# UL 845

## STANDARD FOR SAFETY

Motor Control Centers

UL Standard for Safety for Motor Control Centers, UL 845

Sixth Edition, Dated June 28, 2021

***SUMMARY OF TOPICS***

***This new Sixth Edition of ANSI/UL 845 dated June 28, 2021 includes revised requirements for Temperature Terminations.***

The requirements are substantially in accordance with Proposal(s) on this subject dated August 28, 2020 and January 29, 2021.

No Text on This Page

**Association of Standardization and Certification**
**NMX-J-353-ANCE-2021**
**Third Edition**

**CSA Group**
**CSA C22.2 No. 254:21**
**Second Edition**

**Underwriters Laboratories Inc.**
**UL 845**
**Sixth Edition**

# Motor Control Centers

June 28, 2021



**ANSI/UL 845-2021**

**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.



**ISBN 978-1-4883-3254-8 © 2021 Canadian Standards Association**



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.

To purchase CSA Group Standards and related publications, visit CSA Group’s Online Store at www.csagroup.org/store/ or call toll-free 1-800-463-6727 or 416-747-4044.



This ANSI/UL Standard for Safety consists of the Sixth Edition. The most recent designation of ANSI/UL 845 as an American National Standard (ANSI) occurred on June 28, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 845 on April 20, 1993. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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.

To purchase UL Standards, visit UL's Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call toll-free 1-888-853-3503.

## CONTENTS

No Text on This Page

# Preface

This is the harmonized ANCE, CSA Group, and UL standard for Motor Control Centers. It is the third edition of NMX-J-353-ANCE, the second edition of CSA C22.2 No. 254, and the sixth edition of UL 845. This edition of NMX-J-353-ANCE/CSA C22.2 No. 254/UL 845 supersedes the previous edition published on August 31, 2005.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), the CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Subcommittee 17D – Motor Control Centers 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 motor control centers manufactures and users.

This standard was reviewed by the CSA Integrated Committee on Industrial Control, 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 identical standard for ANCE, CSA Group, and UL.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. 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.

No Text on This Page

# Motor Control Centers

## 1 Scope

### 1.1 Products covered

1.1.1 This standard applies to motor control centers to be used in accordance with the U.S. *National Electrical Code*, ANSI/NFPA 70, CSA C22.1, *Canadian Electrical Code, Part 1*, and the Mexican *Electrical Installations (Utility)*, NOM-001-SEDE.

1.1.2 These requirements cover motor control centers for use on circuits having available short-circuit currents not more than 200 000 A rms symmetrical or 200 000 A dc.

1.1.3 This standard applies to single- and three-phase 50 and 60 Hz and dc motor control centers rated not more than 1000 V ac or dc.

1.1.4 Requirements for fire pump controllers are as provided in Annex C, item 11.

### 1.2 Products not covered

These requirements do not cover switchboards or panelboards intended for the control of electric light and power circuits, nor do they cover an individual unit for this purpose. Such units, however, that consist of manually or automatically operated switches, branch-circuit or service-circuit circuit-breakers, overcurrent-protective devices, or the like may be used within a motor control center.

### 1.3 Equipment

1.3.1 A motor control center can contain, but is not limited to, any combination of equipment such as the following:

a) full-voltage reversing or non-reversing combination motor control units;

b) full-voltage multispeed combination motor control units;

c) reduced-voltage part-winding, wye-delta or auto-transformer combination motor control units;

d) solid-state industrial controllers, such as adjustable-speed drives, programmable controllers, protective relays, and the like;

e) lighting or distribution panelboards;

f) feeder-tap units;

g) incoming-line equipment, such as main lugs, fusible switch, isolation switch, or circuit-breaker;

h) control or lighting transformers;

i) special equipment assemblies;

j) combination contactor units.

1.3.2 The foregoing equipment can contain, but is not limited to, such items as pushbuttons, selector switches, indicating lights, control transformers, control circuit fuses, and auxiliary devices incorporated as an integral part of the units.

### 1.4 Units of measurement

The first values given are SI (metric) units. Alternate measurements shown in parentheses are US customary units, which sometimes are not strict conversions.

## 2 Normative references

The normative references listed in Annex C contain provisions which, through reference in this text, constitute provisions of this standard. Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the edition of that code or standard and all published changes up to the time when this standard was approved.

In Canada, general requirements are as indicated in Annex C, item 16.

## 3 Definitions

3.1 For the purposes of this standard, the following apply.

3.2 **auxiliary devices** – types of devices such as indicating meters (instruments), current transformers, control devices, control relays, timers, protective relays or protective devices, communications devices, etc.

3.3 **available short-circuit current** – the short-circuit current available at the equipment line terminals plus any motor contribution. The available ac short-circuit current is expressed in rms symmetrical A.

3.4 bus, horizontal – a bus that extends through a motor control center section.

3.5 **bus, vertical** – a bus that serves the units in a section and that originates from the horizontal bus. This bus may be replaced by insulated wiring.

3.6 **Class I motor control centers** – mechanical groupings of combination motor control units, feeder-tap units, other units, and electrical devices arranged in an assembly. (See Annex H).

