

IEEE Guide for Motor Control Centers Rated up to and including 600 V AC or 1000 V DC with Recommendations Intended to Help Reduce Electrical Hazards

IEEE Industry Applications Society

Developed by the
Petroleum & Chemical Industry Committee

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IEEE Guide for Motor Control Centers Rated up to and including 600 V AC or 1000 V DC with Recommendations Intended to Help Reduce Electrical Hazards

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Approved 4 November 2025

IEEE SA Standards Board

Abstract: Functional design recommendations and field practices for motor control centers (single- and three-phase 50 Hz and 60 Hz and dc) are provided in this guide. The features and practices described in this guide are intended to help reduce the probability that an incident will occur due to shock or arc flash hazards when qualified persons are performing certain activities. The recommendations within this guide are intended to augment the existing requirements of applicable standards for motor control centers, e.g., NEMA ICS 18 Motor Control Centers, UL 845 Motor Control Centers, NMX-J-353-ANCE, and CSA C22.2 No. 254. This guide also provides recommendations for interface relationships between the specifier, manufacturer, installer, and user for safety-related concerns. It also provides a framework from which specifiers/users can select specific motor control center (MCC) features and system characteristics that are applicable to their specific situation and needs.

Safety requirements and procedures as stipulated by workplace safety standards, site practices, and site procedures—e.g., NFPA 70E, Standard for Electrical Safety in the Workplace, CSA Z462, Workplace Electrical Safety Standard, and site practices on personal protective equipment (PPE)—are complemented by the recommendations in this guide.

Keywords: arc flash, arc resistant, circuit protection, electrical safety, IEEE 1683™, low voltage, MCC, motor control centers, selectivity, shock, thermal monitoring

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Introduction

This introduction is not part of IEEE Std 1683-2025, IEEE Guide for Motor Control Centers Rated up to and including 600 V AC or 1000 V DC with Recommendations Intended to Help Reduce Electrical Hazards.

Low-voltage motor control centers (MCCs) are the most widely used control and distribution equipment in industrial and commercial establishments. The IEEE working group for this guide consisted of dedicated industry professionals who realized that enhancing the safety of the operating and maintenance personnel interfacing with low-voltage motor control centers is paramount.

The working group believes that enhancing safety relies on a combination of system design, product selection, product design, procedures, training, and other factors based on operation and maintenance requirements. Every decision in system design, product selection, installation, maintenance activity, usage activity, procedures, tools, protective equipment, and training of personnel who use and maintain MCCs can impact the safety of workers who must interface with the equipment for many years after initial installation. The working group has endeavored to create one cohesive document of guidelines to assist users, system designers, manufacturers of MCCs, and maintenance personnel, as well as others, in making decisions that may lead to a greater degree of safety surrounding this important type of electrical control equipment. In many cases, decisions are not clearly incorrect or correct, and readers will need to use engineering judgment to determine the best course of action for their specific situation and facility. However, it is hoped that this guide will assist in making better decisions when such judgments must be made.

The guidelines in this document are strictly voluntary and are not intended to replace mandatory manufacturing, testing, or safety standards, codes, or regulations that apply in relevant situations.

Readers who find this document useful, or lacking, are encouraged to participate in future revisions of this IEEE guide to improve it for future generations of electrical workers.

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CAUTION

The guidelines in this document are strictly voluntary and are not intended to replace mandatory manufacturing, testing, or safety standards, codes, or regulations that apply in relevant situations.

1. Overview

1.1 General

This guide provides functional design recommendations for motor control centers (MCCs) intended to help reduce the likelihood of shock and arc flash injuries. Users are instructed to comply with all safety laws and regulations applicable to their location, systems, equipment, and operations. For additional guidance regarding personnel safety around electrical equipment, refer to the National Electrical Safety Code C2, NFPA 70E, CSA Z462, or other similar applicable standard for worker electrical safety.⁶

It is not the intent of this guide to encourage or endorse work of any kind on energized equipment. However, it is recognized by the working group that such work on occasion does transpire for a variety of reasons. The recommendations in applicable safety standards, such as NFPA 70E and CSA Z462, state that any such work shall only be done by a qualified person in a manner that helps to safeguard persons and property, including placing the equipment in an electrically safe work condition whenever possible prior to the start of any work.

This guide primarily focuses on shock and arc flash hazards and provides recommendations intended to reduce the probability that an incident will occur due to these hazards. As with any electrical power equipment, steps should be taken to address these (and other) hazards. The prudent step is always to remove the hazard whenever possible. In the case of an energized MCC, this can be done by establishing an electrically safe working condition and verifying the absence of voltage.⁷ However, de-energizing equipment may not be appropriate for certain diagnostic tasks. Workplace safety standards (such as NFPA 70E, CSA Z462, and other equivalent national standards) recognize that tasks may require MCC doors to

⁶ Information on references can be found in [Clause 2](#).

⁷ This concept is discussed in NFPA 70E.

be open while qualified persons work on or near energized conductive components (live parts) under specific situations where they can be justified. Working on or near energized parts should be a last resort in the workplace, utilized only after all opportunities for establishing an electrically safe work condition have been exhausted. Work on energized parts at 50 V or more should only be performed if the employer can demonstrate that de-energizing would introduce additional hazards or is not feasible due to equipment design or operational limitations.⁸

In contrast to the stated work situations recognized by workplace safety standards, the intent of the present base MCC standards is more restrictive; they are written with the expectation that qualified persons only perform limited inspection activities near, but in no case perform maintenance activities on, energized parts. The purpose of this guide is to augment the requirements of the base MCC standards and identify specific MCC design features and field practices that help reduce the likelihood of shock or internal arcing faults when qualified persons are performing normal activities on and near energized parts. However, the design features and field practices described in this guide may not eliminate all potential hazards. It is not the intention of this guide to enable every user to perform all possible maintenance tasks on or near energized parts. Rather, it is to help enable qualified persons to perform the types of activities described in this guide with less likelihood of an incident or injury.

Thus, when an MCC is manufactured and applied in accordance with the base MCC standards and augmented with some of the design and application features proposed by this guide, the MCC should be better equipped for a broader range of activities to be carried out under the requirements of NFPA 70E, CSA Z462, or other applicable workplace safety standards.

Although the features described in this guide provide options that can be selected when specifying an MCC, not all features within this guide may be available from all manufacturers, and some features may be incompatible with others or unsuitable for all situations. Additionally, some of the content of the guide addresses system design decisions, not equipment or features provided by MCC manufacturers. Therefore, it is not the intent of this guide to be cited within a specification as a standard for a manufacturer to meet. Rather, the intent is to provide a guide from which users can select specific MCC features and system characteristics that are applicable to their specific situation and needs. These equipment features and system characteristics should be incorporated into the specifications and system design as appropriate.

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection. Compliance with the provisions of this guide does not constitute compliance with applicable laws and regulations. Users of this guide are responsible for observing all such laws and regulations, including all applicable local, state, national, and regional safety requirements for the installation, operation, and maintenance of electrical equipment.

Part of obtaining a safer low-voltage (LV) MCC installation is to realize that IEEE Std 1584™-2018 is substantially different from IEEE Std 1584-2002. Arc flash incident energy calculation and protective device settings based on an arc flash study performed using the 2002 model should be reviewed as soon as possible using the newer 2018 model. Arcing current may be lower or higher than the previous study may have indicated, and incident energy may be different as well, making personal protective equipment (PPE) selections based on the IEEE 1584-2002 model inadequate relative to the new model.

1.2 Scope

This guide applies to single- and three-phase 50 Hz and 60 Hz motor control centers (MCCs) rated not more than 600 V ac or 1000 V dc.

The recommendations within this guide augment the existing requirements of applicable MCC standards (UL 845/NMX-J-ANCE/CSA C22.2 No. 254, collectively referred to as “base MCC standards”). In

⁸ See NFPA 70E-2024, Article 130.1 for the exact and full text.

addition, this guide provides recommendations for electrical system design to help improve the safety of the motor control system.

The recommendations in this guide should be used in conjunction with safety requirements and procedures as stipulated by appropriate workplace safety standards, site practices and procedures, and manufacturers' instructions.

1.3 Equipment condition and maintenance

All information contained in this guide is based on the premise that the existing conditions related to the equipment and installation are such that the installation:

- a) Was specified and designed correctly based on the application requirements and in accordance with applicable codes and standards.
- b) Was installed in accordance with applicable codes, standards, and the manufacturer's requirements.
- c) Has been correctly operated and maintained since its installation in accordance with applicable codes, standards, and the manufacturer's requirements.

This guide assumes these conditions to be true, which is the basis for the information in this guide. This guide is further based on the premise that, should any of these conditions prove to be false or absent, the information contained herein cannot be applied as stated.

1.4 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall equals is required to*).^{9, 10}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should equals is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may equals is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can equals is able to*).

2. Normative references

The following documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). The ANCE, CSA 22.2, and UL documents are specific to LV motor control design, manufacturing, and testing. CSA Z462, NFPA, and IEEE Std 1584 are often referred to as having significant influence on how LV MCC may be applied, installed, and used. Because these documents influence installers and users, it is believed that system designers and specifiers should be familiar with these standards as well. Hence, all these documents are believed to be particularly valuable to users of this IEEE guide. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

⁹ The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

¹⁰ The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

CANENA Tri-national standards (these three standards are identical, except for language):

- ANCE NMX-J-353-ANCE, Motor control centers—Specifications and test methods.
- CSA 22.2 No. 254, Motor control centres.¹¹
- UL 845, Motor control centers.¹²

CSA Z462, Standard for Electrical Safety in the Workplace.

IEEE Std 1584™-2018, IEEE Guide for Performing Arc Flash Hazard Calculations.^{13, 14}

NFPA 70, National Electrical Code® (NEC®).¹⁵

NFPA 70E, Electrical Safety for Employee Workplaces.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹⁶

arc flash: An electrical explosion caused by vaporizing metal, and characterized by a plasma ball, extreme heat and pressure, loud noise, bright light, molten metal splatter, and smoke. This term is commonly used to identify the hazard to human life caused by an electrical arc.

arc flash boundary: A distance from an arc flash hazard where the calculated incident energy is 5 J/cm² (1.2 cal/cm²), when plotted encircling the arc flash hazard, inside of which additional arc flash risk control, such as personal protective equipment (PPE) is required.

NOTE—A second-degree burn is possible by an exposure of unprotected skin to an electric arc flash above the incident energy level of 5 J/cm² (1.2 cal/cm²).^{17, 18}

current-limiting overcurrent device: A device that, when interrupting currents in its current-limiting range, reduces the peak current, and consequently the effective root mean square (RMS) current and let-through energy flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.¹⁹

current-limiting range: The prospective fault current range over which a current-limiting overcurrent device will reduce the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

electrically safe work condition: A state achieved when potentially energized electrical conductors or circuit parts have been disconnected from other energized parts and sources, have been suitably locked and

¹¹ CSA publications are available from the Canadian Standards Association (<https://www.csa.ca/>).

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¹⁶ *IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

¹⁷ See NFPA 70E-2024 for exact text.

¹⁸ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

¹⁹ Adapted from definition found in NFPA 70-2023, article 100.

tagged in accordance with established standards and accepted workplace practices, verified to ensure the absence of voltage during the course of the expected work task and while the locks are in place, and grounded if determined necessary during the risk analysis.²⁰

finger-safe: Energized terminals or parts that cannot be contacted by an IEC articulated probe that is shown in Figure 10 of UL 845.

motor control center (MCC): 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. These units are mounted one above the other in the vertical sections. These 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 connection, or by suitable wiring.²¹

overcurrent protective device (OCPD): A fuse or circuit breaker that interrupts current flow upon current exceeding a combined magnitude and time threshold.

qualified person: One who has skills and knowledge related to the construction and operation of the electrical equipment and installations, and has received safety training to recognize and avoid the hazards involved.²²

short-circuit protective device (SCPD): A device that may not provide protection from overloads or low-level ground faults, such as a circuit breaker with only an instantaneous trip; sometimes referred to as a motor circuit protector (MCP).

stab: Part of a self-coupling separable contact assembly provided to connect and disconnect the main circuit(s) between a plug-in motor control center unit and a motor control center vertical section, or any modular device from the bus assembly in other electrical equipment.

zone selective interlocking (ZSI): A method used to improve the response of protective devices in the event of a fault by allowing line-side devices to react faster to faults within their zone of protection while maintaining selectivity for faults that occur within the zone of protection of the load-side device. ZSI utilizes a signal between a load-side overcurrent protective device and the line-side protective devices to indicate that the load-side device has sensed and is reacting to an overcurrent condition. The signal is used by line-side devices to alter a corresponding protective characteristic to a slower response to allow the signaling device to clear the fault without sacrificing selectivity.

3.2 Acronyms and abbreviations

ANCE	Asociación Nacional de Normalización y Certificación del Sector Electric (National Association for Standardization and Certification of Electrical Sector; Mexico)
CANENA	Consejo de Armonización de Normas Electrotécnicas de las Naciones en las Américas (Council for Harmonization of Electrotechnical Standards of the Nations in the Americas)
CSA	Canadian Standards Association
DCS	distributed control system
ERMS	energy reducing maintenance switch (NEC)

²⁰ See NFPA 70E-2024 for exact text.

²¹ From NEMA ICS-18-2001, now an obsolete document; a similar definition is in UL 845.

²² See NFPA 70E-2024 for exact text.