	X	X
Overload Test, Section D5	X	–	X
Temperature Test, Section D6	X	X	X
Endurance Test, Section D7	X	X (no load)	X
Dielectric Voltage-Withstand Test, Section D8	X	X	X
Short-Circuit Withstand Test, Section D9	X	X	X
Short-Circuit Closing Test, Section D11	X	–	X
Dielectric Voltage-Withstand Test (following short-circuit withstand or closing tests), Section D12	X	X	X

D4 Normal Operation Test

D4.1 Bypass/isolation switches shall be capable of operating acceptably for all conditions of their marked intended performance.

D4.2 To determine compliance with D4.1, a bypass/isolation switch shall be operated in each intended position and the effectiveness of all interlocks shall be determined by attempting to place the mechanism in positions intended to be prevented by the interlock.

D5 Overload Test

D5.1 A bypass/isolation switch employing load-break contacts shall perform acceptably when subjected to an overload test in accordance with the Overload test, 9.10.

D6 Temperature Test

D6.1 A bypass/isolation switch shall perform acceptably when subjected to a temperature test in accordance with the Temperature rise test, 9.8.

D6.2 If the configuration and ampacity of the bus bars and switching components used in various modes differ, more than one temperature test can be required.

D7 Endurance Test

D7.1 In Mexico and the United States, other than as noted in D7.2, a bypass/isolation switch shall perform acceptably when subjected to an endurance test in accordance with the Endurance test, 9.12.

In Canada, this requirement does not apply.

D7.2 If a bypass/isolation switch employs overlapping contacts (non-load-break), they may be tested without load for the total number of operations indicated in Table 23.

D8 Dielectric Voltage-Withstand Test

D8.1 A bypass/isolation switch shall perform acceptably when subjected to the dielectric voltage-withstand test in accordance with the Dielectric voltage-withstand test, 9.9.

D9 Short-Circuit Withstand Test

D9.1 Both the bypass contacts and the isolation contacts shall comply with the Rated short-circuit capacity (withstand) test specified in 9.13.3.

D10 Short-Time Current Rating Test (Optional)

D10.1 A bypass/isolation switch shall comply with the requirements in the Short-time current rating test (optional), 9.15.

D11 Short-Circuit Closing Test

D11.1 A bypass/isolation switch employing load-break contacts shall perform acceptably when subjected to a Rated short-circuit making capacity (closing) test, specified in 9.13.2.

D12 Dielectric Voltage-Withstand Test (following short-circuit withstand or closing tests)

D12.1 A bypass/isolation switch that has been subjected to the short-circuit withstand or closing test shall perform acceptably when subjected to the Dielectric voltage-withstand test (following short-circuit withstand or closing tests), 9.14.

D13 Rating – Details

D13.1 A bypass/isolation switch shall be rated in accordance with Summary of characteristics, 4.1.

D14 Marking – Details

D14.1 A bypass/isolation switch shall be marked in accordance with the applicable requirements in Marking requirements, 5.2 and shall also be marked with clear operating instructions.

D14.2 The operating instructions referred to in D14.1 shall be of a permanent type and shall be located on the outside of the enclosure where they will be readily readable by the operator.

D14.3 The marking required in D2.6 shall be located adjacent to the operating instructions.

Annex E (normative)

Transfer Switches for Fire Pump Service

E1 Scope

E1.1 These requirements are intended to cover the additional features required for transfer switches for fire pump service in accordance with Annex A1, Item 1, and Annex A1, Item 27. These transfer switches shall comply with the applicable requirements for transfer switches for emergency systems in accordance with Sections 1 – 10, Annex A1, Annex A2, and Annexes B – D of this standard, except as modified by Annex E.

E1.2 These requirements apply to:

a) Stand-alone open and enclosed fire pump transfer switches which do not include the fire pump controller and do not include disconnecting means; and

b) Stand-alone enclosed fire pump transfer switch assemblies which include disconnecting means and which do not include the fire pump controller.

E1.3 When a fire pump transfer switch is part of a combination transfer switch and fire pump controller assembly, the transfer switch shall meet the requirements of Annex A1, Item 22, and be housed in a barriered compartment of the controller enclosure or in a separate enclosure attached to the controller.

E1.4 These requirements cover transfer switches for the control of motors where the locked rotor current is not more than 6 times the rated amperes of the transfer switch.

E1.5 In Canada, fire pump transfer switches may not be marked as suitable for service entrance.

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

E2 Construction – General

E2.1 A fire pump transfer switch shall be an automatic, electrically operated transfer switch with the contacts mechanically held closed.

E2.2 A fire pump transfer switch shall be provided with manual operating means for maintenance and servicing, which when accessible only by opening the enclosure, shall have all arcing parts, except the control circuit, shielded to protect the operator against arcing in the event of an inadvertent operation of the switch under load. The manual operating means, including the control circuit, shall be located, with regard to other components so that it is accessible for operation without subjecting the operator to the risk of electric shock or injury to persons from adjacent moving parts.

E2.3 A disconnecting means may be installed within the enclosure of a transfer switch assembly such that it is located ahead of the normal and/or alternate supply terminals. In Canada, a disconnecting means shall be installed within the transfer switch enclosure, and shall be located ahead of the alternate supply terminals. In Mexico and the United States, a disconnecting means is optional. A disconnecting means shall comply with either E2.3(a), E2.3(b), or E2.3(c).

a) If an isolating switch is provided, it shall comply with the following:

1) It shall be either a manually operable motor circuit switch that complies with Annex A1, Item 23, or a molded-case switch that complies with Annex A1, Item 24.

2) It shall be externally operable.

3) It shall have an ampere rating at least 100 percent of the transfer switch ampere rating.

4) In Mexico and the United States, a non-load break rated isolating switch operating handle shall be provided with a spring latch that shall be so arranged that it requires the simultaneous releasing of the latch in order to open or close the switch and shall be marked in accordance with E6.7.

5) When a load break rated isolating switch is used, the latch and markings in E6.7 are not required.

6) It shall have a short-circuit rating equal to or greater than the short-circuit rating of the transfer switch assembly as determined by the short-circuit test (see E4.1).

b) If a circuit breaker is provided, it shall comply with the following:

1) It shall comply with Annex A1, Item 24.

2) It shall not be less than 125 percent of the transfer switch ampere rating unless the circuit breaker is rated for operation at 100 percent of its rating, in which case its rating shall not be less than the transfer switch rating.

3) It shall be externally operable and resettable.

4) It shall be trip free of the handle.

5) It shall be marked in accordance with E6.9.

6) It shall have non-thermal type overcurrent sensing elements.

7) It shall have an instantaneous trip to provide the short-circuit rating of the assembly, as determined by the tests described in E4.1.

8) It shall not trip within 25 msec at 24 times the rated amperes of the transfer switch assembly.

9) It shall not trip within 2 minutes at 6 times the rated amperes of the transfer switch assembly.

10) It shall not trip within 10 minutes at 3 times the rated amperes of the transfer switch assembly.

11) It shall have trip settings that are not field adjustable other than by dismantling of the device or breaking of a seal.

c) If both an isolating switch and circuit breaker are provided as a group disconnecting means, they shall comply with the following:

1) The isolating switch shall comply with E2.3(a).

2) The circuit breaker shall comply with E2.3(b).

3) When a molded-case isolating switch is provided with self-protected instantaneous short-circuit overcurrent, it shall be coordinated such that it does not trip unless the circuit breaker trips.

4) For a construction with the isolating switch and the circuit breaker so interlocked that the isolating switch is not capable of being opened nor closed while the circuit breaker is closed, the latch and markings in E2.3(a)(5) are not required and shall be marked as described in E6.8.

5) In Canada, the isolating switch shall be interlocked with the circuit breaker and shall be marked in accordance with E6.7.

6) The line side of the circuit breaker shall be directly connected to the load side of the isolating switch with one pole connected to each ungrounded circuit conductor.

7) The load side of the circuit breaker(s) shall be directly connected to the normal and/or alternate supply terminals of the transfer switch.

E2.4 A fire pump transfer switch shall be provided with undervoltage sensing of all ungrounded conductors for the normal source. If a circuit breaker is provided as part of the transfer switch assembly, the normal source voltage shall be sensed at the load terminals of the circuit breaker. If a circuit breaker is not provided, the normal source voltage shall be sensed at the line terminals of the transfer switch.

E2.5 Transfer to an alternate supply source shall be initiated when the normal voltage on any phase falls below 85 percent of the rated voltage of the motor.

E2.6 Transfer to an alternate supply source shall be initiated upon sensing normal source phase reversal.

E2.7 Other than as noted in E2.8, frequency-sensing shall be provided for the alternate supply. Voltage sensing of all ungrounded conductors of the alternate supply shall be provided. Transfer to the alternate or normal source shall be inhibited until the required voltage and frequency are available for the fire pump load. Any time delays shall be automatically bypassed if the alternative source fails.

E2.8 When the transfer switch is intended for use only with a utility as the alternate source, frequency sensing is not required for the alternate source. The switch shall be marked in accordance with E6.3 or E6.5.

E2.9 Visual indicators shall be provided to indicate to which source the load is connected. In addition, auxiliary open or closed contacts, mechanically operated by the fire pump power transfer switch mechanism, shall be provided for remote indication that the fire pump transfer switch has been transferred to the alternate source.

E2.10 No integral short-circuit, ground-fault, or overcurrent protection shall be provided as part of a fire pump transfer switch. All fire pump transfer switches shall be type A.

E2.11 Other than as noted in E2.12, alternate source starting contacts shall be provided. These contacts shall be provided with a time delay to minimize the occurrence of nuisance starting due to momentary dips and interruptions of the normal source.

E2.12 A transfer switch that is not intended for use with a generator as the alternate source need not be provided with alternate source starting contacts. Such a transfer switch shall be marked in accordance with E6.3 or E6.5.

E2.13 The transfer switch shall be provided with means to prevent the sending of the signal for the starting of an alternate source generator when the isolating switch provided on the alternate source side of the transfer switch is open. Opening the normal source isolating switch or the normal source circuit breaker shall not inhibit operation of the transfer switch.

E2.14 Auxiliary contacts shall be provided to indicate when the alternate source isolating switch and/or alternate source circuit breaker is in the open position.

E2.15 Means and suitable instructions shall be provided to prevent higher than normal inrush currents when transferring the fire pump motor from one source of supply to the other.

E2.16 Fire pump transfer switches shall not be provided with in-phase monitoring between the normal and alternate source.

E2.17 A fire pump transfer switch shall not permit the connection of a load simultaneously to the normal source and the alternate source.

E2.18 The enclosure of a fire pump transfer switch shall comply with the requirements of a Type 2 Enclosure as defined by Annex A1, Items 2 and 13.

E2.19 Insulated conductors shall be suitable for the service intended with respect to voltage, temperature, and grouping. Conductors shall be copper and shall be not smaller than 0.2 mm^2 (24 AWG). The temperature rating shall be not less than 90 °C (194 °F) unless investigation proves the suitability of other conductors.

E2.20 The bus bars, conductors, and wiring devices in the power circuits shall be rated for continuous duty.

E3 Performance

E3.1 The performance of a fire pump transfer switch shall be investigated by subjecting the representative switch or switches in commercial form to the tests described in Test Requirements – General, Section 9, and Annex D, if applicable.

E3.2 The performance of a fire pump transfer switch assembly which includes disconnecting means on the normal and/or alternate supply input shall be additionally investigated by subjecting the representative assembly or assemblies in commercial form to the tests described in Performance Tests – Transfer Switch Assembly, Section E4.

E4 Performance Tests – Transfer Switch Assembly

E4.1 Short-circuit test (short-circuit rating)

E4.1.1 A fire pump transfer switch assembly that includes a circuit breaker on the normal and/or alternate supply input shall be tested to verify the short-circuit rating. The test shall be conducted at an available short-circuit current and shall be in accordance with Table 25.

E4.1.2 The test described in E4.1.3 shall be conducted on each transfer switch supply input (normal or alternate source) that is connected to a circuit breaker. If both supply inputs are connected to a circuit breaker and the construction of the transfer switch normal and alternate source circuits are representative of each other, the test may be conducted on either supply input if:

a) Each supply input is connected only to a circuit breaker and the manufacturer, rating, and construction of the circuit breakers are the same; or

b) Each supply input is connected to a circuit breaker and an isolating switch and the manufacturer, rating, and construction of the circuit breakers and isolating switches are the same.

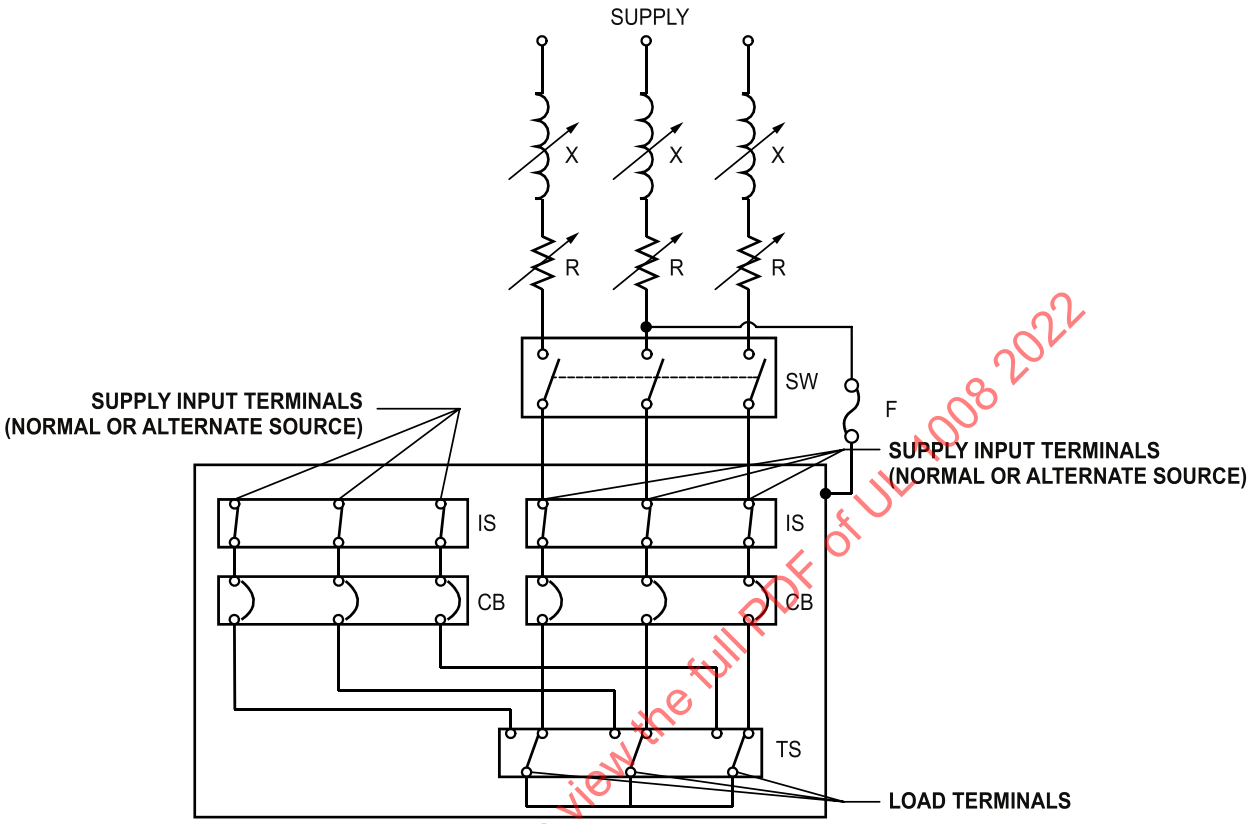
E4.1.3 Each supply input requiring testing as described in E4.1.2 shall be subjected to tests E4.1.3(a) and E4.1.3(b) at the same test current. If both supply inputs require testing, the test for each supply input may be conducted on a separate sample.

a) The isolating switch, if provided, and the circuit breaker shall be in the fully closed position. The transfer switch shall be closed on the supply input under test. The test circuit closing switch shall then be closed on the circuit until after the circuit breaker interrupts the current (see Figure E4.1).

b) The isolating switch, if provided, and the circuit breaker shall be in the fully closed position. The transfer switch shall be open from the supply input under test. The test circuit closing switch shall be used to apply the test voltage to the circuit before the transfer switch is closed on the supply input under test and until after the circuit breaker interrupts the current. See Figure E4.1.

Figure E4.1

Circuit for Short-Circuit Rating Tests



su3007a

Legend:
SW – switch
F – fuse
IS – isolating switch
CB – circuit breaker
TS – transfer switch

E4.1.4 At the conclusion of each test described in E4.1.3(a) and E4.1.3(b), the transfer switch assembly shall comply with the following:

a) The transfer switch shall meet the criteria in 9.13.3.2.

b) There shall be no discharge of parts.

c) There shall be no damage to a conductor or terminal connector, and no conductor shall pull out of a terminal connector.

d) There shall be no breakage of insulating bases to the extent that the integrity of the mounting of live parts is impaired.

e) The door or cover shall not be blown open. The door shall be prevented by its latch, without bolt or lock installed therein, from opening, and it shall be possible to open the door or cover. Deformation of the enclosure shall not result in the accessibility of live parts as determined by the use of the probe specified in Annex A1, Item 26.

f) If a molded-case isolating switch provided with self-protected instantaneous short-circuit overcurrent is included and it is in the tripped position at the conclusion of the test, the circuit breaker shall also be in the tripped position.

g) The circuit breaker and isolating switch, when provided, shall be capable of being operated to the opened and closed positions manually with its operating handle.

h) The fuse mentioned in 9.13.3.28 shall not open.

i) There shall be no breakage of the transfer switch base to the extent that the integrity of the mounting of live parts is impaired.

j) Neither end of the circuit breaker or isolating switch, when provided, shall be completely separated from the mounting means, and the line terminals of the circuit-breaker or isolating switch shall not bridge from the mounting means to dead-metal.

k) The transfer switch assembly shall comply with the requirements in the Dielectric voltage-withstand test described in E4.2.

E4.1.5 The adjustable instantaneous trip setting of the circuit breaker, if present, shall be adjusted to the maximum setting.

E4.1.6 A fire pump transfer switch assembly shall be tested with alternating current at rated frequency on a circuit as indicated in Figure E4.1. The test shall be performed as described in 9.13.3.17 (a) – (e).

E4.1.7 Instrumentation and calibration of high capacity circuits shall be performed in accordance with the procedures in Annex H. For Canada, Annex H is informative and represents one acceptable method of calibrating the short-circuit test.

E4.1.8 The reactive components of the impedance in the line shown in Figure E4.1 may be paralleled if of the air-core type, but no reactance shall be connected in parallel with resistances, except that an air-core reactor(s) in any phase may be shunted by resistance as determined in accordance with Annex H, H5.20.

E4.1.9 The test source terminals shall be included in the circuit for the connections described in E4.1.10. In determining the available short-circuit current of the circuit, these terminals shall be short-circuited in each instance by bus bars.

E4.1.10 The transfer switch assembly shall be mounted as intended in service and tested with 1.2 m (4 feet) of wire attached to each load and supply input line terminal. The wire shall be the smallest size having an ampacity equal to the rating of the assembly. The wire size shall be in accordance with Table 10 based upon the wire temperature rating marked on the equipment. When the terminal will not receive that

size of wire, or the equipment is marked to limit the size of wires, the maximum wire size shall be used. The load terminal leads shall be connected together.

E4.1.11 The total length of rated phase conductor or conductors in the test circuit shall not exceed 2.4 m (8 feet) per conductor unless the excess length is included in the test circuit calibration as specified in Annex H, Test Circuit Calibration, Section H2.

E4.1.12 Three-phase tests shall be considered to cover single-phase tests for a device of the same design.

E4.1.13 The enclosure cover shall be held closed only by the intended latch mechanism and securement means.

E4.1.14 The enclosure shall be connected through a 30 A, non-delay-type cartridge fuse to the line lead of the pole least likely to arc to the enclosure. The fuse shall have a voltage rating not less than the rated voltage of the equipment being tested. This connection shall be made on the load side of the limiting impedance by a 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 meters (4 – 6 feet) long. Refer to Figure E4.1.

E4.2 Dielectric voltage-withstand test

E4.2.1 Following the short-circuit tests described in E4.1, a transfer switch assembly shall be capable of withstanding for 1 minute, without breakdown, the application of a 60 Hz potential of twice rated voltage, but not less than 900 V:

a) Between line and load terminals of the circuit breaker in the open position;

b) Between line and load terminals of the isolating switch, when provided, with the isolating switch in an open position;

c) Between terminals of opposite polarity with the circuit breaker and isolating switch, when provided, in an open position and the transfer switch alternately closed to the normal source and alternate source;

d) Between uninsulated live parts and the enclosure with the circuit breaker and isolating switch, when provided, both opened and closed and the transfer switch alternately closed to the normal source and alternate source;

e) Between uninsulated live parts of different circuits;

f) Between terminals of the transfer switch normal source and alternate source with the transfer switch alternately closed to the normal and alternate source and the circuit breaker and isolating switch, when provided, in an open position; and

g) Between control wiring to ground and phase with the switch and circuit breakers open and closed. All control wires may be shorted together for this test. The voltage shall be 900 V.

E4.3 Rated short-circuit capacity (withstand)

E4.3.1 A fire pump transfer switch assembly that includes an isolating switch and not a circuit breaker on the normal and/or alternate supply input shall be tested to verify the short-circuit rating capacity withstand rating. The test shall be conducted at an available short-circuit current and shall be in accordance with Table 25.

E4.3.2 The test described in E4.3.3 shall be conducted on each transfer switch supply input (normal or alternate source) that is connected to an isolating switch and not a circuit breaker. If both supply inputs are so connected and the construction of the transfer switch normal and alternate source circuits are representative of each other, the test may be conducted on either supply input if the manufacturer, rating, and construction of the isolating switches are the same.

E4.3.3 Each supply input requiring testing as described in E4.3.2 shall be subjected to the tests as described in 9.13.2 – 9.13.2.4, 9.13.3, 9.13.3.7(c) – 9.13.3.9, 9.13.3.17 – 9.13.3.25, and 9.13.3.28 – 9.13.3.29 where all references to the term “transfer switch” refer instead to the “transfer switch assembly” including the isolating switch and fire pump transfer switch for the supply input under test except as relates specifically to transfer switch features.

E4.3.4 Three-phase tests shall be considered to cover single-phase tests for a device of the same design.

E4.3.5 At the conclusion of the withstand and closing test described in E4.3.3, the transfer switch assembly shall comply with the following:

a) The transfer switch shall meet the criteria in 9.13.3.2.

b) There shall be no discharge of parts.

c) There shall be no damage to a conductor or terminal connector, and no conductor shall pull out of a terminal connector.

d) There shall be no breakage of insulating bases to the extent that the integrity of the mounting of live parts is impaired.

e) The door or cover shall not be blown open. The door shall be prevented by its latch, without bolt or lock installed therein, from opening, and it shall be possible to open the door or cover. Deformation of the enclosure shall not result in the accessibility of live parts as determined by the use of the probe specified in Annex A1, Item 26.

f) The isolating switch shall be capable of being operated to the opened and closed positions manually with its operating handle.

g) The fuse mentioned in 9.13.3.28 shall not open.

h) There shall be no breakage of the transfer switch base to the extent that the integrity of the mounting of live parts is impaired.

i) Neither end of the isolating switch shall be completely separated from the mounting means, and the line terminals of the isolating switch shall not bridge from the mounting means to dead-metal.

j) The transfer switch assembly shall comply with the requirements in the Dielectric voltage-withstand test described in E4.4.

E4.4 Dielectric voltage-withstand test

E4.4.1 Following the short-circuit tests described in E4.3, a transfer switch assembly shall be capable of withstanding for 1 minute, without breakdown, the application of a 60 Hz potential of twice rated voltage, but not less than 900 V:

a) Between line and load terminals of the isolating switch with the isolating switch in an open position;

b) Between terminals of opposite polarity with the isolating switch in an open position and the transfer switch alternately closed to the normal source and alternate source;

c) Between uninsulated live parts and the enclosure with the isolating switch both opened and closed and the transfer switch alternately closed to the normal source and alternate source;

d) Between uninsulated live parts of different circuits;

e) Between terminals of the transfer switch normal source and alternate source with the transfer switch alternately closed to the normal and alternate source and the isolating switch in an open position; and

f) Between control wiring to ground and phase with the switch and circuit breakers open and closed. All control wires may be shorted together for this test. The voltage shall be 900 V.

E4.5 Circuit breaker time-current protection test

E4.5.1 A fire pump transfer switch assembly that includes a circuit breaker on the normal and/or alternate supply input shall be tested to verify the time-current protection requirements for the circuit breaker(s).

E4.5.2 The tests described in E4.5.3 shall be conducted on each transfer switch supply input (normal or alternate source) that is connected to a circuit breaker. If both supply inputs are connected to a circuit breaker the test may be conducted on either supply input if the manufacturer, rating, settings, and construction of the circuit breakers are the same. The tests of a particular supply input (normal or alternate source) shall be conducted on the same sample. If both supply inputs are required to be tested, a second sample may be used to test the other supply input.

E4.5.3 When tested in accordance with E4.5.4 – E4.5.12, the circuit breaker(s) of a fire pump transfer switch assembly shall:

a) Not trip within 10 minutes at 300 percent of the rated amperes of the transfer switch assembly; and

b) Not trip within 2 minutes at 600 percent of the rated amperes of the transfer switch assembly.

E4.5.4 For the purposes of testing, the transfer switch assembly shall be mounted as intended in service. Thermomagnetic circuit breakers shall be tested with 1.2 m (4 feet) of copper wire attached to each load and supply input line terminal. The wire shall be the smallest size having an ampacity equal to the rating of the assembly. The wire size shall be in accordance with Table 10 based upon the wire temperature rating marked on the equipment. When the terminal will not receive that size of wire, or the equipment is marked to limit the size of wires, the minimum wire size shall be used. Electronic trip circuit breakers shall be tested with any length and/or size of wire attached to each load and supply input line terminal.

E4.5.5 Any convenient test voltage may be used at the rated frequency of the assembly to provide the specified test current. An assembly rated at 50/60 Hz may be tested at either frequency for this test.

E4.5.6 A test current equal to 600 percent of the rated amperes of the transfer switch assembly shall be applied to the supply input of the assembly. The test shall be terminated if the circuit breaker trips before 2 minutes have elapsed, and the test shall be evaluated as described in E4.5.11. The test current shall be turned off after 2 minutes.

E4.5.7 Immediately after the test in E4.5.6 the test described in E4.5.8 shall be conducted.

E4.5.8 A test current equal to 300 percent of the rated amperes of the transfer switch assembly shall be applied to the same supply input of the assembly. The test shall be terminated if the circuit breaker trips before 10 minutes have elapsed and the test shall be evaluated as described in E4.5.11. The test current shall be turned off after 10 minutes.

E4.5.9 Immediately after the test in E4.5.8 the tests described in E4.5.6 – E4.5.8 shall be repeated three (3) times for a total of four (4) test sequences.

E4.5.10 Alternatively, the conducting of test E4.5.6 followed by E4.5.8 for four (4) test sequences may instead be conducted as 4 sequences of either test E4.5.6 or E4.5.6 immediately followed by four (4) sequences of the remaining test.

E4.5.11 The circuit breaker shall not trip during any test sequence of tests E4.5.6 and E4.5.8.

E4.5.12 When tested in accordance with E4.5.13, the circuit breaker(s) of a fire pump transfer switch assembly shall not trip within 25 msec at 24 times the rated amperes of the transfer switch assembly.

E4.5.13 Each supply input requiring testing as described in E4.1.2 shall be subjected to two (2) repetitions of the test described in E4.5.14 and E4.1.5 – E4.1.14.

E4.5.14 Each supply input requiring testing as described in E4.1.2 shall be subjected to tests E4.5.14(a) and E4.5.14(b) at a current of 24 times the rated amperes of the transfer switch assembly. If both supply inputs require testing, the test for each supply input may be conducted on a separate sample.

a) The isolating switch, if provided, and the circuit breaker shall be in the fully closed position. The transfer switch shall be closed on the supply input under test. The test circuit closing switch shall then be closed on the circuit for at least 0.025 seconds (see Figure E4.1).

b) The isolating switch, if provided, and the circuit breaker shall be in the fully closed position. The transfer switch shall be open from the supply input under test. The test circuit closing switch shall be used to apply the test voltage to the circuit before the transfer switch is closed on the supply input under test and until the test current passes through the transfer switch for at least 0.025 seconds (see Figure E4.1).

E4.5.15 At the conclusion of the test described in E4.5.13, the transfer switch assembly shall comply with the following:

a) The circuit breaker shall not be in the tripped position.

b) If a molded-case isolating switch provided with self-protected instantaneous short-circuit overcurrent is included, it shall not be in the tripped position.

c) The contacts of the tested source side of the transfer switch and the isolating switch, if provided, shall be undamaged. For the purpose of this requirement, any pitting, welding, fracturing, or deformation of the contacts or contact arms is considered to be an indication of damage. If there is any evidence of damage to the tested contacts, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8, with the test current passing through the tested contacts.

d) There shall be no damage to a conductor or terminal connector, and no conductor shall pull out of a terminal connector.

e) There shall be no breakage of insulating bases to the extent that the integrity of the mounting of live parts is impaired.

f) The door or cover shall not be blown open. The door shall be prevented by its latch, without bolt or lock installed therein, from opening, and it shall be possible to open the door or cover. Deformation of the enclosure shall not result in the accessibility of live parts as determined by the use of the probe specified in Annex A1, Item 26.

g) The circuit breaker and isolating switch, when provided, shall be capable of being operated to the opened and closed positions manually with its operating handle.

h) The fuse mentioned in 9.13.3.28 shall not open

i) There shall be no breakage of the transfer switch base to the extent that the integrity of the mounting of live parts is impaired.

j) Neither end of the circuit breaker or isolating switch, when provided, shall be completely separated from the mounting means, and the line terminals of the circuit-breaker or isolating switch shall not bridge from the mounting means to dead-metal.

k) The transfer switch assembly shall comply with the requirements in the Dielectric voltage-withstand test described in E4.2.

E4.6 Temperature rise test

E4.6.1 When tested under the conditions described in 9.8.2 – 9.8.13, fire pump transfer switch assemblies shall not attain a temperature at any point high enough to constitute a risk of fire or to damage any materials employed in the device, and shall not show temperature rises at specific points greater than those indicated in Table 16.

E4.6.2 For the temperature test the transfer switch shall be operated under normal conditions of its intended use and shall carry its test current continuously. Coils and heating elements shall be energized by a source of voltage as specified in Table 15. For other than a coil or heating element, any convenient voltage supply may be used as long as the specified current is caused to flow. The tests on all parts shall be made simultaneously, as the heating of one part could affect the heating of another part.

E4.6.3 The test current shall be 100 percent of the rated ampacity of the transfer switch assembly.

E4.6.4 Other than as noted in E4.6.5, transfer switch assemblies that have wiring terminals shall be connected with not less than 1.2 m (4 feet) of copper wire, per terminal. The wire size shall correspond to the rating of the transfer switch assembly as given in 6.13.1.4. The wire type shall be a type which is suitable for field connection in accordance with Annex A1, Item 1. For a transfer switch assembly rated 100 A or less the wire size shall also be based on the temperature rating of the wire as marked on the transfer switch assembly. Where a dual temperature rating is marked, the test shall be conducted with wire based on the ampacity for 75 °C wire.

E4.6.5 When there is only provision for the connection of bus bars to a transfer switch assembly rated at 800 A or more, copper bus bars of the size shown in Table 17 and not less than 1.2 m (4 feet) in length shall be used. The spacing between multiple bus bars within each phase shall be 6.4 mm (1/4 inch) or less with no intentional wider spacing except as required at the individual terminals of the transfer switch assembly.

E4.6.6 The temperature test measurements shall be conducted as described in 9.8.9 – 9.8.13.

E5 Rating – Details

E5.1 A fire pump transfer switch or assembly shall be rated in volts and amperes in accordance with the rating requirements in 4.2.

E6 Marking – Details

E6.1 In addition to the marking requirements in 5.2, a fire pump transfer switch shall be marked "Fire Pump Power Transfer Switch". Where applicable, this marking shall also include one of the markings in E6.3 – E6.5. For enclosed devices, this marking shall be on the front exterior of the enclosure.

E6.2 In addition to the marking requirements in 5.2, a fire pump transfer switch assembly as described in E1.2(b) shall be marked on the front exterior of the enclosure, “Fire Pump Power Transfer Switch Assembly”. Where applicable, this marking shall also include one of the markings in E6.4 – E6.5.

E6.3 A fire pump transfer switch not suitable for use with a generator as the alternate source shall be marked "Not suitable for use with a generator as the alternate source". See E2.8 and E2.12.

E6.4 A fire pump transfer switch not suitable for use with a generator as the primary source shall be marked "Not suitable for use with a generator as the primary source".

E6.5 A fire pump transfer switch suitable for use only with utility supply on both sources shall be marked "Suitable for use only with utility supply on both sources".

E6.6 A fire pump transfer switch shall have a cautionary marking to indicate that the normal and alternate source disconnecting means and/or isolating switches for the transfer switch and fire pump controller it serves shall be opened before servicing the transfer switch, fire pump controller, or motor.

E6.7 With reference to E2.3(a)(5) and E2.3(c)(5), an isolating switch shall be marked on the outside of the enclosure adjacent to the operating handle with the signal word, "WARNING", and the following or equivalent statement, "RISK OF ELECTRIC SHOCK – DO NOT OPEN OR CLOSE THIS SWITCH WHILE THE CIRCUIT BREAKER (DISCONNECTING MEANS) IS IN THE CLOSED POSITION."

E6.8 With reference to E2.3(c)(4), an instruction label shall be provided on the outside of the enclosure adjacent to the operating handles of the isolating switch and circuit breaker which directs the order of operation.

E6.9 The circuit breaker defined in E2.3(b) shall be provided with a nameplate with the legend, "CIRCUIT BREAKER – DISCONNECTING MEANS", in letters not less than 10 mm (3/8 in) high, located on the outside of the transfer switch assembly enclosure adjacent to the means for operating the circuit breaker.

Annex F
(Normative in Canada) (Informative in Mexico and the United States)

Hybrid Transfer Switches

F1 Scope

F1.1 This annex covers requirements for hybrid transfer switches.

F2 Construction

F2.1 An enclosed switch or switches manufactured in accordance with the requirements of Annex A1, Item 23, shall be provided on hybrid transfer switches to permit isolation of solid-state power switching components from all mechanical transfer switch power source terminals (normal and alternate and load).

F2.2 Overcurrent protection shall be provided for each solid-state power switching component and shall be installed between the anode of the solid-state power switch and the line terminals of the mechanical transfer switch.

F2.3 A hybrid transfer switch shall incorporate mechanical isolating means for servicing the transfer switch where failure or leakage through a solid-state device could result in a transfer of energy between two power sources. The disconnecting means shall be provided as an integral part of the hybrid transfer switch and be connected in the circuit in such a way that when opened it will prevent transfer of energy between different power sources. To facilitate servicing, barriers, or other suitable means and/or marking shall be provided for the protection of service personnel from live parts located ahead of isolating switches.

F3 Performance

F3.1 The performance of a hybrid transfer switch shall be investigated by subjecting the representative switch or switches in commercial form to the tests described in Test Requirements – General, Section 9, and Annex D, if applicable.

F3.2 Hybrid transfer switches shall have only two modes of operation – open transition and hybrid transition. Each mode may be operator selectable. In the hybrid transition mode, a solid-state power switch will be energized in parallel with the mechanical transfer switch while the mechanical switch transfers.

F3.3 Hybrid transfer switches shall have a primary control/protective device to ensure that the normal and alternative power sources are in synchronism before enabling a hybrid transfer.

F3.4 Hybrid transfer switches shall have circuitry to detect, and provide an alarm for, the failure to achieve synchronism.

F3.5 Hybrid transfer switches shall permit an open transition when the conditions of F3.3 or F3.6 are not achieved.

F3.6 Failure of a hybrid transfer switch solid-state power switching component shall result in the solid-state power switching components being electrically isolated from the line of the mechanical transfer switch; and the transfer switch shall revert to standard open transition operation under any of the following conditions:

a) The solid-state power switching component is not capable of conducting current;

b) The circuit controlling the solid-state power switching component fails to operate;

c) An isolating switch is open; or

d) A control circuit prevents operation of the power selector contactor.

F3.7 The solid-state power switching components of hybrid transfer switches shall be capable of operation only when two adequate power sources are present and in synchronism. On failure of a source to which the load is connected, the mechanical transfer switch may transfer to an adequate alternate power source.

F4 Rating

F4.1 Mechanical current-carrying components including disconnecting means, power selector contactor, solid-state power switching component protective devices (fuses and/or circuit breakers), and conductors used solely in the momentary duty (i.e., less than 2 seconds) current path may be rated at less than the full load rating of the device of the mechanical transfer switch if testing is done to verify that they will operate as intended during the endurance and short-circuit testing. The power selector contactor shall be rated for full make and break duty unless shorted solid-state power switching component detection circuitry is provided that prevents operation of the power selector contactor when the solid-state power switching component is shorted.

F4.2 Solid-state power carrying components shall be individually rated at the full rated current of the mechanical transfer switch. Peak Inverse Voltage (PIV) ratings shall be not less than 400 percent of rated voltage.

F5 Marking

F5.1 Hybrid transfer switches shall be marked in accordance with F5.2 – F5.5.

F5.2 The applicable requirements in Product Information, Section 5 of this standard shall apply other than in 5.2.1.2 the marking "Transfer Switch" shall be "Hybrid Transfer Switch".

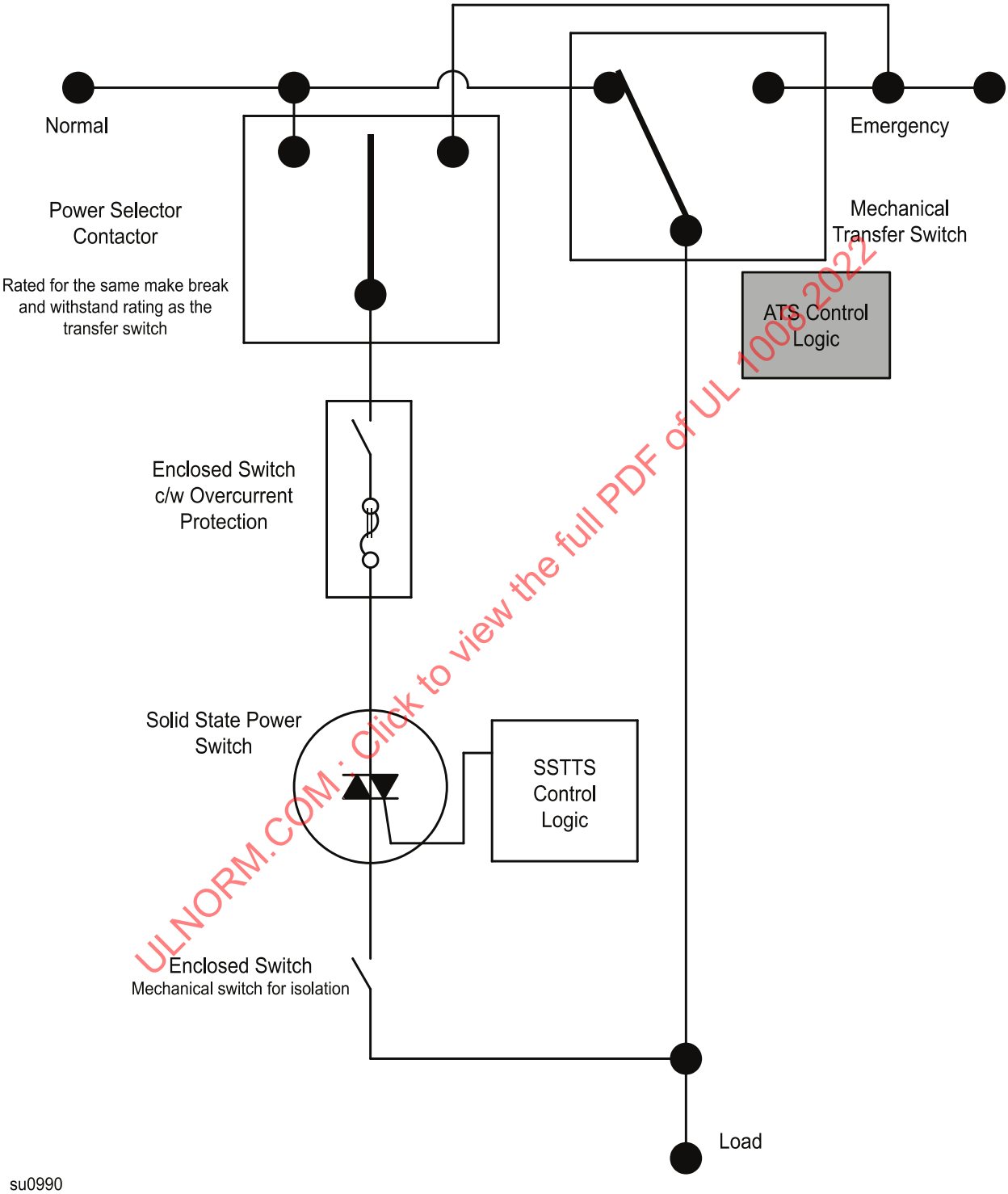
F5.3 Hybrid transfer switches shall be individually marked with their momentary current rating and voltage rating.

F5.4 Hybrid transfer switches containing capacitors as part of their power circuitry shall be marked "WARNING – Capacitor Circuit – Wait 5 Minutes After Opening, Then Verify Capacitors Are Discharged Before Handling".

F5.5 A hybrid transfer switch shall be marked in close proximity to the fuse disconnect "DANGER – Risk of Electric Shock" and the following or equivalent. "ISOLATE USING DISCONNECT SWITCHES ON BOTH THE LINE SIDE AND LOAD SIDE OF THE FUSE BEFORE REPLACEMENT".

Figure F5.1

Solid State Transition Transfer Switch Single Line



Annex G
(normative)

Softload Transfer Switches

G1 Scope

G1.1 These requirements cover automatic transfer switches that provide a softloading function.

G1.2 Automatic transfer switches with softloading capability may be applied as service equipment if so marked.

G2 General Requirements

G2.1 General Requirements, Section 2 of this standard applies.

G3 Definitions

G3.1 Definitions, Section 3 of this standard applies.

G4 Characteristics

G4.1 Characteristics, Section 4 of this standard applies.

G5 Product Information

G5.1 Data requirements

G5.1.1 Data requirements, 5.1 of this standard applies.

G5.2 Marking requirements

G5.2.1 Marking requirements, 5.2 of this standard applies, except that:

a) In 5.2.1.2(c) the marking "Transfer Switch" shall be "Softload Transfer Switch"; and

b) 5.2.1.30 does not apply.

G5.2.2 A Softload ATS shall be marked, "Closed Transition Transfer Will Not Occur Unless Alternate And Normal Sources Are Synchronized". A Softload ATS shall additionally be marked "Transfer Between Sources May be Gradual. Transfer Time May Exceed 100 msec".

G5.2.3 A softload ATS shall be marked, "The short-circuit and short-time ratings marked on this product assume only one source is suppling power. During soft load transition, the transfer switch could be subjected to fault current from both sources."

G5.3 Instructions for installation, operation, and maintenance

G5.3.1 Instructions for installation, operation, and maintenance, 5.3 of this standard applies.

G5.3.2 A Softload ATS shall be provided with the following information in the instructions:

a) Notification that the generator must be able to be actively synchronized;

b) Notification that the generator must be capable of accepting signals to provide kw [speed] and kvar [voltage] control;

c) A wiring diagram to interface the Softload ATS to the generator controls;

d) Instructions for interfacing to distribution system, including external protective functions, if required;

e) Instructions indicating that a coordination study must be performed, with consideration of the available short-circuit current from both sources simultaneously; and

f) If the Softload ATS is not provided with an integral generator feeder breaker, instructions to indicate that an appropriate generator feeder breaker must be provided.

G6 Constructional Requirements

G6.1 Construction Requirements, Section 6 of this standard applies.

G6.2 The system shall be evaluated to the requirements appearing in Annex A1, Item 10.

G7 Performance Requirements

G7.1 A Softload ATS:

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

b) Shall only transfer in closed transition mode when synchronization is achieved;

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

d) Shall be provided with:

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

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

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

4) Circuitry to prevent the sources from being paralleled for longer than the maximum time specified by the manufacturer; and

5) Circuitry to detect an extended parallel operation time [greater than noted in G7.1(d)(4)] and cause one or both sources to be disconnected to remove the condition. The time to disconnection may be adjustable up to 500 ms beyond the maximum time noted in G7.1(d)(4).

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

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

G7.2 Operating mechanism, 7.1 of this standard applies, except the marking required by 7.1.10(f) shall be in accordance with G5.2.

G7.3 Controls of the generator are not required to be in the softload transfer switch, if a marking indicates that the control circuit wiring is to be in conduit. See 5.2.1.11.

G7.4 Protective controls shall be provided as necessary to prevent unintended extended paralleling of sources. These controls shall be factory connected and located within the transfer device enclosure and shall comply with 7.1.18.

G7.5 Softload transition transfer equipment shall include active synchronizing functions in conjunction with other features that parallel the two sources. The instruction manual shall provide instructions for coordinating the transfer switch and generator controls.

G7.6 A Softload ATS not marked for use as an optional standby transfer switch shall comply with all of the following:

a) When operating in the parallel mode, loss of any source shall cause disconnection from the lost source and keep the load connected to the available source;

b) When not operating in parallel mode, loss of any source shall cause an open transition transfer to the available source; and

c) A failure of the softload controls shall not result in inhibiting a transfer upon loss of any source.

In Canada only, the requirements of G7.6 shall apply for all Softload ATS.

G8 Service Equipment

G8.1 Service Equipment Requirements, Section 8 of this standard applies.

G9 Test Requirements

G9.1 The performance of softload transfer switches shall be investigated by subjecting a representative sample or samples in commercial form to the tests described in Test Requirements – General, Section 9, G9.2, and G9.3.

G9.2 Where failure of an operating mechanism (including welding of a contact) or failure of a control circuit can result in unintended extended paralleling of sources, the Softload ATS shall be operated normally, and the unintended extended paralleling of sources shall be simulated. The protective control shall take action to end the paralleling.

G9.3 Operation on loss of supply voltage when operating in the parallel mode – To determine whether an automatic transfer switch complies with the requirements of G7.6(a), the switch shall be mounted in the intended manner and the normal and alternate supply terminals shall be connected to separate circuits of voltage and frequency in accordance with Table 15. The switch operating in parallel mode with no load connected shall be caused to operate by the following means:

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

b) Interrupting and then restoring, in turn, each conductor of the alternate supply.

G10 Manufacturing and Production Tests

Note: In Mexico and the United States, this requirement is applicable. In Canada, this requirement does not apply.

G10.1 Factory tests shall be conducted on 100 percent of production to verify all operational circuits and protective control circuits are functional.

Annex H
(Normative in Mexico and the United States) (Informative in Canada)

Instrumentation and Calibration of High Capacity Circuits

H1 General

H1.1 In order to determine that the specified current is available when the system is short-circuited in accordance with H2.1 and that the test circuit has the characteristics specified in 9.13.3.17, an oscillograph shall be used in measuring the circuit characteristics.

H2 Test Circuit Calibration

H2.1 Other than as noted in H2.2 – H2.4, the available rms symmetrical current shall be determined at the line terminals of the separate main device or, if no separate main device is used, at the line terminals of the transfer switch.

H2.2 For circuits rated 25,000 A or less, the available current may be determined at the test station terminals.

H2.3 The available current may be determined at the test station terminals if:

a) For circuits between 25,001 – 50,000 A, the available current is determined to be 5 percent higher than the required test current; or

b) For circuits between 50,001 – 200,000 A, the available current is determined to be 10 percent higher than the required test current.

H2.4 If the available current is determined at the test station terminal and the physical arrangement in the test station requires leads longer than specified, the additional length of leads shall be included in the circuit calibration.

H3 Direct Current

H3.1 When the direct current source is rectified alternating current, the requirements of H3.2 – H3.4 shall be applied.

H3.2 The open-circuit voltage of the circuit shall not be less than 100 percent or more than 105 percent of the rated voltage of the unit under test, except that higher voltage may be employed if agreeable to those concerned. This measurement shall be determined by a voltmeter of recent calibration and, in addition, the open circuit voltage, as determined by the arithmetic average of the maximum and minimum values of the voltage wave read from the oscillogram shall be within 99 – 105 percent of the rated voltage of the switch except that a higher voltage may be employed if agreeable to those concerned.

H3.3 The minimum point on the voltage wave shall not be less than 90 percent of the rated voltage of the transfer switch.

H3.4 The available current capacity of the circuit shall not be less than the value as required for the rating of the transfer switch as indicated in 9.13.3.17(b). With the supply terminals short-circuited, the capacity shall be determined at the minimum point on the current wave closest to, but not less than, 1/2 cycle after circuit closure based on a 60-cycle timing wave.

H4 Alternating Current

H4.1 For an alternating-current circuit intended to deliver 5000 or 10,000 A, the determination of current and power factor shall be in accordance with H4.2. For circuits designed to deliver more than 10,000 A, the determination of the current and power factor shall be in accordance with the requirements of H5.12 –

H5.20. Instrumentation used to measure test circuits of over 10,000 A shall meet the requirements of H5.1 – H5.11.

H4.2 The current in a 3-phase test circuit shall be checked by averaging the root-mean-square (rms) values of the first complete cycle of current in each of the three phases; the current in a single-phase test circuit shall be checked by determining the root-mean-square value of the first complete cycle when the circuit is closed to produce an essentially symmetrical current wave form. The d-c component shall not be added to the value obtained when measured as shown. In order to obtain the desired symmetrical waveform of the single-phase test circuit, controlled closing is recommended although random closing methods may be used. The power factor shall be determined by referring the open-circuit voltage wave to the two adjacent zero points at the end half of the first complete current cycle by transposition through an appropriate timing wave, the power factor shall be computed as an average of the values obtained by using these two current zero points, and the voltage to neutral shall be used in the case of a 3-phase circuit.

H5 Galvanometers

H5.1 The galvanometers in a magnetic oscillograph employed for recording voltage and current during circuit calibration and while testing shall be of a type having a flat (± 5-percent) frequency response from 50 to 1200 Hz.

H5.2 Galvanometers shall be calibrated as indicated in H5.3 – H5.6.

H5.3 When a shunt is used to determine the circuit characteristics, a direct-current calibrating voltage is normally used. The voltage applied to the oscillograph galvanometer circuit shall result in a deflection of the galvanometer approximately equivalent to that which is expected when the same galvanometer circuit is connected to the shunt and the nominal short-circuit current is flowing. The voltage shall be applied to cause the galvanometer to deflect in both directions. Additional calibrations are to be made using approximately 50 percent and approximately 150 percent of the voltage used to obtain the deflection indicated above, except that if the anticipated maximum deflection is less than 150 percent, such as in the case of a symmetrically closed single-phase circuit, any other appropriate calibration point shall be chosen. The sensitivity of the galvanometer circuit in volts per inch (or millimeter) shall be determined from the deflection measured in each case, and the results of the six trials averaged. The peak amperes per inch (or millimeter) shall be obtained by dividing the sensitivity by the resistance of the shunt. This multiplying factor shall be used for the determination of the rms current as described in H5.12.

H5.4 A sine-wave potential may be used for calibrating the galvanometer circuit, using the same general method described in H5.3. The resulting factor shall be multiplied by 1.414.

H5.5 When a circuit transformer is used to determine the circuit characteristics, an alternating current is used to calibrate the galvanometer circuit. The value of current applied to the galvanometer circuit shall result in a deflection of the galvanometer approximately equivalent to that which is expected when the same galvanometer is connected to the secondary of the current transformer and nominal short-circuit current is flowing in the primary. Additional calibrations shall be made at approximately 50 percent and approximately 150 percent of the current used to obtain the deflection indicated above, except that if the anticipated maximum deflection is less than 150 percent, such as in the case of a symmetrically closed single-phase circuit, any other appropriate calibration point shall be chosen. The sensitivity of the galvanometer circuit in rms amperes per inch (or millimeter) shall be determined in each case and the results averaged. The average sensitivity is multiplied by the current-transformer ratio and by 1.414 to obtain peak amperes per inch. This constant is used for the determination of the rms current as described in H5.12.

H5.6 All the galvanometer elements employed shall line up properly in the oscillograph, or the displacement differences shall be noted and used as needed.

H5.7 The sensitivity of the galvanometers and the recording speed shall be sufficient to provide a record from which values of voltage, current, and power factor can be measured accurately. The recording speed shall not be less than 1.52 meters per second (60 inches per second), and higher speeds are recommended.

H5.8 With the test circuit adjusted to provide the specified values of voltage and current and with a noninductive (coaxial) shunt that has been found acceptable for use as a reference connected into the circuit, the tests indicated in H5.9 and H5.10 shall be conducted to verify the accuracy of the manufacturer's instrumentation.

H5.9 With the secondary open-circuited, the transformer shall be energized and the voltage at the test terminals observed to determine if rectification is taking place. If rectification is occurring, the circuit is not acceptable for test purposes because the voltage and current will not be sinusoidal. Six random closings shall be made to demonstrate that residual flux in the transformer core will not cause rectification as evidenced by both the voltage and current waves appearing sinusoidal. If testing is done by closing the secondary circuit, this check may be omitted providing testing is not started before the transformer has been energized for approximately 2 seconds, or longer, if an investigation of the test equipment shows that a longer time is necessary.

H5.10 With the circuit short-circuited by connecting the test terminals together by means of a copper bar, a single-phase circuit shall be closed as nearly as possible at the angle which will produce a current wave with maximum offset. The short-circuit current and voltage shall be recorded. The primary voltage shall be recorded if primary closing is used. The current measured by the reference shunt shall be within 5 percent of that measured using the manufacturer's instrumentation and there shall be no measurable variation in phase relationship between the traces of the same current. Controlled closing is not required for poly-phase circuits.

H5.11 When the verification of the accuracy of the manufacturer's instrumentation is completed, the reference coaxial shunt shall be removed from the circuit and shall not be used during the final calibration of the test circuit nor during the testing of the switches.

H5.12 The RMS symmetrical current shall be determined, with the supply terminals short-circuited, by measuring the alternating-current component of the wave at an instant 1/2 cycle – on the basis of a 60 Hz timing wave – after the initiation of the short-circuit. The current shall be calculated in accordance with Figure 7 of Annex A1, Item 18.

H5.13 For a 3-phase test circuit, the rms symmetrical current shall be the average of the currents in the three phases as long as the components of the circuit are such that equal impedance (and currents) exists in all phases. The rms symmetrical current in any one phase shall be no less than 90 percent of the value of the switch marked short-circuit current.

H5.14 For a single-phase circuit, closing to produce minimum asymmetry may be selected, but one test shall also be made at the closing angle that will produce maximum asymmetry, since this is required for power factor determination.

H5.15 The test circuit and its transients shall be such that 3 cycles (1/20 second) after initiation of the short-circuit, the symmetrical alternating component of current will not be less than 90 percent of the symmetrical alternating component of current at the end of the first half-cycle. In 3-phase circuits the symmetrical alternating component of current of all three phases shall be averaged.

H5.16 The power factor shall be determined at an instant one-half cycle – on the basis of a 60 Hz timing wave – after the short-circuit occurs. The total asymmetrical rms amperes shall be measured in accordance with H5.17 and the ratio M_A or M_M calculated as follows:

$$Ratio\ M_A\ (for\ 3\ \varphi\ \ tests) = \frac{Av.\ 3\ phases\ \ Asymmetrical\ \ RMS\ \ Amperes}{Av.\ 3\ phases\ \ Symmetrical\ \ RMS\ \ Amperes}$$

$$Ratio\ M_M\ (for\ 1\ \varphi\ \ tests) = \frac{Asymmetrical\ \ RMS\ \ Amperes}{Symmetrical\ \ RMS\ \ Amperes}$$

Using ratio M_A or M_M, the power factor is determined from Table H5.1.

Table H5.1
Short-Circuit Power Factor

Short-circuit power factor, percent	Ratio M_M	Ratio M_A	Short-circuit power factor, percent	Ratio M_M	Ratio M_A
0	1.732	1.394	30	1.130	1.066
1	1.697	1.374	31	1.122	1.062
2	1.662	1.354	32	1.113	1.057
3	1.630	1.336	33	1.106	1.053
4	1.599	1.318	34	1.098	1.050
5	1.569	1.302	35	1.091	1.046
6	1.540	1.286	36	1.085	1.043
7	1.512	1.271	37	1.079	1.040
8	1.486	1.256	38	1.073	1.037
9	1.461	1.242	39	1.068	1.034
10	1.437	1.229	40	1.062	1.031
11	1.413	1.216	41	1.058	1.029
12	1.391	1.204	42	1.053	1.027
13	1.370	1.193	43	1.049	1.025
14	1.350	1.182	44	1.045	1.023
15	1.331	1.172	45	1.041	1.021
16	1.312	1.162	46	1.038	1.019
17	1.295	1.152	47	1.035	1.017
18	1.278	1.144	48	1.032	1.016
19	1.262	1.135	49	1.029	1.014
20	1.247	1.127	50	1.026	1.013
21	1.232	1.119	55	1.016	1.008
22	1.219	1.112	60	1.009	1.004
23	1.205	1.105	65	1.005	1.002
24	1.193	1.099	70	1.002	1.001
25	1.181	1.092	75	1.0008	1.0004
26	1.170	1.087	80	1.0002	1.0001
27	1.159	1.081	85	1.00004	1.00002
28	1.149	1.076	100	1.00000	1.00000
29	1.139	1.071			

H5.17 The power factor of a 3-phase circuit may be calculated by using controlled closing so that upon subsequent closings a different phase will be caused to have maximum asymmetrical conditions. Each phase would then have the power factor determined using the method described for single-phase circuits in H5.16. The power factor of the 3-phase circuit shall be considered to be the average of the power factors determined for each of the phases.

H5.18 The recovery voltage shall be at least equal to the rated voltage of the transfer switch. The peak value of the recovery voltage within the first full half-cycle after clearing and for the next three successive peaks shall be at least equal to 1.414 times the rms value of the rated voltage of the switch. Each of the peaks shall be displaced by not more than ±10 electrical degrees from the peak values of the open-circuit recovery voltage, that is, the displacement of the peak from its normal position on a sinusoidal wave. The average of the instantaneous values of recovery voltage of each of the first six half cycles measured at the 45-degree and 135-degree points on the wave shall be not less than 85 percent of the rms value of the rated voltage of the switch. The instantaneous value of recovery voltage measured at the 45-degree and 135-degree points of each of the first six half cycles shall not be less than 75 percent of the rms value of the rated voltage of the switch.

H5.19 If in a circuit that employs secondary closing there is no attenuation or phase displacement of the first cycle of the recovery voltage wave when compared with the open-circuit secondary voltage wave before current flow, the detailed measurement of recovery voltage characteristics as indicated in H5.18 is not required.

H5.20 With reference to 9.13.3.18, the shunting resistance used with an air core reactor having negligible resistance may be calculated from the formula:

$$R = 167 \times \frac{E}{I}$$

where:

E is the voltage across the air-core reactor with current *I* flowing as determined by oscillographic measurement during the short-circuit calibration or, by proportion, from meter measurements at some lower current.

Annex I
(informative)

Sample Markings

I1 Scope

I1.1 This annex contains example markings for short-circuit and short-time ratings.

I2 Example 1

I2.1 Example that may be used for a device with short-circuit, but not short-time current ratings and with integral overcurrent protection.

SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS

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 IS TO INCLUDE AN INSTANTANEOUS TRIP RESPONSE THAT CANNOT BE DISABLED.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)
65	240
50	480
42	600

SHORT-TIME CURRENT RATINGS

THIS TRANSFER SWITCH DOES NOT INCLUDE SHORT-TIME CURRENT RATINGS

I3 Example 2

I3.1 Example that may be used for a device with short-circuit and short-time ratings, and with integral overcurrent protection.

SHORT-CIRCUIT WITHSTAND/CLOSING
AND SHORT-TIME CURRENT RATINGS

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 IS TO BE COORDINATED WITH THE SHORT-TIME CURRENT RATING OF THE TRANSFER SWITCH AS MARKED BELOW.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)
65	240
50	480
42	600

SHORT-TIME CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	TIME DURATION (Sec, MAXIMUM)
20	480	0.5
35	480	0.3

I4 Example 3

I4.1 Example that may be used for a device with short-circuit, but not short-time current ratings, protected by an external circuit breaker.

SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS

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 IS TO INCLUDE AN INSTANTANEOUS TRIP RESPONSE THAT CANNOT BE DISABLED.

THE MAXIMUM CLEARING TIME OF THE INSTANTANEOUS TRIP RESPONSE IS TO BE EQUAL TO OR LESS THAN THE TIME DURATION SHOWN FOR THE MARKED SHORT-CIRCUIT CURRENT.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	TIME DURATION (Sec, MAXIMUM)
65	240	0.050
50	480	0.050
42	600	0.050
35	480	0.067

SHORT-TIME CURRENT RATINGS

THIS TRANSFER SWITCH DOES NOT INCLUDE SHORT-TIME CURRENT RATINGS

I5 Example 4

I5.1 Example that may be used for a device with short-circuit, but not short-time current rating, protected by a specific external circuit breaker.

SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS WHEN USING SPECIFIC CIRCUIT BREAKERS

WHEN PROTECTED BY A CIRCUIT BREAKER OF THE SPECIFIC MANUFACTURE, 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.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	MANUFACTURER	TYPE	RATING (AMPERES)
65	480	MFG. A	X1	1600
65	480	MFG. B	A1	1600

I6 Example 5

Example that may be used for a device with short-circuit and short-time ratings, protected by an external circuit breaker.

SHORT-CIRCUIT WITHSTAND/CLOSING
AND SHORT-TIME CURRENT RATINGS

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 IS TO 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 IS TO BE LESS THAN OR EQUAL TO 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 IS TO BE COORDINATED WITH THE SHORT-TIME CURRENT RATING OF THE TRANSFER SWITCH AS MARKED BELOW.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	TIME DURATION (Sec, MAXIMUM)
65	240	0.050
50	480	0.050
42	600	0.050
35	480	0.067

SHORT-TIME CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	TIME DURATION (Sec, MAXIMUM)
20	480	0.5
35	480	0.3

I7 Example 6

I7.1 Example that may be used for a device with short-circuit and short-time ratings, protected by a specific external circuit breaker.

SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS
AND SHORT-TIME CURRENT RATINGS
WHEN USING SPECIFIC CIRCUIT BREAKERS

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 AS SHOWN BELOW.

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.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	MANUFACTURER	TYPE	RATING (AMPERES)
65	480	MFG. A	X1	1600
65	480	MFG. B	A1	1600

SHORT-TIME CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	TIME DURATION (Sec, MAXIMUM)
20	480	0.5
35	480	0.3

I8 Example 7

I8.1 Example that may be used for a device to be protected by fuses at 10 kA or less.

SHORT-CIRCUIT WITHSTAND AND CLOSING RATINGS WHEN PROTECTED BY FUSES RATED 10KA OR LESS

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.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	MANUFACTURER	TYPE	RATING (AMPERES)
10	480	MFG. A	F1	1500
10	480	MFG. B	F2	1500

I9 Example 8

I9.1 Example that may be used for a device to be protected by fuses above 10 kA.

SHORT-CIRCUIT WITHSTAND/CLOSING RATING WHEN PROTECTED BY 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.

SHORT-CIRCUIT CURRENT (RMS SYMMETRICAL AMPERES X 1000)	VOLTAGE (VOLTS AC, MAXIMUM)	FUSE CLASS	RATING (AMPERES)
65	480	J	1600
65	480	L	2000

Annex J
(normative)

Inlet Assemblies for Transfer Switch Equipment

INTRODUCTION

J1 Scope

J1.1 These requirements cover permanently installed inlet assemblies rated 600 V or less, which are intended to facilitate temporary connection of portable generators to automatic and non-automatic (manual) transfer switches through the use of single pole separable connectors. These requirements do not apply to power inlets consisting of multiple pole connectors. Such products shall comply with the requirements of Inlets for generator connection, 6.20.

J1.2 The inlet assemblies covered by these requirements are intended only for use with transfer switches for optional standby systems as described in Annex A1, Item 1. They are not intended for use with transfer switches in emergency or legally required standby systems as described in Annex A1, Item 1.

J1.3 These requirements do not apply to inlet assemblies which are integral to transfer switches.

J1.4 These requirements apply only to inlet assemblies for use in ordinary locations as defined in Annex A1, Item 1.

J1.5 These requirements do not address the portable cabling or the connectors attached to the cable used between the portable generator and the inlet assembly.

J1.6 Inlet assemblies are not intended to be used for transfer of, connection to, or disconnection of loads when the connecting cables are energized.

J2 Components

J2.1 Except as indicated in J2.2, a component of a product covered by this standard shall comply with the requirements for that component.

J2.2 A component is not required to comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

J2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

J2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

J2 Units of Measurement

J2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

J4 Undated References

J4.1 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.

CONSTRUCTION

J5 General

J5.1 Inlet assemblies shall employ materials throughout which are acceptable for the particular use, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

J5.2 Inlet assemblies consist of multiple single pole inlets, installed in a completely enclosed assembly.

J5.3 Other than as noted in J5.4, inlet assemblies shall be mechanically interlocked in such a manner that plugs shall be connected in the following sequence and disconnected in the reverse order:

a) Equipment-grounding conductor connection, if provided;

b) Grounded circuit conductor connection, if provided; and

c) Ungrounded conductor connection.

J5.4 Inlet assemblies rated above 60 A need not comply with J5.3 when marked in accordance with 5.2.7.5 – 5.2.7.6.

J5.5 Inlet assemblies rated 100 A or greater shall comply with one or more of the following:

a) Be provided with a disconnecting means that is mechanically interlocked such that the mating attachment connectors may not be inserted or removed unless the disconnecting means is in the open position;

b) Be provided with inlets rated for disconnection under load; or

c) Be marked and provided with instructions in accordance with J27.15.

J6 Enclosure

J6.1 All inlet assemblies shall be provided with an enclosure which completely encloses all uninsulated parts, both with and without the portable cables connected to the assembly.

J6.2 Enclosures shall provide separate compartments for the permanently installed conductors which connect the inlet assembly to the transfer switch and the temporary conductors which will be connected to the portable generator. Access to the temporary conductors shall be possible without exposing the permanently installed conductors or uninsulated live parts.

J6.3 The enclosure shall be such that when the covers and doors are properly secured, accidental contact with the body of all separable connectors is prevented.

J6.4 Access panels and doors provided for the attachment and removal of portable wiring shall be secured by means of a latching mechanism incorporating a lock and key, a fastener requiring the use of a tool, or shall have provision for locking.

J6.5 The enclosure shall comply with the requirements of Enclosures, 6.5.

J6.6 The enclosure shall comply with the requirements for outdoor use enclosures, with and without the temporary conductors connected, in accordance with J6.7 – J6.10.

J6.7 Covers or doors that provide access to the inlets shall be spring-closing covers, or covers that are closed by gravity, and shall have no rest position other than the closed position. Covers need not be spring or gravity closing if the enclosure meets the requirements of the rain test with the covers and doors open and closed, and with or without the connectors installed.

J6.8 Other than as noted in J6.9, a spring-closing cover shall comply with the Spring-Closing Cycling Test, Section J23. Gaskets shall meet requirements specified in Gasket Tests, Section J24. The spring shall be made of a material that is inherently resistant to corrosion.

J6.9 Equipment provided with spring-closing outlet box covers evaluated for use in wet locations are considered to comply with these requirements without performance of the Spring-Closing Cycling Test, Section J23 or Gasket Tests, Section J24.

J6.10 When conducting the appropriate environment enclosure test outlined in Enclosures, 6.5, the cover is to be opened to its fullest extent, then allowed to assume the rest position prior to conducting the test. The test is to be conducted both with and without connectors mated to the inlet assembly.

J6.11 Marking and instructions on the exterior of an enclosure shall be permanent and suitable for outdoor use. See J27.1.

J7 Insulating Material

J7.1 Material for the support of uninsulated live parts shall be porcelain, phenolic or cold molded composition, or other material acceptable for the support of such parts in accordance with the Annex A1, Item 7, and shall be capable of withstanding the most severe conditions likely to be met in service.

J7.2 Insulating material, including barriers between parts of opposite polarity (phase barriers) and material that may be subject to the influence of an arc formed by the opening of a switch, shall be acceptable for the particular application.

J8 Mounting of Parts

J8.1 All parts of inlet assemblies shall be securely mounted in position and prevented from loosening or turning if such motion could affect adversely the intended performance of the equipment, or could affect the risk of fire and injury to persons incident to the operation of the equipment.

J8.2 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 could result in a reduction of spacings to less than those required in Clearance and creepage distances, 6.3. The security of contact assemblies shall be such as to provide the continued alignment of contacts.

J8.3 Friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part as required in J8.1 and J8.2, but a lock washer, properly applied, may be accepted.

J8.4 External handles and push-buttons shall be located in accordance with the following:

a) Control and switch handles and push-buttons shall be located in a readily accessible location at an elevation above the equipment mounting surface not in excess of 1.98 m (78 inches).

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

J8.5 In determining compliance with J8.4, measurements shall be made to the center of the handle grip with the handle in the highest possible position. Where the handle grip is not clearly defined, it shall be considered to be at a point 76 mm (3 inches) in from the end of the handle.

J8.6 If the mechanism of a switching device is such that automatic operation of a switch, or operation of a remote or automatic tripping devices will permit sudden movement of an operating handle, the motion of the handle shall be restricted, or the handle shall be guarded to prevent injury to persons in the vicinity of the handle.

J9 Guarding and Accessibility of Live Parts

J9.1 Energized uninsulated 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.

J9.2 When access is required to a compartment that contains energized parts, barriers shall be provided to:

a) Keep from unintentional contact with energized parts; and

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

J9.3 Any barrier intended to be removed during routine maintenance or servicing shall be marked in accordance with J27.6.

J10 Current Carrying Parts

J10.1 A current-carrying part shall have mechanical strength and current-carrying capacity for the service, and shall be of metal that is acceptable for the particular application.

J10.2 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 are to be disregarded in a determination of the number of threads engaged.

J11 Field Wiring Connections

J11.1 Field wiring terminals for the connection of conductors to a transfer switch shall comply with Field-wiring terminals, 6.13.

J11.2 Inlets shall be provided for the connection of a portable generator using temporary cables. Inlets shall be of the male connector type and shall be energized only when an energized female connector is mated with the inlet.

J11.3 Multi-pole inlets shall be constructed such that the ground pin is the first to make and last to break during the mating process.

J11.4 Inlet assemblies using multiple single pole inlets shall be marked in accordance with J27.12.

J12 Wiring

J12.1 Internal wiring

J12.1.1 Internal wiring of inlet assemblies shall comply with Internal wiring, 6.14.

J12.2 Conductors passing through metal barriers

J12.2.1 An opening in a barrier through which factory installed wiring passes, or through which field installed wiring may pass, shall be provided with a bushing, or shall be formed so that there are no sharp edges with which conductors can come in contact.

J12.2.2 A bushing employed as described in J12.2.1 shall be of glass, ceramic, hard fiber, phenolic composition, cold-molded composition, or other polymeric material which has been investigated and found suitable for the application. Rubber, neoprene, and similar materials are not acceptable for this bushing.

J12.2.3 Except as noted in J12.2.4, if the conductors of an alternating-current circuit pass through a wall or partition of metal having magnetic properties, all of the conductors of the circuit, including the neutral, shall be run through the same opening. See J12.2.4 and J12.2.5.

J12.2.4 With reference to the requirement in J12.2.3, the conductors may pass through individual openings in a wall or partition of metal having magnetic properties if:

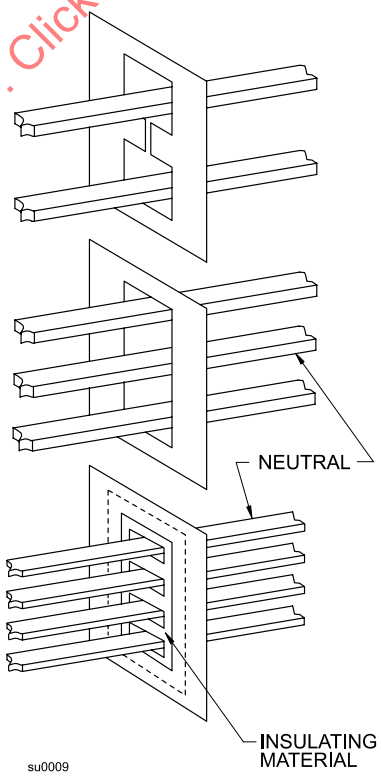
a) The openings are connected by slots cut in the metal wall; or

b) During the temperature test, temperatures are recorded on interposed metal to determine that conductor insulation is not adversely affected. The conductors may be run through individual openings in an insulating block used to cover an opening in the metal wall sufficiently large for all the conductors of the circuit if no metal bracket, brace, or the like, is placed across the insulating material between the conductors. See Figure J12.1.

J12.2.5 The requirements of J12.2.3 and J12.2.4 also apply to the mounting of the multiple single pole inlet connectors.

Figure J12.1

Conductors Through Openings



J13 Disconnect Switches

J13.1 General

J13.1.1 If an inlet assembly is provided with a disconnect switch, it shall comply with the requirements of this clause.

J13.2 Disconnecting means

J13.2.1 The disconnecting means shall be an externally-operable, gang-operated, disconnecting means which provides an air gap when in the open position. The disconnecting means shall be capable of interrupting the full load current rating of the inlet assembly. The disconnecting means can be any one of the following:

a) A manually operable isolating switch (with or without integral fuseholders) or a circuit breaker; or

b) A power operated switch (with or without integral fuseholders) or a circuit breaker.

J13.2.2 The disconnecting mechanism indicated in J13.2.1, shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. One pole of the disconnecting means may disconnect a permanently grounded conductor, provided that the disconnecting means is so constructed that the pole in the grounded conductor cannot be opened without disconnecting all conductors of the circuit in the same operation.

J13.2.3 The isolating means shall provide visible evidence that the switch is open.

J13.2.4 The isolating means shall have provision for being padlocked in the open position.

J13.2.5 All switch blades shall be de-energized when the switch is in the open position. Switches may have energized blades in the open position if:

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

b) The switch is marked in accordance with J27.7.

J14 Grounding and Bonding

J14.1 Inlet assemblies 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.

J14.2 Small, isolated (insulated) dead metal parts are not required to be grounded.

J14.3 Provisions shall be made for connection of an equipment grounding conductor sized in accordance with Table J14.1.

Table J14.1
Size of Equipment Grounding Conductors for Grounding Interior Raceways and Equipment

Inlet assembly rating, (amperes)	Size			
	Copper wire	(mm^2)	Aluminum or copper-clad aluminum wire	(mm^2)
15	14 AWG	(2.1)	12 AWG	(3.3)
20	12	(3.3)	10	(5.3)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	4	(21.1)
400	3	(26.7)	1	(42.4)
600	1	(42.4)	2/0	(67.4)
800	0	(53.5)	3/0	(85.0)
1000	2/0	(67.4)	4/0	(107)
1200	3/0	(85.0)	250 kcmil	(127)
1600	4/0	(107)	350	(177)
2000	250 kcmil	(127)	400	(203)
2500	350	(177)	600	(304)
3000	400	(203)	600	(304)
4000	500	(253)	800	(405)

J14.4 A dead metal part is not considered likely to become energized if acceptable results are obtained during dielectric voltage withstand with the part connected to ground during the tests.

J14.5 Secondary circuits of current and potential instrument transformers, if provided, shall be grounded.

J14.6 Metal cases of instrument transformers, instruments, meters, relays, and similar equipment shall be grounded using a conductor not smaller than 3.3 mm^2 (12 AWG) copper or equivalent. Metallic cases of equipment mounted directly on the grounded metal structure are considered adequately grounded when mounted using paint penetrating hardware.

J15 Ground-Fault Protection

J15.1 Ground fault protection is not required. However, if provided, it shall comply with Ground-fault protection, 6.16.

J16 Spacings

J16.1 Spacings shall be in accordance with Clearance and creepage distances, 6.3.

J17 Wiring Space

J17.1 Wiring space shall be in accordance with Wiring spaces, 6.18. When considering wiring space for temporary conductors, consideration shall be given to the length of the anticipated connectors to be used.

PERFORMANCE

J18 Inlet Assemblies

J18.1 The performance of inlet assemblies shall be investigated by subjecting a representative device or devices in commercial form to the tests described in Sections J19 – J22. Unless otherwise indicated, the various tests shall be conducted at rated supply frequency and voltage.

J18.2 All tests shall be conducted on enclosed samples. One sample is to complete the temperature, and dielectric voltage-withstand tests. A previously untested sample may be used for the short circuit withstand tests.

J19 Temperature Test

J19.1 Inlet assemblies, when tested under the conditions described in J19.2 – J19.8 shall not attain a temperature at any point high enough to constitute a risk of fire or to damage any materials employed in the device, and shall not show temperature rises at specific points greater than those indicated in Table J19.1.

Table J19.1
Maximum Acceptable Temperature Rises

Materials and compounds	°C	°F
1. Buses, Connecting Joints, Moving or hinge contacts		
Where both mating surfaces are copper	30	54
Where one mating surface is copper and the other is silver, tin or equivalent	50	90
Where both mating surfaces are silver, tin, or the equivalent	65	117
2. Field-wiring terminals:		
Terminals rated up to 400 A	50[d]	90
Terminals rated more than 400 A	60[c]	108
3. Insulation materials	a	a
4. Parts subject to contact by personnel		
Parts handled by operator in normal use of duty	50[b]	90[b]
Parts accessible to operator during normal course of duty	70[b]	126[b]

[a] Total temperature for insulation materials or parts in contact with insulation materials shall not exceed the Relative Thermal Index (RTI) for the insulation material. For maximum allowable rise, subtract test ambient from the RTI for the material.

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

[c] Refer to 5.2.1.22 for information on the marking required for devices for which the maximum temperature rise recorded on its terminals exceeds 50 °C (90 °F).

[d] Equipment marked for use with 60 °C or 60/75 °C wire may use 90 °C conductors provided the size shall be determined based on the ampacity of wire rated 60 °C or 75 °C as applicable.

J19.2 For the temperature test the inlet assembly is to be operated under intended use conditions and is to carry its test current continuously. A low-potential source of supply may be used for temperature tests on parts other than coils, which shall be tested at rated voltage. The tests on all parts shall be made simultaneously as the heating of one part may affect the heating of another part.

J19.3 The test current shall be 100 percent of the rated current.

J19.4 Terminals of inlet assemblies intended for connection of permanently installed conductors are to be connected with not less than 1.2 m (4 feet) of copper wire, provided with black insulation, per terminal. The wire size is to correspond to the rating of the inlet assembly. When agreeable to those concerned, insulation of a color other than black is not prohibited from being used.

J19.5 Inlets for connection to portable generators shall be connected with the mating connector specified by the manufacturer, using not less than 1.2 m (4 feet) of the cable size and type specified by the manufacturer. The cable shall have black insulation.

J19.6 For a device employing a fuseholder, a copper bar, copper tubing, or an equivalent material with negligible impedance instead of a fuse is to be used during the test.

J19.7 The temperature readings are to be obtained by means of thermocouples and an indicating instrument. A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previous elapsed duration of the test, but not less than 10-minute or more than 20-minute intervals, indicate that stable conditions have been reached.

J19.8 Temperatures are to be measured by thermocouples in accordance with 9.8.9.

J20 Dielectric Voltage-Withstand Test

J20.1 An inlet assembly shall be capable of withstanding for 1 minute without breakdown the application of a 60-Hz sinusoidal potential of 1000 V plus two times maximum rated voltage. The potential shall be applied:

a) Between live parts and the enclosure with an isolating switch (if provided) in the open and closed positions; and

b) Between uninsulated live parts of different circuits.

J20.2 With reference to J20.1, a transformer, a coil, or a similar device connected between lines of opposite polarity is to be disconnected from one side of the line during test in J20.1(b).

J20.3 To determine whether an inlet assembly complies with the requirements in J20.1, the device is to be tested by means of a 500 VA or larger capacity transformer, the output voltage of which can be varied. The waveform of the voltage is to approximate a sine wave. The applied potential is to be increased gradually from zero to the required test value and is to be held at that value for one minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter in the output circuit of the test transformer.

J21 Short Circuit Withstand Test

J21.1 When tested under the conditions described in J21.1 – J21.10, an inlet assembly shall withstand the designated levels of current until the overcurrent protective devices open or for a time as designated in J21.3. At the conclusion of the test:

a) The fuse mentioned in J21.13 shall not open;

b) There shall be no breakage to the extent that the integrity of the mounting of live parts is impaired;

c) The door shall be prevented by its latch, without bolt or lock installed therein, from being blown open, and deformation of the door alone is not determined to be unacceptable;

d) No conductor shall have pulled out of a terminal connector and there is no damage to the conductor insulation or the conductor; and

e) The point of contact on the inlet and associated connector is to be the same both mechanically and electrically as before the test.

J21.2 The overcurrent protective devices specified in J21.1 shall be one of the following:

a) The integral circuit breaker provided in the inlet assembly, with any protective devices set at the least responsive setting;

b) The maximum ampere rated fuse that can be inserted if integral fuseholders are provided; or

c) If no provisions are made for integral overcurrent protective devices, an externally connected circuit breaker or fuses, as marked on the inlet assembly, shall be used. The ampere rating of such circuit breakers or fuses shall not be less than 125 percent of the inlet assembly ampere rating. When an externally connected circuit breaker is used, the protective function of the circuit breaker during this test shall be set at the least responsive setting.

J21.3 The test current is to be maintained until the overcurrent protection device noted in J21.1 opens the circuit.

J21.4 The tests specified in J21.1 may be performed without overcurrent protective devices if it can be shown that the test circuit current is maintained for a period of time at least equal to the opening time of the specified overcurrent protective devices at the level of current involved.

J21.5 If an inlet assembly has a maximum short circuit withstand rating higher than 20 times the inlet assembly rating, and if the fuse or circuit breaker specified for the test is considered to begin current limiting above 20 times the inlet assembly rating, the inlet assembly shall be subjected to short circuit withstand tests:

a) At the maximum short circuit withstand rating with the maximum allowable size fuses and circuit breaker; and

b) At 20 times the inlet assembly ampere rating with the maximum allowable size fuses and circuit breakers. A separate sample may be used for the second test.

J21.6 An inlet assembly intended for use on an alternating-current system shall be tested with alternating current at rated frequency on a circuit as indicated in Figure J21.1. The test is to be performed in accordance with the following:

a) The open-circuit voltage of the power-supply circuit shall not be less than the maximum rated voltage of the inlet assembly.

b) Except as noted in (c), the available short-circuit rms symmetrical current in amperes at the test source terminals shall not be less than the rated short-circuit current of the inlet assembly.

c) The available short-circuit current for an inlet assembly incorporating circuit breakers shall not be greater than the marked interruption current rating of the breaker.

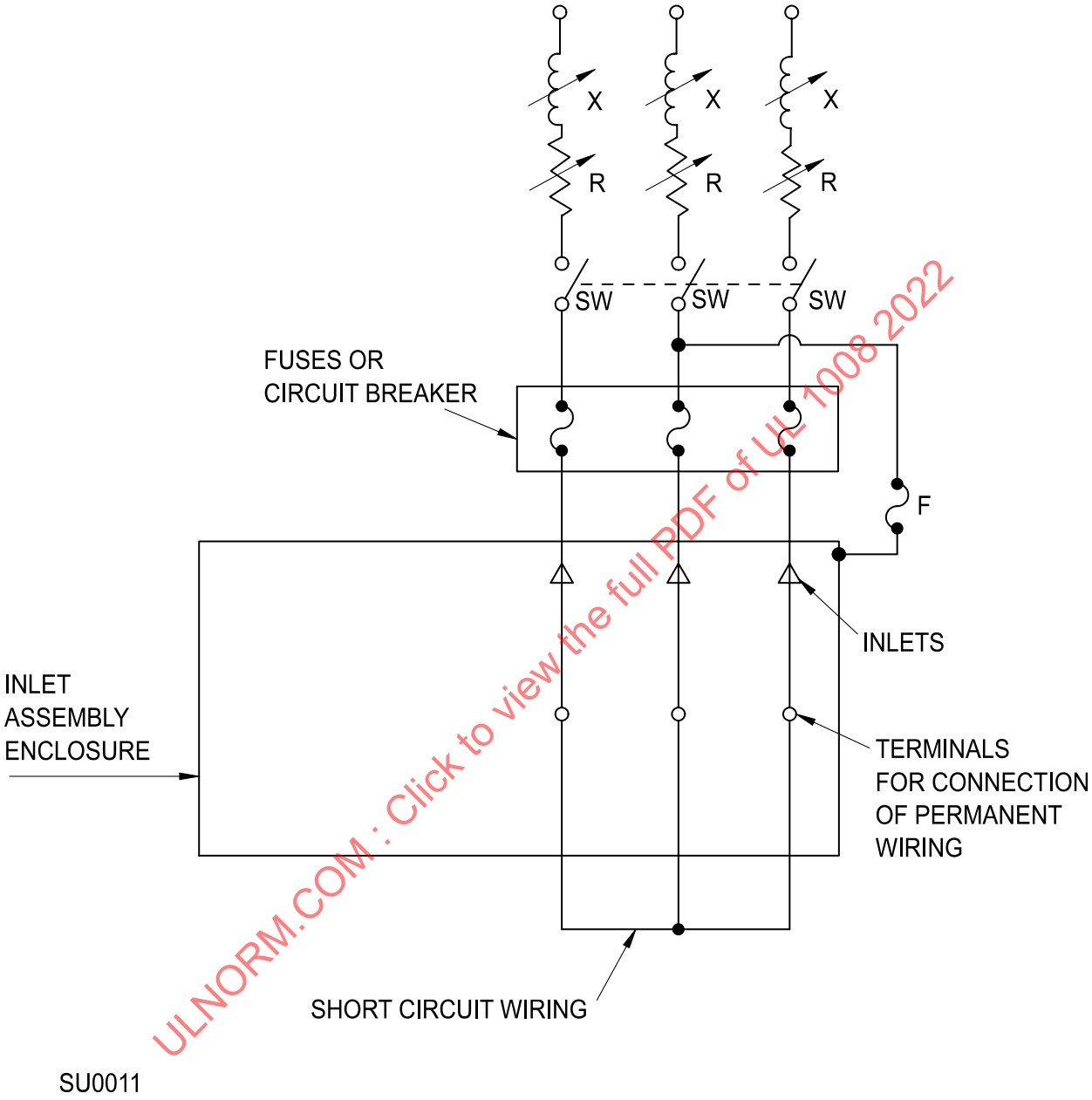
d) The test source circuit shall include the necessary measuring equipment and the fuse-mounting means if necessary.

e) The power factor of the circuit shall be 0.40 – 0.50 for currents of 10,000 A or less, 0.25 – 0.30 for currents of 10,001 – 20,000 A and 0.20 or less for currents greater than 20,000 A. Lower power factors may be used if agreeable to those concerned.

f) The test source terminals are to be included in the circuit, for the connections described in J21.8. In determining the available short-circuit current of the circuit these terminals, as well as the fuse-mounting means shall be short-circuited in each instance by bus bars.

Figure J21.1

Circuit for Short Circuit Withstand Test



Legend

Supply – Rated Voltage 3 Phase

X – Variable tap air-core reactor

R – Variable resistor

SW – Closing switch – may be located as shown or ahead of limiting impedance

F – Enclosure fuse

J21.7 The reactive components of the impedance in the line shown in Figure J21.1 may be paralleled if of the air-core type but no reactance is to be connected in parallel with resistances except that an air-core reactor(s) in any phase may be shunted by resistance as determined in accordance with H5.20.

J21.8 For performing the test, the inlets of the assembly are to be connected to the corresponding test circuit terminals by the flexible cable and connectors specified by the manufacturer. Lengths are to be in accordance with J21.9, J21.11, and J21.12. The terminals for connection of cable to the transfer switch are to be short circuited using conductors based on the ampere rating of the inlet assembly.

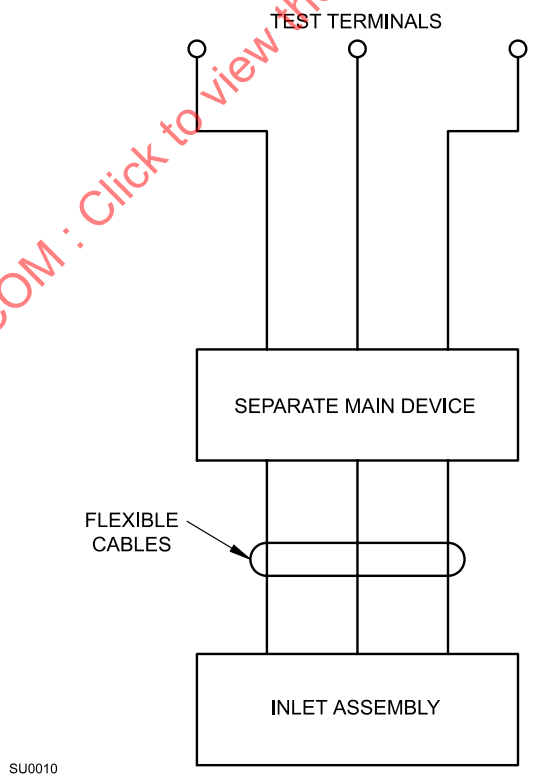
J21.9 The total length of phase conductor or conductors in the test circuit is not to exceed 2.4 m (8 feet) per conductor unless the excess length is included in the test circuit calibration.

J21.10 In an inlet assembly provided with integral fuseholders, the supply conductor is to be connected to the inlets of the assembly. The fuses intended to be used in the equipment shall be installed during the test. Where more than one type or rating of fuse is specified, that fuse having the highest peak current and highest current let through characteristics shall be used.

J21.11 When a separate main device is used, the method of line connection is to be as shown in Figure J21.2. In the case of a separate fusible main, fuses are to be installed in an external fuseholder. The main device terminals are to be connected by a conductor in accordance with J21.10. The combined length of each conductor (line, external fuseholder, and connections between the separate main device and inlet assembly) shall not exceed the length permitted by J21.10.

Figure J21.2

Line Connection for Tests



J21.12 The enclosure is to be connected through a 30 A, fuse to ground The fuse is to have a voltage rating not less than the rated voltage of the equipment being tested. This connection is to be made on the load side of the limiting impedance by a minimum 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 m (4 – 6 feet) long.

J21.13 With any integral switches in the fully closed position, the test circuit is to be closed on the inlet assembly. For magnetically operated devices, the magnet is to be held closed electrically.

J21.14 A three-phase inlet assembly shall be tested on a three-phase circuit.

J21.15 A single-phase inlet assembly, including a design employing adjacent poles of a three-phase construction shall be tested on a single-phase circuit.

J21.16 Closing for the Short Circuit Withstand Test on a single-phase circuit shall be controlled so that the closing angle with respect to the zero point of the supply voltage is within plus 10 degrees.

J21.17 An inlet assembly having:

a) A switched neutral of different construction than a power pole;

b) A neutral bus that is spaced closer to a line bus than the spacing between adjacent line buses; or

c) A different means of support for the neutral bus,

shall be tested with a line-to-neutral fault in addition to the line-to-line test.

J21.18 Neutral short-circuit tests shall be made at the marked line to neutral voltage and short-circuit current rating of the inlet assembly. The neutral and nearest phase bus are to be used for this test.

J22 Dielectric Voltage-Withstand Test (Repeated)

J22.1 An inlet assembly that has been subjected to the tests in Section J21 and Section J22 shall comply with the requirements in the Dielectric Voltage-Withstand Test, Section J20, except that the test potential is to be 60 percent of the original Dielectric Voltage-Withstand Test voltage.

J23 Spring-Closing Cycling Test

J23.1 When subjected to the cycling test described in J23.2, a cover plate shall not crack, deform, or otherwise be damaged so as to allow the entrance of water as verified by the appropriate environmental test outlined in Enclosures, 6.5. Verification of cover plate performance is to be conducted with the cover opened completely and then allowed to assume its natural position.

J23.2 A cover plate shall be subjected to 1000 cycles of operation. One cycle of operation is considered to be complete opening of the cover followed by allowing the cover to assume its natural position.

J24 Gasket Tests

J24.1 A gasket of an elastomeric or thermoplastic material or a composition gasket utilizing an elastomeric material used to comply with enclosure performance requirements of Annex A1, Item 2 is to be subjected to the tests specified in J24.2 and J24.3.

J24.2 A gasket shall be secured with adhesive or by mechanical means. The gasket and its securing means shall not be damaged when the joint is opened.

J24.3 Gaskets shall be of such quality that samples subjected to a temperature of 69 – 70 °C (156 – 158 °F) in circulating air for 168 hours have a tensile strength of not less than 75 percent and an elongation of not less than 60 percent of values determined for unaged samples. At the conclusion of the tests, there shall be no visible deterioration, deformation, melting, or cracking of the material and the material shall not harden as determined by normal hand flexing.

J25 Routine Tests – Ground-Fault Protection

Note: In Mexico and the United States, this requirement applies. In Canada, this requirement does not apply.

J25.1 If provided with ground fault protection, an inlet assembly shall comply with Ground-fault protection, 10.1.

RATINGS

J26 General

J26.1 Inlet assemblies shall be rated in volts and amperes the number of phases, and the frequency.

J26.2 Inlet assemblies shall have the short circuit rating expressed in symmetrical rms amperes or kA.

J26.3 Terminals for auxiliary circuits shall be rated in volts and amperes or volt-amperes.

MARKINGS

J27 General

J27.1 Inlet assemblies shall be plainly marked with the manufacturer's name or trademark, or other descriptive marking by which the organization responsible for the product may be identified, a distinctive catalog number or the equivalent, and all electrical ratings. All markings shall be located to be visible after installation.

J27.2 Marking, as indicated in J27.1, is not required to be located on the outside of an enclosure provided it is readily visible by opening a door or removing a cover after installation.

J27.3 When the manufacturer produces or assembles inlet assemblies 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.

J27.4 Wiring terminals shall be marked to indicate the connections.

J27.5 The enclosure of an inlet assembly shall be marked where visible after installation with the environmental condition type number or numbers.

J27.6 A removable barrier, as mentioned in J9.3, shall be marked to indicate that reinstallation is required.

J27.7 An inlet assembly constructed in accordance with J13.2.5 shall be marked "DANGER – Switch Blades May Be Live When Open." This marking shall be expanded to include reference to fuses and fuseholders if applicable.

J27.8 An inlet assembly shall be marked "DANGER – Any terminal may be energized when any cable is connected. De-energize cables at the generator prior to opening this cover." This marking shall be located so as to be visible before opening any cover giving access to the inlets.

J27.9 An inlet assembly that is not provided with integral overcurrent protective devices shall be provided with instructions indicating the intended overcurrent protection. The specified overcurrent protection shall be that which was used in the Short circuit withstand test, Section J21.

J27.10 Doors which provide access to components containing uninsulated live parts shall be marked "DANGER – HIGH VOLTAGE – KEEP OUT."

J27.11 Inlet assemblies shall be marked "DANGER – Risk of Electric Shock. For use only for connection of a portable generator to the source terminals of a transfer switch, such that the inlets are only energized from the generator." This marking shall appear adjacent to the wiring terminals of the device and shall be visible after installation and during the field wiring process.

J27.12 Inlet assemblies that use multiple single pole inlets that are not sequentially interlocked in accordance with J5.3 shall be marked in accordance with 5.2.7.5 – 5.2.7.6.

J27.13 All DANGER and WARNING markings shall comply with Annex A2, Item 10. The signal word "DANGER" or "WARNING" shall be in minimum 3.2-mm (1/8-inch) high letters, with the remaining text in minimum 1.6-mm (1/16-inch) high letters.

J27.14 Inlet assemblies shall be marked in accordance with 5.2.7.12.

J27.15 When required by J5.5(c), inlet assemblies 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 inlet assembly 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 inlet assembly.

J28 Permanence of Marking

J28.1 A marking shall be molded, die-stamped, paint-stenciled, stamped, or etched metal that is permanently secured, or indelibly applied lettering on a label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, including likely exposure to weather and other ambient conditions, handling, storage, and the like of the equipment is considered in the determination of the acceptability of the application.

INSTALLATION

J29 Installation Test Procedures

J29.1 If an inlet assembly is provided with ground fault protection, it shall comply with Instructions for installation, operation, and maintenance, 5.3.

Annex K
(normative)

Arc Resistant Transfer Switch Equipment

K1 Scope

K1.1 This Annex provides requirements for testing Transfer Switch Equipment (TSE) for resistance to the effects of arcing due to an internal fault.

K1.2 The requirements in this Annex are only applicable to arcing faults occurring entirely in air within the enclosure when all doors and covers are properly secured. This Annex does not apply to arcing faults which occur within components of the TSE.

K1.3 TSE that meet the requirements of this Annex will be referred to as arc resistant TSE.

K1.4 Flush mount enclosed equipment is not covered by this Annex.

K2 General

K2.1 Consequences of internal arc faults:

a) Transfer Switch Equipment (TSE) is designed to withstand the mechanical forces caused by short-circuits occurring directly on the load terminals of the TSE. The ability of TSE to withstand these forces is demonstrated in the Short-Circuit Withstand and Closing Tests in this Standard.

b) Arcing inside the TSE produces many physical phenomena, including:

1) Sudden pressure increase inside the enclosure;

2) Localized overheating, resulting in both severe mechanical and thermal stresses on the equipment; and

3) Gaseous or particulate by-products which may be discharged to the outside of the enclosure.

K2.2 This Annex includes requirements to evaluate the effect of abnormal internal pressure acting on properly latched or secured covers, doors, inspection windows, etc. The requirements also consider the thermal effects of the arc on the enclosure and of ejected hot gases and particles.

K2.3 TSE evaluated to these requirements provides an additional degree of protection to the personnel performing normal operating duties near the TSE under normal conditions, including:

a) Maintenance of controls while the TSE is providing power to critical loads; and

b) Maintenance of a transfer switch in bypass / isolation designs while the bypass mode is active and providing power to critical loads.

K2.4 Annex A1, Item 28 provides guidance for testing equipment for resistance to the effects of internal arcing faults, but does not specifically address the unique features of TSE. This Annex is intended to supplement the test methods in these two documents.

K3 Referenced Publications

K3.1 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.

K4 Glossary

K4.1 For the purpose of this Annex, the following definitions apply.

K4.2 Compartment – A portion of the equipment enclosing a specific component or function separated by metal barriers.

K4.3 Bypass/Isolation Compartment – A compartment containing a bypass/isolation switch.

K4.4 Transfer Switch Compartment – A compartment containing the transfer switch.

K5 Accessibility Types

K5.1 For the purposes of this Annex, accessibility types 1 and 2 and suffixes A, B, C and D as defined in the documents in Annex A1, Items No. 28 and 29, are applicable.

K5.2 For wall mounted TSE, the suffix A also indicates the top and bottom surfaces of the TSE have been assessed.

K5.3 The use of suffix C does not indicate that it is safe to work in one compartment while an adjacent compartment is energized.

K6 Construction

K6.1 TSE may consist of a single section or multiple vertical sections. TSE to be tested for resistance to the effects of arcing due to an internal fault shall comply with the construction requirements of this annex as well as all the applicable construction requirements for TSE of this standard.

K6.2 When bus is provided, it is typically uninsulated bus, but insulated bus may be available as an option. Where main bus is provided and passes from one vertical section to the next, a single opening for this purpose is common. Through-bushings and isolation between sections may be available as an option.

K6.3 Common factors that may affect performance are listed below and shall be addressed by the test program:

a) When the TSE has a main bus that passes through a large opening from one vertical section to another, a representative assembly of vertical sections containing the minimum acceptable main bus compartment volume shall be tested.

b) When the TSE consists of only one vertical section or the TSE includes a main bus passing between vertical sections using a through bushing, each configuration of vertical sections shall be tested. The test sample shall be representative of the minimum volume utilized in the design. Testing of individual vertical sections rather than a multiple section lineup is acceptable for all compartments except the incoming main bus compartment, which shall be evaluated with respect to the main bus compartments in the adjacent vertical sections.

c) When a vertical section is provided with separate compartments for components other than those in instrument compartments, and each compartment is identical other than its vertical location within the section, the compartment with the longest vent path for pressure relief shall be tested. This test is considered representative of the compartment design for all other locations.

d) When the TSE is provided with blowers or fans used to supplement convective air flow through a compartment for cooling purposes (i.e. forced ventilation), a single test shall be conducted with the fans off and all ventilation in its normal state when the fans are off.

e) When each vertical section is provided with internal overpressure relief means, the section with the smallest internal volume of all the sections shall be tested to represent the other sections. Any openings between sections shall be sealed for the test.

f) The presence of bus insulation may affect the behavior of the internal arcing fault. If the TSE is offered with and without insulation, separate tests shall be conducted on both configurations. When testing designs with bus insulation, all bus insulation that is normally provided shall be present during the test, including the bus joints (boots, tape, etc.), except at the point of arc initiation where the insulation is compromised by the fault initiating wire.

K7 Testing of Wall Mounted TSE

K7.1 General

K7.1.1 Wall mounted TSE will typically be accessibility Type 1 but may be Type 2 when subjected to applicable testing. In the case of Type 2, the back surface is not considered accessible.

K7.1.2 While most wall mounted TSE is a single compartment, compartmentalization is an option. Suffixes A, B, C or D may be used, as applicable.

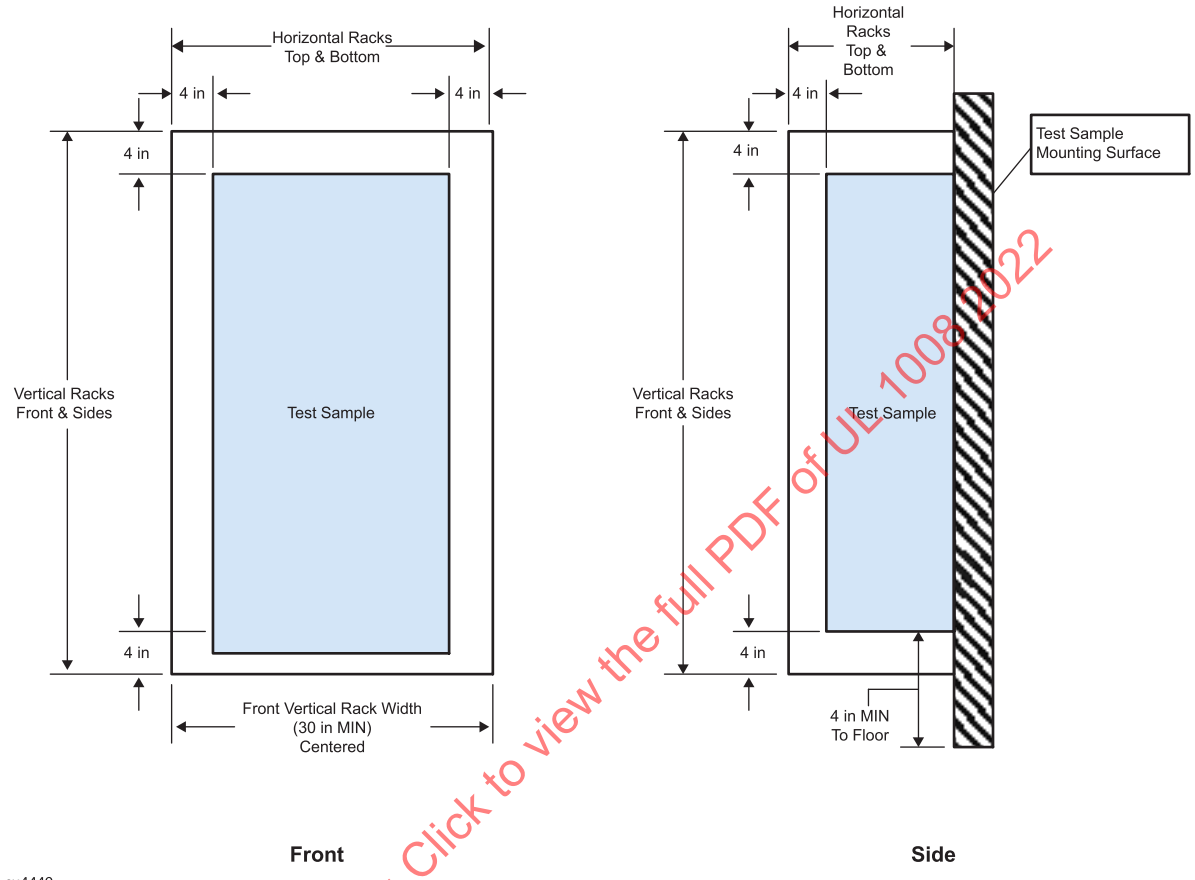
K7.1.3 Because the TSE is wall mounted, the top and bottom sides shall be assessed.

K7.2 Test method

K7.2.1 The test described in K7.2.2 – K7.2.8 and Figure K7.1 shall be conducted for Types 1 and 2A and shall be in accordance with Annex A1, Item 28, with the modifications in this section.

NOTE: For evaluation of suffixes B, C, or D, refer to Annex A1, Item 28.

Figure K7.1
Evaluation of Wall Mounted TSE
Types 1 & 2A



K7.2.2 The enclosure shall be mounted as intended in service, at a height no less than 10.2 cm (4 in) above the floor.

K7.2.3 Additional indicators are to be located horizontally 10.2 cm (4 in) above the TSE top surface and 10.2 cm (4 in) below the bottom TSE surface.

NOTE: These are in addition to the required horizontal indicators and are intended to capture gases vented out the top of a wall mounted enclosure because the top surface may be less than 79 inches from the floor and these gases may impact an operator. Likewise, the lower indicators are intended to capture gases vented out the bottom of a wall mounted enclosure.

K7.2.4 Vertical indicators are to be located 10.2 cm (4 in) from the front surface as specified except the indicators need only be located from a location starting at 4 inches below the plane of the bottom surface of the TSE and extending to 4 inches above the top surface of the TSE. The minimum width of the vertical indicator rack shall be 30 inches (76.2 cm) or the width of the TSE plus 20.3 cm (8 in), whichever is greater. The indicator rack shall be centered on the TSE midpoint.

NOTE: Since the mounting height of the wall mounted enclosure is not controlled, the vertical indicators need not be located from the floor to a height of 2 m (79 in), but must cover the entire front surface of the enclosure plus 20.3 cm (8 in). These vertical indicators, in combination with the additional indicators provided above and below the enclosure, are expected to capture any gases expelled towards the operator. The minimum width of the indicator rack is intended to provide protection from arcing products that are deflected off the mounting surface.

K7.2.5 For TSE having no compartmentalization, arcs shall be initiated at:

a) Each set of line side terminals, unless the construction of each set of terminals is identical with respect to phase to phase and phase to ground spacings and with respect to vent path for exhaust gases; and

b) Load side terminals.

K7.2.6 For TSE having multiple compartments, each compartment containing bus or power components shall be tested. Arcs shall be initiated in each of these compartments as described in K7.2.6.1 and K7.2.6.2.

K7.2.6.1 In compartments with no switch or circuit breaker in the main circuit, the arc is to be initiated at the cable terminations farthest away from the source.

K7.2.6.2 In compartments containing a switch or circuit breaker in the main circuit, the arc is to be initiated as follows:

a) On the line side terminals of the switch or circuit breaker, with the device in the open position;

b) On the load side terminals of the switch or circuit breaker, with the device in the closed position; and

c) On cable terminations farthest from the source, if different from the terminals tested in (b).

K7.2.7 In all cases, the arc shall be initiated by means of a 2.6 mm (0.10 in) diameter or 10 AWG metal wire.

K7.2.8 Since wall mounted TSE will normally be mounted below 2.1 m (83 in) from the floor, when wall mounted TSE is provided with an exhaust duct, vertical and horizontal indicators shall be placed around the duct in accordance with the requirements for exhaust ducts mounted below 2.1 m (83 in) from the floor as described in Annex A1, Item 28.

K8 Testing of Floor Mounted TSE

K8.1 General

K8.1.1 Floor mounted TSE may be Type 1 or Type 2. Suffixes A, B, C or D may be used, as applicable.

K8.2 Test method

K8.2.1 Test shall be in accordance with Annex A1, Item 28 with the modifications in K8.2.2 – K8.2.7.

K8.2.2 For TSE having no compartmentalization, arcs shall be initiated at:

a) Each set of line side terminals, unless the construction of each set of terminals is identical with respect to phase to phase and phase to ground spacings and with respect to vent path for exhaust gases; and

b) Load side terminals.

K8.2.3 For TSE having multiple compartments, each compartment containing bus or power components shall be tested. Arcs shall be initiated in each of these compartments as described in K8.2.4 and K8.2.5.

K8.2.4 In compartments with no switch or circuit breaker in the main circuit, the arc is to be initiated at the cable terminations farthest away from the source.

K8.2.5 In compartments containing a switch or circuit breaker in the main circuit, the arc is to be initiated as follows:

a) On the line side terminals of the switch or circuit breaker, with the device in the open position;

b) On the load side terminals of the switch or circuit breaker, with the device in the closed position; and

c) On cable terminations farthest from the source, if different from the terminals tested in (b).

K8.2.6 In all cases, the arc shall be initiated by means of a 2.6 mm (0.10 in) diameter or 10 AWG metal wire.

K8.2.7 When floor mounted TSE is provided with an exhaust duct, vertical and horizontal indicators shall be placed around the duct in accordance with the requirements for exhaust ducts in Annex A1, Item 28.

K8.2.8 If the TSE construction is such that the TSE consists of a single cabinet (i.e. there are no provisions for adding vertical sections), the test sample shall be a single cabinet.

K9 Markings

K9.1 See Annex A1, Item 28.

Annex L
(informative)

Electromagnetic Compatibility (EMC) Requirements for Transfer Switches

INTRODUCTION

L1 Scope

L1.1 These requirements cover optional electromagnetic compatibility (EMC) testing for all transfer switch equipment.

L2 Referenced Publications

L2.1 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.

L2.2 The following publications are referenced in this Annex:

UL 60947-1, *Low Voltage Switchgear and Controlgear – Part 1: General Rules*

IEC 60947-6-1, *Low-Voltage Switchgear And Controlgear – Part 1: General Rules*

IEC 61000-3-2, *Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits For Harmonic Current Emissions (Equipment Input Current 16 A Per Phase)*

IEC 61000-3-3, *Electromagnetic Compatibility (EMC) – Part 3-3: Limits – Limitation Of Voltage Changes, Voltage Fluctuations And Flicker In Public Low-Voltage Supply Systems, For Equipment With Rated Current ≤16 A Per Phase And Not Subject To Conditional Connection*

IEC 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signaling at a.c. power port, low-frequency immunity tests*

CISPR 32, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

CONSTRUCTION

L3 General

L3.1 Environmental conditions

L3.1.1 Two sets of environmental conditions are considered:

a) Environment A – low-voltage non-public or industrial networks/locations/installations including highly disturbing sources. Environment A corresponds to equipment class A in CISPR 11; or

b) Environment B – low-voltage public networks such as domestic, commercial and light industrial locations/installations. Highly disturbing sources such as arc welders are not covered by this environment. Environment B corresponds to equipment class B in CISPR 11.

L3.1.2 Power-frequency magnetic field tests are not required because the devices are naturally submitted to such fields. Immunity is demonstrated by the successful completion of the Overload test, 9.10 and the Endurance test, 9.12.

L3.1.3 For the purpose of this Annex, the phrase “electronic circuit” excludes circuits in which all components are passive (including diodes, resistors, varistors, capacitors, surge suppressors, and inductors).

L3.2 Immunity

L3.2.1 Equipment not incorporating electronic circuits is not sensitive to electromagnetic disturbances in normal service conditions, and therefore no immunity tests are required.

L3.2.2 Equipment incorporating electronic circuits shall have a satisfactory immunity to electromagnetic disturbances.

L3.3 Emission

L3.3.1 General

L3.3.1.1 For equipment not incorporating electronic circuits the requirements for electromagnetic emissions are considered to be satisfied, and no verification is required. Electromagnetic disturbances can only be generated by equipment during occasional switching operations. The duration of the disturbances is less than 200 mS in accordance with CISPR 32. The frequency, level and consequences of these emissions are considered as part of the normal electromagnetic environment of low-voltage installations.

L3.3.2 Equipment incorporating electronic circuits

L3.3.2.1 The high-frequency (greater than 9 kHz) continuous emissions from equipment incorporating electronic switching circuits shall not exceed the limits described in L6.2, Radiated radiofrequency emission tests. One-time disturbances less than or equal to 200 mS do not require evaluation.

L3.3.2.2 For equipment which generates low frequency harmonics, where applicable, the requirements of IEC 61000-3-2 apply.

L3.3.2.3 For equipment which generates low frequency voltage fluctuations, where applicable, the requirements of IEC 61000-3-3 apply.

PERFORMANCE

L4 General

L4.1 All emission and immunity tests are type tests, and shall be carried out under representative conditions, both operational and environmental, using the manufacturer's recommended wiring practices, and including any enclosures specified by the manufacturer.

L4.2 The requirements described in the General requirements clause of UL 60947-1 shall be followed. The test sample shall be in the open or closed position, whichever is worse, and shall be operated with the rated control supply. The test results shall comply with the Evaluation of test results clause of UL 60947-1.

L4.3 The test report shall be provided as described in the Test reports clause of UL 60947-1. The test report shall include any special measures that have been taken to achieve compliance, for example the use of shielded or special cables. If auxiliary equipment is used with the device in order to comply with immunity or emission requirements, it shall be included in the report.

L5 Immunity

L5.1 General

L5.1.1 The tests described in the Tests for EMC – Immunity table of UL 60947-1 are required. Special requirements are described in L5.2 to L5.8.

L5.1.2 If during the EMC tests, conductors are to be connected to the test sample, the cross-section and the type of the conductors is optional but shall be in accordance with the manufacturer's literature.

L5.1.3 Disturbances should be applied at all the power sources of the controller.

L5.2 Electrostatic discharges

L5.2.1 Electrostatic discharge tests shall be conducted as described in the Electrostatic discharges clause of UL 60947-1.

L5.2.2 Electrostatic discharge tests shall be conducted only on the parts of the equipment which are normally accessible to the operator in normal service.

L5.2.3 The equipment shall comply with performance criterion B shown in Table L5.1.

Table L5.1
Performance criteria of immunity test

Item	Acceptance criteria (performance criteria during tests)		
	A	B	C
Overall performance	Normal TSE operations without noticeable changes of the operating characteristic.	Temporary degradation or loss of performance which is self-recoverable	Temporary degradation or loss of performance which, after the test, requires operator intervention or system reset. No damaged components.
Power switching operation, interlocking and controller functions	No unwanted operation of the TSE. No change of state of the controller. No change of the auxiliary contacts. TSE fully operational.	Temporary degradation mode of the controller which is self-recoverable. No unwanted operation of the TSE. No change of the auxiliary contacts.	Temporary or loss of the transfer function availability, which, after the test, is recoverable by operator intervention or the reset of the controller or any electronics. No unwanted operation of the TSE. No change of the auxiliary contacts.
Operation of displays, and control panels	No changes to visible display information. Only slight light intensity fluctuation, or slight movement of displayed information.	Temporary visible changes on the display (flickering). Undesired display illumination. No change of the operating mode.	Shutdown or permanent loss of display. Recoverable after the test by operator intervention or the controller reset.
Information processing, communication, and sensing functions	Undisturbed communication, sensing functions and information exchange to external devices.	Temporarily variation of analogic values, disturbed communication, possible error reports of the internal and external devices. No irreversible loss of data.	Loss of data and/or information. Erroneous processing of information, errors in communication recoverable, after the test, by operator intervention or the controller reset.

L5.3 Radio-frequency electromagnetic fields

L5.3.1 Conducted immunity tests shall be conducted as described in the Conducted disturbances induced by radio-frequency fields clause of UL 60947-1 using the performance criterion A shown in Table L5.1.