3.7 **Class II motor control centers** – a Class I motor control center provided with manufacturer-furnished electrical interlocking and wiring between units, as specifically described in overall control system diagrams supplied by the user. (See Annex H).

3.8 **combination controller unit** – a control unit containing a magnetic or solid-state controller and an externally operable disconnecting means and overcurrent protection. The controller may or may not contain motor overload protection.

3.9 **combination motor control unit** – a control unit that contains components that perform the following functions: externally operable circuit-disconnecting means, motor branch-circuit overcurrent protection, motor overload protection, and motor control.

NOTE Two sets of externally operable circuit-disconnecting means, each with branch-circuit overcurrent protection and motor controller, may be mounted in a single compartment to form a dual unit.

3.10 **dummy fuse** – a current-carrying part made of copper and 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.

3.11 **feeder-tap unit** – a unit that includes an externally operable circuit-disconnecting means and branch-circuit overcurrent protection, principally used for non-motor loads.

NOTE Two sets of externally operable circuit means, each with branch-circuit overcurrent protection, may be mounted in a single compartment to form a dual unit.

3.12 **incoming supply conductor** – a conductor installed to provide power to the equipment.

3.13 **main bonding jumper** – the connection between the grounded circuit conductor and the equipment grounding conductor at the service.

3.14 **motor control center** – a floor-mounted assembly of one or more enclosed vertical sections typically having a horizontal common power bus and principally containing combination motor control units.

NOTE Usually, units are mounted one above the other in the vertical sections. The sections normally incorporate vertical buses connected to the common power bus, thus extending the common power supply to the individual units. Power may be supplied to the individual units by bus bar connections, by stab connections, or by suitable wiring.

3.15 **motor control center section** – the vertical enclosure and assembly that is prevented by the structural framework from being physically separated into smaller parts and is intended to receive individual combination motor control units. The function of the vertical section is to support the horizontal and vertical buses, units, covers, and doors when the doors are not mounted directly to the unit.

3.16 **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 cut-off of the supply.

3.17 **system bonding jumper** – the connection between the grounded circuit conductor and the equipment grounding conductor at a separately derived system.

3.18 **Type A wiring** – user (field) load and control wiring connected directly to device terminals internal to the unit (See Annex H.)

3.19 **Type B wiring** – user (field) control wiring connected to unit terminal blocks; the field load wiring is connected either to power terminal blocks or directly to the device terminals. Terminal blocks are internal or adjacent to the unit. (See Annex H.)

3.20 **Type C wiring** – user (field) control wiring connected to master terminal blocks; the field load wiring is connected either to master power terminal blocks or directly to the device terminals. Master terminal blocks are mounted at the top or bottom of the vertical sections that contain combination motor-control units or control assemblies. (See Annex H.)



## 4 Application information and components

4.1 Recommended classifications and application information are given in Annex H.

### 4.2 Components

4.2.1 A component of a product covered by this standard shall comply with the requirements for that component. See Annex D 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.

4.2.2 A component shall be used in accordance with its rating established for the intended conditions of use except as otherwise permitted in this standard.

## 5 Characteristics

### 5.1 General

5.1.1 A motor control center section shall be rated as follows:

a) voltage (Volt, V, Vac, Vdc);

b) phase (Ø, phase);

c) frequency (Hz, hertz);

d) horizontal and vertical power bus ampacity (A, ampere), including neutral bus when supplied;

e) bus short-circuit current ratings (A rms sym, or A dc V max).

5.1.2 A motor control center unit shall be rated as follows:

a) voltage (Volt, V, Vac, Vdc);

b) phase (Ø, phase);

c) frequency (Hz, hertz);

d) load (hp, A, ampere, kW, kVA, kvar). In Mexico, kW is required for motor loads;

e) unit short-circuit current ratings (A rms sym or A dc – V max).

### 5.2 Voltage ratings

The voltage rating of a motor control center shall not be more than 1000 V ac or dc. Common ratings are shown in Table 1.

### 5.3 Current

#### 5.3.1 Incoming rating

5.3.1.1 A motor control center shall be assigned an incoming rating for current that shall not exceed the ampacity of the horizontal bus.

5.3.1.2 In Mexico and the United States, the supply rating of equipment that is marked to indicate it is suitable for use as service equipment, has provision for 2 watt-hour meters without provision for current transformers, and is provided with two main disconnects shall not be less than 50 % of the sum of the continuous ampere range of the assembled meter positions. (See Annex G.)

In Canada, this is not permitted.

#### 5.3.2 Horizontal bus rating

The horizontal common power bus shall have a continuous-current rating of 600 A or higher. Preferred ratings are 800, 1 000, 1 200, 1 600, or 2 000 A.

### 5.3.3 Vertical bus

A vertical bus shall have a minimum continuous-current rating of 300 A.

## 5.4 Short-circuit

### 5.4.1 Standard short-circuit current ratings of motor control center units

5.4.1.1 Each unit of a motor control center containing a short-circuit protective device shall be assigned a short-circuit current rating. Except for units containing only control-circuit components, the rating shall be the applicable rating from Table 2.

5.4.1.2 Each unit of a motor control center containing only control-circuit components shall be assigned a short-circuit current rating not greater than the interrupting rating of the short-circuit protective device, but not exceeding 100 kA.

