ARTICLE 430 - MOTORS, MOTOR CIRCUITS AND CONTROLLERS

A. General

430-1.(a). Motor Feeder and Branch Circuits. (See Diagram 430-1(a).

(b) General. The following general requirements cover provisions for motors, motor circuits, and controllers which do not properly fall into the other parts of this Article.

430-3. Part Winding Motors. A part-winding-start induction or synchronous motor is one arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. The purpose is to reduce the initial values of the starting current drawn or the starting torque developed by the motor. A standard part-winding-start induction motor is arranged so that one-half of its primary winding can be energized initially and, subsequently, the remaining half can be energized, both halves then carrying the same current. A sealed "hermetic type" refrigeration compressor motor is not to be considered a standard part-winding-start induction motor.

When separate overcurrent devices are used with a standard part-winding-start induction motor, each half of the motor winding shall be individually protected in accordance with Sections 430-32 and 430-37, except that the trip current shall be one-half that specified.

Each motor winding connection shall have short circuit and ground fault protection rated at not more than one-half that specified by Section 430-52 except that a single device having this half rating may be used for both windings if this will allow the motor to start.

430-4. In Sight From. Where in this Article it is specified that some equipment shall be "in sight from" another equipment, it means that the equipment must be visible and not more than 50 feet distant.

430-5. Other Articles. Motors and controllers shall also comply with the applicable provisions of the following:

Capacitors ..... Section 460-9
Cranes and Hoists ..... Article 610
Elevators, Dumbwaiters, Escalators,
and Moving Walks ..... Article 620
Garages, Aircraft Hangars, Gasoline Dispensing
and Service Stations, Bulk Storage Plants,
Finishing Processes and Flammable Anesthetics..... Article 511
..... Articles 513, 514, 515, 516, and 517
Hazardous Locations ..... Article 500-503
Metalworking Machine Tools ..... Article 670
Motion-picture Projectors ..... Sections 540-12, 540-17
Motion-picture Studios ..... Article 530
Organs ..... Section 650-3
Resistors and Reactors ..... Article 470
Theaters ..... Section 520-48

430-6. Ampacity Determination. Ampacities shall be determined as follows:

(a) General Motor Applications. Except as noted in Sections 430-6(b), and 430-6(c) whenever the current rating of a motor is used to determine the ampacity of conductors, switches, branch-circuit over-current devices, etc., the values given in Tables 430-147, 430-148, 430-149, and 430-150, including notes, shall be used instead of actual current rating marked on the motor nameplate. Separate motor running overcurrent protection shall be based on the motor nameplate current rating. When a motor is marked in amperes, but not horsepower, the horsepower rating shall be assumed to be that corresponding to the value given in Tables 430-147, 430-148, 430-149, and 430-150 interpolated if necessary.

Exception: For multispeed motors, see Sections 430-22(a) and 430-52.

(b) Sealed (Hermetic Type) Motor-Compressors. For sealed (hermetic-type) motor compressors, the full-load current marked on the nameplate of the equipment in which the compressor is employed shall be used to determine the ampacity of the disconnecting

means, the branch-circuit conductors, the controller, the branch-circuit overcurrent protection, and the motor-running protection. Where no full-load current rating is shown on the equipment nameplate, the full-load current shown on the compressor nameplate shall be used. For disconnecting means and controllers, see also Sections 430-83 and 430-110.

(c) Torque Motors. For torque motors the rated current shall be locked-rotor current and this nameplate current shall be used to determine the ampacity of the branch-circuit conductors (see Sections 430-22 and 430-24) and motor operating overcurrent protection. For motor controller and disconnecting means, see Section 430-83, Exception 4 and Section 430-110.

430-7. Marking on Motors and Multimotor Equipment.

(a) Usual Motor Applications. A motor shall be marked with the following information:

(1) Maker's name.
(2) Rated volts and full-load amperes.
(3) Rated full-load speed.
(4) Rated temperature rise or the insulation system class and rated ambient temperature.
(5) Time rating.
(6) Rated horsepower if 1/8 horsepower or more.
(7) Code letter if an alternating-current motor rated 1/2 horsepower or more (see Section 430-7(b).
(8) Secondary volts and full-load amperes if a wound-rotor induction motor.

A multispeed motor, except a shaded-pole or permanent-split capacitor motor, shall be marked with the amperes and horsepower at each speed. A motor provided with a thermal protector complying with Section 430-32 (a-2) or 430-32 (c-2) shall be marked "Thermally Protected." A motor complying with Section 430-32 (c-4) shall be marked "Impedance Protected." The time rating shall be 5, 15, 30, or 60 minutes, or continuous.

Exception No. 1. On motors of arc welders, the horsepower rating may be omitted.

Exception No. 2. On polyphase wound-rotor motors the code letter shall be omitted.

(b) Locked Rotor Indicating Code Letters. Code letters marked on motor nameplates to show motor input with locked rotor shall be in accordance with Table 430-7(b).

