Listed or Labeled Equipment
Listed or labeled equipment must be installed in accordance with instructions included in the listing or labeling [110.3(B)]. Be sure to observe maximum branch circuit fuse size labels. When the equipment label is marked with a maximum fuse amp rating rather than marked with maximum overcurrent device amp rating, only fuses can be used for protection of this equipment.

Panelboards
A maximum of 42 fuses (excluding main fuses) are permitted to be installed in a lighting and appliance branch circuit panelboard (408.35). Each lighting and appliance branch circuit panelboard must be individually protected on the supply side by not more than two sets of fuses having a combined rating not greater than that of the panelboard (408.36). Exception No. 1: Individual protection is not required when the panelboard feeder has overcurrent protection not greater than that of the panelboard. Exception No. 2: Individual protection in existing installations is not required for individual residential occupancy service entrance panelboards [408.36(A)]. A power panelboard having supply conductors which include a neutral and having more than 10% of its overcurrent devices protecting branch circuits of 30A or less, shall have individual protection on the line side not greater than the rating of the panelboard. Individual protection is not required when the power panel is used as service equipment in accordance with 230.71 [408.36(B)]. Panels with snap switches rated at 30A or less must be protected by fuses not larger than 200A [408.36(C)]. Fusible panelboards are available with heavy duty toggle switches rated more than 30A; these panelboards are not restricted by this 200A requirement.

If the panelboard is supplied through a transformer, the fuses for the protection of the panelboard must be located on the transformer secondary [408.36(D)] except when the fuse on the primary complies with 240.2(C)(1). [408.36(D) Exception].

Appliances
Appliance branch circuits shall be protected in accordance with 240.5. If a fuse rating is marked on an appliance, the branch circuit fuse rating cannot exceed that rating marked on the appliance [422.11(A)]. See 430.6(A)(1) exception No.3 for situations where the appliance is marked with both a horsepower rating and an amp rating.

For branch circuits which supply a single non-motor operated appliance rated more than 13.3A, the fuse rating shall not exceed 150% of the appliance rating [422.11(E)(3)].

Electric heating appliances using resistance heating elements rated more than 48A shall have the heating elements subdivided such that each subdivision does not exceed 48 amps and each subdivision shall be protected by a branch circuit listed fuse not to exceed 60A in rating. These fuses shall be factory installed by the heater manufacturer, be accessible, and be suitable for branch circuit protection [422.11(F)(1)].

Fixed appliances are considered protected when supplied from 15, 20, 25, or 30A branch circuits. Fixed cooking appliances are permitted to be protected by 40 or 50A branch circuits (210.23). Household appliances with surface heating elements that have a maximum rating greater than 60A must be divided into two or more circuits, each of which is protected by a fuse of no greater than 50A [422.11(B)].

Portable appliances are considered as protected when supplied from a 15, 20A, or 30A branch circuit (210-23).

Supplementary Protection
Supplementary overcurrent protection is permitted by the National Electrical Code® for specific uses such as in lighting fixtures, appliances, and other equipment or for certain internal control circuits and components of equipment.

This type of protection must not be used as a substitute for branch circuit protection as described in Article 210. This type of protection is not required to be readily accessible as are branch circuit devices. There are a wide variety of supplementary fuses and fuse holders, which have small physical dimensions and are easily installed in or on equipment, appliances, or fixtures. The advantages of supplementary protection are closer fuse sizing for better individual protection, isolation of equipment on overcurrents so that the branch circuit fuse is not disturbed, ease in locating troubled equipment, and generally direct access to the fuse at the location of the equipment. For instance, the in-line fuse and holder combination, such as the Type HLR fuse holder with Type GLR or GMF fuses, protects and isolates fluorescent lighting fixtures in the event of an overcurrent.

The Tri-National Standard for supplementary fuses is UL/CSCA/ANCE 248-14. When supplementary overcurrent protective devices are considered for proper use, it is important (1) not to use these devices as a substitute for branch circuit protection and (2) to be sure that the device’s interrupting rating equals or exceeds the available short-circuit current (see the discussion for 110.9 in this booklet).

Air Conditioning and Refrigeration
Air conditioning and refrigeration equipment requirements are covered in Article 440 of the National Electrical Code®. Hermetic motor-compressors are not rated in “full-load amps” as are standard motors. Instead, different terms are used, such as rated load current, branch circuit selection current, maximum continuous current, minimum circuit ampacity, and maximum overcurrent protection. This equipment has overcurrent protection requirements that differ from that for ordinary motors covered in Article 430. Some highlights are presented here.

Branch Circuit Protection HVAC
Individual Motor-Compressor(s) and HVAC Equipment Having Motor-Compressor(s) and Other Loads (Such as Fan Motors, Electric Heaters, Coils, etc.).
Fuses sized for branch circuit protection only must not exceed 175% of the hermetic motor-compressor rated-load current or branch circuit selection current (whichever is larger). If this size fuse cannot withstand the motor starting current, a higher amp rating is permitted, but in no case can the fuse size exceed 225% [440.22(A)].

Low-Peak dual-element and Fusetron dual-element fuses are recommended for branch circuit protection of air conditioning and refrigeration hermetic motor-compressors because these fuses have an adequate time-delay for motor starting surges.

Refer to the nameplate on the equipment. The sizing (amp rating) for the overcurrent protection has been determined by the manufacturer of the equipment. It is not necessary to apply any further multipliers to arrive at the proper size. This has already been done by the manufacturer.

The marked protective device rating is the maximum protective device rating for which the equipment has been investigated and found acceptable by nationally recognized testing laboratories.
See “Listed or Labeled Equipment” for requirement when nameplate states Maximum Size Fuse. This is a critical requirement, and must be followed without exception to be in compliance with 110.3(B) of the Code. NEC® 110.3(B) requires that listed or labeled equipment must be installed in accordance with any instructions included in the listing or labeling.
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)]. 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)]. 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 (JNJ and JJS) 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.
Air Conditioning and Refrigeration Equipment
With Multimotor and Combination-Loads

A new 2005 NEC® 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. Also any equipment that has an industrial control panel is now required per the new 2005 NEC® 409.110 to have the short-circuit current rating marked on the label. For more information on how to determine the short-circuit current rating for an industrial control panel, see Short-Circuit Current Ratings section in this publication. For proper protection and compliance with NEC® 110.10, the short-circuit current rating for equipment shall be equal to or greater than the available short-circuit current where the equipment is being installed in the system.

HVAC equipment must be properly installed to “Meet Code.” To connect HVAC equipment in locations where the available fault current exceeds the listed short-circuit current levels could present a real hazard to property as well as personnel trouble-shooting the equipment. That is why the new Short-Circuit Current Rating marking requirement is so important.

Means to Mark HVAC Short-Circuit Current Rating

It is recommended that HVAC units, for other than single-family residences, have the HVAC electrical panels listed to UL 508A Industrial Control Panels. UL 508A has a specific procedure for Air Conditioning and Refrigeration Equipment. Any electrical panel can be evaluated to UL 508A. Most important to this discussion is that the general procedures for UL 508A require a short-circuit current rating be marked on the nameplate.

Clause SB5.1.1 and SB5.1.2 state:

SB5.1.1: The nameplate rating of an industrial control panel shall include: ‘Short circuit current:____kA RMS symmetrical, ____V maximum’ or the equivalent.

SB5.1.2: An industrial control panel marked with a high fault short-circuit current rating and is not provided with the required branch circuit protective device as specified in the Exception to SB4.2.3 shall be marked with the type and size of branch circuit protection required to be installed in the field. This marking shall be included as part of the marking in SB5.1.1.

With this system, it is as straightforward as the AHJ (Authority Having Jurisdiction) requiring: Electrical panels of the HVAC equipment (this is not the electrical distribution panel, but rather the electrical panel that is part of the HVAC equipment) shall be listed and marked to UL 508A and the unit short circuit current rating shall be marked on the nameplate. The short circuit current rating of the HVAC unit, which is on the nameplate, shall be equal to or greater than the available short circuit current at the terminals of the HVAC unit. If the UL 508A listed HVAC unit nameplate specifies a specific type and size overcurrent protective device (not supplied integral with the unit), then that specific size (as a maximum) and type overcurrent protective device shall be in the building distribution system that supplies the unit.

Note: UL 508A is a new standard with clauses having various effective dates. Clauses SB5.1.1 and SB5.1.2 have an effective date of April 25, 2006. However, manufacturers can have their equipment evaluated, listed and marked to these clauses today if the specific request is made to the National Recognized Testing Laboratory. But it is important for the AHJ to explicitly mandate that the HVAC electrical panel be marked with a short-circuit current rating and that it be evaluated, listed, and marked to UL 508A Clauses SB5.1.1 and SB5.1.2.

Nameplate Specifies Overcurrent Protective Device

Per UL 1995, the HVAC nameplate can specify the type of overcurrent protective device that must be used. When the nameplate does not specify the type overcurrent device, then either a circuit breaker or fuse is permitted. A typical nameplate will show the “Maximum Size Fuse” or “Maximum Size Fuse or HACR Type Breaker.” If only fuses are specified on the nameplate, then fuse protection must be present in accordance with the label. If a HACR type breaker is allowed, then the circuit breaker must be marked “HACR.”