5.4.1.3 A unit not containing any short-circuit protective device shall not be connected directly to the power bus (with the exception of lightning and surge arresters) and shall not be assigned a short-circuit current rating, which shall be indicated as "NA." Absence of a short-circuit current rating on such a unit does not affect the short-circuit current rating of the motor control center.

### 5.4.2 Combination motor control units

A combination motor control unit, for other than variable speed drives, may have a short-circuit current rating greater than the short-circuit current rating of any individual component if evaluated by design tests.

For combination motor control units containing variable speed drives the short circuit current rating shall not be greater than the interrupting rating of the short-circuit protective device. When the short-circuit protective device is an instantaneous-trip circuit breaker, it shall be evaluated by design tests.

### 5.4.3 Separately derived systems

Motor control center short-circuit current ratings are not affected by units connected to a separately derived system in a motor control center. The short-circuit current rating for such a unit shall be equal to or greater than the short-circuit current capacity of the separately derived system.

### 5.4.4 Rating of bus structure

The bus structure (horizontal and vertical bus) of a motor control center shall have a short-circuit current rating. The rating shall be the applicable rating from Table 3.

# 6 Markings and product information

## 6.1 Identification

The following information shall be given by the manufacturer for both sections and units, where applicable:

a) manufacturer's name or trademark. If a manufacturer produces or assembles motor control centers at more than one factory, the factory location shall be identified. Factory identification may be in coded form; and

b) type designation, serial number, or equivalent.

## 6.2 Product information

6.2.1 The following information shall be given by the manufacturer for sections:

a) electrical ratings (see Clause 5.1);

b) enclosure type;

c) termination and wiring information, as follows:

1) tightening torque for field-installed conductors (pound-inches, lb-in, or N-m). In Mexico, N-m is required as a minimum;

2) required temperature rating for field installed power conductors (°C);

3) material requirements for conductors (Cu, Al, Cu-Al, Al-Cu).

6.2.2 The following information shall be given by the manufacturer for units:

a) electrical ratings (see Clause 5.1.2);

b) technical information, as follows:

1) wiring diagrams or tables;

2) current element tables for overload relays, where applicable;

3) instantaneous-trip circuit-breaker setting information, where applicable.

c) service disconnect (see Annex G);

d) if applicable, suitability for use as service entrance equipment (see Annex G);

e) termination and wiring information, as follows:

1) tightening torque for field-installed power conductors (pound-inches, lb-in, or N-m). In Mexico, N-m is required as a minimum;

2) required temperature rating for field-installed conductors (°C);

3) material requirements for conductors (Cu, Al, Cu-Al, Al-Cu).



## 6.3 Marking

6.3.1 All markings shall be in the appropriate language (or symbols as noted in this standard), as necessary, for the country in which the motor control center will be installed (Spanish for Mexico, and English for Canada and the United States.). A manufacturer may choose to utilize multiple languages on a motor control center. See Annex B for translations of some markings that are also required to be in French if installed in Canada.

6.3.2 Markings shall be located as specified in Table 7, Table 8, and Table 9.

6.3.3 A required marking shall comply with the permanence of marking requirements of Annex C, item 3.

6.3.4 The manufacturer's name or trademark and the type designation, serial number, or equivalent, as described in Clause 6.1, shall be marked on the equipment.

6.3.5 Applicable characteristics as described in Clause 6.2 shall be marked on the equipment and shall be easily legible and plainly visible after installation. The characteristic marking may be omitted under the following conditions:

a) If the tightening torque for a field-wiring terminal is provided on a component in a visible location, the motor control center unit need not be marked.

b) Technical information (see Clause 6.2.2) provided in a pocket need not be marked on the equipment.

6.3.6 Motor control center sections not containing bus shall have the electrical ratings marked “N/A”.

6.3.7 Motor control center units not containing short-circuit protective devices shall be marked with a short-circuit current rating “N/A”, in accordance with Clause 5.4.1.

6.3.8 The short-circuit current rating of a motor control center section shall be an integral part of a marking containing the manufacturer's name or other required marking.

6.3.9 A motor control center section shall be marked

“Short-circuit current rating ___A rms symmetrical, ____ V maximum. Do not install on circuits with available short-circuit currents higher than the lowest short-circuit current rating of any installed unit" or the equivalent.

If the short-circuit current rating of a motor control center section is dependent upon the use of a specific overcurrent-protective device ahead of the center, the section shall be marked

“When used with ____ ampere maximum Class ____ fuses (type ____ circuit-breaker), this motor control center section is acceptable for use on a circuit capable of delivering not more than ____ A rms symmetrical, ____ V maximum.”

An individual section need not be marked with the short-circuit current rating provided that the section is part of a motor control center line-up having an unspliced, common main bus and that one of the sections is marked as required above.

*For dc rated assemblies, replace “rms symmetrical” with “DC”.

6.3.10 A motor control center unit shall be marked

"Unit short-circuit current rating_____ A rms symmetrical*, _____ V maximum, when equipped with___", or the equivalent.

The information that shall be provided in the third blank is the class and ampere rating of fuse or the manufacturer’s name and type designation of the circuit-breaker, whichever is applicable.

If the short-circuit current rating of a motor control center unit is dependent upon the use of a specific protective device ahead of the unit, the motor control center unit shall be marked

"When used with ____ ampere maximum Class ____ fuses (type ____ circuit-breaker), this motor control center unit is acceptable for use on a circuit capable of delivering not more than ___ A rms symmetrical* _____ V maximum", or the equivalent.

* For dc rated assemblies, replace “rms symmetrical” with “DC”.

6.3.11 Technical information [see Clause 6.2.2 b)] for individual units shall be

a) secured to each unit in a plainly visible location;

b) secured to the inside of the unit door; or

c) provided at a single location on or in the motor control center in a pocket expressly for this purpose and the individual units 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.

### 6.3.12 Marking for service equipment

6.3.12.1 In Canada, if a motor control center is intended for use as service equipment, it shall be marked as follows (see Annex G):

"Suitable for use as service equipment."

6.3.12.2 In Mexico and the United States, if a motor control center is intended for use as service equipment, the following applies (see Annex G):

a) In the case of an insulated neutral, it shall be marked with the following:

"Suitable for use as service equipment."

b) In the case of a factory-bonded neutral, it shall be marked with the following:

"Suitable only for use as service equipment."

6.3.13 With reference to Clause 8.2.9.4, vertical bus bars that are common for both rear-mounted units, and front-mounted units shall be marked to indicate the C, B, A phase arrangement for the rear-mounted units.

6.3.14 In Mexico and the United States, if a motor control center section or unit is marked "Suitable for use as service equipment", instructions for installing the bonding means specified in Clause 8.2.33.2 shall be provided if the installation method is not apparent. (See Annex G.) 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 them near the disconnect handles when the equipment is used as service equipment.

In Canada, this requirement is not permitted.

6.3.15 If a motor control center section or unit is marked "Suitable only for use as service equipment", a service-disconnecting device for ungrounded conductors shall be marked "Service disconnect" on or adjacent to the switch or circuit-breaker handle. (See Annex G.)

6.3.16 A motor control center section or unit not provided with ground-fault protection as covered in Clause 8.2.21.7 shall be marked for the use specified in Clauses 6.3.17 and 6.3.18.

6.3.17 In Mexico and the United States, a motor control section or unit rated 3-phase, 4-wire and having a solidly grounded neutral shall be marked as follows (see Annex G):

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."

In Canada, this requirement is not permitted.

6.3.18 In Mexico and the United States, a motor control center section or unit that is marked "Suitable only for use as service equipment" or "Suitable for use as service equipment" and that is not provided with ground-fault protection, or that is marked as described in Clause 8.2.21.7 c), shall be marked for

a) supplying a fire pump;

b) an alternate source for legally required standby service;

c) a 3-phase, 4-wire system that is a wye-connected service and that is not solidly grounded but impedance grounded (see Annex G) ; or

d) use as the disconnecting means for a separate building or a structure on the property where ground-fault protection is provided at the service entrance.

In Canada, this requirement is not permitted.

6.3.19 Ground fault signalling for service entrance

6.3.20 In Mexico and the United States, a motor control center section or unit fed by an alternate source that has ground-fault protection with only an audible or visual signal as covered in Clause 8.2.21.11 shall be marked as specified in Clause 6.3.18 (see Annex G).

In Canada, this requirement is not permitted.

6.3.21 If a service equipment unit is supplied by a 3-phase, 4-wire system that is not solidly grounded (an impedance grounded wye-connected system) and has ground-fault protection with only an audible or visual signal, it shall be marked as specified in Clause 6.3.18 (see Annex G).

6.3.22 The markings specified in Clause 6.3.12 shall be plainly visible after installation without requiring the opening of a door or cover. Other markings shall not be located within 3.0 mm (0.12 in) of the above markings unless the above markings are on a contrasting colour or located in a distinctly separated area. Markings within 12.7 mm (0.5 in) of the markings required in Clause 6.3.16 shall be of less height.

6.3.23 A motor control center section or unit that has had the neutral bonded at the factory by means of a removable bonding means shall be marked, “Bonded neutral – must not be disconnected except for testing” (see Annex G).

6.3.24 If the motor control center section or unit is 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 (see Annex G).

6.3.25 The current element table referenced in Clause 6.2.2 b) 2) shall include a current element rated for use at the maximum rating of the motor control unit.

6.3.26 The current element table referenced in Clause 6.2.2 b) 2) shall not include a current element or overload relay that is not intended to be used with the associated controller. A table may cover more than one size of starter or may cover the use of one, two, or three overload relays or heater elements, provided that the table is clearly marked to indicate the limits of its use. A resistance- or autotransformer-type controller, a combination-starter unit, or a similar device intended for limited horsepower rating may be provided with a table covering the elements furnished as if the limiting feature were not present.

6.3.27 In Canada, the following marking requirement for utility compartments shall apply. A motor control center compartment for electrical utility supply authority use shall be marked

“COMPARTMENT FOR ELECTRICAL SUPPLY AUTHORITY USE ONLY.”

In Mexico and the United States, this requirement does not apply (see Annex G).

6.3.28 The word “terminal” as used in Clauses 6.3.29 to 6.3.31, 6.3.41, and 6.3.42 signifies any terminal of the motor control center, as well as any terminal in any component unit, such as a circuit-breaker, switch, and the like, that is installed or intended to be installed in the motor control center and to which power conductors are connected in the field. The motor control center shall be marked in accordance with Clause 6.3.29, 6.3.30 or 6.3.31, whichever applies.

6.3.29 With regard to Clause 6.3.28, if, because of wiring space or other factors, no terminal of the motor control center is acceptable for use with aluminum conductors, the motor control center shall be marked “Use Copper/Cu Wire Only” or equivalent.

6.3.30 If the wiring space and other factors are such that all terminals of the motor control center are acceptable for use with aluminum conductors as well as with copper conductors the motor control center shall be marked

“USE COPPER OR ALUMINUM WIRE” or “CU – AL” or equivalent.

6.3.31 If the wiring space and other factors are such that some terminals of the motor control center are acceptable for use with aluminum as well as copper conductors, while the remainder or the terminals are acceptable for use with copper conductors only, the motor control center shall be marked

“USE COPPER WIRE ONLY EXCEPT AT TERMINALS _____” or equivalent.

The marking shall clearly identify the terminals that are acceptable for use with aluminum wire.

6.3.32 Marking provided in accordance with Clause 6.3.29, 6.3.30, or 6.3.31 shall be readily and clearly visible after the installation with the cover or trim removed.

6.3.33 Motor control centers shall be marked to indicate the temperature rating (60 °C only, 60/75 °C, or 75 °C only) of the field-installed conductors for which the equipment has been investigated unless the field wiring terminal is only intended for the connection of a control circuit conductor.

6.3.34 Where required by Clause 8.2.17.3, the motor control center incoming supply sections/units shall be permanently marked with the allowable ampacity of the field-installed incoming supply conductors, in a location readily visible prior to wiring, with the following or equivalent wording:

“Field installed incoming supply conductors may use 75/90 °C ampacity ratings.” and “Les conducteurs d’alimentation entrants installés sur site peuvent utiliser une intensité nominale de 75/90 °C.”

Note: See also Rule 4-006 of the Canadian Electrical Code, Part I, and Article 110.14(C) in the.

6.3.35 As required in Clauses 8.2.16.8 and 8.2.29.3.2, the maximum conductor sizes allowable shall be identified by a prominent marking, such as a wiring diagram, in the motor control center that will state the number and size of wires for which the construction is intended.

6.3.36 Equipment shall be marked to show the range of values or the nominal value of tightening torque to be applied to the clamping screws of all terminal connectors for field wiring.

When the line terminal torque value is above normal levels as permitted in Clause 9.10.8.3, the marking shall be located adjacent to the terminals and shall specify the minimum value of torque that shall be applied to the terminal screws.

6.3.37 Limited energy circuit field-wiring

6.3.38 As allowed by Clause 8.2.15.2 a), circuits that are intended to be supplied from a Class 1 extra-low-voltage, low-energy power source shall be identified "Input ____ V, ____ A Class 1 Only", or the equivalent. Class 1 supplies conforming to the requirements of Annex C, item 13, shall be permitted to be identified "Output ____ V, ____ A, Class 1."

6.3.39 As allowed by Clause 8.2.15.2 b), circuits that are intended to be supplied from a Class 2 extra-low-voltage, low-energy power source shall be identified "Input ____ V, ____ A Class 2," or the equivalent. Class 2 supplies conforming to the requirements of Annex C, item 14, shall be permitted to be identified "Output ____ V, ____ A, Class 2."

6.3.40 The identification noted in Clauses 6.3.38 and 6.3.39 shall be given in an instruction sheet, in drawings, or by marking the termination point as a Class 1 or Class 2 circuit.

6.3.41 Where leads, wire-binding screws, or pressure wire connectors are not provided on the equipment as shipped, the equipment shall be marked stating which pressure wire connector or component terminal kits are acceptable for use with the equipment. A terminal kit shall carry an identifying marking, an identification of wire size, and the manufacturer's name or trademark.

6.3.42 Where special terminals such as crimped lugs are provided, they are sometimes included in the equipment at the factory. Instructions including reference to necessary tools to effect proper connection of the conductor shall be provided.

6.3.43 With reference to Clause 8.2.21.5 or 8.2.21.6, if ground-fault protection is provided in a motor control center section or unit, 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 motor control center with the motor control center cover removed, a separate marking, on a wiring diagram or in another suitable location, shall be provided (see Annex G).

6.3.44 In a motor control center section or unit with ground-fault protection, that part of the neutral bus which is for load terminations shall be marked with the hazard signal word or symbol (e.g., "WARNING" or "DANGER") and with the following or equivalent wording:

"RISK OF FIRE AND ELECTRIC SHOCK – 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 (see Annex G).

In Canada, this marking is not permitted.

6.3.45 With respect to Clause 8.2.21.16, when intended to be 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 ____ V (ac or dc)". Terminals for external sources for other types of control circuits shall be similarly marked (see Annex G).

6.3.46 The disconnecting means shall clearly indicate whether they are in the “OPEN-OFF” or “CLOSED-ON” position. In applications employing separate external operating mechanisms, the contacts shall be open when the position indicator shows “OPEN-OFF”, but the position indicator may show “CLOSED-ON” when the contacts are in either the trip or closed position.

NOTE International IEC symbols, “I” indicating on and “O” indicating off, also may be used.

6.3.47 If a transformer providing control voltage or an instrument or control circuit fuse is connected to the line side of the main disconnect or to a separate source, this disconnect may be identified as the "Main", but the motor control center shall be marked on the dead front adjacent to the main disconnect with the word "DANGER" and with the following or equivalent wording:

"RISK OF ELECTRIC SHOCK. THIS MAIN DOES NOT DISCONNECT CONTROL AND INSTRUMENT CIRCUITS."

6.3.48 A motor control center section that is designated for either top cable entry only or bottom cable entry only shall be marked

"TOP ENTRY ONLY" or "BOTTOM ENTRY ONLY" or equivalent.

The marking shall be located adjacent to the incoming terminals or as indicated on the wiring diagram.

6.3.49 A combination motor control unit in the motor control center shall be marked with a hazard signal word (e.g., “WARNING”, “DANGER”, “CAUTION”) and the following or equivalent:

"THE OPENING OF THE BRANCH-CIRCUIT PROTECTIVE DEVICE CAN BE AN INDICATION THAT A FAULT CURRENT HAS BEEN INTERRUPTED. TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, CURRENT-CARRYING PARTS AND OTHER COMPONENTS OF THE COMBINATION CONTROLLER SHOULD BE EXAMINED AND REPLACED IF DAMAGED. WHEN A FAULT CURRENT HAS BEEN INTERRUPTED, THE COMPLETE OVERLOAD RELAY MUST BE REPLACED.”

The marking may be in the form of a single label mounted on the motor control center sections that can incorporate combination motor control units.

6.3.50 A motor control center unit intended to be used with a protective device in an accessory kit as permitted in Clause 8.2.14.3 shall be marked to identify the kit to be used in that unit.

6.3.51 An accessory intended for field installation shall be provided with installation and wiring instructions. An accessory shall be plainly marked with

a) the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified, hereinafter referred to as “the manufacturer's name”;

b) the electrical rating;

c) the catalogue number or equivalent.

6.3.52 Identification of the kits that can be installed in a motor control center shall be marked on the equipment, supplied separately, or included in the manufacturer’s catalogue.

6.3.53 A motor control center unit utilizing an instantaneous-trip circuit-breaker without additional protection for control circuit conductors as permitted in Clause 8.2.14.2 shall be marked with the maximum control-circuit protective-device rating corresponding to the size of the control-circuit wire used within the equipment, as specified in Table 4.

6.3.54 Where a supplementary fuse is provided there shall be a marking near the fuseholder specifying the voltage and current rating of the replacement fuse.

6.3.55 With reference to Clauses 8.2.14.1 to 8.2.14.5, where a branch-circuit type (other than supplementary) fuse is provided and the fuseholder will accept a fuse having a higher current rating than as specified in Table 12, a marking specifying the maximum fuse size shall be provided near the fuseholder.

6.3.56 Where the fuse used to determine compliance with the fuse-clip temperature-rise requirement (see Clause 8.2.8.3) is a Class G or K, there shall be a marking near the fuseholder specifying the class of the replacement fuse.

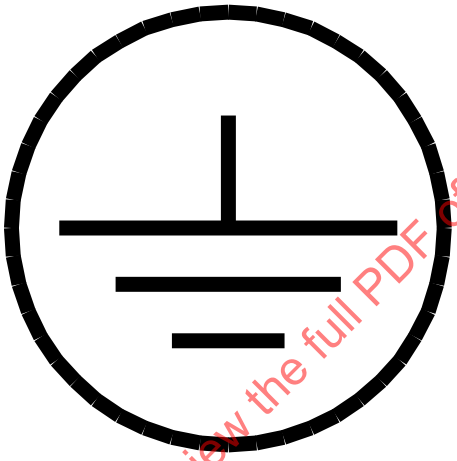
6.3.57 Unless its intended use is obvious the equipment-grounding terminal or assembly shall be

a) green, or the heads of the terminal screws shall be green; or

b) identified by one of the following adjacent to the terminal:

1) the marking “Equipment Grounding Terminal”, or an equivalent marking or abbreviation; or

2) the symbol



Grounding Symbol
See IEC 60417, Symbol 5019



6.3.58 With reference to Clause 8.2.34.5, if an equipment-grounding-terminal assembly is intended for field installation,

a) the section shall be marked to indicate the catalogue or type number of the terminal assembly intended to be used;

b) proper 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.

6.3.59 Cautionary markings required by this standard shall be located on a part that cannot be removed without impairing the operation or appearance of the equipment.

6.3.60 A cautionary marking shall be prefixed with the hazard signal word "CAUTION", "WARNING", or "DANGER", as applicable, in letters not less than 2.3 mm (0.09 in) high or 9 point. The remaining letters of the cautionary marking, unless specified otherwise in individual marking requirements, shall not be less than 1.5 mm (0.06 in) high or 6 point.

6.3.61 With respect to Clause 9.10.8.1, a marking specifying the type of bracing to be added to cables routed through the section between the point of entry and the incoming terminals shall be located adjacent to the incoming terminals or shall be supplied in separate instructions provided with the equipment.

Bracing items not provided as a part of the center shall consist of components readily available to the installer.

6.3.62 A motor control center that does not preclude the installation of a unit with the operating handle higher than 2 m (6 ft, 7 in) shall be marked

"THE MOTOR CONTROL CENTRE UNIT INSTALLED IN THE UPPERMOST POSITION SHALL BE SELECTED SO THAT THE CENTRE OF THE GRIP OF THE HANDLE IS LOCATED NOT MORE THAN 2 METRES (6 FEET, 7 INCHES) FROM THE FLOOR OR A WORKING PLATFORM."

A motor control center unit requiring an additional accessory, such as an extension, chain, or similar operating means, to meet the operating handle height limits shall have the list of accessories provided in the unit, in the instructions, or in a separate catalogue.

6.3.63 When required by Clause 8.1.4, equipment shall be marked with the following or equivalent wording:

"WARNING: WHEN MOUNTING ON OR OVER A COMBUSTIBLE SURFACE, A FLOOR PLATE OF AT LEAST 1.43 mm (0.056 INCH) GALVANIZED OR 1.6 mm (0.063 INCH) UNCOATED STEEL EXTENDED TO THE OUTSIDE PERIMETER OF THE EQUIPMENT MUST BE INSTALLED."

This marking need not be permanent.

6.3.64 Equipment that is energized from more than one circuit and that does not have means for disconnecting all ungrounded conductors within a single enclosure or compartment shall be permanently marked on the outside with the following or equivalent wording:

"WARNING: MORE THAN ONE LIVE CIRCUIT. SEE DIAGRAM."

NOTE This clause does not apply to circuits of extra-low voltage as defined in Annex C, item 1.

6.3.65 Power conversion equipment incorporating capacitors shall be marked with the following or equivalent wording:

"WARNING: CAPACITIVE VOLTAGES ABOVE 50 V CAN REMAIN FOR _____ S AFTER POWER IS DISCONNECTED."

6.3.66 A unit incorporating an instantaneous-trip circuit-breaker shall be provided with complete instructions for the breaker adjustment and overload relay current element selection to provide protection in accordance with Annex C, item 1.

6.3.67 A unit employing an overload relay that can be selected for automatic reset and supplied with a wiring diagram indicating two-wire control shall be permanently marked to indicate that a motor connected to the circuit can start automatically when the relay is in the automatic reset position.

6.3.68 When two or more bonding conductors 13.3 $mm^2$ (6 AWG) or smaller are terminated in a single or multiple-conductor terminal that accepts a range of conductor sizes, the marking

"WARNING: TWIST WIRES TOGETHER BEFORE INSERTING IN TERMINAL"

shall appear adjacent to the grounding terminal. If the terminal is suitable for both copper and aluminum conductors, the following marking shall be added:

"COPPER WIRES MUST NOT BE MIXED WITH ALUMINUM WIRES IN THE SAME TERMINAL HOLE."

6.3.69 With respect to Clause 8.2.32.3, if a grounding electrode conductor is required, a motor control center section containing a power transformer feeding circuits that leave the section from a secondary winding not conductively connected to the primary shall be marked, or have indicated on the wiring diagram, the need for connecting the secondary neutral conductor to a grounding electrode, where applicable, in accordance with existing installation requirements pertaining to separately derived systems.

6.3.70 In Canada, motor control centers intended for service entrance use and constructed in accordance with Clause 8.2.20.13 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 followed by specific instructions applicable to the particular construction*.") (see Annex G).

6.3.71 When required by Clause 9.12.5.1 or 9.12.5.6, a combination motor control unit shall be marked with the type of protective device used and the maximum size of the protective device.

6.3.72 When disconnects or circuit breakers are reverse or back-fed, the unit shall be marked with the following words or the equivalent: DANGER: REVERSE FED DEVICE – LINE SIDE POWER CONNECTED TO LOAD SIDE TERMINALS OF DEVICE. DE-ENERGIZE POWER BEFORE SERVICING.

### 6.4 Installation instructions

The ground-fault protection equipment instructions and test form shall be provided with the equipment.

## 7 Normal service and transport conditions

### 7.1 General

Additional service and transportation conditions are given in Annex H or in individual application information.

### 7.2 Normal service conditions

Apparatus within the scope of this standard shall be capable of operation within its performance specifications under the following conditions:

a) The temperature of the air outside of the enclosure and the ambient temperature is above 0 °C but does not exceed 40 °C, and its average value, measured over a 24 h period, does not exceed 35 °C.

b) The ambient air is not significantly polluted by dust, smoke, corrosive and/or flammable gases, vapors, or salt.

c) The average value of relative humidity, measured over a period of 24 h, does not exceed 95 % non-condensing.

d) The altitude does not exceed 2 000 m (6 600 ft), or 1 000 m (3 300 ft) if the equipment includes solid-state controllers.

NOTE: See Annex H for abnormal service conditions.

## 8 Construction and performance requirements

### 8.1 General assembly

8.1.1 A motor control center section shall have all enclosure panels and bus bars in place except for any necessary bus bar links or enclosure panels that are completed by the installation of an adjacent section. Motor control center units that plug into the bus bars need not be shipped with the section, but provision shall be made for the proper installation of such units. Motor control center units may be shipped without doors, but provision shall be made for the installation of such doors.

### 8.1.2 Enclosure – General

8.1.2.1 A motor control center enclosure shall comply with the requirements of Annex C, item 10, except for modifications and additional requirements as specifically described in this Standard. For environmental rating tests, see Annex C, item 2.

8.1.2.2 A nonmetallic plug or other closure assembled as part of the enclosure shall comply with the requirements of Annex C, item 10, as applicable.

8.1.3 No horizontal covering shall be required across the bottom of the surrounding enclosure if exposed live parts within the device are not less than 152 mm (6 in) above the plane of the mounting surface. Insulated parts located within 152 mm (6 in) of the lower edge of the enclosure shall be guarded. Equipment provided with longitudinal base channels shall have a vertical covering between the base channels at the ends of the equipment or have a bottom plate above the base channels.

8.1.4 Motor control centers shall be so constructed that molten or flaming particles cannot fall to the surface on which the equipment is mounted or shall be marked in accordance with Clause 6.3.63.

### 8.1.5 Openings for operating handles

8.1.5.1 Openings provided for an operating handle or other component projecting through a door shall be close-fitting. The clearance between the edge of the hole and the handle or component escutcheon shall not exceed 2.4 mm (0.093 in) on either side (one side only) and 3.2 mm (0.125 in) total (both sides).

8.1.5.2 Operating handle clearances shall be measured with the handle in the " ON", "OFF", and "TRIP" positions when a tripping mechanism is provided, with the handle and its supporting member assembled in any position that will result from ordinary factory assembly.

8.1.6 In a unit incorporating fused switches, the location of the fuses shall be such that

a) fuses will be accessible and the fuse terminals will be dead when the switch is open; and

b) fuses can be replaced without a person touching any live part.

### 8.1.7 Door interlock

8.1.7.1 The door of a motor control center unit having a disconnecting device shall be interlocked with the disconnecting device so that the door cannot be opened without first opening the disconnecting device and so that the door cannot be closed unless the disconnect handle is in the same position as the disconnect device. Where two sets of circuit-disconnecting means are mounted in a single compartment to form a dual unit, each disconnecting device shall be interlocked with its associated door. This requirement does not apply to a ground fault control circuit disconnect that does not have an external operating handle.

8.1.7.2 Provision for deactivating the interlock for inspection purposes while the disconnecting device is closed shall be permitted.

### 8.1.8 Securing doors and covers

8.1.8.1 A part of a motor control center enclosure, such as a door or a cover, shall be provided with means, such as latches, locks, interlocks, or screws, for firmly securing it in place.

8.1.8.2 If bare live parts are exposed by the opening of doors or covers, means requiring the use of a tool to open them or means that can be locked shall be provided to secure the doors or covers in the closed position.

NOTE Electrical components that are behind a barrier/dead front or that are not contacted by the IEC articulate probe as shown in Figure 10 are not considered to be bare live parts.

8.1.9 Doors required to be opened during normal operation may have hand-operated latches or screws, and

a) doors shall be hinged such that the door will not come off inadvertently;

b) barriers or finger-safe devices shall be used to prevent contact with bare live parts during normal operation, unless the door is provided with an interlock to a disconnecting means that de-energizes all hazardous voltages.

NOTE The replacement of fuses is not considered a normal operation with respect to industrial control equipment, but the resetting of overload devices, repeated adjustment of timers or switches, etc., are considered normal operations.

8.1.10 There shall be no openings in the surface of a unit enclosure, other than those allowed in Clauses 8.1.5.1 and 8.2, that will be exposed after the installation of the unit in the motor control center.

8.1.11 The number, arrangement, and ratings or settings of overcurrent protective devices used in motor control centers shall be in accordance with the requirements of Annex C, item 1.

8.1.12 Provision shall be made for securely mounting a device to a supporting surface. A bolt, screw, or other part used to mount a component of an assembly shall not also be used to mount the assembly to the supporting surface.

8.1.13 Devices that can be handled in normal operation, such as switches and rheostats, shall be staked or otherwise prevented from rotating. Such devices that rely solely on friction shall not be acceptable.

8.1.14 A single-throw knife switch shall be mounted so that gravity will not tend to close it.

8.1.15 A single-throw knife switch shall be connected so that the blade or blades will be dead when the switch is open unless the switch is designed so that all live parts are inaccessible when the switch is in the open position.

8.1.16 A separate disconnecting means shall be provided for each motor starter in a grouped control except where such a control assembly is a coordinated drive of a single machine and all motors forming part of the machine drive are disconnected by a single suitable switch.

8.1.17 When control power for a motor controller is obtained conductively from a grounded system, the control circuit shall be so arranged that an accidental ground in the wiring from the controller to any remote control or signal device will not

a) start the motor; or