NECA 420

Standard for Fuse Applications

ANSI Recirculation Draft

~~August~~ September 2024

National Electrical Installation Standards and *NEIS*
are trademarks of the National Electrical Contractors Association

Table of Contents

(This foreword is not a part of the Standard)

Foreword

National Electrical Installation Standards™ (*NEIS™*) are designed to improve communication among specifiers, purchasers, and suppliers of electrical construction services. They define a minimum baseline of quality and workmanship for installing electrical products and systems. *NEIS*™ are intended to be referenced in contract documents for electrical construction projects. The following language is recommended:

> Low-voltage, medium-voltage, and high-voltage fuses shall be installed in accordance with NECA 420-2XXX, *Standard for Fuse Applications (ANSI)*.

Use of *NEIS*™ is voluntary, and the National Electrical Contractors Association (NECA) assumes no obligation or liability to users of this publication. Existence of a standard shall not preclude any member or non-member of NECA from specifying or using alternate installation methods permitted by applicable regulations.

This publication is intended to comply with the National Electrical Code (NEC). Because they are quality Standards, NEIS may in some instances go beyond the minimum safety requirements of the NEC. It is the responsibility of users of this publication to comply with State and local electrical Codes and Federal and State OSHA safety regulations as well as follow manufacturer instructions when installing electrical products and systems.

Suggestions for revisions and improvements to this Standard are welcome. They should be addressed to:

NECA Standards & Safety
3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814
(301) 657-3110
(301) 215-4500 Fax
www.neca-neis.org
neis@necanet.org

To purchase National Electrical Installation Standards, contact the NECA Order Desk at (301) 215-4504 tel, (301) 215-4500 fax, or orderdesk@necanet.org. NEIS can also be purchased in .pdf download format at www.neca-neis.org/standards.

1. Scope

1.1 Products and Applications Included

This Standard describes application and installation practices and procedures for low-, medium-, and high-voltage fuses. This publication applies to all classifications of fuses used for overcurrent protection of distribution, utilization, and control equipment used for power, heating, and lighting loads for commercial, institutional, and industrial use in nonhazardous indoor and outdoor locations.

It also covers periodic routine maintenance and troubleshooting procedures for fuses, and special procedures used after adverse operating conditions, such as overcurrents, ground-faults, or exposure to water or other liquids.

1.2 Products and Applications Excluded

This Standard does not apply to electronically actuated fuses.

This Standard does not include fuses rated over 1000V with the exception of fuses applied to transformers with windings rated over 1000V. See Section 4.7.

1.3 Regulatory and Other Requirements

All information in this publication is intended to conform to the National Electrical Code (ANSI/NFPA 70). Workers shall follow the NEC, applicable State and local Codes, manufacturer instructions, and contract documents when installing electrical equipment and systems.

Only qualified persons as defined in the NEC familiar with the construction, installation, and operation of fuses shall perform the technical work described in this publication. Administrative functions such as receiving, handling, and storing fuses and other tasks shall be performed under the supervision of a qualified person. All work shall be performed in accordance with NFPA 70E, Standard for Electrical Safety in the Workplace.

General requirements for installing electrical products and systems are described in NECA 1, Standard Practices for Good Workmanship in Electrical Construction (ANSI). Other NEIS provide additional guidance for installing particular types of electrical products and systems. A complete list of NEIS is provided in Annex B.

1.4 Mandatory Requirements, Permissive Requirements, Quality and Performance Recommendations, Explanatory Material, and Informative Annexes

Mandatory requirements in manufacturer instructions, Codes, or other mandatory Standards that may or may not be adopted into law are those that identify actions that are specifically required or prohibited and are characterized in this Standard by the use of the terms “must” or “must not,” “shall” or “shall not,” or “may not,” or “are not permitted,” or “are required,” or by the use of positive phrasing of mandatory requirements. Examples of mandatory requirements may equally take the form of, “equipment must be protected…,” “equipment shall be protected…,” or “protect equipment…,” with the latter interpreted (understood) as “(it is necessary to) protect equipment…”

Permissive requirements of manufacturer instructions, Codes, or other mandatory Standards that may or may not be adopted into law are those that identify actions that are allowed but not required or are normally used to describe options or alternative means and methods and are characterized in this Standard by the use of the terms “may,” or “are permitted,” or “are not required.”

Quality and performance instructions identify actions that are recommended or not recommended to improve the overall quality or performance of the installation and are characterized in this Standard by the use of the terms “should” or “should not.”

Explanatory material, such as references to other Codes, Standards, documents, references to related sections of this Standard, information related to another Code, Standard, or document, and supplemental application and design information and data, is included throughout this Standard to expand the understanding of mandatory requirements, permissive requirements, and quality and performance instructions. Such explanatory material is included for information only and is identified by the use of the term “NOTE,” or by the use of italicized text.

Non-mandatory information and other reference Standards or documents relative to the application and use of materials, equipment, and systems covered by this Standard are provided in informative annexes. Informative annexes are not part of the enforceable requirements of this Standard but are included for information purposes only.

2. Definitions

NOTE: The following terms are used in this Standard. The definitions below apply only to the context in which the terms are used in this Standard.

Ampacity. The maximum current, in Amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Ampere Rating. The continuous-current-carrying capacity of a fuse under defined laboratory conditions. The Ampere rating is marked on each fuse.

Available Fault Current. The maximum short circuit current that can flow in a given circuit.

Cable Protector (Cable Limiter). A fuse with characteristics designed to protect cables against fault damage, having a variety of unique mounting terminals.

Contacts. The external live part of the fuse that provide continuity between the fuse and the balance of the circuit; also referred to as ferrules, blades, or terminals.

Continuous Load. A load where the maximum current is expected to continue for 3 hours or more.

Coordination, Selective (Selective Coordination). Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents.

Current-Limiting Fuse. A fuse that limits both the magnitude and duration of current flow under short circuit conditions within its current-limiting range.

Current-Limiting Range. The range of short circuit currents that a fuse will clear in less than a ½ cycle and limit the potential magnitude of current flowing. The current-limiting range is from the threshold current to the maximum interrupting rating.

Dual Element Fuse. A term describing fuse element construction utilizing two current-responsive elements in series, one for overload conditions and one for short circuit conditions, typically used to achieve time delay characteristics.

Element. A calibrated conductor inside a fuse that melts when subjected to excessive current. The element is enclosed by the fuse body and usually surrounded by an arc-quenching medium such as silica sand. The element is sometimes referred to as a link.

Fault. An unintentional connection of a power system conductor, often resulting in an abnormally high flow of current. Faults typically produce higher overcurrent than do overloads, depending upon the fault impedance. During a fault, current flows outside its normal path. See Short Circuit.

Fault Current. The amount of current flowing in a faulted circuit.

- **Bolted Fault**. The amount of current flowing if all current-carrying conductors were bolted together, creating essentially a zero-impedance connection. *NOTE: This is the highest fault current possible in a circuit. This value is used to select the proper interrupting rating for overcurrent protective devices and short circuit current ratings for system components*.
- **Arcing Fault**. The amount of current that flows through the air in the form of arcs through plasma. These arcs may occur between conductors or between one or more conductors and a grounded part. *NOTE: The arcing fault current can vary depending upon the type of arcing fault and circuit characteristics. The arcing fault current value is used in the calculation of incident energy which then determines the level of personal protective equipment (PPE) used for the protection of personnel*.

Fuse. An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it. *NOTE: A fuse comprises all of the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit*.

- **Bolt-in Fuse**. A fuse intended to be bolted directly to bus bars, contact pads, or fuse blocks.
- **Cartridge Fuse**. A fuse with a tubular body having a terminal on each end and a current-responsive element (link) inside.
- **Class CC Fuse**. A small, current-limiting rejection type fuse rated 0-30A, 600V, with an interrupting rating of 200,000A.
- **Class CD Fuse**. A small, current-limiting rejection type fuse rated 31–60A, 600V, with an interrupting rating of 200,000A.
- **Class CF Fuse**. A current-limiting rejection type fuse rated 0-100A, 600V, with an interrupting rating of 300,000A. Class CF fuses, when utilized with fuse blocks or switches designed for Class CF fuses, are finger safe.
- **Class G Fuse**. A small current-limiting rejection type fuse that is available in four physical sizes: 0-15A, 20A, 25-30A, and 35-60A, rated 600V up to 20A, and 480V for 25-60A, with a 100,000A interrupting rating.

- **Class H Fuse**. A 250V or 600V nonrejection fuse, renewable or nonrenewable, rated up to 600A with a 10,000A interrupting rating. *Note: Renewable Class H fuses are not permitted for new installations in accordance with the NEC.*
- **Class J Fuse**. A 600V current-limiting rejection type fuse rated up to 600A with up to a 300,000A interrupting rating.
- **Class K Fuse**. A 250V or 600V nonrejection fuse rated up to 600A with an interrupting rating of 50,000A, 100,000A or 200,000A, having three sub-classes K1, K5, and K9 each meeting different specific Ip and I2t limits.
- **Class L Fuse**. A 600V bolt-in, current-limiting rejection type fuse rated 100-6000A with up to a 300,000A interrupting rating.
- **Class R Fuse**. A 250V or 600V current-limiting rejection type fuse up to 600A with up to a 300,000A interrupting rating.
- **Class T Fuse**. Small 300V or 600V current-limiting rejection type fuse rated up to 1200A, with a 200,000A interrupting rating.
- **Expulsion Fuse**. A vented fuse unit in which the expulsion effect of gases produced by the arc and lining of the fuseholder, either alone or aided by a spring, extinguishes the arc.
- **Fast-Acting Fuse**. A fuse with no intentional time-delay.
- **Miniature or Glass Fuses**. A common term describing a group of fuses used for supplementary circuit or component protection, with glass, fiber or ceramic bodies, having dimensions smaller than midget fuses. They are typically 6 mm x 25 mm (1/4 x 1 inch) or smaller. *NOTE: These fuses are used to protect small electronic circuits or components.*
- **Micro Fuse**. A common term describing a group of the smallest size fuses used for supplementary circuit or component protection, typically mounted on or used to protect printed circuit boards or small electronic components.
- **Midget Fuse**. A common term describing a group of fuses used for supplementary circuit or component protection, usually having dimensions of 10 mm x 38 mm (13/32 x 1-1/2 in.).
- **Non-Vented Power Fuse**. A fuse without intentional provisions for the escape of arc gases, liquids, or solid particles to the atmosphere during circuit interruption.
- **Plug Fuse**. A residential type of fuse with a threaded base, such as an Edison-base or Type S tamperproof base, rated 0-30A, 125V.
- **Power Fuse**. A vented, non-vented, or controlled vented fuse unit in which the arc is extinguished by being drawn through solid material, granular material, or liquid, either alone or aided by a spring.
- **Rejection Fuse**. A current-limiting fuse with a high interrupting rating and with unique dimensions or mounting provisions, that, when utilized with a rejection fuseholder or switch, prevents insertion of a different class of fuse.
- **Renewable Fuse**. A fuse that can be restored for service by the replacement of its element.
- **Special Purpose Fuse**. Fuse with special performance characteristics or ratings intended to protect specific equipment or components under unique or specified conditions, such as a photovoltaic fuse. a semiconductor fuse, or a welder protector.
- **Time-Delay Fuse**. A fuse that carries a specified temporary overload for a minimum specified time without opening. *NOTE: The specified current and time requirements are defined in the UL/CSA/NOM 248 fuse standards*.
- **UL/CSA/ANCE Class Fuse**. General-purpose fuse that complies with industry "class" standards. *NOTE: Qualifying fuses are typically certified by UL, CSA, or ANCE to tri-national fuse standard 248*.
- **Vented Power Fuse**. A fuse with provisions for the escape of arc gases, liquids, or solid particles to the surrounding atmosphere during circuit interruption.

Fuse Block or Fuse Holder. A device consisting of fuse clips, insulators, and terminals designed and intended to hold a fuse and to provide the means to connect it to the electrical circuit.

- **Rejection Fuse Block**. A fuse block that only accepts fuses of a specific UL Class. *NOTE: Rejection is a safety feature intended to prevent the insertion of a fuse with inadequate voltage or interrupting ratings*.

Fuse Clip. A conductive mechanical device for accepting and securing the conductive part of a fuse to an electrical terminal or connection.

Fuse, Electronically Actuated*. An overcurrent protective device that generally consists of a control module that provides current-sensing, electronically derived time-current characteristics, energy to initiate tripping, and in interrupting module that interrupts current when an overcurrent occurs. Such fuses may or may not operate in current-limiting fashion, depending on the type of control selected.

I2t (Ampere Squared Seconds). A measure of the thermal energy associated with current flow. I2t is equal to (IRMS)2 x t, where t is the duration of current flow in seconds.

- **Clearing I2t**. The total I2t passed by a fuse as the fuse clears a fault, with t being equal to the time elapsed, in seconds, from the initiation of the fault to the instant the fault has been cleared.
- **Melting I2t**. The I2t required to melt the fuse element.

Interrupting Rating. The maximum current a fuse can safely interrupt. Abbreviated I.R. *NOTE: Some fuses may also have a "minimum interrupting rating," which is the minimum current a fuse can safely interrupt*.

kiloAmperes. 1,000A. Abbreviated kA.

Limiter or Back-Up Fuse. A fuse intended to provide short circuit protection only.

Noncontinuous Load. A load where the maximum current is expected to continue for less than 3 hours.

Overcurrent. Any current in excess of conductor ampacity or equipment continuous current rating which include overloads, short circuits, faults, or ground faults.

Overload. Operation of equipment in excess of normal, full-loaded rating or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. An overload current flows within the normal current path.

Peak Let-Thru Current (Ip). The maximum peak instantaneous current passed by a current-limiting fuse when clearing a fault within its current-limiting range.

Photovoltaic Fuse (PV fuse). A direct-current (DC) non-current-limiting non-renewable cartridge fuse having a 10,000A interrupting rating with special performance characteristics used for the protection of strings or arrays of Photovoltaic (PV) cells and the associated wiring to provide protection against overloads or low-level short circuits. PV fuses are rated up to 1500VDC and are marked with the letters "PV," "gPV," or the words "Photovoltaic Fuse."

RMS Let-Thru Current (IRMS). The maximum rms current passed by a current-limiting fuse when clearing a fault within its current-limiting range.

Semiconductor Fuse. An extremely fast-acting fuse intended for the protection of power semiconductors. Sometimes referred to as a rectifier, high-speed, or ultra-fast fuse.

Short Circuit. Excessive current flow caused by insulation breakdown, accidental contact with live parts, defective components, or wiring errors. A short circuit is an overcurrent that flows outside of its normal path.

Short Circuit Current Rating. The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

Threshold Current. The current level at which a fuse becomes current limiting.

Voltage Rating. The maximum voltage at which a fuse is designed to operate. *NOTE: Fuse voltage ratings are AC unless the fuse is specifically labeled DC.*

Welder Protector (Limiter). A fuse with special characteristics to withstand the heavy inrush current demands of an electric welder without operating, and to protect the electric welder in case of short circuit.

* Not included as part of the Standard.

3. Application Data for Fuses

For applications of fuses rated greater than 1000V, follow manufacturer recommendations for the types and ratings of fuses to protect specific equipment, and follow contract documents, drawings and specifications, for the types and ratings of fuses to protect conductors, equipment, circuits, and systems.

3.1 Fuse Types and Classifications

Underwriters Laboratories (UL), the Canadian Standards Association (CSA), and the Association of Normalization and Certification (ANCE) classify low voltage (600VAC and less) fuses into main classes, such as CC, G, H, R, J, T, L, K, plug, C, CA, CB, CD, CF, PV, Semiconductor, or Supplemental. Fuses suitable for branch circuit protection include class CC, G, H, R, J, T, L, K, plug, C, CA, CB, ~~and~~ CD, and CF. Semiconductor and Supplemental fuses are typically used only on the load side of a branch circuit overcurrent protective device to protect sensitive individual components of equipment from damage.

Each class is defined by its characteristics, size, and function. Low-voltage cartridge fuses are further classified as either renewable, nonrenewable, or plug type. Cartridge fuses have ferrules, blades, or bolt-in methods of installation.

Branch circuit fuses are generally intended for and suitable for supplementary, branch circuit, feeder, and service entrance overcurrent protection in accordance with the NEC.

3.2 Fuse Ratings

Fuses are rated by their class type, current rating, voltage rating, time-delay characteristics, current-limiting ability, and interrupting rating. Class, type, current, and voltage ratings have unique physical dimensions, and fuses are typically not interchangeable.

3.2.1 Voltage Ratings

Although some low-voltage fuses are designed for up to 1500V, most low-voltage cartridge fuses are rated for either 250VAC, 300VAC, or 600VAC. Fuses can be used at voltages lower than their marked rating, but fuses must not be used at voltages higher than their rating. See Section 3.2.4 for fuse ratings for DC applications.

3.2.2 Current Ratings

Low-voltage cartridge fuses used as branch circuit, feeder, or service entrance overcurrent protection in industrial and commercial applications are generally available in ratings from 1/10A through 6000A.

Each fuse class covers a range of current ratings up to its maximum rating. For example, Class R fuses are available through 600A and Class L fuses cover ratings from 100A through 6000A. The current rating of the fuse selected will vary depending on the application.

For most applications, the normal full load circuit current should not exceed 80% of the fuse marked current rating.

3.2.3 Interrupting Ratings

Each fuse has an interrupting rating for its particular type and size. Older style class H fuses have an interrupting rating of 10,000A, while modern current-limiting class R, J, and L fuses have an interrupting rating up to 300,000A. The interrupting rating of the fuse selected must always be greater than or equal to the maximum available fault current of the circuit it is intended to protect.

3.2.4 DC Ratings

DC ratings are optional for most fuse classes. There are, however, different interrupting ratings for each DC voltage rating dependent upon the circuit time constant. Because maximum DC voltage and interrupting ratings vary, consult the manufacturer for guidance for specific fuse applications.

3.3 Current-Limiting Fuses

The use of current-limiting fuses reduces electrical hazards such as arc-flash and can increase the short circuit current (withstand) rating of equipment that uses components with lower short circuit current (withstand) ratings.

In accordance with NEC Section 240.2, a current-limiting fuse operating in its current-limiting range must limit the maximum peak current to a value less than the peak current possible if the fuse were replaced by a non-current-limiting overcurrent protective device or solid conductor having the same impedance.

Current-limiting fuses must meet maximum peak current values and I2t (Ampere-squared seconds) values for each type and class of fuse at various levels of fault currents (50kA, 100kA, 200kA, and 300kA).

4. Sizing and Selection

4.1 Main, Feeder, and Branch Circuits

In general, fuses are sized not greater than 125% of the continuous load plus 100% of the non-continuous load. Larger sizing may be permitted for motors and transformers. See Sections 4.2 and 4.7. Specific fuse sizing for branch circuits is addressed in NEC Section 210.20, for feeders in NEC Section 215.3, and for services in NEC Section 230.90.

4.1.1 Interrupting Ratings

The interrupting rating of a fuse must be equal to or greater than the available fault current at the line side of the fuse at nominal circuit voltage, in accordance with NEC Section 110.9. An interrupting rating equal to or greater than the available fault current indicates that the fuse is able to safely open under short circuit conditions. The NEC prohibits the use of overcurrent protective devices with inadequate interrupting ratings.

4.1.2 Short Circuit Current Ratings

The short circuit current rating of electrical equipment is based on the short circuit current rating of its components as well as the interrupting rating of the circuit overcurrent protective devices.

Electrical system components are required to be protected within their marked short circuit current rating in accordance with NEC Section 110.10 in general, and in accordance with NEC Section 409.22 for industrial control panels and NEC Section 670.5 for industrial machinery.

Overcurrent protective devices and equipment must be selected and coordinated to clear a fault without extensive damage to electrical components in the circuit. When required, current-limiting fuses can be used for this purpose.

4.2 Motor Protection

4.2.1 Motor and branch circuit overload protection

NEC Article 430 Part III specifies motor and branch-circuit overload protection. For continuous duty motors, NEC Section 430.32 specifies the maximum ratings of fuses and overload protective devices for motor and branch circuit overload protection.

When utilized without overload relays, dual element time-delay fuses are typically sized at no more than 115% of a continuous-duty motor's full-load current for a 1.0 service factor motor and no more than 125% of a continuous-duty motor's full-load current for a 1.15 service factor motor. The motor's full-load current is based on the manufacturer nameplate data, or, when possible, the actual motor running current for lightly loaded motors.

When the sensing element or sizing of the overload device is not sufficient to start the motor or to carry the load, higher size sensing elements are permitted to be used in accordance with NEC Section 430.32(C).

When fuses are used for overload protection, NEC Section 430.36 requires fuses in each conductor of a three-phase, three-wire, AC motor circuit, including three-phase, three-wire, corner grounded (grounded B Phase) applications.

4.2.2 Motor branch circuit short circuit protection

NEC Section 430.52 and NEC Table 430.52(C)(1) specify the maximum ratings of fuses for individual motor branch circuit short circuit protection. In general, dual element time-delay fuses can be sized close to motor full-load currents, which can also provide motor overload protection and single-phase protection in addition to motor branch circuit short circuit protection.

The type or class of fuse can affect the selection of current rating of the fuse. Use NEC Tables 430.248 through 430.250 when sizing AC fuses for branch circuit, short circuit, and ground fault protection. These tables provide typical full-load current values for different types of motors, horsepower ratings, and voltages.

4.2.3 Semiconductor fuses

NEC Section 430.52(C)(5) permits the use of high-speed semiconductor fuses for the motor branch circuit short circuit protection of power electronic devices, associated electromechanical devices, such as bypass contactors and isolation contactors, and conductors in a solid-state motor control system if the marking for replacement fuses is provided adjacent to the fuses.

4.2.4 Group motor protection

NEC Section 430.53 permits the use of a single branch circuit to supply two or more motors or one or more motors and other loads, provided other requirements found in this NEC section are met. Dual element time-delay fuses are recommended to protect these circuits when fuses are required.

4.2.5 Motor branch circuit overload, short circuit, and ground-fault protection

NEC Section 430.55 permits motor branch-circuit overload, short circuit, and ground-fault protection required in NEC Section 430.52 to be combined in a single protective device where the rating or setting of the device provides the overload protection required in NEC Section 430.32.

Properly sized dual element time delay current-limiting fuses provide the maximum overload ratings permitted in NEC Section 430.32, are able to withstand normal motor-starting currents and temporary surges without nuisance operation, and respond quickly to short circuits and ground faults.

4.2.6 Motor control circuit protection

NEC Section 430.72 and NEC Table 430.72(B)(2) specify the maximum ratings of fuses used to protect motor control circuits and permits different levels of protection based on whether a control circuit transformer is used or whether the circuit is line voltage and the size and location of control circuit wiring.

4.3 Drives, Rectifiers, and Inverters

Fuses used to protect drives, rectifiers, and inverters must operate very rapidly to protect the internal junctions of power semiconductors or to isolate a damaged semiconductor, especially in the case of short circuits. Special fuses offering this high level of protection are known as semi-conductor fuses or high-speed fuses. In general, most standard general-purpose current-limiting fuses are not fast enough to provide an adequate level of protection for this type of equipment and must not be used as a substitute for semiconductor fuses.

Typically, semiconductor fuses are selected and sized by the manufacturer of the drive, rectifier, inverter, or power electronic system to provide only short circuit protection, as overload protection is usually provided by other devices in the circuit. Semiconductor fuses are equipment specific and are not sized and applied in the field.

Consult the equipment manufacturer to identify the proper fuse type and rating. Semiconductor fuses must be replaced with the same type and rating of fuse that was originally installed. Failure to use the manufacturer recommended fuse type and rating will likely result in damage to the equipment, may result in serious personal injury or death, and will likely void the equipment manufacturer warranty.

4.4 Series-Rated Circuit Breakers

A fuse and circuit breaker series-rated combination, permitted in accordance with NEC Section 240.86, is a specific combination of fuses and circuit breakers that can be applied at available short circuit current levels above the interrupting rating of the load-side circuit breaker, but not above the interrupting rating of the line-side fuses.

In accordance with NEC Section 240.86(A) for existing installations, a licensed professional engineer engaged primarily in the design or maintenance of electrical installations must select the series rated combination devices. For calculated applications, the engineer must ensure that the downstream circuit breaker(s) that are part of the series rated combination remain passive during the interruption period of the line side fully rated current-limiting device.

The series-rated combination is required to be documented by the engineer for use by the designer, installer, inspector, and user. In accordance with NEC Section 110.22(B), such equipment must be legibly marked in the field as directed by the engineer to indicate that the equipment has been applied with a series combination rating and that identified replacement components are required. Where the upstream device protecting the downstream circuit breaker is in a different enclosure, both enclosures are required to be marked in accordance with NEC Section 110.22.

In accordance with NEC Section 240.86(B) for new installations, the manufacturer of equipment, such as switchboards and panelboards, must test and mark the end use equipment with the details of the tested series rated combination devices.

NEC Section 240.86(C) requires that series rated combination devices shall not be used where motor circuits are connected between the higher-rated overcurrent protection device of a series-rated combination and the lower-rated circuit breaker or where the sum of motor full load currents exceeds 1% of the load-side circuit breaker's individual interrupting rating.

In accordance with NEC Section 110.22(C), such equipment must be legibly marked in the field to indicate that the equipment has been applied with a series combination rating and that identified replacement components are required. Where the upstream device protecting the downstream circuit breaker is in a different enclosure, both enclosures are required to be marked in accordance with NEC Section 110.22.

4.5 Selective Coordination

Use fuse manufacturer selective coordination ratio tables and fuse or circuit breaker time-current characteristic curves to achieve selective coordination. See NECA 700 for additional information.

Selective coordination may require specific types and ratings of fuses and types, ratings, and settings of circuit breakers and relays. Do not use series-rated combination systems when selective coordination is required.

Consult the automatic transfer switch manufacturer for specific fuse types and ratings when installing fuses for short circuit protection for automatic transfer switches when selective coordination is required.

Selective coordination is required in the NEC for the following applications:

- NEC Section 517.31(G) for the essential electrical system of Healthcare Facilities. *NOTE: Coordination is only required for faults lasting more than 0.1 seconds.*
- NEC Section 620.62 where more than one driving machine disconnecting means is supplied by the same source for elevators.
- NEC Section 645.27 for critical operations data systems.
- NEC Section 695.3(C)(3) for fire pumps.
- NEC Section 700.32 for emergency systems.
- NEC Section 701.32 for legally required standby systems.
- NEC Section 708.54 for critical operations power systems (COPS).

4.6 Capacitors

In accordance with NEC Section 460.8(B), an overcurrent protective device is required to be provided in each ungrounded conductor of each capacitor bank with the exception of capacitors connected on the load side of a motor overload protective device. The rating or setting of capacitor overcurrent protective devices must be as low as practicable.

Fuses used to protect capacitor banks provide reasonable protection if the capacitors are the metallized film, self-healing type. Other types of capacitors should be fused individually. Individual capacitor fusing is especially important in large banks of parallel capacitors. When individual fusing is not provided, parallel connected capacitors can discharge into a faulted capacitor that remains connected to the system, which can result in the violent rupture of the case of the faulted capacitor.

Consult the capacitor manufacturer for recommendations for fuse placement locations when capacitors are installed in banks comprised of both series and parallel combinations to prevent overvoltages and damage to capacitors in the network caused by the opening of improperly placed fuses.

Size fuses for capacitor applications in accordance with manufacturer recommendations. For capacitor applications of 600V or less in general, a non-time-delay Class J or Class RK1 fuse is used and sized at 185% to 220% of the capacitor current rating. For applications over 600V in general, fuses are typically sized at 165% to 200% of the capacitor current rating. Ensure that fuses have a voltage rating equal to or greater than the nominal system voltage for capacitor applications. Many fuse manufacturers offer specially designed fuses for capacitor applications. Replace such fuses only with fuses of the same type and rating.

4.7 Transformer Protection

4.7.1 General

When voltage is switched on to energize a transformer, the transformer core typically saturates. This results in a large primary inrush current, which is greatest during the first half-cycle and becomes progressively lower over the next several cycles until the transformer reaches its normal magnetizing current.

To accommodate this inrush current, fuses must be selected with opening characteristics that can withstand a minimum of 12 times the transformer rated primary current for 0.1 second, and 25 times the transformer rated primary current for 0.01 second without operating. *NOTE: Some small control type transformers may have substantially greater inrush currents. For these applications, the fuse may have to be selected to withstand up to 45 times (or greater) transformer primary rated current for 0.01 second.*

4.7.2 Transformers with primary rated over 1000V, nominal

Transformers with primary windings rated over 1000V, nominal, must have overcurrent protection in accordance with NEC Section 450.3(A) and NEC Table 450.3(A). When fuses are provided for transformer overcurrent protection, the rules are summarized below:

Table 1. Maximum Rating of Fuse Protection for Transformers Over 1000V (as a Percentage of Transformer Rated Current)

<table>
<tr><th rowspan="3">Location Limitations</th><th rowspan="3">Transformer Rated Impedance</th><th rowspan="2">Primary Protection Over 1000V</th><th colspan="2">Secondary Protection[1]</th></tr>
<tr><th>Over 1000V</th><th>1000V or less</th></tr>
<tr><th>Fuse Rating</th><th>Fuse Rating</th><th>Fuse Rating</th></tr>
<tr><td rowspan="2">Any Location</td><td>Not more than 6%</td><td>300%[2]</td><td>250%[2]</td><td>125%[2]</td></tr>
<tr><td>More than 6% and not more than 10%</td><td>300%[2]</td><td>225%[2]</td><td>125%[2]</td></tr>
<tr><td rowspan="3">Supervised Locations Only[3]</td><td>Any</td><td>250%[2]</td><td>Not required</td><td>Not required</td></tr>
<tr><td>Not more than 6%</td><td>300%</td><td>250%[4]</td><td>250%[4]</td></tr>
<tr><td>More than 6% and not more than 10%</td><td>300%</td><td>225%[4]</td><td>250%[4]</td></tr>
</table>

Table Notes:

1 Where secondary overcurrent protection is required, the secondary overcurrent device must be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are used, the total of all device ratings must not exceed the allowed value of a single overcurrent device. If both circuit breakers and fuses are used as the overcurrent device, the total of the device ratings must not exceed that allowed for fuses.

2 Where the fuse rating does not correspond to a standard rating, the next higher standard rating for fuses 1000V and below may be used, or the next commercially available rating for fuses above 1000V may be used.

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Transformers equipped with coordinated thermal protection by the manufacturer are permitted to have separate secondary protection omitted.

4.7.3 Transformers with primary rated 1000V, nominal, and less

Transformers with primary windings rated 1000V, nominal, and less must have overcurrent protection in accordance with NEC Section 450.3(B) and NEC Table 450.3(B) unless the transformer is installed as a motor control circuit transformer in accordance with NEC Section 430.72(C)(1) through (5). When fuses are provided for transformer overcurrent protection, the rules are summarized below:

Table 2. Maximum Rating of Fuse Protection for Transformers 1000V, nominal, and less (as a Percentage of Transformer Rated Current)

Protection Method	Primary Protection			Secondary Protection[1]	
	Currents of 9A or more	Currents less than 9A	Currents less than 2A	Currents of 9A or more	Currents less than 9A
Primary Protection only	125%[2]	167%	300%	Not required	Not required
Primary and Secondary Protection	250%[3]	250%[3]	250%[3]	125%[2]	167%

Table Notes:

1 Where secondary overcurrent protection is required, the secondary overcurrent device is permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are used, the total of all the device ratings must not exceed the allowed value of a single overcurrent device.