The code letter indicating motor input with locked rotor must be in an individual block on the nameplate, properly designated. This code letter is to be used for determining branch-circuit overcurrent protection by reference to Table 430-152, as provided

in Section 430-52.

Table 430-7(b). Locked Rotor Indicating Code Letters

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0 - 3.14
B	3.15 - 3.54
C	3.55 - 3.99
D	4.0 - 4.49
E	4.5 - 4.99
F	5.0 - 5.59
G	5.6 - 6.29
H	6.3 - 7.09
J	7.1 - 7.99
K	8.0 - 8.99
L	9.0 - 9.99
M	10.0 - 11.19
N	11.2 - 12.49
P	12.5 - 13.99
R	14.0 - 15.99
S	16.0 - 17.99
T	18.0 - 19.99
U	20.0 - 22.39
V	22.4 - and up

The above table is an adopted standard of the National Electrical Manufacturers Association.

(1) Multi-speed motors shall be marked with the code letter designating the locked-rotor KVA per horsepower for the highest speed at which the motor can be started, except constant horsepower motors which shall be marked with the code letter giving the highest locked-rotor KVA per horsepower.

(2) Single-speed motors starting on Y connection and running on delta connections shall be marked with a code letter corresponding to the locked-rotor KVA per horsepower for the Y connection.

(3) Dual-voltage motors which have a different locked-rotor KVA per horsepower on the two voltages shall be marked with the code letter for the voltage giving the highest locked-rotor KVA per horsepower.

(4) Motors with 60- and 50-cycle ratings shall be marked with a code letter designating the locked rotor KVA per horsepower on 60 cycles.

(5) Part-winding-start motors shall be marked with a code letter designating the locked-rotor KVA per horsepower that is based upon the locked-rotor current for the full winding of the motor.

(c) Sealed (Hermetic-Type) Motor-Compressors. A sealed (hermetic-type) motor-compressor shall be marked with the following information:

(1) The manufacturer's name, trademark, or symbol.

(2) The voltage, phase, and frequency.

(3) The full-load current.

(4) The locked-rotor current if a polyphase motor or if a single phase motor having a full-load current more than 4.5 amperes at 230 volts or 9 amperes at 115 volts.

(5) The words "Thermally Protected" if a thermal protector integral with the motor-compressor is provided.

Exception: The full-load current may be marked on the nameplate of the equipment in which the compressor is used, provided such marking for multi-compressor equipment indicates the specific motor-compressor with which the marking is associated.

(d) Torque Motors. Torque motors are rated for operation at stand-still and shall be marked in accordance with paragraph (a) except that locked rotor torque shall replace horsepower.

(e) Multimotor and Combination Load Equipment. Multimotor and combination load equipment shall be provided with a visible nameplate marked with the maker's name, the rating in volts, frequency and number of phases, minimum circuit ampacity, and the maximum rating of the circuit protective device. The ampacity shall be calculated by using Section 430-25 and counting all of the motors and other loads which will be operated at the same time. The protective device rating shall not exceed the value calculated by using Section 430-53(c) (3). Multimotor equipment for use on two or more circuits shall be marked with the above information for each circuit.

When the equipment is not factory wired and the individual nameplates of motors and other loads are visible after assembly of the equipment, these nameplates may serve as the required marking.

430-8. Marking on Controllers. A controller shall be marked with the maker's name or identification, the voltage, the current or horsepower rating, and such other data as may be needed to properly indicate the motors for which it is suitable. A controller which includes motor running overcurrent protection, when suitable for group motor application shall be marked with the motor running overcurrent protection and the maximum branch circuit overcurrent protection for such applications.

Combination controllers employing adjustable instantaneous circuit breakers (without time delay) shall be clearly marked to

indicate the ampere settings of the adjustable trip element.

Where a controller is built in as an integral part of a motor or of a motor-generator set, the controller need not be individually marked when the necessary data is on the motor nameplate. For controllers which are an integral part of equipment approved as a unit, the above marking may be on the equipment nameplate.

430-9. Marking at Terminals. Terminals of motors and controllers shall be suitably marked or colored where necessary to indicate the proper connections.

430-10. Wiring Space in Enclosures. Enclosures for controllers and disconnecting means for motors shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to the other apparatus unless designs are employed which provide adequate space for this purpose.

430-11. Protection Against Liquids. Suitable guards or enclosures shall be provided to protect exposed current-carrying parts of motors and the insulation of motor leads where installed directly under equipment, or in other locations where dripping or spraying oil, water, or other injurious liquid may occur, unless the motor is designed for the existing conditions.

430-12. Motor Terminal Housings.

(a) When motors are provided with terminal housings, the housings shall be of metal and of substantial construction.

Exception: In other than hazardous locations, substantial non-metallic, non-burning housings may be used on motors larger than 34 inches in diameter provided internal grounding means between the machine frame and the conduit connection is incorporated within the housings.

See USA Standard Method of Test for Flammability of Rigid Plastics over 0.127CM (0.050 inch) in thickness, K65.21-1965 for non-burning test.

(b) When these terminal housings enclose wire-to-wire connections, they shall have minimum dimensions and usable volumes in accordance with the following:

Table 430-12(b). Terminal Housing-Wire to Wire Connections

Hp	Cover Opening, Minimum Dimension, Inches	Usable Volume, Minimum, Cubic Inches
1 and smaller*	1 5/8	7 1/2
1 1/2, 2 and 3†	1 3/4	12
5 and 7 1/2	2	16
10 and 15	2 1/4	22 1/2
20 and 25	2 7/8	33
30 and 40	3	44
50 and 60	3 1/2	72 1/2
75 and 100	3 1/2	100
125 and 150	6	216

*For motors rated 1 horsepower and smaller and with the terminal housing partially or wholly integral with the frame or end shield, the volume of the terminal housing shall be not less than 0.8 cubic inch per wire-to-wire connection. The minimum cover opening dimension is not specified.

†For motors rated 1 1/2, 2 and 3 horsepower and with the terminal housing partially or wholly integral with the frame or end shield, the volume of the terminal housing shall be not less than 1.0 cubic inch per wire-to-wire connection. The minimum cover opening dimension is not specified.

(c) When these terminal housings enclose rigidly mounted motor terminals, the terminal housing shall be of sufficient size to provide minimum terminal spacings and usable volumes in accordance with the following:

Table 430-12(c)(1). Terminal Spacings - Fixed Terminals

	Minimum Spacing, Inches	
Volts	Between Line Terminals	Between Line Terminals and Other Uninsulated Metal Parts
250 or less	1/4	1/4
251 or 600, inc.	3/8	3/8

Table 430-12(c)(2). Usable Volumes - Fixed Terminals

Power Supply Conductor Size, AWG	Minimum Usable Volume per Power Supply Conductor, Cubic Inches
14	1.0
12 or 10	1 1/4
8 and 6	2 1/4

(d) For larger wire sizes or when motors are installed as a part of factory-wired equipment, without additional connection being required at the motor terminal housing during equipment installation, the terminal housing shall be of ample size to make connections, but the fore-going provisions for the volumes of terminal housings need not apply.

430-13. Bushing. Where wire pass through an opening in an enclosure, conduit box or barrier, a bushing shall be used to protect the conductors from the edges of the openings having sharp edges. The bushing shall have smooth, well-rounded surfaces where it may be in contact with the conductors. If used where there may be a presence of oils, greases, or other contaminants, the bushing shall be made of material not deleteriously affected.

For conductors, see Section 310-7.

430-14. Location of Motors.

(a) Ventilation and Maintenance. Motors shall be located so that adequate ventilation is provided and so that maintenance such as lubrication or bearings and replacing of brushes can be readily accomplished.

(b) Open Motors. Open motors having commutators or collector rings shall be located or protected so that sparks cannot reach adjacent combustible material. This does not prohibit the installation of these motors on wooden floors or supports.

430-16. Overheating from Dust Accumulations. In locations where dust or flying material will collect on or in motors in such quantities as to seriously interfere with the ventilation or cooling of motors, and thereby caused dangerous temperatures, suitable types of enclosed motors which will not overheat under the prevailing conditions, shall be used. Especially severe conditions may require the use of enclosed pipe ventilated motors, or enclosure in separate dust-tight rooms, properly ventilated from a source of clean air.

430-17. Highest Rated (Largest) Motor. In determining compliance with Sections 430-24, 430-53(b), 430-53(c), and 430-62(a), the highest rated (largest) motor shall be considered to be that motor which has the highest rated full-load current. For other than sealed (hermetic-type) motor-compressors, the full-load current used to determine the highest rated motor shall be the equivalent value corresponding to the motor horsepower rating selected from Tables 430-147, 430-148, 430-149, and 430-150.

B. Motor Circuit Conductors.

430-21. General. The provisions of Part B specify sizes of conductors capable of carrying the motor current without overheating under the conditions specified.

Table 430-22 (a-Exception). Duty Cycle Service

Classification of Service	Percentages of Nameplate Current Rating			
	5-Minute Rated Motor	15-Minute Rated Motor	30 & 60 Minute Rated Motor	Continuous Rated Motor
Short-Time Duty				
Operating valves, raising or lowering rolls, etc.....	110	120	150	...
Intermittent Duty				
Freight and passenger elevators, tool heads, pumps, drawbridges, turntables, single-operator arc welders for manual welding, etc.....	85	85	90*	140
Periodic Duty				
Rolls, ore and coal-handling machines, etc.....	85	90	95	140
Varying Duty	110	120	150	200

*This figure also applies for conductors which supply a motor-generator single-operator arc welder which has a 60 per cent duty cycle rating.

Any motor application is considered to be for continuous duty unless the nature of the apparatus which it drives is such that the motor will not operate continuously with load under any condition of use.

For long runs, it may be necessary in order to avoid excessive voltage drop, to use conductors of sizes larger than the minimum sizes selected from Tables 310-12 to 310-15 inclusive.

See Example No. 8, Ch. 9, and Diagram in Section 430-1.

(a) The provisions of Articles 250, 300, and 310 are not intended to apply to conductors which form an integral part of approved equipment, or to integral conductors of motors, motor controllers, and the like. See Sections 300-1(d) and 310-1(c).

430-22. Single Motor.

(a) Branch-circuit conductors supplying a single motor shall have an ampacity not less than 125 per cent of the motor full-load current rating.

In case of a multispeed motor, the selection of branch circuit conductors on the line side of the controller shall be based on the highest of the full load current ratings shown on the motor name plate; selection of branch circuit conductors between the controller and the motor, which are energized for that particular speed, shall be based on the current rating for that speed.

Exception: Conductors for a motor used for short-time, intermittent, periodic, or varying duty shall have an ampacity not less than the percentage of the motor nameplate current rating as shown in Table 430-22 (a-Exception) unless the authority having jurisdiction grants special permission for conductors of smaller size.

(b) The conductors between a stationary motor rated one horsepower or less, and the separate terminal enclosures permitted in Section 430-145(b) may be smaller than No. 14 but not smaller than No. 18, provided they have an ampacity as specified above.

430-23. Wound-Rotor Secondary.

(a) For continuous duty the conductors connecting the secondary of a wound-rotor alternating-current motor to its controller shall have an ampacity which is not less than 125 per cent of the full-load secondary current of the motor.

(b) For other than continuous duty, these conductors shall have an ampacity, in per cent of full load secondary current, not less than that specified in Table 430-22 (a-Exception).

(c) Where the secondary resistor is separate from the controller, the ampacity of the conductors between controller and resistor shall be not less than that given in Table 430-23(c).

Table 430-23(c). Secondary Conductor

Resistor Duty Classification	Ampacity of Wire in Per Cent of Full-Load Secondary Current
Light starting duty	35
Heavy starting duty	45
Extra heavy starting duty	55
Light intermittent duty	65
Medium intermittent duty	75
Heavy intermittent duty	85
Continuous duty	110

430-24. Conductors Supplying Several Motors. Conductors supplying two or more motors shall have an ampacity equal to the sum of the full load current rating of all the motors plus 25 per cent of the highest rated motor in the group.

Where one or more motors of the group are used on short time intermittent, periodic, or varying duty, the ampacity of the conductors shall be calculated as follows:

(a) Determine the needed ampacity for each motor used for other than continuous duty from Table 430-22 (a-Exception).

(b) Determine the needed ampacity for each continuous duty motor based on 100 per cent motor full load current rating.

(c) Multiply the largest single motor ampacity determined from (a) or (b) by 1.25. Add all other motor ampacities from (a) and (b) and select the conductor for this total ampacity.

Exception: When the circuitry is so interlocked as to prevent the starting and running of a second motor or group of motors, the conductor size shall be determined from the larger motor or group of motors that is to be operated at a given time.

See Example No. 8, Chapter 9.

430-25. Supply Conductors.

(a) Combination Load. Conductors supplying a motor load, and in addition a lighting or appliance load as computed from Article 220 and other applicable Sections, shall have an ampacity sufficient for the lighting or appliance load plus the required capacity for the motor load determined in accordance with Section 430-24, or, for a single motor, in accordance with Section 430-22.

(b) Multimotor and Combination Load Equipment. The ampacity of the conductors supplying multimotor and combination load equipment shall not be less than the minimum circuit ampacity

marked on the equipment in accordance with Section 430-7(e).

430-26. Feeder Demand-Factor. Where a reduced heating of the conductors results from motors operating on duty-cycle, intermittently, or from all motors not operating at one time the authority having jurisdiction may grant permission for feeder conductors to be of a capacity less than specified in the Sections 430-24 and 430-25, provided the conductor is of sufficient ampacity for the maximum load determined by the sizes and number of motors supplied and the character of their loads and duties.

430-27. Capacitors with Motors: For provisions covering conductors where capacitors are installed on motor circuits, see Sections 460-7, 460-8, 460-9.

C. Motor and Branch Circuit Running Overcurrent (Overload) Protection

430-31. General. The provisions of Part C specify overcurrent devices intended to protect the motors, the motor-control apparatus, and the branch-circuit conductors against excessive heating due to motor overloads or failure to start.

(a) Overload in electrical apparatus is an operating overcurrent which, when it persists for a sufficient length of time, would cause damage or dangerous overheating of the apparatus. It does not include short circuits or ground faults.

(b) These provisions shall not be interpreted as requiring overcurrent protection where it might introduce additional or increased hazards as in the case of fire pumps [see NFPA Standard for Centrifugal Fire Pumps (No. 20)].

430-32. Continuous Duty Motors.

(a) More Than One Horsepower. Each continuous duty motor rated more than one horsepower shall be protected against running over-current by one of the following means:

(1) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at no more than the following per cent of the motor full-load current rating:

Motors with a marked service factor not less than 1.5 125%
Motors with a marked temperature rise not over 40°C 125%
Sealed (hermetic-type) motor compressors
overload relays 140%
other devices 125%
All other motors

115%

For a multispeed motor, each winding connection shall be considered separately. This value may be modified as permitted by Section 430-34.

When a separate motor running-overcurrent device is so connected that it does not carry the total current designated on the motor nameplate, such as for wye-delta starting, the proper percentage of nameplate current applying to the selection or setting of the overcurrent device shall be clearly designated on the equipment or the manufacturer's selection table shall take this into account.

(2) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. If the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(3) For motors larger than 1500 horsepower, a protective device employing embedded temperature detectors which cause current to the motor to be interrupted when the motor attains a temperature rise greater than marked on the nameplate in an ambient of 40°C.

Standards for the application of embedded temperature detectors are given in the USA Standards for Rotating Electrical Machinery, USAS C50.2-1955 and C50.4-1965.

(b) One Horsepower or Less, Manually Started.

(1) Each continuous duty motor rated at one horsepower or less which is not permanently installed, is manually started and is within sight from the controller location, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit. This branch circuit overcurrent device shall not be larger than that specified in Part D, of Article 430, except that any such motor may be used at 125 volts or less on a branch circuit protected at 20 amperes.

(2) Any such motor which is not in sight from the controller location shall be protected as specified in Section 430-32(c). Any motor rated at one horsepower or less which is permanently installed, shall be protected in accordance with Section 430-32(c).

(c) One Horsepower or Less, Automatically Started. Any motor of one horsepower or less which is started automatically shall be protected against overcurrent by the use of one of the following means:

(1) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at no more than the following per cent of the motor full-load

current rating:

Motors with a marked service factor not less than 1.15 125%

Motors with a marked temperature rise not over 40°C 125%

Sealed (hermetic-type) motor compressors

overload relays 140%

other devices 125%

All other motors 115%

For a multispeed motor, each winding connection shall be considered separately. This value may be modified as permitted by Section 430-34.

(2) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. Where the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(3) The motor shall be considered as being properly protected where it is part of an approved assembly which does not normally subject the motor to overloads and which is also equipped with other safety controls (such as the safety combustion controls of a domestic oil burner) which protect the motor against damage due to stalled rotor current. Where such protective equipment is used it shall be indicated on the nameplate of the assembly where it will be visible after installation.

(4) In case the impedance of the motor windings is sufficient to prevent overheating due to failure to start, the motor may be protected as specified in Section 430-32(b) (1) for manually started motors.

Many alternating-current motors of less than 1/20 horsepower, such as clock motors, series motors, etc., and also some larger motors such as torque motors, come within this classification. It does not include split-phase motors having automatic switches to disconnect the starting windings.

(d) Wound-Rotor Secondaries. The secondary circuits of wound-rotor alternating-current motors, including conductors, controllers, resistors, etc., shall be considered as protected against overcurrent by the motor-running overcurrent device.

430-33. Intermittent and Similar Duty. A motor used for a condition of service which is inherently short time, intermittent, periodic, or varying duty, as illustrated by Table 430-22 (a-Exception), shall be considered as protected against overcurrent

by the branch-circuit over-current device, provided the overcurrent protection does not exceed that specified in Tables 430-152 and 430-153.

Any motor application shall be considered to be for continuous duty unless the nature of the apparatus which it drives shall be such that the motor cannot operate continuously with load under any condition of use.

430-34. Selection or Setting of Protective Device. Where the values specified for motor-running overcurrent protection in Sections 430-32(a-1) and 430-32(c-1) do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit breakers, thermal cutouts, thermal relays, the heating elements of thermal trip motor switches, or the possible settings of adjustable circuit breakers adequate to carry the load, the next higher size rating, or setting may be used, but not higher than the following per cent of motor full-load current rating:

Motors with a marked service factor not less than 1.15 140%
Motors with a marked temperature rise not over 40°C 140%
Sealed (hermetic-type) compressor motors 140%
All other motors 130%

In case it is not shunted during the starting period of the motor (see Section 430-35), the protective device shall have sufficient time delay to permit the motor to start and accelerate its load.

430-35. Shunting During Starting Period.

(a) In the case of a motor that is manually started (including starting with a magnetic starter having push-button control), the running overcurrent protection may be shunted or cut out of circuit during the starting period of the motor, provided the device by which the over-current protection is shunted or cut out cannot be left in the starting position, and fuses or time-delay circuit breakers rated or set or at not over 400 per cent of the full-load current of the motor, are so located in the circuit as to be operative during the starting period of the motor.

(b) The motor-running overcurrent protection shall not be shunted or cut out during the starting period if the motor is automatically started.

430-36. Fuses - In Which Conductor. Where fuses are used for motor-running protection, a fuse shall be inserted in each ungrounded conductor.

Exception: A fuse shall also be inserted in a grounded conductor under the circumstances set forth in the note following Table 430-37.

430-37. Devices Other Than Fuses - In Which Conductor. Where

devices other than fuses are used for motor-running overload protection. Table 430-37 shall govern the minimum allowable number and location of overcurrent units such as trip coils, relays, or thermal cutouts.

Table 430-37 - Running Overcurrent Units

Kind of Motor	Supply System	Number of location of overcurrent units, such as trip coils, relays or thermal cutouts
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C. ungrounded	1 in either conductor
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C., one conductor grounded	1 in ungrounded conductor
1-phase A.C. or D.C.	3-wire, 1-phase A.C. or D.C., grounded-neutral	1 in either ungrounded conductor
2-phase A.C.	3-wire, 2-phase A.C., ungrounded	2, one in each place
2-phase A.C.	3-wire, 2-phase A.C., one conductor grounded	2 in ungrounded conductors
2-phase A.C.	4-wire, 2-phase A.C. grounded or ungrounded	2, one per phase in ungrounded conductors
2-phase A.C.	5-wire, 2-phase, A.C. grounded neutral or ungrounded	2, one per phase in any ungrounded phase wire
3-phase A.C.	3-wire, 3-phase A.C., ungrounded	*2 in any 2 conductors
3-phase A.C.	3-wire, 3-phase A.C., one conductor	*2 in ungrounded conductors
3-phase A.C.	3-wire, 3-phase A.C. grounded-neutral	*2 in any 2 conductors
3-phase A.C.	4-wire, 3-phase A.C. grounded-neutral or ungrounded	*2 in any 2 conductors except the neutral

***Note:** Three running overcurrent units shall be used where three-phase motors are installed in isolated, inaccessible, or unattended locations, unless the motor is protected by other approved means.

Unattended (Definition): Lacking the presence of a person (not necessarily an electrician) capable of exercising responsible control of the motor under consideration. Such a person need not

be in sight of the motor at all times but must be available for opening the motor circuit in the event of motor overheating.

430-38. Number of Conductors Opened by Overcurrent Device. Motor-running protective devices, other than fuses, thermal cutouts, or thermal protectors, shall simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

430-39. Motor Controller as Running Overcurrent Protection. A motor controller may also serve as the running overcurrent device where the number of overcurrent units complies with Section 430-37 and where these overcurrent units are operative in both the starting and running position in the case of a direct-current motor. When a nonautomatic motor controller serves as the running overcurrent device, it is recommended that all ungrounded conductors be opened.

430-40. Thermal Cutouts and Overload Relays. Thermal cutouts, overload relays, and other devices for motor-running protection which are not capable of opening short circuits, shall be protected by fuses or circuit breakers with ratings or settings in accordance with Section 430-52, unless approved for group installation and marked to indicate the maximum size of fuse or time limit circuit breaker by which they must be protected.

Exception: The fuse size marking may be located on the nameplate of approved equipment in which the thermal cutout or relay is used.

For instantaneous circuit breakers, see Section 430-52.

430-42. Motors on General Purpose Branch Circuits. Overcurrent protection for motors used on general purpose branch circuits as permitted in Article 210, shall be provided as follows:

(a) One or more motors without individual running overcurrent protection may be connected to general purpose branch circuits only where the limiting conditions specified for each of two or more motors in Section 430-53(a) are compiled with.

(b) Motors of larger ratings than specified in Section 430-53(a) may be connected to general purpose branch circuits only in case each motor is protected by running overcurrent protection selected to protect the motor as specified in Section 430-32. Both the controller and the motor-running overcurrent device shall be approved for group installation with the protective device of the branch circuit to which the motor is connected. See Section 430-53.

(c) Where a motor is connected to a branch circuit by means of a plug and receptacles, and individual running overcurrent protection is omitted as provided in Section 430-42(a), a rating of the plug and receptacle shall not exceed 15 amperes at 125 volts or 10 amperes at 250 volts. Where individual overcurrent protection is required as provided in 430-42(b) for a motor or motor-operated appliance provided with an attachment plug for attaching to the branch circuit through a receptacle, the running overcurrent device shall be an integral part of the motor or of the appliance. The rating of the plug and receptacle shall be assumed to determine the rating of the circuit to which the motor may be connected, as provided in Article 210.

(d) The overcurrent device protecting a branch circuit to which a motor or motor-operated appliance is connected shall have sufficient time delay to permit the motor to start and accelerate its load.

430-43. Automatic Restarting. A motor-running protective device which can restart a motor automatically after overcurrent tripping shall not be installed unless approved for use with the motor which it protects. A motor which can restart automatically after shutdown shall not be installed so that its automatic restarting can result in injury to persons.

D. Motor Branch Circuit Short Circuit and Ground Fault Protection

430-51. General. The provisions of Part D specify overcurrent devices intended to protect the motor branch circuit conductors, the motor control apparatus, and the motors against overcurrent due to short circuits or grounds. They are in addition to or amendatory of the provisions of Article 240.

430-52. Rating or Setting for Individual Motor Circuit. The motor branch circuit overcurrent device shall be capable of carrying the starting current of the motor. Short circuit and ground fault overcurrent protection shall be considered as being obtained when the overcurrent device has a rating or setting not exceeding the values given in Table 430-152 or 430-153. An instantaneous trip circuit breaker (without time delay) shall be used only if adjustable and if part of a combination controller having overcurrent protection in each conductor and the combination is especially approved for the purpose.

Exception: Where the overcurrent protection specified in the tables is not sufficient for the starting current of the motor:

a. The rating or setting of a fuse or time limit circuit breaker may be increased but shall in no case exceed 225 per cent of the full load current for sealed hermetic compressor motors of 400 kva locked rotor or less, not more than 400 per cent for all other motors.

b. The setting of an instantaneous trip circuit breaker (without time delay) may be increased over 700 per cent but shall in no case exceed 1300 per cent of the motor full load current.

c. Torque motor branch circuits shall be protected at the motor nameplate current rating. See Section 240-5(a), Exceptions Nos. 1 and 2.

For a multispeed motor, a single short circuit and ground fault protective device may be used for one or more windings of the motor provided the rating of the protective device does not exceed the above applicable percentage of the name plate rating of the smallest winding protected.

Where maximum protective device ratings shown on manufacturer's heater table for use with a motor controller are less than 15 amperes, the protective device rating shall not exceed the manufacturer's values marked on the equipment.

See Example No. 8, Chapter 9, and Diagram in Section 430-1.

430-53. Several Motors on One Branch Circuit. Two or more motors may be connected to the same branch circuit under any of the following conditions:

(a) Several motors each not exceeding 1 hp in rating may be used on a branch circuit protected at not more than 20 amperes at 125 volts or less, or 15 amperes at 600 volts or less, provided that all of the following conditions are met:

(1) The full-load rating of each motor shall not exceed six (6) amperes.

(2) The rating of the branch circuit protective device marked on any of the controllers shall not be exceeded.

(3) Individual running overcurrent protection shall conform to Section 430-32.

(b) If the branch circuit protective device is selected not to exceed that allowed by Section 430-52 for the motor of the smallest rating, two or more motors each having individual running overcurrent protection may be connected to a branch circuit when it can be determined that branch circuit protective device will not open under the most severe normal conditions of service which might be encountered.

(c) Except as provided for in Section 430-53(d), two or more motors of any rating, each having individual running overcurrent protection, may be connected to one branch circuit provided all of the following conditions are complied with:

(1) Each motor-running overcurrent device must be approved for group installation with a specified maximum rating of fuse and/or circuit breaker.

(2) Each motor controller must be approved for group installation with a specified maximum rating of fuse and/or circuit breaker.

(3) Each circuit breaker must be of the time limit type and approved for group installation.

(4) The branch circuit shall be protected by fuses or time limit circuit breakers having a rating not exceeding that specified in Section 430-52 for the largest motor connected to the branch circuit plus an amount equal to the sum of the full load current ratings of all other motors connected to the circuit.

(5) The branch circuit fuses or time limit circuit breakers must not be larger than allowed by Section 430-40 for the thermal cutout or relay protecting the smallest motor of the group.

(6) The conductors of any tap supplying a single motor need not have individual branch circuit protection, provided they comply with either of the following: (1) no conductor to the motor shall have an ampacity less than that of the branch circuit conductors, or (2) no conductor to the motor shall have an ampacity less than one-third that of the branch circuit conductors, with a minimum in accordance with Section 430-22; the conductors to the motor-running protective device being not more than 25 feet long and being protected from physical damage.

(d) For the purpose of this Section, a room air conditioner shall be treated as a single motor unit in determining its branch circuit requirements when all of the following conditions are met:

(1) The unit is cord connected.

(2) Its rating is not more than 40 amperes full-load current and 250 volts, single phase.

(3) Total full-load current is shown on the unit nameplate rather than that of individual motor currents.

(4) The rating of the branch circuit protective device does not exceed the ampacity of the branch circuit conductors or the rating of the receptacle, whichever is less. See Section 422-40.

430-54. Multi-Motor and Combination Load Equipment. The rating of the branch circuit protective device for multimotor and combination load equipment shall not exceed the rating marked on the equipment in accordance with Section 430-7(e).

430-55. Combined Overcurrent Protection. Motor-branch-circuit over-current protection and motor-running overcurrent protection may be combined in a single overcurrent device when the rating or setting of the device provides the running overcurrent protection specified in Section 430-32.

430-56. Overcurrent Devices - In Which Conductor. Overcurrent devices shall comply with the provisions of Section 240-11.

430-57. Size of Fuseholder. Where fuses are used for motor-branch-circuit protection, the fuseholders shall not be of a smaller size than required to accommodate the fuses specified by Sections 430-152 and 430-153.

Exception: Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in Sections 430-152 and 430-153 may be used.

430-58. Rating of Circuit Breaker. A circuit breaker for motor-branch-circuit protection shall have a current rating in accordance with Sections 430-52 and 430-110.

430-59. Feeder Taps in Inaccessible Location. If the location of the connection of a tap to the feeder conductors is not accessible, the motor-branch-circuit overcurrent device may be placed where it will be accessible, provided the conductors between the tap and the overcurrent device have the same ampacity as the feeder, or provided they have an ampacity of at least 1/3 that of the feeder and are not more than 25 feet long and are protected from physical damage.

430-60. Selection or Setting of Protective Device. In case the values for branch circuit protective devices determined by Table 430-152 or 430-153 do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit breakers, or thermal devices, or possible settings of adjustable circuit breakers adequate to carry the load, the next higher size, rating or setting may be used. See Section 240-5(b) for Standard Ratings.

E. Motor-Feeder Short-Circuit and Ground Fault Protection

430-61. General. The provisions of Part E specify overcurrent devices intended to protect feeder conductors supplying motors against overcurrents due to short circuits or grounds.

430-62. Rating or Setting - Motor Load.

(a) A feeder which supplies a specific fixed motor load and consisting of conductor sizes based on Section 430-24 shall be provided with overcurrent protection which shall not be greater than the largest rating or setting of the branch-circuit protective device, for any motor of the group (based on Tables 430-152 and 430-153), plus the sum of the full-load currents of the other motors of the group.

Where two or more motors of equal horsepower rating are the largest in the group, one of these motors shall be considered as the largest for the above calculations.

Where two or more motors of a group must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection.

See Example No. 8, Chapter 9.

(b) For large capacity installations, where heavy capacity feeders are installed to provide for future additions or changes, the feeder over-current protection may be based on the rated ampacity of the feeder conductors.

430-63. Rating or Setting - Power and Light Loads. Where a feeder supplies a motor load, and in addition a lighting or a lighting and appliance load, the feeder overcurrent protective device may have a rating or setting sufficient to carry the lighting or the lighting and appliance load as determined in accordance with Articles 210 and 220, plus, for a single motor, the rating permitted by Section 430-52, and for two or more motors, the rating permitted by Section 430-62.

F. Motor Control Circuits

430-71. General. Part F contains modifications of the general requirements and applies to the particular conditions of motor control circuits.

Control Circuit (Definition): The control circuit of a control apparatus or system is the circuit which carries the electric signals directing the performance of the controller, but does not carry the main power circuit.

430-72. Overcurrent Protection. Conductors of control circuits shall be protected against overcurrent in accordance with Section 240-5(a), Exception No. 5.

Exception. Such conductors shall be considered as being properly protected by the branch-circuit overcurrent devices under any one of the following conditions:

(1) Where the rating or setting of the branch-circuit overcurrent device is not more than 500 per cent of the ampacity of the control-circuit conductors.

(2) Where the controlled device and the point of control (start and stop buttons, pressure switch, thermostatic switch, etc.) are both located on the same machine and the control circuit does not extend beyond the machine and the branch circuit overcurrent device is a fuse or time limit circuit breaker.

(3) Where the opening of the control circuit would create a hazard; as for example, the control circuit of fire-pump motors, and the like.

430-73. Mechanical Protection of Conductor. Where damage to a control circuit would constitute a hazard, all conductors of such remote-control circuit shall be installed in a raceway or be otherwise suitably protected from physical damage outside the control device itself.

When one side of the control circuit is grounded, the control circuit shall be so arranged that an accidental ground in the remote control devices will not start the motor.

430-74. Disconnection.

(a) Control circuits shall be so arranged that they will be disconnected from all sources of supply when the disconnecting means is in the open position. The disconnecting means may consist of two separate devices, one of which disconnects the motor and the controller from the source of power supply for the motor, and the other, the control circuit from its power supply. Where the two separate devices are used, they shall be located immediately adjacent one to the other.

(b) Where a transformer or other device is used to obtain a reduced voltage for the control circuit and is located in the controller, such transformer or other device shall be connected to the load side of the disconnecting means for the control circuit.

G. Motor Controllers

430-81. General. The provisions of Part G are intended to require suitable controllers for all motors.

(a) Definition. For definition of "Controller," see Article 100. For the purpose of this Article, the term "Controller" includes any switch or device normally used to start and stop the motor.

(b) Stationary Motor or 1/8 Horsepower or Less. For a stationary motor rated at 1/8 horsepower or less, that is normally left running and is so constructed that it cannot be damaged by overload or failure to start, such as clock motors and the like, the branch-circuit overcurrent device may serve as the controller.

(c) Portable Motor of 1/3 Horsepower or Less. For a portable motor rated at 1/3 horsepower or less, the controller may be an attachment plug and receptacle.

430-82. