Disconnecting Means
(Individual hermetic motor-compressor)
The amp rating of the disconnect shall be at least 115% of the compressors rated load current or branch-circuit selection current, whichever is greater [440.12(A)(1)]. Exception permits a nonfused disconnect rated less than 115% of the specified current if this disconnect has a horsepower rating not less than the equivalent horsepower rating per 440.12(A)(2).
The equivalent horsepower rating to comply with 430.109 can be obtained by taking the larger horsepower value from: (1) NEC® Tables 430.248, 430.249 or 430.250 using the greater of either the rated load current or the branch circuit selection current to select the corresponding horsepower rating, or (2) horsepower rating from Tables 430.251(A) and 430.251(B) corresponding to the locked-rotor current. For both preceding (1) and (2), if the value falls between two horsepower ratings in a table, the equivalent horsepower rating to use is the larger of the two; i.e. round up to the larger HP. [440.12(A)(2)].

Disconnecting Means (Equipment that has hermetic motor-compressor and other loads)
The amp rating of the disconnecting means must be at least 115% of the sum of all of the individual loads within the equipment at rated load conditions [440.12(B)(2)]. Exception permits a nonfused disconnect rated less than 115% of the sum of all the individual loads if the disconnect has a horsepower rating not less than the equivalent horsepower rating per 440.12(B)(1).
The horsepower rating of the disconnecting means must be at least equal to the equivalent horsepower determined per 440.12(B)(1) which accounts for all the individual loads with the equipment at rated load conditions.

Controller
The controller for a hermetic motor-compressor must have a continuous duty full-load current rating not less than the nameplate rated current or branch circuit selection current (whichever is larger) [440.41] and the controller must also have a locked rotor current rating equal to or greater than the locked rotor current of the compressor [440.41(A)]. Where the controller serves a hermetic motor-compressor(s) plus other loads, the controller rating is determined according to 440.12(B), in much the same manner as determining the disconnecting means rating. It may be necessary to refer to Tables 430.251(A) & (B) to convert locked rotor current values to horsepower.
The branch circuit protective device rating shall not exceed the maximum protective device rating shown on a manufacturer’s heater table for use with a given motor controller [440.22(C)]. Where the equipment is marked Maximum Size Fuse amp rating rather than stating Maximum Overcurrent Device amp rating, only fuses can be used for the branch circuit protection.

Marked Short-Circuit Current Rating - New Air Conditioning and Refrigeration Equipment with Multimotor and Combination-Loads
440.4(B) requires the nameplate of this equipment to be marked with its short-circuit current rating. There are exceptions for which this requirement does not apply to this equipment:
• One and two family dwellings
• Cord and attachment-plug connected equipment
• Or equipment on a 60A or less branch circuit
So for most commercial and industrial applications, air conditioning and refrigeration equipment with multimotor and combination loads must have the short-circuit current rating marked on the nameplate. This facilitates the inspection and approval process. Inspectors need this information to ensure that NEC® 110.10 is met. A potential hazard exists where the available short-circuit current exceeds the short-circuit current rating. For more information, see the Assembly Short-Circuit Current Rating section in this publication or Short-Circuit Current Rating web page on www.cooperbussmann.com.

Room Air Conditioners
Room air conditioners (hermetic refrigerant motor-compressor) installed in the conditioned room are considered as single-motor units when the conditions of 440.62 are met. This condition also applies to conditioners containing a heating unit. Branch circuit requirements are determined by nameplate rating (440.62).

Because of all the fires caused by mistreated cords, single phase cord-and-plug connected room air conditioners are now required to have either an AFCI (arc fault circuit interrupter) or a LCDI (leakage current detection and interruption) attached to the plug.

Electric Heat
Electric space heating equipment employing resistance type heating elements, rated more than 48A, must have heating elements subdivided. Each subdivided load must not exceed 48A, and the fuse for each load should not exceed 60A [424.22(B)]. If a subdivided load is less than 48A, the fuse rating should be 125% of that load.
Exception: Boilers employing resistance type immersion electric heating elements in an ASME rated and stamped vessel may be subdivided into circuits not exceeding 120A, and protected by a fuse at not more than 150A [424.22(B) and 424.72(A)]. If a subdivided load is less than 120A, the fuse rating should be 125% of that load.
Fusetron dual-element fuses in the sizes required above provide protection for electric heat applications (their lower internal resistance offers cooler operation than ordinary fuses).
T-Tron fast-acting fuses (JUN and JUS) in the sizes required above provide protection for electric heat applications and offer small physical size to reduce space and material cost.

Capacitors
The purpose of fusing capacitors is for short circuit protection. When a capacitor fails, it shorts out. Proper fusing is intended to remove the shorted capacitor from the circuit, prevent the shorted capacitor from rupturing and protect the conductors from damage due to short-circuit current. However, proper fusing must also be sized such that the capacitor can operate normally; that is the fuse should not open due to the normal steady state current or the inrush current when voltage is applied. For example, when the circuit is switched on, a capacitor in the circuit can draw a very high inrush current for a very brief time. Therefore, a capacitor fuse must have the characteristics to not open due to the initial inrush current. Also, the steady state current of a capacitor is directly proportional to the applied voltage; when the voltage increases the capacitor current increases.
Elevator Circuits and Required Shunt Trip Disconnect — A Simple Solution.

When sprinklers are installed in elevator hoistways, machine rooms, or machinery spaces, ANSI/ASME A17.1 requires that the power be removed to the affected elevator upon or prior to the activation of these sprinklers. This is an elevator code requirement that affects the electrical installation. The electrical installation allows this requirement to be implemented at the disconnecting means for the elevator in NEC® 620.51(B). This requirement is most commonly accomplished through the use of a shunt trip disconnect and its own control power. To make this situation even more complicated, interface with the fire alarm system along with the monitoring of components required by NFPA 72 must be accomplished in order to activate the shunt trip action when appropriate and as well as making sure that the system is functional during normal operation. This requires the use of interposing relays that must be supplied in an additional enclosure. Other requirements that have to be met include selective coordination for multiple elevators (620.62) and hydraulic elevators with battery lowering [620.91(C)].

There is a simple solution available for engineering consultants, contractors, and inspectors to help comply with all of these requirements in one enclosure called the Cooper Bussmann Power Module™.

Selective Coordination Requirement

In the 2005 NEC®, 620.62 states:

Where more than one driving machine disconnecting means is supplied by a single feeder, the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent protective devices.

A design engineer must specify and the contractor must install main, feeder, sub-feeder, and branch circuit protective devices that are selectively coordinated for all values of overloads and short circuits.

To better understand how to assess if the overcurrent protective devices in an electrical system are selectively coordinated refer to the Selective Coordination Section of this booklet. Below is a brief coordination assessment of an elevator system in a circuit breaker system (example 1) and in a fuse system (Example 2).

The Power Module contains a shunt trip fusible switch together with the components necessary to comply with the fire alarm system requirements and shunt trip control power all in one package. For engineering consultants this means a simplified specification. For contractors this means a simplified installation because all that has to be done is connecting the appropriate wires. For inspectors this becomes simplified because everything is in one place with the same wiring every time. The fusible portion of the switch utilizes Low-Peak LPJ-(amp)SP fuses that protect the elevator branch circuit from the damaging effects of short-circuit currents as well as helping to provide an easy method of selective coordination when supplied with an upstream Low-Peak fuse with at least a 2:1 amp rating ratio. More information about the Cooper Bussmann Power Module can be found at www.cooperbussmann.com.
Example 1 Circuit Breaker System
In this example, molded case circuit breakers (MCCB) will be used for the branch and feeder protective devices and an insulated case circuit breaker (ICCB) will be used for the main protective device.

Example 2 Fusible System
In our second example, LPJ-(amp)SP fuses will be used for the branch protection, LPS-RK-(amp)SP fuses will be used for the feeder protection, and KRP-C-(amp)SP fuses will be used for the main protection.

Looking at the time current curves for the circuit breaker in the figure above, where any two circuit breaker curves overlap is a lack of selective coordination. The overlap indicates both devices open. If any fault current greater than 750A and less than 3100A occurs at EL-1, EL-2 or EL-3, the 200A circuit breaker will open as well as the 100A branch circuit breaker - this is not a selectively coordinated system and does not meet the requirements of 620.62. This lack of selective coordination could result in stranding passengers in elevators or not having elevators available for fire fighters. Fault currents above 3100A will open the 400A circuit breaker as well and faults above approximately 16,000A will open the 1600A circuit breaker - which further illustrates the lack of coordination. For a better understanding of how to assess circuit breaker coordination, see the section on Circuit Breaker Coordination in this book. A system that is not in compliance may result in needlessly stranding passengers and creating a serious safety hazard.

To verify selective coordination, go no further than the Fuse Selectivity Ratio Guide in the Fuse Selective Coordination section in this book. The Low-Peak fuses just require a 2:1 amp rating ratio to assure selective coordination. In this example, there is a 4:1 ratio between the main fuse (1600A) and the first level feeder fuse (400A) and a 2:1 ratio between the first level feeder fuse and the second level feeder fuse (200A). As well, there is a 2:1 ratio between the second level feeder fuse and the branch circuit fuse (100A). Since a minimum of a 2:1 ratio is satisfied at all levels for this system, selective coordination is achieved and 620.62 is met.

As just demonstrated in the prior paragraph, the fuse time current curves do not have to be drawn to assess selective coordination. For illustrative purposes, the time current curves for this example are shown above.
Motor and motor circuit disconnecting means provide the function of isolating the motor or motor circuit from the source of supply for maintenance work. Motor controllers serve as an On/Off function for the motor and, as the name implies, serve as control of the motor.

In addition to these functional blocks, there are various requirements for motor control circuit components and other specialized components. This discussion will focus on the motor (power) branch circuit requirements and the devices corresponding thereto. Various devices are available on the market to provide these functions. Some devices perform only one of these functions and some perform multiple functions. Some devices, such as UL508 disconnects and Manual Motor Protectors have spacing requirements that are less than UL98 disconnects or UL489 molded case circuit breakers, and therefore, have limitations on their application. Below is an overview of such devices:

### Motor Circuit Devices

#### Branch Circuit Fuses

As Listed To UL/CSA/ANCE 248 Series of Standards

These are fuses that cannot be replaced with fuses having a lower voltage rating. When installed in rejection style clips, current-limiting branch circuit fuses cannot be replaced with fuses which are not current-limiting. Examples of branch circuit fuses are Class L, RK1, RK5, T, J, K1, K5, G, H, CC, and plug fuses. Interrupting ratings range from 10,000 amps to 300,000 amps. These fuses are listed for branch, feeder, and main protection. In a motor circuit they provide branch circuit, short-circuit, and ground fault protection. In addition, enhanced overcurrent protection such as back-up overload and Type 2 “No Damage” protection can be provided with the selection of certain fuse sizes and types.

**Allowed Uses:**

- Motor Branch Short-circuit and Ground Fault Protection
- Motor Overload Protection (some fuse types based upon amount of time delay)
- Group Motor Protection as the short-circuit and ground fault protective device
- Motor Branch Circuit and “at the motor” Disconnecting Means when used in conjunction with a UL98 fusible switch
- Motor Controller when used in conjunction with a UL98 fusible switch, UL508 Manual Motor Controller, or UL1429 pullout.

**Identification**

Fuses listed to UL/CSA/ANCE 248 will contain a marking near the agency symbol. This marking should read listed fuse.

**UND. LAB. INC.® LISTED FUSE FP07-34 INT. RAT. 200ka**
Warning
Supplemental Protectors are NOT suitable for Motor Branch Circuit Protection

Supplemental protectors are being used for motor branch circuit protection in numerous applications throughout the industry. This is a MISAPPLICATION and the urgency of the matter is prompting the creation of safety notices, articles, and technical bulletins to alert the users of this misapplication. Supplemental protectors are not suitable for branch circuit protection and cannot be used for this purpose per 240.10 of the National Electrical Code®. Supplemental protectors are intended to be used as a component of an end product such as commercial appliances, kitchen appliances, luminaires (lighting fixtures), etc. They are offered in a wide variety of performance characteristics, voltage ratings, and interrupting ratings and therefore each supplemental protector is only allowed to be used under specific conditions. Supplemental protectors are UL recognized to UL1077, Supplemental protectors for use in Electrical Equipment, for this reason. A recognized or restricted product is not field installable and therefore an investigation assuring application of the product within its conditions of acceptability is required.

Why Are They Being Misapplied?

Here are some of the popular reasons why:
• Supplemental protectors look very similar to Molded Case Circuit Breakers leading to the assumption that they provide the same protection
• Supplemental protectors are often labeled as circuit breakers or Miniature Circuit Breakers (MCB) in literature
• Many of these devices are rated as a circuit breaker per IEC and confusion over North American and IEC ratings leads to misapplication

So What Do I Need To Do?

In order to correct the application, suitable protection for the motor branch circuit needs to be provided. The simplest correction to this problem is the replacement of the misapplied supplemental protector with a device that is suitable for branch circuit protection.

• A WORD OF CAUTION: The supplemental protector can only be used in an end product that is evaluated as an assembly. If the equipment does not go through an investigation, there is no assurance that the supplemental protector is being used for its intended use within its conditions of acceptability. Therefore the replacement of this device is the safest approach.

So What Can I Use?

NEC® 430.52 provides a list of acceptable devices for motor branch circuit protection. Among the list of acceptable devices are time delay and fast acting branch circuit fuses.

Summary

Supplemental protectors are being misapplied on numerous occasions. Many reasons lead to this misapplication including mistaking supplemental protectors as North American circuit breakers. The key to properly identifying supplemental protectors is to look for the recognition mark. If the device you are using has a recognition mark, more than likely it is a supplemental protector and replacement is necessary for a proper installation.

For more in-depth discussion, download Tech Talk 3 and Supplement from www.cooperbussmann.com

Motor Circuit Protection Device Selection Chart & Supplemental Protectors

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<tr>
<td>Allowed Uses Per 2002 NFPA79 and NEC®</td>
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<td></td>
<td></td>
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<tr>
<td>Motor Circuit and Controller Disconnect</td>
<td>Yes¹</td>
<td>Yes</td>
<td>No</td>
<td>Yes⁶,⁷</td>
<td>No</td>
<td>No</td>
<td>Yes⁵,⁶</td>
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<tr>
<td>Motor Branch Short Circuit and Ground Fault Protection</td>
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<td>Yes⁶</td>
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<td>No</td>
<td>No</td>
<td>Yes⁵,⁶</td>
<td>No</td>
</tr>
<tr>
<td>Motor Controller</td>
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<td>Yes</td>
<td>Yes⁹</td>
<td>Yes⁹</td>
<td>Yes</td>
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<tr>
<td>Motor Overload</td>
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<td>Yes⁵</td>
<td>Yes¹⁰</td>
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<tr>
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<td>Yes</td>
<td>Yes⁴</td>
<td>Yes</td>
<td>No</td>
<td>Yes⁴</td>
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¹. When used in conjunction with a UL98 Fusible Switch.
². When used in conjunction with a UL98 or UL508 fusible switch. If UL508 switch, see footnote 4
³. Often cannot be sized close enough.
⁴. Must be located on the load side of motor branch short-circuit protective device, marked “Suitable as Motor Disconnect,” and be provided with a lockable handle.
⁵. When used in conjunction with a motor starter as part of a listed and labeled combination motor controller.
⁶. Limited to single motor circuit applications.
⁷. Additional Terminal Kit Often Required.
⁸. If Slash Voltage Rated, Limited to Solidly Grounded Wye Systems ONLY.
⁹. Additional Contactor Required for Remote Control.
10. Class 10 Overload Protection Only.