2 Where 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, a higher rating that does not exceed the next higher standard rating may be used.

3 Transformers equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current are permitted to have primary fuses rated at not more than 600% of the rated current of the transformer for transformers having not more than 6% impedance and at not more than 400% of the rated current of the transformer for transformers having more than 6% impedance but not more than 10% impedance.

4.8 Fire Pumps

NEC Section 695.4 requires that fuses used for overcurrent protection for individual sources to fire pumps be rated to carry indefinitely the sum of the locked rotor currents of the largest fire pump motor and the full-load current of all of the other pump motors and accessory equipment.

Where the locked-rotor current value does not correspond to a standard overcurrent device size, the next standard overcurrent device size shall be used in accordance with NEC Section 240.6. The requirement to carry the locked-rotor currents indefinitely do not apply to conductors or devices other than overcurrent devices in the fire pump motor circuit(s).

4.9 Welder Protection

4.9.1 General

NEC Section 630.12 requires overcurrent protection for arc welders and the conductors that supply arc welders. Similarly, NEC Section 630.32 requires overcurrent protection for resistance welders and the conductors that supply resistance welders. Where the values of overcurrent protection do not correspond to standard ampere ratings provided in NEC Section 240.6 or where the rating specified results in unnecessary opening of the overcurrent protective device, the next higher standard rating is permitted.

In general, the welder nameplate provides the rated current information necessary to select supply conductors and overcurrent protection devices. When systems have a relatively high available fault current and a requirement for selective coordination, current-limiting fuses are recommended for overcurrent protection for electric welders, such as an appropriately sized time-delay RK5 fuse.

Fuses that provide overcurrent protection for AC transformer, DC rectifier, and motor-generator electric arc welders shall be rated not more than 200% of the welder I1max nameplate current rating, if given, or not more than 200% of the rated primary current of the welder in accordance with NEC Section 630.12(A). Where the welder supply conductors have overcurrent protection that satisfies the welder overcurrent protection requirements, a separate overcurrent device is not required for the welder.

Fuses that provide overcurrent protection for resistance welders shall be rated not more than 300% of the rated primary current of the welder in accordance with NEC Section 630.32(A). Where the welder supply conductors have overcurrent protection that satisfies the welder overcurrent protection requirements, a separate overcurrent device is not required for the welder.

4.9.2 Welder protectors (limiters)

Specialty fuses known as welder protectors may be required for severe duty welder applications, such as high ambient temperatures, high weld cycle rates, and exceptionally high available fault currents.

Welder protectors are intended to only provide short circuit protection and do not provide thermal protection or overload protection of welders or supply conductors. Thermal protection and overload protection must be provided by one or more other protective devices in addition to welder protectors for welder applications. Consult the welder and welder protector manufacturers for recommendations.

Where used, only replace welder protectors with devices of the same type and ratings.

5. Design Considerations

5.1 System Studies

As with all electrical equipment, conductors and components, fuses must be applied within their various ratings, including interrupting rating and ampacity. Many of the operating parameters for overcurrent protective devices, such as fuses, are determined by electrical system studies, including a short circuit study, a coordination study (including selective coordination as required in accordance with the NEC), and an arc flash hazard assessment in accordance with the requirements of NFPA 70E, which is depended upon both the short circuit and coordination studies. Therefore, electrical studies must be completed during the detailed design process to ensure that equipment with appropriate ratings is selected for installation.

5.1.1 Short circuit study

A short circuit study is used to calculate the available fault current throughout the electrical system, from the electrical system service point to the branch circuit overcurrent devices. The available fault current is calculated at each point in the system and is then used to select the proper interrupting rating of overcurrent protective devices in accordance with NEC Section 110.9, the proper protection of electrical system components within their ampacity and temperature limitations in accordance with NEC Section 110.10, and the proper application of equipment within marked short circuit current rating (SCCR) in accordance with NEC Section 110.10. See Annex A for additional NEC Sections related to the proper marking of short circuit current rating of specific equipment.

5.1.2 Coordination study

Based on the short circuit study, overcurrent protective devices are selected and applied within their ratings to ensure coordination, where only the closest upstream overcurrent protective device operates to clear the faulted portion of the system, while all unfaulted portions of the system remain in operation.

During the coordination study, overcurrent protective devices and system components are analyzed for coordination as well as to ensure the proper protection of system components, such as conductors, motors, and transformers. The time-current characteristic curves of overcurrent protective devices and equipment damage curves are compared up to the point of the available fault current where the device is located.

An overlap of overcurrent protective device time-current characteristic curves indicates a potential lack of coordination where more than one overcurrent protective device operates simultaneously to remove the faulted portion of the system, which can result in an unnecessary loss of power to unfaulted portions of the system up to and including a facility-wide power outage. Additionally, an overlap of the overcurrent protection device time-current characteristic curves with equipment damage curves indicates that an overcurrent condition may result in potential equipment damage.

Certain equipment and systems are required to achieve selective coordination in accordance with the NEC, where no overlap in overcurrent protective device operation is allowed. See Section 4.5. Also, see NECA 700, Installing Overcurrent Protection to Achieve Selective Coordination (ANSI), for additional information.

5.1.3 Arc flash hazard assessment

NEC Section 110.16 requires that certain equipment be marked to warn qualified persons of potential arc flash hazards. Requirements for the arc flash hazard assessment are found in NFPA 70E Section 130.5 and IEEE 1584, IEEE Guide for Performing Arc-Flash Hazard Calculations.

The arc flash hazard assessment includes a requirement to label electrical equipment with the incident energy available at the equipment in the event of an arcing ground fault, along with the boundaries associated with the equipment and the PPE necessary for personnel exposed to energized components within the equipment, such as when checking for voltage during the lockout/tagout process to positively verify that equipment has been de-energized and locked out.

The arc flash hazard assessment relies on information found in the short circuit study, such as the available fault current at each point in the system, and the coordination study, such as the overcurrent protective device clearing time.

When cartridge fuses rated 1200A or higher are installed, it is also necessary to comply with the arc energy reduction requirements of NECA Section 240.67, including documentation, method to reduce clearing time to 0.07 seconds or less, and performance testing of the system.

5.2 Conductors

5.2.1 Phase and equipment grounding

Conductors sized in accordance with the NEC are typically of sufficient size to withstand all overcurrent conditions without exceeding their temperature limitations while the overcurrent protective device operates to clear the faulted portion of the circuit.

When used and sized in accordance with the NEC, tap conductors may not be adequately protected by non-current-limiting overcurrent devices when high levels of fault current are available, requiring either larger sized tap conductors or the use of current-limiting overcurrent protective devices.

The use of non-current-limiting fuses or circuit breakers may also require larger size equipment grounding conductors to carry higher levels of fault current for the longer duration of time that it takes for non-current-limiting overcurrent devices to operate.

As a design consideration, current-limiting fuses may be used to reduce damaging I2t (Ampere-squared seconds) heating effects, limit the peak current, and allow the use of smaller sized conductors.

5.2.2 Cable limiters

Cable limiters are current-limiting fusible devices designed to attach directly to individual conductors up to 750 kcmil. Cable limiters are selected based on cable size, conductor material, and type of termination. The most common cable limiter design is a bolt-on termination that is crimped directly on the conductor.

The most common applications of cable limiters include service entrance conductors, such as when there are three or more parallel conductors installed per phase, and providing short circuit protection for tap conductors.

Cable limiters provide short circuit protection only and, when properly applied, limit the short circuit current available to the equipment on the load side of the cable limiter. Current-limiting overcurrent device operation may allow the use of equipment with lower short circuit current ratings in accordance with the NEC.

When installed on both ends of conductors in parallel conductor applications, cable limiters can isolate a conductor fault to the individual damaged conductor and permit the remaining conductors to remain in operation.

5.3 Finger-Safe Fuseholders

The use of finger-safe fuseholders and covers reduces the shock hazard and arc flash hazard of the equipment because energized electrical components are electrically insulated and physically isolated from contact with the added benefit of reducing the risk that a conductive tool or part can fall across bare energized components creating an arc fault. *NOTE: Finger safe fuse holders have not been evaluated to be opened under load and are non-load-break devices*.

5.4 Fusible Disconnects

Fusible disconnect switches equipped with current-limiting fuses located within sight of equipment are used in many applications and permit the user to isolate equipment for inspections, testing, maintenance, and repair using proper lockout/tagout procedures.

6. Receiving, Inspection, Handling and Storage

6.1 Receiving and Inspection

Unload fuses carefully, observing all packing label warnings. Follow the manufacturer instructions for proper protection, handling, and storage of fuses.

Upon delivery of equipment and accessories and prior to unloading, visually inspect packaging for physical damage. If damage has occurred, notify the shipper and the manufacturer in writing immediately. Comply with the shipper and manufacturer processes for shipping damage claims. Retain packing materials for storage or return shipment, if necessary.

Compare the fuses received with the bill of materials to verify that the shipment is correct and complete. Verify that fuses received conform to approved submittals and manufacturer quotations. If the shipment is not complete, notify the manufacturer in writing immediately. Comply with the manufacturer process for shortages or incorrect material claims.

6.2 Handling and Storage

Handle fuses carefully. Inspect mishandled fuses for physical damage. Test mishandled fuses for continuity. Replaced damaged fuses with new. Do not install damaged fuses.

Store fuses in a clean, dry space. Protect fuses from dirt, water, debris, and physical damage in accordance with the packing documentation.

7. Installation

7.1 Environmental Conditions

Fuses must be installed in equipment or enclosures that protect the fuses from physical and environmental damage, such as exposure to moisture. Because fuses respond directly to heat, fuses applied in high ambient temperatures may require derating to avoid nuisance opening. Consult the manufacturer for derating requirements for high ambient temperature environments.

7.2 General Installation Requirements

Consult equipment manufacturer installation instructions for information pertaining to equipment specific fuse applications. *NOTE: Some equipment manufacturers provide fuses for their equipment and ship the fuses separately to prevent damage during shipping or storage of the equipment*.

Ensure equipment is de-energized before installing fuses. When necessary, de-energize equipment in accordance with established safety procedures and NFPA 70E lockout procedures.

Verify fuses are of the correct type and ratings in accordance with the project documentation and any labeling of equipment. Where labeled, verify that fuses are equal to or exceed the short circuit current rating of equipment.

Inspect fuses for physical damage and contamination. Test suspect fuses for continuity. Replace damaged fuses with new. Do not install damaged fuses

Verify the proper location of movable fuse clips for the particular class of fuse to be used, if applicable.

Inspect the general condition of the equipment prior to installing fuses. Check that equipment is clean and ready for the installation of fuses. Checking the tension of the fuse clips prior to installing fuses. Do not alter fuses or fuse terminations in any way. Torque bolted connections in accordance with manufacturer instructions. Install fuses after all conductors are terminated.

Replace fuses only with the same type and rating in accordance with manufacturer instructions. Failure to do so could result in serious injury or death to personnel or severe damage to equipment.

To assure proper replacement, label equipment with the appropriate replacement fuse type and rating.

7.3 Fuse Pullers

Use fuse pullers appropriate for the fuses used.

7.4 Spare Fuses

Installing a spare fuse cabinet that contains replacement fuses of the proper types and ratings for the equipment at the installation site is recommended to assist service and maintenance personnel when fuse replacement is necessary.

7.5 Energizing Equipment

Perform final inspections, checks, and testing of equipment prior to energizing. Energize equipment in accordance with manufacturer instructions and established safety procedures.

8. Inspections and Maintenance

Ensure equipment is de-energized before inspecting, testing, removing, or replacing fuses. When necessary, de-energize equipment in accordance with established safety procedures and NFPA 70E lockout procedures.

Replace damaged fuseholders and nonrenewable fuses. Low-and medium-voltage fuseholders and low- and medium-voltage nonrenewable fuses are not permitted to be reconditioned in accordance with the NEC.

8.1 Frequency of Inspections and Maintenance

Consult manufacturer instructions for the frequency of inspections and maintenance of fuses. See NFPA 70B for additional information. Base inspections and maintenance intervals for fuses on the environmental and service conditions of the equipment and the criticality of the loads served, but not less than the frequency of inspections and maintenance recommended by the manufacturer.

8.2 Routine Inspections and Testing

Conduct routine inspections and testing in accordance with the equipment manufacturer recommendations.

Inspect fuses, fuseholders, conductors, and connections for signs of arcing, overheating, physical damage, and contamination. Investigate and correct sources of overheating. Repair or replace damaged components in accordance with manufacturer instructions.

8.3 Periodic Cleaning, Inspection, and Maintenance

Conduct periodic cleaning, inspections, and maintenance in accordance with the equipment manufacturer recommendations.

Inspect fuses, fuse clips, fuse holders, conductors, terminations, and connections for discoloration and evidence of arcing, overheating, poor contact, physical damage, contamination, and corrosion. Investigate and correct sources of overheating. Clean, repair, or replace damaged components in accordance with manufacturer instructions.

Verify equipment fuse clips exert sufficient pressure to maintain good contact. Replace weak or damaged fuse clips.

Remove fuses from equipment and inspect for evidence of deterioration, discoloration, or damage. Replace fuses showing signs of deterioration, discoloration, or damage.

Check fuse and fuse holder contact surfaces. Contact surfaces should be free of corrosion and oxidation. Clean contact surfaces in accordance with manufacturer instructions using approved materials and methods. Reinstall fuses in equipment after cleaning.

Inspect and tighten all connections. Torque connections in accordance with manufacturer instructions, if applicable.

8.4 Inspection, Testing, and Fuse Replacement Following an Overcurrent or Ground-Fault

After an overcurrent or ground-fault, de-energize equipment in accordance with manufacturer instructions and established safety procedures and in accordance with NFPA 70E lockout procedures.

Investigate and correct the cause of the overcurrent or ground-fault. Repair or replace damaged components in accordance with manufacturer instructions.

Remove fuses from equipment, using a fuse puller where possible. Check both indicating and non-indicating fuses for continuity. For bladed-style fuses, test continuity at the fuse blades and not the fuse endcaps.

Reinstall existing fuses that exhibit continuity. Replace failed or opened fuses with fuses of the same types and ratings. Do not alter or modify fuses, fuse holders, clips, or connections to accept incorrect fuses for the equipment.

Energize equipment in accordance with manufacturer instructions and established safety procedures.

8.5 Fuses Sprayed, Splashed, Soaked, or Submersed Under Water

Replace fuses that have come in contact with water or other types of liquids.

8.6 Infrared Scanning

Perform infrared scanning of fuses, fuse clips, fuse holders, conductors, connections, and terminations in accordance with equipment and test equipment manufacturer instructions. Use calibrated infrared scanning equipment. Check loose connections and terminations as possible sources of overheating. Tighten, rework, or replace loose connections and terminations as required.

Verify proper working clearances in accordance with NEC Section 110.26 prior to examining exposed energized components.

8.7 Troubleshooting

Troubleshoot equipment while de-energized. Where not feasible or where it would result in a greater hazard to de-energize equipment during troubleshooting, follow NPFA 70E for safety related work practices for working in close proximity to energized components.

(This annex is not part of the Standard)

Annex A: NEC Requirements for Fuses

Section 110.9 requires that all equipment intended to interrupt current at fault levels must have an interrupting rating at least equal to the available fault current at the line terminals of the equipment.

Section 110.10 requires components to be applied within their short circuit current ratings.

Section 110.16 requires field marking of potential electrical arc flash hazards.

Section 110.22 requires field marking of series combination ratings (see Section 240.86).

Section 110.24 requires field marking of service entrance equipment with the maximum available short circuit current at the time of installation and whenever changes are made to the line side distribution system.

Section 210.20 covers requirements for fuses protecting branch circuits.

Section 215.3 covers requirements for fuses protecting feeder circuits.

Section 230.90 covers requirements for fuses protecting service equipment.

Article 240 covers the general requirements and practices for overcurrent protection and protective devices.

Section 240.6 and Table 240.6(A) covers standard fuse sizes.

Section 240.40 requires disconnecting means for fuses on their supply side so that each circuit containing fuses can be independently disconnected from the source of power.

Section 240 Part V provides requirements for plug fuses, fuseholders, and adapters.

Sections 240.60 and 240.61 deal specifically with cartridge fuses and fuseholder ratings, markings, and practices.

Section 240.60(D) prohibits the use of renewable class H fuses in new construction.

Section 240.67 requires one of several alternatives to reduce arc-flash incident energy levels whenever 1200 Ampere or larger cartridge fuses are utilized.

Section 240.86 allows, for an existing installation, a properly selected current-limiting fuse to be used in a series-rated combination to protect a circuit breaker with an interrupting rating less than the available fault current.

Section 245.21 covers the requirements of power fuses, fuse holders, distribution cutouts, and expulsion type fuse links for systems rated over 1000 Volts AC or 1500 Volts DC.

Sections 409.22, 409.110(4), 670.3(A)(4), and 670.5 requires that industrial control panels and industrial machinery must be marked with a short circuit current rating and applied so that the available short circuit current does not exceed the marked short circuit current rating.

Sections 430.8 and 440.4 requires that motor controllers be marked with short circuit current ratings. The marking may depend on the use of the proper current-limiting fuses.

Section 430.32 covers sizing requirements when fuses are required to provide motor overload protection.

Section 430.52 covers sizing requirements for fuses protecting motor branch circuits.

Section 430.53 covers sizing requirements for fuses protecting group motor applications.

Section 430.72 covers sizing requirements for fuses protecting motor control circuits.

Section 495.44 covers requirements for fused interrupter switches over 1000 Volts AC or 1500 Volts DC, nominal.

Section 517.31(G) requires coordination of a healthcare essential electrical system for faults lasting more than 0.1 seconds. *NOTE: "Coordination" and "coordinated" as used in this Section do not cover the full range of overcurrent conditions as required elsewhere in the NEC. Specifically, see Sections 620.62, 645.27, 695.3(C)(3), 700.32, 701.32, and 708.54 that require full coordination of overcurrent protective devices.*

Sections 620.62, 645.27, 695.3(C)(3), 700.32, 701.32, and 708.54 require that overcurrent protective devices (fuses and/or circuit breakers) be selectively coordinated with all other supply-side overcurrent protective devices for power circuits such as elevator feeders, emergency systems, legally required standby systems, fire pumps for multibuilding campus-style complexes, critical operations power systems, and critical operations data systems.

Section 695.4 covers requirements for fuses protecting fire pumps.

(This annex is not part of the Standard)

Annex B: Reference Standards

This publication, when used in conjunction with the National Electrical Code and manufacturers' literature, provides sufficient information to install and maintain switchboards.

National Fire Protection Association 1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
(617) 770-3000 tel
(617) 770-3500 fax
www.nfpa.org

NFPA 70-2023, National Electrical Code (ANSI)

NFPA 70B-2023, Standard for Electrical Equipment Maintenance (ANSI)

NFPA 70E-2024, Standard for Electrical Safety in the Workplace

National Electrical Contractors Association 3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814
(301) 215-4504 tel, (301) 215-4500 fax
www.neca-neis.org

Current National Electrical Installation Standards™ Published by NECA: