UL 891

STANDARD FOR SAFETY

Switchboards

UL Standard for Safety for Switchboards, UL 891

Twelfth Edition, Dated July 19, 2019

Summary of Topics

This new edition of ANSI/UL 891 covers switchboards nominally rated at 1 000 V or less and intended for use in accordance with the Canadian Electrical Code, Part I (CE Code, Part I), the National Electrical Code (NEC), ANSI/NFPA 70, and the Mexican Standard for Electrical Installations (Utility), NOM-001-SEDE.

The requirements are substantially in accordance with Proposal(s) on this subject dated April 27, 2018 and November 9, 2018.

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NMX-J-118/2-ANCE-2019
Fourth Edition

CSA Group
CSA C22.2 No. 244:19
Second Edition

Underwriters Laboratories Inc.
UL 891
Twelfth Edition

Switchboards

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Approved American National Standard

ANSI/UL 891-2019

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 inquires@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 Twelfth Edition.

The most recent designation of ANSI/UL 891 as an American National Standard (ANSI) occurred on July 19, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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

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Preface

This is the harmonized ANCE, CSA Group, and UL standard for Switchboards. It is the Fourth edition of NMX-J-118/2-ANCE, the Second edition of CSA-C22.2 No. 244, and the Twelfth edition of UL 891. This edition of NMX-J-118/2-ANCE supersedes the previous edition published on October 31, 2012. This edition of CSA-C22.2 No. 244 supersedes the previous edition published on July 26, 2005. This edition of UL 891 supersedes the previous edition published on July 26, 2005.

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, 17D – Panelboard and Switchboard on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

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

The present Mexican standard was developed by the CT CDI Control y Distribucion Industrial from the Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, A.C., CONANCE, with the collaboration of the switchboard manufacturers and users.

This standard was reviewed by CSA C232(ICSP) – Integrated Committee on Switchgear Products, 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 Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

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

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

Level of harmonization

This standard is published as an equivalent standard for 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.

Interpretations

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

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Switchboards

1 General

1.1 Scope and object

1.1.1 This Standard applies to switchboards nominally rated at 1 000 V or less and intended for use in accordance with the Canadian Electrical Code, Part I (CE Code, Part I), the National Electrical Code (NEC), ANSI/NFPA 70, and the Mexican Standard for Electrical Installations (Utility), NOM-001-SEDE.

1.1.2 In this standard the term switchboard is intended to refer to a dead-front switchboard.

1.1.3 These requirements do not cover the following switchboard types: preset and dimmer control (theater), live front, railway control or electrification; or constructions intended only for receiving motor control center units.

1.1.4 These requirements cover switchboards for use on circuits having available short-circuit currents of not more than 200 000 A.

1.1.5 These requirements do not cover switchboards with short-time current ratings.

2 General

2.1 Undated references

2.1.1 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. See Annex B.

2.2 Multiple countries codes

2.2.1 When compliance with multiple countries' codes or Standards is required, but the product is not intended for use in all three countries, the product need only comply with the codes or Standards for the country or countries in which it is intended to be used.

2.3 Products for Canada

2.3.1 For products intended for use in Canada general requirements are given in Reference Item No. 15 of Annex B.

2.4 Components

2.4.1 A component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of Standards covering components generally used in the products covered by this Standard. A component shall comply with the Underwriters Laboratories Inc. Standards, the ANCE Standards, and the Canadian Standards Association Standards for the component. When a product is not intended for use in all three countries, a component need only comply with the component Standards for the country or countries in which it is intended to be used.

2.4.1.1 A component need not comply if it is:

a) used in a Class 2 circuit; and

b) treated as an arcing part as covered in 8.2.1.3.1.1 and 8.8.1.8.5.

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

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

b) Is superseded by a requirement in this standard.

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

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

3 Definitions

3.1 For the purposes of this standard, the following definitions apply:

3.2 **Accessible, front:** an enclosure in which incoming and outgoing field termination points are accessible from the front. Other connections shall be permitted to be rear or side accessible. If necessary, a limited number of barriers or covers shall be permitted to be removed to achieve this accessibility.

3.3 **Accessible, rear:** an enclosure in which all incoming and outgoing field termination points are accessible from the rear. Other connections shall be permitted to be front or side accessible. If necessary, a limited number of barriers or covers shall be permitted to be removed to achieve this accessibility.

3.4 **Ambient temperature:** the temperature of the surrounding medium that comes in contact with the switchboard. For an enclosed switchboard, it is the temperature of the medium outside the enclosure.

3.5 **Ampacity:** the current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

3.6 **Barrier:** a partition for the insulation or isolation of electric circuits or electric arcs.

3.7 **Bonding:** the permanent joining of metallic parts to form an electrically conductive low impedance path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

3.8 **Bus:** a conductor, or group of conductors, that serves as a common connection for two or more circuits.

3.9 **Bus, branch:** a bus that originates at a section bus and terminates in one or more overcurrent devices.

3.10 **Bus, ground:** a bus to which the equipment grounding conductors from individual pieces of equipment are connected and which, in turn, is connected to the grounding electrode conductor at one point. It provides a continuous ground in multiple equipment sections through which it passes. See Figure 1, Figure 2, and Figure 3.

3.11 **Bus, neutral:** a bus having the appropriate number of terminals to provide for the connection of the neutral line and load conductors.

3.12 **Bus, section:** a portion of a bus structure which serves one or more overcurrent devices in the switchboard section and comprises that part of the bus between the through bus and branch bus. See Figure 1.

3.13 **Bus, splice:** a bus that electrically connects switchboard sections. See Figure 1.

3.14 **Bus structure:** an assembly of bus conductors with associated connecting joints and insulating supports.

3.15 **Bus, through:** a bus that extends through a switchboard section. It is sometimes called a horizontal, cross or main bus.

3.16 **Circuit breaker:** a device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overcurrent, without injury to itself when properly applied within its rating.

3.17 **Circuit breaker, molded case:** a circuit breaker which is assembled as an integral unit in a supporting and enclosing housing of insulating material.

3.18 **Compartment:** an area within the equipment that is constructed to isolate devices in that compartment from the surrounding area except for openings used for interconnections, control or ventilation.

3.19 **Continuous current:** the amount of current a conductor, a device or a piece of equipment can carry continuously for an indefinite period of time without exceeding its allowable temperature rise.

3.20 **Control wiring:** the wiring for the circuit(s) of a piece of equipment that carries the electrical signals directing the performance of the devices in that equipment, but which does not carry power current.

3.21 **Current rating:** the designated maximum direct or alternating current in rms amperes at rated frequency that a device can carry continuously under specified conditions.

3.22 **Dead-front switchboard:** a switchboard which has no exposed live parts on the front.

3.23 **Device:** a component of an electrical system that is intended to carry or control, but not utilize, electrical energy.

3.24 **Dielectric voltage withstand tests:** tests to determine the ability of the insulating materials and spacings to withstand overvoltages.

3.25 **Disconnecting means:** a device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

3.26 **Distribution section:** a switchboard section having branch or feeder circuit switching and overcurrent protective devices.

3.27 **Double-ended switchboard (multiple source):** a switchboard construction that provides for the connection of two sources of power. See Figure 2 and Figure 3.

3.28 **Dummy fuse:** a current carrying part made of copper having such dimensions that it will fit its fuse mounting means with the same conditions of pressure, contact and cross sectional areas as are obtained on terminals of the fuse that it is intended to replace.

3.29 **Enclosure:** a surrounding case constructed to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

3.30 **Filler plate:** a plate intended to close an opening that would otherwise be closed by the subsequent installation of a circuit breaker or other device.

3.31 **Frame size:** applies to a group of molded case circuit breakers that are physically interchangeable with each other. Frame size is expressed in amperes and corresponds to the largest ampere rating available in the group. Groups may or may not be physically interchangeable with each other whether furnished by one manufacturer or by various manufacturers.

3.32 **Fuse:** a protective device which opens by the melting of a current-sensitive element during specified overcurrent conditions.

3.33 **Fusible switch:** a switch in which one or more poles have a fuse in series in a composite unit.

3.34 **Ground-fault protector (GFP):** a ground-fault protector is a device or system that provides protection for equipment (not for personnel) by opening the circuit in case of a predetermined ground-fault current. A ground-fault protector includes a ground-fault current sensing device and relaying equipment or a combination of ground-fault current sensing device and relaying equipment that will operate to cause a disconnecting means to function at a predetermined value of ground-fault current.

3.35 **Individually mounted device:** a device which is not panel-mounted and which may or may not be enclosed in its own compartment.

3.36 **Inlet:** a permanently mounted plug intended to receive power from a cable connector.

3.37 **Interlock:** an electrical or mechanical component actuated by the operation of a device or other means, with which it is directly associated to govern succeeding operations of the same or allied devices.

3.38 **Interrupting rating:** the highest current at rated voltage that a device is intended to interrupt under standard test conditions.

3.39 **Isolated:** (as applied to location) not readily accessible to persons unless special means for access are used.

3.40 **Main device:** a single device that disconnects all ungrounded conductors, other than control power conductors when used, from the supply bus. See Figure 1.

3.41 **Main section (s):** a portion of a switchboard where the main or service disconnect device (s) is located. The section shall also be permitted to contain utility meters or other instruments. Incoming line conductors may be terminated in this section.

3.42 **Neutral:** neutral refers to a conductor (when one exists) of a polyphase circuit or single-phase, 3-wire circuit which is intended to have a voltage such that the voltage differences between it and each of the other conductors are approximately equal in magnitude and are equally spaced in phase, such as:

a) the center point of a wye connected system;

b) the midpoint of a 3-wire, single phase system;

c) the midpoint of one side of a delta connected system.

3.43 **Outlet:** a device that is intended to provide power to an inserted plug, and that is installed as a fixed receptacle on equipment.

3.44 **Peak let-through current:** the maximum instantaneous current through an overcurrent device during the total clearing time.

3.45 **Rating:** a designated limit of operating characteristics based on definite conditions.

3.46 **Rating Plug:** a self-contained portion of a circuit breaker that is interchangeable and replaceable in a circuit breaker trip unit by the user. It sets the Rated Current (In) of the circuit breaker.

3.47 **Service equipment:** the necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply.

3.48 **Short-circuit current rating:** the maximum RMS prospective (available) current to which a device can be connected. The rating is expressed in amperes and volts.

3.49 **Switch:** a device, manually operated, unless otherwise designated, for opening and closing or for changing the connection of a circuit.

3.50 **Switchboard:** a large single panel, structural frame or assembly of panels or structural frames on which may be mounted, on the face or back or both: switches, overcurrent, and other protective devices, buses, and instruments.

Note: Switchboards may be accessible from the rear as well as from the front and are not intended to be installed in cabinets.

3.51 **Switchboard enclosure:** an enclosure intended to:

a) enclose one or more switchboard sections or switchboard interiors; or

b) provide auxiliary wiring space for an adjacent switchboard section.

3.52 **Switchboard interior:** the interior part of a switchboard intended to be installed in a switchboard enclosure to become the equivalent of a switchboard section.

3.53 **Switchboard section:** that portion of a switchboard that is prevented by the structural framework from being physically separated into smaller units.

Note: Framework that is welded or joined with steel rivets over 6.4 mm (1/4 in) in diameter is considered to constitute a single section. However, framework that is joined with one-way (tamper-proof) bolts is not considered to constitute a single section. An assembly consisting of an enclosure and terminal blocks or bus bars is considered to be a switchboard section.

3.54 **Symmetrical current:** symmetrical current is alternating current having no offset or transient component and, therefore, having a wave form essentially symmetrical about the zero axis. Symmetrical current is expressed in terms of rms amperes.

3.55 **Tap:** A terminal or provision for a terminal intended for field wiring that is located on the supply side of the service disconnecting means, for uses permitted by the installation rules of the country of installation.

4 Units of measurement

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

4.2 Unless indicated otherwise all voltage and current values mentioned in this standard are root-mean-square (rms).

5 Electrical characteristics of assemblies

5.1 General

5.1.1 A switchboard shall be rated in amperes, volts, frequency and short circuit current. An alternating-current rating shall include the number of phases, if other than single-phase.

5.1.2 If a switchboard section or interior is intended to be connected to more than one energy source, including any incoming control circuit, each source shall be rated as indicated above.

5.2 Rated voltages

5.2.1 The voltage rating of a switchboard section or interior shall be nominally rated at 1 000 V or less and is the maximum value for which the assembly has been evaluated. Common ratings are shown in Table 1.

5.2.2 The voltage rating of any individual part (such as a switch or circuit breaker) that is provided in the switchboard section or interior and that is connected to the main supply circuit shall equal or exceed the nominal voltage of the circuit to which it shall be connected.

5.2.3 A switchboard section or interior containing a transformer, other than a control or potential transformer, with a secondary circuit leaving the section shall have a secondary voltage rating.

5.3 Continuous current rating

5.3.1 Supply rating

5.3.1.1 A switchboard section or interior shall be assigned a continuous current supply rating that shall not exceed the ampacity of the supply or through bus or wire that is provided with the section or interior, or that is specified for field installation.

5.3.1.1.1 Through or splice bus bars which extend beyond the point where the section bus bars are connected may have reduced ampacity as described in 8.8.1.6.16.1 – 8.8.1.6.16.2. Such reduced rating shall be shown if the next section is to be installed at some future time.

5.3.1.2 The supply rating of a switchboard section or interior shall not be less than the percent of the sum of the continuous ampere range of the assembled meter positions specified in Table 2 if the switchboard:

a) is marked to indicate it is suitable for use as service equipment;

b) has provision for two or more watthour meters without provision for current transformers; and

c) is not provided with a single main disconnect. A single main disconnect is required in Canada.

5.3.2 Section rating

5.3.2.1 A switchboard section or interior shall be assigned a rating for current that shall not exceed the ampacity of the section bus, as covered in 8.8.1.6.9 – 8.8.1.6.16.2, or the main switch, main fuseholder, main circuit breaker, or circuit breaker frame, if such are provided in the section.

5.3.2.2 If there is provision for mounting branch circuit units both above and below the point where the section bus is connected to the supply, the switchboard section or interior may be assigned both upper and lower section bus ratings.

5.3.2.3 If the ampacities of the various phase bus bars covered in 5.3.1.1 and 5.3.2.1, including the neutral bus bar as covered in 8.8.1.6.8, are not identical, the rating for current shall specify the ampacity of each bus bar or terminal.

5.4 Short-circuit current rating

5.4.1 The short-circuit current rating of a switchboard section or interior shall be one or more of the values shown in Table 3.

5.5 Rated peak withstand current (I_{pk}) (of a circuit of an assembly)

Reserved.

5.6 Rated conditional short-circuit current (I_{cc}) (of a circuit of an assembly)

Reserved.

5.7 Rated fused short-circuit current (I_{cf}) (of a circuit of an assembly)

Reserved.

5.8 Rated diversity factor

Reserved.

5.9 Rated frequency

5.9.1 An AC switchboard shall be rated in frequency.

6 Information to be given regarding the assembly

6.1 Nameplates

6.1.1 Locations

6.1.1.1 Markings shall be located as specified in Table 4. Markings in location category A shall be visible without removing the trim or the cover of the enclosure. This includes the front of the enclosure or on the inside of a hinged door. It also includes the front of a dead-front within a Type 3R enclosure if the door may be opened regardless of the position of the disconnecting means. Markings in location category B shall be visible without disassembly or the removal of a device and when the trim or cover of the enclosure is

removed. Markings in location category B may be located as specified for location category A but shall remain visible with the cover removed and upon installation of any additional component permitted by marking.

6.1.2 Letter height

6.1.2.1 The characters in the markings described in 6.2.1.2 (c), 6.2.1.3, 6.2.1.4, 6.2.1.6, 6.2.1.9 – 6.2.1.12, 6.2.2.1, 6.2.3.1 – 6.2.3.5, 6.2.3.7 – 6.2.3.11, 6.2.5.3, 6.2.7.3 – 6.2.7.6, 6.2.7.15, 6.2.10.1, 6.2.11.1, 6.2.13.2, 6.2.15.1, and 6.3.2.1 shall not be less than 2.4 mm (3/32 in) high.

6.1.3 Permanence of marking

6.1.3.1 A required marking shall comply with the permanence of marking requirements in Reference Item No. 12, Annex B.

Note: Etched or stamped markings on metal nameplates are considered permanent.

6.2 Markings

6.2.1 General

6.2.1.1 All markings shall be in the appropriate language for the country in which the switchboard will be installed. (Spanish for Mexico, English for the USA, English for Canada). A manufacturer may choose to utilize multiple languages on a switchboard.

Note: In Canada, there are two official languages, English and French. Annex C provides French translations of the markings specified in this standard. Markings required by this standard may have to be provided in other languages to conform with the language requirements of the country where the product is to be used.

6.2.1.2 A switchboard section or separate switchboard interior shall be marked with:

a) the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified (hereafter referred to as manufacturer's name);

b) catalog number, a general type designation, or other mark used for distinguishing purposes;

c) the electrical characteristics. (See clause 5). Both supply and section ratings shall be included, if different. If all phases and neutral are not the same, ratings of each shall be marked or indicated on a wiring diagram.

1) Voltage – See Table 1 for common values. Voltage shall be followed by:

i) volts or V,

ii) the symbol for alternating current (see Figure 4) and/or for direct current (see Figure 5).

2) Frequency – If alternating current the frequency number shall be followed by Hz or hertz.

3) Phases – if alternating current and other than single-phase, the symbol Φ (Greek letter phi) may be used in place of the word phase.

4) Current – Current shall be expressed as the ampere rating followed by A or Ampere(s).

5) Short-circuit current – See Table 3 for values. See clauses 6.2.1.12 – 6.2.1.15.

Note: The use of k to denote thousands is acceptable.

6.2.1.2.1 If a manufacturer produces or assembles switchboard sections, interiors, or enclosures at more than one factory, each finished switchboard section, interior, or enclosure shall have a distinctive marking, that may be in code, by which it may be identified as a product of a particular factory.

6.2.1.3 If a switchboard section is intended for stock and is rated for several different voltages or number of phases or wires, the individual voltage and phase ratings may be on a wiring diagram provided with the switchboard or attached in location category B in accordance with Table 4 (see footnote a to Table 4) if the maximum voltage is shown on the outside of the section and there is a reference to the wiring diagram.

6.2.1.4 If a switchboard section or interior is provided with provision for connection to two or more supply sources or with devices to which both line and load connections are to be made in the field, the current and voltage ratings for each supply source or each device shall be given. The marking may be on one or more nameplates. If the marking is on only one nameplate, it shall clearly indicate the buses and devices involved and their ratings, or shall refer to a wiring diagram provided in location category A in accordance with Table 4.

6.2.1.5 If a switchboard section or interior is provided with provision for connection to an external source of control circuit power, terminals for that connection shall be identified, and the current and voltage ratings for the source shall be marked or indicated on a wiring diagram.

6.2.1.6 A switchboard enclosure shall be marked as required by 6.2.1.2 (a) and (b), and if intended and marked for field installation of a particular switchboard interior, the enclosure shall be marked with electrical ratings, unless the markings on the interior will be visible after installation.

6.2.1.7 Switchboard Sections shall be marked with section numbers as follows:

a) A single section switchboard shall be marked "1 of 1".

b) A section of a multi-section switchboard shall be marked "___ of ___". The first blank shall be filled in with a number indicating the position that the section occupies in the series of sections constituting the switchboard. The section on the left side when facing the front of the switchboard shall be section 1. The second blank shall be filled in with the total number of sections in the switchboard.

c) A switchboard section mounted on top of one or more sections shall be marked "____T" where the blank is filled with the number of the initial section covered.

d) A switchboard enclosure (pull or auxiliary section) may be included in the numbering sequence if it is located at either end of the switchboard and shall be included in the numbering sequence if located between switchboard sections.

6.2.1.8 A switchboard shall be marked with the following or equivalent wording (see 6.2.1.1):

"Maximum continuous loads not to exceed 80 percent of the overcurrent protective device (circuit breaker and fuses) ratings employed in other than motor circuits, except for those circuits employing circuit breakers marked as suitable for continuous operation at 100 percent of their ratings."The marking shall be provided in location category B in accordance with Table 4.

6.2.1.9 With regard to 8.8.1.6.9 – 8.8.1.6.13 and 8.8.2.3.8, if the supply rating of a switchboard section or interior having a main fuseholder or circuit breaker frame or the ampacity of a branch bus or wire in series with a fuseholder or interchangeable circuit breaker trip unit is less than the rating of the largest fuse accommodated by a fuseholder or the largest trip unit of an interchangeable trip circuit breaker, there shall be a clear and permanent marking, plainly visible when the fuse or trip unit is being changed, prohibiting the use of a fuse or trip unit having a rating greater than the ampacity of the bus bar or wire. The marking shall be provided in location category B in accordance with Table 4.

6.2.1.10 With regard to 8.6.6.8 – 8.6.8.4 and 8.6.15.2, if a fuseholder for a miscellaneous or miniature (supplemental) fuse is provided, there shall be a marking near the fuseholder specifying the voltage and current rating of the fuse. The marking shall indicate the manufacturer and type designation of the fuse but may also include "or equivalent." A fuseholder for a 10.3 mm by 38.1 mm (13/32 by 1-1/2 inches) miscellaneous fuse may also indicate that a Class CC fuse may be used.

6.2.1.11 A switchboard section or interior supplied with branch circuit bus bars to which a branch circuit unit (circuit breaker, switch, or fuseholder) may be added in the field shall be plainly marked (on a wiring diagram, or in some other location) to indicate the ampacity of that bus bar, unless:

a) the ampacity of the bus bar is not less than the maximum current rating of any unit that is intended to be connected to it; or

b) the ampacity of the bus bar is not less than the section current rating.

6.2.1.12 A switchboard section or interior shall be marked with the following or the equivalent information:

a) the phrase "Short-Circuit Current Rating," the short-circuit current rating in amperes or rms symmetrical amperes for alternating current (See Table 3);

b) if the switchboard contains meter mounting equipment other than those for use with current transformers, it shall be marked with the phrase "Watt-hour meter not included in short-circuit current rating.";

c) the maximum voltage rating for each short-circuit current rating;

d) a phrase indicating that an additional or replacement device (other than a fuse) shall be of the same manufacturer, type designation, and equal or greater interrupting rating. This may be accomplished by specific reference to the device if the interrupting rating of the device is not less than any marked short-circuit-current rating of the switchboard. For a fuse, the class of fuses shall be specified;

e) the ampere rating of the devices if not all of the same type designation are acceptable for the short-circuit current rating of the switchboard;

f) when applicable, the identity of the combinations of integral or remote main and branch-circuit overcurrent-protective devices that are required when applying the marked short-circuit current rating (See 6.2.1.14);

g) a statement that the short-circuit current rating is limited to the lowest short-circuit current rating of any switchboard section connected in series, any installed circuit breaker or fused switch other than those located in a control circuit, the short-circuit current rating marked on the switchboard of any installed combination series-connected circuit breaker or any installed panelboard having a marked short-circuit current rating. See Annex D.

6.2.1.12.1 A switchboard section containing only a transformer and associated wiring need not be marked with a short-circuit current rating.

6.2.1.12.2 Switchboards with inlets (see 8.8.4.2) shall be marked with an additional short circuit rating where a different rating exists when connected to the inlets.

6.2.1.13 The short-circuit current rating of a switchboard section or interior shall be an integral part of:

a) a marking containing the manufacturer's name, trade name, trademark, or the like as specified in 6.2.1.2; or

b) another required marking.

If there is more than one short-circuit current rating, all such ratings shall appear together in location category A or B in accordance with Table 4.

6.2.1.14 If the short-circuit current rating of a switchboard is dependent upon the use of specific overcurrent devices ahead of the switchboard, the switchboard in addition to the marking specified in 6.2.1.12 shall be marked "When protected by _____ ampere maximum Class R + fuse or (Manufacturer's name and type designation) circuit breaker rated not more than _____ amperes this switchboard is suitable for use on a circuit capable of delivering not more than _____ rms symmetrical (for AC circuits) amperes, _____ volts maximum" or the equivalent. The value of amperes shall correspond to the values given in Table 3.

Note: Class CC, G, J, L, T, or R. RK1 or RK5 may be specified in place of or in addition to Class R.

6.2.1.15 A switchboard section or interior shall be marked with a short-circuit current rating as specified in Table 3 that does not exceed the short-circuit current rating of any overcurrent device or panelboard intended to be installed therein, 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 Table 16.

6.2.1.15.1 A circuit breaker connected to the load side of the integral or remote main overcurrent protective device may have a short-circuit current or interrupting rating less than the marked short-circuit current rating of the switchboard section if the combination is tested in accordance with 9.1.1.6 and the switchboard is marked as specified in 6.2.1.12(g)

6.2.1.15.2 The switchboard section or interior short-circuit current rating may exceed the component short-circuit current rating marked on the component or in accordance with Table 16 if the component short-circuit rating is adequate for the assumed available short-circuit current as covered in 8.5.1.2 and 8.5.1.3.

6.2.1.15.3 The short-circuit current rating of the switchboard may exceed that of a factory- or field-installed circuit breaker or a fused switch under the following conditions:

a) the marking covered in 6.2.5.3 specifies at least one circuit breaker or fused switch that has a short-circuit current rating not less than that of the section or interior; and

b) the circuit breaker or fused switch identified by the marking is physically interchangeable with the factory- or field-installed circuit breaker or fused switch.

6.2.1.15.4 For switchboards with inlets (see 8.8.4.2) and an additional short circuit current rating as specified in 6.2.1.12.2, that portion of the switchboard circuit which will only be powered when connected to the alternate source may include components with short circuit current ratings less than the rating marked on the section or interior, but not less than the rating noted in 6.2.1.12.2.

6.2.2 Marking for service equipment

6.2.2.1 If a switchboard is intended for use as service equipment, it shall be marked as follows:

a) in the case of an insulated neutral, one of the following:

1) "Suitable for use as service equipment"; or

2) "Suitable for use as service equipment when not more than six main disconnecting devices are installed."

b) in the case of a factory bonded neutral, one of the following:

1) "Suitable only for use as service equipment"; or

2) "Suitable only for use as service equipment. Install no more than six main disconnecting devices."

6.2.2.2 If a switchboard section or interior is marked "Suitable for use as service equipment" or "Suitable for use as service equipment when not more than six main disconnecting devices are provided," the marking "Service disconnect" shall be provided in the form of pressure sensitive labels in an envelope, or on a card, with instructions to apply near the disconnect handles if the equipment is used as service equipment. If the switchboard is intended for a particular installation in which it is known that it will be used as service equipment, the markings may be applied at the switchboard factory.

6.2.2.3 If a switchboard section or interior is marked "Suitable for use as service equipment," instructions for installing the bonding means shall be provided.

6.2.2.4 If a switchboard is marked "Suitable only for use as service equipment," each service disconnecting device for ungrounded conductors shall be marked: "Service disconnect" on or adjacent to the switch or circuit breaker handles.

6.2.2.5 A switchboard section or interior rated 3-phase, 4-wire and having a solidly grounded neutral but not provided with ground fault protection as covered in 8.1.13.2(b) shall be marked for the use specified as follows (not for Canada):

a) "Suitable only for use as service equipment when supplying a continuous industrial process"; or

b) "Suitable for use as service equipment only if supplying a continuous industrial process."

6.2.2.6 A switchboard section or interior that is marked "Suitable only for use as service equipment" or "Suitable for use as service equipment" and not provided with ground fault protection as covered in 8.1.13.2(c) shall be marked for:

a) supplying a fire pump;

b) an alternate source for legally required standby service (not for Canada); or

c) use as the disconnecting means for a second-building on the property where ground-fault protection is provided on the supply side of this disconnecting means (not for Canada).

6.2.2.7 A switchboard section or interior that has ground fault protection with only an audible or visual signal shall be marked for an alternate source for an emergency system as covered in 8.1.13.5.1 (not for Canada).

6.2.2.8 Marking for Canadian utility compartment

6.2.2.8.1 A switchboard compartment for the electric utility supply authority use shall be marked as such (see 6.2.1.1).

Note: This is a requirement only for switchboards intended to be installed in Canada.

6.2.2.9 Switchboard assemblies intended for service entrance use and constructed in accordance with 8.1.12.13 shall be provided with a temporary tag, instruction sheet, or the equivalent indicating how the bond shall be removed when required by electrical inspection authorities (e.g., "where electrical inspection authorities require the neutral assembly to be disconnected from the enclosure, ...*..."). (For Canada only.)

Note: *Each manufacturer shall add specific instructions applicable to the particular construction.

6.2.3 Switching devices

6.2.3.1 A switch not rated for operation under load shall be identified by a conspicuous marking on the front of the switchboard stating "For isolating use only do not open under load."

6.2.3.2 If a tie-switch has not been tested for reverse line and load connection, the switchboard shall be marked to indicate that the tie-switch is not to be opened under load (not for Canada).

6.2.3.3 A switchboard intended to be connected to multiple sources shall be marked to alert the user that both ends of a disconnecting device may be energized. The marking shall be provided on all covers that give access to the disconnecting device.

6.2.3.4 The markings indicating the "ON" and "OFF" positions for switches and circuit breakers shall be visible without removing the switchboard trim or dead-front.

6.2.3.5 If the handle of a circuit breaker, or a simple extension of that handle, assumes other than the "OFF" position when the breaker is tripped, the switchboard shall be marked to indicate the tripped position of the handle. The method of resetting the breaker shall be marked.

6.2.3.5.1 Marking to indicate the "tripped" position is not required in the case of a separate, external operating handle – other than a simple handle extension – that is not part of the circuit breaker. Such a handle may remain in the “ON” position.

6.2.3.6 Unless overcurrent protection is provided within the section on the load side, a molded case switch (non-automatic circuit interrupter) installed in a switchboard shall be marked on or adjacent to the device where visible without removing a trim or dead front, "Does not provide for overcurrent protection" or equivalent wording. The marking shall be a minimum 4.8 mm (3/16 inch) high letters.

6.2.3.7 A switch or circuit breaker that controls all load circuits from a single switchboard section or interior containing more than one load circuit shall be marked "Section Main," and no other switching device in the switchboard section shall be marked merely "Section Main" or "Main." The marking is not required if the switchboard section or interior is marked for use as service equipment.

6.2.3.8 If several sections are intended to be installed in a group, a switch or circuit breaker that controls all load circuits, including any through bus, shall be plainly and permanently marked "Main" and shall appear on or adjacent to the switches or circuit breakers. The marking is not required if the switchboard section or interior is marked for use as service equipment.

6.2.3.9 A switch or circuit breaker that serves as a main for a panelboard within a switchboard section, but is not a section main shall be marked "Panelboard Main," "Submain" or some other descriptive term other than just "Main."

6.2.3.10 A circuit breaker or switch that serves as a main for another section or a panelboard in another section, but is not a main for the complete group of switchboard sections shall be appropriately marked such as "Main (or submain) for Panelboard _____ (or section _____)”; and the corresponding section or panelboard shall be similarly identified.

6.2.3.11 If a transformer providing control voltage for ground-fault protection or an instrument or control circuit fuse is connected to the line side of the main disconnect, this disconnect may be identified as the "main" but the switchboard shall be marked adjacent to the main disconnect to alert the user that it does not disconnect control and instrument circuits.

6.2.4 Emergency circuits

6.2.4.1 Other than as allowed in 8.6.11.13(c) for an automatic transfer switch, a tap, circuit, section, or switchboard shall not be marked for emergency use.

6.2.5 Field-installed equipment

6.2.5.1 If a switchboard section or interior has provision for the mounting of units (switches, circuit breakers, or fuseholders) or a neutral terminal assembly for use with a field-installed panelboard, instructions for the installation and wiring of such units shall be provided with the unit or switchboard. If the construction and orientation of the additional units make the installation method obvious, then instructions are not required.

6.2.5.2 If branch bus bars are to be added in the field as described in 8.1.1.2.2, the switchboard shall be marked to indicate the manufacturer and catalog designation of the bus bar kit to be used with a particular switch, circuit breaker, or fuseholder.

6.2.5.2.1 The bus bar kit shall be marked on the bus or on or in the packaging carton with the identification of the manufacturer, the kit catalog designation, and the installation instructions.

6.2.5.3 If a switchboard section or interior has provision for the mounting of additional equipment (circuit breaker, fuseholder, contactor, meter socket, switch, or the like), the section shall be marked with the manufacturer's name, or trademark of the manufacturer, or other descriptive marking by which the organization responsible for the equipment may be identified and the catalog designation or the equivalent of the equipment that may be added. This marking is not required for a plug-in meter, test block, transformer (current or potential), or the like, to be provided by a utility.

6.2.5.4 A switchboard intended for use with a field-installed filler plate shall be marked to indicate the catalog number of the filler plate with which it may be used.

6.2.5.5 Each filler plate intended to be installed in the field or its unit container shall be marked with the manufacturer's name, trademark, and a catalog number or equivalent.

6.2.6 Field-installed interiors (not for Canada)

6.2.6.1 A switchboard enclosure that is intended for use with a field-installed switchboard interior or panelboard shall be marked to indicate the manufacturer and the catalog number or equivalent of the switchboard interior or panelboard to be used.

This Clause does not apply for Canada.

6.2.6.2 A switchboard interior, as described in 3.28, shall be marked to indicate the manufacturer and type of the switchboard enclosure for which it is intended.

This Clause does not apply for Canada.

6.2.7 Terminals

6.2.7.1 If any terminal of a switchboard section or interior is marked to indicate that aluminum wire may be used at that terminal (such as by being marked with the symbol "AL"), and, if such marking is visible under the conditions described in 6.2.7.2, the switchboard section shall be marked in accordance with 6.2.7.3, 6.2.7.5, or 6.2.7.6.

6.2.7.2 The term visible as used in 6.2.7.1 refers to a marking that will be visible when a front, trim, or dead front 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.

6.2.7.3 If, because of wiring space or other factors, a terminal of the switchboard section is not acceptable for use with aluminum wire, the switchboard shall be marked: "Use copper wire only."

6.2.7.4 If a switchboard is acceptable for aluminum wire only, the switchboard shall be marked "Use aluminum wire only."

6.2.7.5 If the wiring space and other factors are such that all terminals of the switchboard section are rated for use with aluminum conductors as well as with copper conductors, the switchboard sections shall be marked "Use copper or aluminum wire."

6.2.7.6 If the wiring space and other factors are such that some terminals of the switchboard section or interior are rated for use with aluminum conductors as well as with copper conductors, while the remainder of the terminals are for use with copper conductors only, the switchboard section shall be marked "Use copper wire only except at terminals...." The marking shall positively identify the terminals that are for use with aluminum wire.

6.2.7.7 The word "terminal" as used in6.2.7.1 – 6.2.7.6 signifies any terminal of the switchboard section or interior as well as a terminal of any component unit (circuit breaker, switch, or the like) that is installed or intended to be installed in the switchboard and to which conductors are to be connected in the field.

6.2.7.8 A marking employing a wording differing from that given in6.2.7.1 – 6.2.7.7 may be accepted if it clearly and completely conveys the significant information. Any abbreviation designating copper and aluminum shall be "AL-CU," "CU-AL," or equivalent.

6.2.7.9 If a wire terminal has been investigated for securing more than one conductor in an opening and is intended for such use, a marking indicating the number and size of conductors shall be provided. The marking shall be on the wire connector if visible, or in another visible location, such as next to the terminal or on a wiring diagram.

6.2.7.10 A terminal of a switchboard capable of securing two or more combinations of conductors in multiple, any of which has an ampacity acceptable for the application, shall be identified and marked unless the switchboard is acceptable for use with the combination of wires requiring the largest wiring space in accordance with 8.8.3.1.2. The terminal shall be identified by a prominent marking, such as on a wiring diagram, on the switchboard that will state the number and size of wires for which the terminal is acceptable.

6.2.7.11 If pressure terminal connectors are not provided on the equipment as shipped, the equipment shall be marked stating which pressure terminal connector or component terminal assemblies are for use with the equipment.

6.2.7.12 The terminal assembly packages covered in 6.2.7.11 shall carry an identifying marking, wire size, 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 required tightening torque in accordance with 6.2.7.13 unless the value of tightening torque is included along with the switchboard markings as covered in 6.2.7.11.

6.2.7.13 A switchboard shall be marked to indicate the specific tightening torque for each wire connector in the switchboard that is intended for field wiring. If different connectors are used for line, load, neutral, or ground, the specific torques to be applied to each connector shall be clearly indicated.

6.2.7.13.1 The value of tightening torque for a field wiring terminal provided on a component such as a circuit breaker, switch, or the like, need not be marked on the switchboard.

6.2.7.13.2 The value of tightening torque for a wire binding screw or stud and nut type terminal need not be provided.

6.2.7.14 With regard to 6.2.7.13, the torque to be marked for each connector shall be determined as specified in 8.8.2.3.2. An example of a typical torque marking is shown in Annex E.

6.2.7.15 If a pressure wire connector provided in a switchboard for field installation of conductors requires the use of a specific tool other than a common screwdriver or wrench for securing the conductor, the necessary instructions for using the tool shall be provided with the switchboard in a readily visible location, such as on the connector, on a wiring diagram, or on a tag secured to the wire connector.

6.2.7.16 A switchboard using a tool-applied compression wire connector shall be marked with:

a) the tool and die information along with the number of crimps as specified with the wire connector; or

b) reference to the wire connector manufacturer's tool, die, and crimp information as provided with the switchboard or in installation instructions provided with the switchboard.

6.2.7.17 If an equipment grounding assembly is intended for field installation:

a) the switchboard section or interior shall be marked to indicate the catalog or type number of the terminal assembly intended to be used; and

b) installation instructions shall be marked on the equipment in which the terminal assembly is intended to be used or shall be provided on or in the individual shipping package or carton of the terminal assembly.

6.2.7.18 A switchboard shall be provided with a marking readily visible prior to wiring to indicate the required temperature rating of field-installed conductors.

6.2.7.19 If a circuit breaker is to be installed in the field, the marking shall indicate that the circuit breaker is to be marked either 60/75°C or 75°C if conductors sized for 75°C ampacity are to be used.

6.2.7.20 A switchboard or field wiring circuit rated more than 125 A shall be marked for use with conductors sized for 75°C ampacity.

6.2.7.21 With respect to 6.2.7.18, a switchboard that is marked to indicate that only 60°C field-installed conductors are to be used shall not reference a field-installed unit that has been investigated for 75°C conductors only.

6.2.7.22 A switchboard requiring access to field wiring terminals from the rear as covered in 8.8.2.3.15 shall be marked on the front: "Rear access required to make field connections."

6.2.7.22.1 The marking may be omitted if the statement is included in the conduit location instructions covered in 8.8.3.3.3.1 and 6.3.4.1.1.

6.2.7.23 If the temperature rise exceeds 50°C on a wiring connector as covered in item 6 of Table 13, a marking shall be provided near the wiring connector indicating that 90°C wire shall be used and it shall be sized based on the ampacity of wire rated 75°C. If the switchboard 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, AL9CU, or CU9AL. The marking shall be:

a) provided by the switchboard manufacturer if not already provided on the switch or circuit breaker; and

b) visible after installation.

6.2.8 Motor circuits

6.2.8.1 With respect to 8.6.17.2, a wiring diagram and a current element table for overload relays shall be provided for each motor circuit. The table shall be that provided for the open-type motor starter unless the table is verified by calibration testing in the switchboard. The table and a diagram shall be attached to the switchboard section at a plainly visible location. Attachment to the inside of a door or cover is acceptable. Tables, diagrams, and electrical rating information for individual motor circuits may be provided at a central location on or in the switchboard section in a pocket expressly provided for the purpose. The individual motor controller shall have a marking secured at a plainly visible location giving the proper diagram, current element table, and electrical rating information numbers and referencing the location.

6.2.8.2 With respect to 8.6.15.5, if a controller can be set to an automatic reset mode, and if a wiring diagram indicates that 2-wire control may be used, a marking shall be located where visible when making field connections to the control circuit to indicate that a motor connected to the circuit may start automatically when the relay is in the automatic reset position.

6.2.8.3 A marking shall be located at a control circuit disconnect as covered in 8.6.15.3 to identify it as such.

6.2.9 Enclosure environmental conditions

6.2.9.1 An enclosure shall be marked with the environmental Type number or numbers, as specified in Table 12. An enclosure that complies with the requirements for more than one type of enclosure may be marked accordingly with multiple type designations.

6.2.9.1.1 A Type 3R enclosure may also bear the supplemental marking "Rainproof." If used, the supplemental marking shall be an integral part of marking containing the manufacturer's name or trademark, unless it is an integral part of other required markings.

6.2.9.2 A switchboard section or switchboard enclosure marked "Type 3R" and provided with means to accommodate one or more separable conduit hubs or closure fittings shall be marked with the name or trademark of the manufacturer and with the conduit size and corresponding catalog designation of those fittings that can be used with that enclosure.

6.2.9.2.1 A separable conduit hub and a closure fitting shall be marked with the manufacturer's name or trademark and the catalog number or equivalent. Such a hub or fitting may be shipped separately, and any gaskets, hardware, and instructions necessary for installation shall be shipped with the fitting or packaged with the enclosure.

6.2.10 Phase identification

6.2.10.1 A switchboard intended for use on a 240/120-volt, 3-phase, 4-wire, delta system shall be marked to clearly identify the different bus bars with reference to the voltages between them or, if the switchboard is intended for use only on this system, the main bus bar having the higher voltage to ground may be identified by a marking that is orange or by tagging. For Canada the higher phase shall be A phase

and colored Red. The switchboard shall also be marked by means such as a diagram to indicate the necessary voltage rating of the device for each branch-circuit overcurrent-protective-device position.

6.2.11 Meter sockets

6.2.11.1 If a switchboard section or interior has provision for one or more watt-hour meters, the current rating of the meter positions shall be marked on the switchboard section or the interior. If the meter position is rated for continuous duty, the marking shall be "_____ Amps continuous." If the meter position is rated for a maximum rating, the marking shall be "_____ A (_____ A continuous)," in which case the maximum amperes shall not be more than 125 percent of the continuous duty amperes.

6.2.11.2 If a meter socket is provided with a device that will automatically render load circuit parts live when the meter is not in place, the enclosure shall be marked with the following or the equivalent: "Removal of meter does not de-energize circuit." The marking shall appear next to the meter socket.

6.2.11.3 If a meter socket is provided with a manually operated device that will render load circuit parts live when the meter is not in place, the enclosure shall be marked, next to the meter socket, to caution that the circuit may be live with the meter removed.

6.2.12 Neutral

6.2.12.1 If so equipped, the main bonding jumper, the grounding electrode conductor terminal, and the neutral disconnect link shall each be respectively identified as such by a marking or tag located on or adjacent to the part.

6.2.12.2 If the main bonding jumper, the grounding electrode conductor terminal, and the neutral disconnecting means are not in the same section as the service disconnect, the section (s) of a multi-section switchboard in which they are located shall be marked to indicate that condition. In Canada, this arrangement is not permitted.

6.2.12.3 A switchboard provided with a high-impedance grounded neutral system shall be marked with the following or equivalent: "The system neutral conductor shall not be connected to ground at the switchboard or at the source (utility or generator) except through the grounding impedance."

6.2.12.4 With regard to 8.4.8.12, the switchboard section containing the grounding impedance shall be marked with the rated thermal current and rated time of the impedance.

6.2.13 Ground fault protection

6.2.13.1 If ground fault protection is provided in a switchboard section or interior, markings shall be provided to indicate which circuits (main, feeder, or branch) are so protected. If a marking on the ground fault sensing or relaying equipment is not visible from the front of the switchboard with the switchboard cover removed, a separate marking such as on a wiring diagram shall be provided.

6.2.13.2 In a switchboard section or interior with ground fault protection, that part of the neutral bus for load terminations shall be marked with the following or equivalent: "Do not connect grounding conductors to these or any other neutral terminals; to do so will defeat ground fault protection." The marking shall be located on or adjacent to the neutral.

6.2.13.3 If a component of a ground fault protection system is located in an adjacent section, a complete wiring diagram of both sections shall be provided in each of the sections.

6.2.13.4 When connected to an external source, the control circuit for ground fault protection shall be identified by a permanent marking: "External source connection for control circuit of ground fault sensing and relaying equipment volts (ac or dc)" or equivalent.

6.2.14 Field-installed busway

6.2.14.1 If the ground bus does not extend to the busway as covered in 8.4.4.2, the switchboard section shall be marked to indicate that a bonding jumper sized in accordance with Table 14 shall be installed between the ground bus of the switchboard and the busway ground bus or enclosure serving as a ground bus.

6.2.15 Transformers

6.2.15.1 A switchboard section or interior containing a power transformer feeding circuits leaving the section from a secondary winding not conductively connected to the primary shall be marked to indicate the need for connecting the secondary neutral conductor to a grounding electrode in accordance with existing installation requirements pertaining to separately derived systems.

6.2.15.1.1 The marking is not required if the grounding electrode conductor terminal is not required in accordance with 8.4.7.2.1.

6.2.15.2 If a switchboard section or interior contains a transformer and the secondary circuit leaves the section or interior, the section or interior shall be marked with the secondary voltage or voltages as covered in 5.2.3.

6.2.15.3 If a switchboard section or interior contains a power transformer rated more than 25 kVA, the section or interior shall be marked with the kVA rating and percent impedance unless the markings are on the transformer and are visible with the cover removed.

6.2.16 Taps

6.2.16.1 A terminal or provision for a terminal intended to be used as a tap, other than those to be used by the supply utility for voltage metering pick-up, shall be marked "Tap."

6.2.17 Restricted access switchboards

6.2.17.1 A switchboard intended to be accessible only to qualified persons shall be marked: "This switchboard shall be located where accessible only to qualified persons," or equivalent. See 8.4.2.1.

6.2.18 Switchboards with provisions for cord connections

6.2.18.1 Switchboards provided with single pole separable connectors (input or output connections) that are not mechanically interlocked shall be marked:

a) "FOR USE BY QUALIFIED PERSONNEL ONLY", or equivalent, and

b) With instructions as to the proper order of connection and disconnection, as noted in the below example:

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.

6.2.18.2 The marking required by 6.2.18.1 shall be located adjacent to the point of connection.

6.2.18.3 Switchboards with inlets shall be marked to indicate the type of derived system that the switchboard is intended to interconnect in accordance with either (a) or (b):

a) Switchboards that do not switch the neutral conductor shall be marked with the following: “WARNING - For Connection of a Nonseparately Derived (Floating Neutral) System Only.”

b) Switchboards that switch the neutral conductor shall be marked with the following: “WARNING - For Connection of a Separately Derived (Bonded Neutral) System Only”

6.2.18.4 Switchboards with inlets shall be marked to indicate the short circuit current rating when the switchboard is powered by a source that is connected through the use of the inlets. See 6.2.1.12.2.

6.3 Instructions for installation, operation and maintenance

6.3.1 General

6.3.1.1 With regard to 8.2.1.1.2.3, a switchboard section omitting one side shall be marked to indicate either:

a) which separate side panel to order; or

b) which stock sections it is intended to connect to.

6.3.2 Through or splice bus

6.3.2.1 If there is provision for the installation of either a through or a splice bus, and if the through bus or splice bus is not supplied, the switchboard section or interior shall have a marking that is legible and plainly visible during and after installation, stating the proper conductor required.

6.3.3 Bracing

6.3.3.1 With respect to 9.2.4.2.4.1, 9.2.4.2.7.1 and 9.2.4.2.7.2, a marking indicating the type of bracing to be added to cables routed through the switchboard between the point of entry or exit and the terminals shall be located adjacent to the incoming terminals or provided in the installation instructions.

6.3.4 Installation instructions

6.3.4.1 Conduit location instructions

6.3.4.1.1 With respect to 8.8.3.3.3.1, instructions and drawings showing the intended conduit or raceway location shall be supplied. Instructions and drawings need not be supplied by the switchboard manufacturer if the conduit or raceway location information is supplied by the customer or installer to the switchboard manufacturer and the switchboard construction provides the clearance above the conduit or raceway entry point covered in 8.8.3.3.3.

6.3.4.2 Field-installed busway

6.3.4.2.1 A switchboard section or enclosure intended for connection to a busway shall be marked to indicate the manufacturer and type of busway or this information may be provided on the specifications supplied to the installer.

6.3.4.3 Field testing of ground fault protection of equipment

6.3.4.3.1 To provide for system performance testing, each ground fault relay or apparatus incorporating a ground fault relay or its functions intended for protection of a solidly grounded wye service rated more than 150 V to ground but not exceeding 1 000 V phase-to-phase 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 investigated in accordance with the switchboard manufacturer's detailed instructions, and that this investigation shall be undertaken by qualified personnel.

b) The 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 high-voltage testers and resistance bridges may be suggested.

d) The installed system shall be tested for correct response by the application of full scale current into the equipment to duplicate a ground fault condition, or by equivalent means such as by a simulated fault current generated by:

1) a coil around the sensors; or

2) a separate test winding in the sensors.

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

6.3.4.4 Multiple source switchboard

6.3.4.4.1 A multiple source switchboard for parallel operation, without synchronization equipment provided integral to the switchboard (as permitted in 8.6.5.2) shall include the following statement on the installation instructions or factory supplied drawings: “CAUTION - This switchboard is constructed for parallel source applications from multiple sources. Synchronization equipment shall be provided by _____” or equivalent. The blank shall be populated with the name of the synchronizing equipment manufacturer.

7 Service conditions

Reserved

7.1 Normal service conditions

Reserved

7.2 Special service conditions

Reserved.

7.3 Conditions during transport, storage, and erection

Reserved.

8 Design and construction

8.1 Mechanical design

8.1.1 General

8.1.1.1 All screws and nuts shall be staked, headed over, upset or otherwise prevented from loosening, if loosening would result in less than the required spacings.

8.1.1.2 A switchboard section shall be complete, other than identified field installable devices and kits, when it is shipped from the factory.

8.1.1.2.1 If switches, circuit breakers, or the like mounted in a switchboard section must be interconnected in order for the section to perform its intended function, such interconnecting busing or wiring shall be complete before the section is shipped from the factory.

8.1.1.2.2 A switchboard section or interior may have provision for the installation of additional equipment such as branch, splice or through-busses, meter socket bases, circuit breakers, switches, panelboards, terminal connectors, or the like, if it is marked to identify the equipment to be installed.

8.1.1.2.2.1 If a field installable item requires a barrier to comply with the spacing requirements in 8.1.16, the barrier shall be attached to the switchboard or to a required part of the field-installed item.

8.1.1.2.3 A switchboard section or interior which has provision for a field installed meter socket, shall have covers for the meter opening which comply with the requirements in framework and enclosure, clause 8.2.1 or filler plates. See 8.1.18.

8.1.1.2.4 In a switchboard section or interior constructed to house utility installed current transformers and associated equipment, the current transformers and the busing or wiring for the transformer and metering equipment may be omitted if their connection means are provided.

8.1.1.3 A switchboard shall be designed so that any component intended to be field installed can be installed without the use of a special tool.

8.1.1.4 If a space can physically accommodate a branch circuit switch or circuit breaker that is not intended for this use, it shall have any hole for securing a branch bus bar to the section bus bar plugged with a solid metal rivet or one way screw. A dead-front shield over the portion of bus with holes may not be used in place of plugging or omitting the holes in the bus bars. A separate shield secured by one-way screws onto the mounting pan behind the removable dead-front shield is acceptable in lieu of plugging holes in the bus bars.

8.1.1.5 A switchboard enclosure may be provided with means of support for bus bars extending from an adjacent section, and, if marked for use with a switchboard interior, may include a neutral terminal assembly.

8.1.1.6 If a switchboard enclosure contains one or more factory-installed switchboard interiors, bus bars are considered to be part of the interior but they may be supported by the back of the switchboard enclosure.

8.1.1.7 An edge, projection, corner, opening, frame, guard, knob, handle, or the like of a switchboard section, interior, or enclosure shall be smooth and rounded and not sharp enough to cause a cut type injury when contacted during intended use or user maintenance.

8.1.1.8 Any load circuit extending beyond the switchboard is considered to be a branch circuit except for a through main bus, a tap, or a switchboard section mounting a single switch (or circuit breaker) that is intended to serve as the main switch (or circuit breaker) for other switchboard sections.

8.1.1.9 If the inside dimensions of the enclosure of a switchboard section are less than 1.65 m (65 inches) high or 305 mm (12 inches) deep, the enclosure shall be judged under the requirements of this standard, but the internal parts and wiring shall be judged by the applicable requirements in Reference Item No. 1, Annex B.

8.1.1.10 A switchboard interior may be provided without an enclosure if marked in accordance with 6.2.6 (not for Canada).

8.1.2 Corrosion protection

8.1.2.1 Iron and steel parts of enclosing cases, walls, and barriers (whether of sheet steel or cast iron), all springs and other parts upon which intended mechanical operation may depend, and sheet steel parts of fastening devices shall be fabricated of stainless steel or shall be protected against rust by enameling, galvanizing, sherardizing, plating, or equivalent means. The requirement does not apply to bearings, or the like, whose protection is impracticable.

8.1.3 Mechanical assembly

8.1.3.1 A switchboard section, interior or enclosure shall be constructed to provide strength and rigidity in order that it will keep its shape and that doors will close tightly.

8.1.3.2 Metal into which a screw is threaded shall provide for the engagement of at least two full threads. A rivet, screw, bolt, or similar fastener into sheet metal shall have a diameter at least 50 percent greater than the thickness of the finished sheet metal with which the fasteners are used.

8.1.3.3 Sheet metal may be extruded at a tapped hole so as to provide the thickness necessary for two full threads, if the original metal is not less in thickness than the pitch of the thread.

8.1.3.4 An adhesive that is used in the switchboard construction and that is relied upon to reduce a risk of fire, electric shock, or injury to persons (for example, barriers or wire positioning devices) shall comply with the applicable requirements for adhesives Reference Item No. 14, Annex B, and be evaluated for the specific application. Adhesives shall not be used to secure components that include bare live parts.

8.1.3.5 The requirement in 8.1.3.4 also applies to an adhesive used to secure a conductive part (including a switchboard nameplate) that may, if loosened or dislodged:

a) cause an accessible dead metal part to become energized;

b) make a live part accessible;

c) reduce spacings below the minimum required values specified in Table 6; or

d) short-circuit live parts.

8.1.3.6 A single-threaded nut constructed to slip over the edge of sheet metal to receive a retaining screw may be used to secure a dead front to supports, a unit such as a switch or circuit breaker to a mounting panel, or a mounting pan to an enclosure if:

a) the nut is protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means; and

b) the threads do not strip when a torque of 3.4 N·m (30 pound-inches) is applied. See 9.2.10.

8.1.4 Observation windows

8.1.4.1 Observation windows not exceeding 305 mm (12 inches) on any side shall comply with the requirements in Reference Item No. 2 in Annex B. Observation windows exceeding 305 mm (12 inches) on any side shall comply with the impact and pressure test in 9.2.11.

8.1.5 Doors and covers

8.1.5.1 Doors and covers shall comply with the requirements for sheet metal in 8.2.1.2.

8.1.5.2 If bare live parts are exposed by the opening of doors or covers, means requiring the use of a tool to open, or provision for locking, shall be provided to secure them in the closed position. A door over one or more fuses as described in 8.6.7.9 shall be permitted to be held closed with a latch only.

8.1.5.3 A door over a live part shall be provided with a stop to prevent the door from contacting the live part. The stop shall be independent of any other door or removable cover.

8.1.5.4 A metal cover plate intended to be opened for inspection purposes shall not exceed 1.12 m^2 (12 ft^2) in area or 27 kg (60 pounds) in weight unless it is equipped with lifting means or hinges.

8.1.5.5 The enclosure shall be constructed so that any hinged door intended for examination, adjustment, servicing or maintenance of internal components while energized is able to be opened a minimum of 90 degrees from the closed position. Doors that are readily removable or hinged at the top need not comply with this requirement.

8.1.6 Flanges for metallic enclosures

8.1.6.1 Flanges for metallic enclosures shall comply with the requirements for flanges in Reference Item No. 2 in Annex B except as specified in 8.1.6.2 and 8.1.6.3.

8.1.6.2 If a barrier is located behind the flanged opening as shown in Figure 6, and if there are no live parts in the open area, and if the construction complies with 8.2.1.3.1 – 8.2.1.3.2, clearances between flanges shall be 6.4 mm (1/4 inch) maximum.

8.1.6.3 Hinged or unhinged covers secured with screws may be constructed as shown in Figure 7.

8.1.7 Fastenings

8.1.7.1 A removable front panel or trim shall be secured by at least four fastenings. There shall be at least one fastening located not more than 152 mm (6 inches) from each of the four corners, and fastenings shall be spaced not more than 610 mm (24 inches) apart along any vertical side.

8.1.7.1.1 Any front panel or cover may be fastened by a single screw in each of the two opposite sides, when any of the following conditions are met.

Note: The screws need not be at the center of the sides if the construction is such as to hold the front panel or cover against the adjacent flange of the section.

a) having dimensions not exceeding 152 mm (6 inches) high by 508 mm (20 inches) wide; or

b) flanged on all four sides and having dimensions not exceeding 220 mm (9 inches) high by 508 mm (20 inches) wide, or 152 mm (6 inches) wide by 914 mm (36 inches); or

c) flanged on all four sides 12.7 mm (1/2 inch) minimum, one side not more than 220 mm (9 inches), and having an area not exceeding 139 000 mm^2 (215 $inches^2$). A removable panel more than 610 mm (24 inches) long on any side that is flanged 12.7 mm (1/2 inch) minimum may have fastenings spaced not more than 914 mm (36 inches) apart and not more than 254 mm (10 inches) from each of the four corners if the fastenings are not less than 6.4 mm (1/4 inch) in diameter.

8.1.7.1.2 The cover over a meter socket for an individual meter may be secured to the assembly by two fastenings. For these meter socket covers, a latch or overlapping flange shall be considered as a fastening.

8.1.7.1.3 The cover over a meter socket may be fastened by any of the methods permitted by the requirements in Reference Item No. 20 in Annex B.

8.1.7.2 Fastening screws or the screws of clamps or hinges shall not be less than 4.0 mm (5/32 inch) in diameter (No. 8 screw size) for a panel 2323 cm^2 (360 $inches^2$) or less in area and not less than 4.8 mm (3/16 inch) in diameter (No. 10 screw size) for a larger front panel or cover.

8.1.7.3 Fastenings may be omitted along the vertical side of a panel that is adjacent to a panelboard, or the like, if the panel is supported at all four corners and if the panel is either:

a) flanged the full length of both the longer sides; or

b) flanged the full length of one of the longer sides, with the unflanged side secured to a rigid switchboard member.

8.1.8 Latches

8.1.8.1 Each door shall be provided with a positive latch or a captive screw. A captive screw shall be operable by hand or by a conventional tool. A captive screw may be the simple 1/4 or 1/2 turn or multi-turn type. Where the hinged construction is not necessary under these requirements, a non-captive screw fastening is permitted to be used.

8.1.8.2 A door more than 1.22 m (48 inches) long on the hinged side shall be fastened at two or more latch points.

8.1.8.3 A knob, door handle, or a captive screw or other fastening shall be provided for opening a door.

8.1.9 Mounting

8.1.9.1 A switchboard section or enclosure other than the floor supported or freestanding shall be provided with means for mounting.

8.1.10 Bases and supports – insulating material

8.1.10.1 Insulation material in contact with live parts shall have the minimum values specified in Table 5. Molded thermoplastic bases and supports shall be subjected to the Mold Stress Relief test in 9.2.8.

8.1.10.2 An insulation material having values below those contained in Table 5 may be accepted based on acceptable end-product performance tests, as outlined in Reference Item No. 3 in Annex B.

Note No. 1: This requirement does not apply in Canada.
Note No. 2: Reference Item 3 in Annex B contains guidance in selecting and performing such tests to evaluate material weaknesses.

8.1.11 Service equipment use (not for Canada)

8.1.11.1 A switchboard section or interior marked for service equipment use shall be provided with both overcurrent protection and disconnecting means for all incoming conductors. Both single-disconnect and multiple-disconnect constructional approaches are covered by the Standard.

a) Single Disconnect Construction – In this construction, disconnection of all ungrounded load conductors from the source of supply shall be achievable by the operation of one disconnect device. Switchboards using this construction shall be marked as required by 6.2.2.1(a)(1) or 6.2.2.1 (b)(1).

b) Multiple-Disconnect Construction – This construction requires that disconnection of all ungrounded load conductors from the source of supply be achievable by the operation of not more than six operating handles. Switchboards using this construction shall be marked as required by 6.2.2.1(a)(2) or 6.2.2.1(b)(2).

Note: A switchboard section or interior intended for use with multiple sources of supply and marked "Service Equipment" is to be provided with a means to disconnect load conductors from all sources of supply terminated in that section. Switchboard assemblies intended for use with multiple sources may be provided with nonservice-rated sections. Nonservice sources may terminate in nonservice sections without a means to disconnect load conductors from the nonservice rated source of supply.

8.1.11.1.1 In determining the allowable number of disconnects, a device used solely for disconnecting power monitoring equipment, surge-protective devices, or the control circuit of power operable service disconnecting means, including a ground-fault protection system, shall not be considered a service disconnecting means. This provision is only applicable to those disconnects that provide control to the equipment identified above which are installed as part of the switchboard by the switchboard manufacturer.

8.1.11.2 In a group of sections having a main switch or circuit breaker, only the main section/ compartment shall be marked for service equipment use.

8.1.11.3 A switchboard interior or a section marked for service equipment use shall be provided with a grounding electrode conductor terminal, and, if a neutral is provided, means for disconnecting the neutral service conductors, and, if rated for alternating current, a main bonding jumper.

8.1.11.4 In a multi-section switchboard, only one section need contain a main bonding jumper and a grounding electrode conductor terminal. The main bonding jumper and the grounding electrode conductor terminal need not be located in a section marked for service equipment use.

8.1.11.5 In a multi-section switchboard, means for disconnecting the neutral from the service conductors may be located in only one section if it disconnects all the outgoing neutral conductors in all the sections from the service conductors. The neutral disconnecting means need not be located in a section marked for service equipment use.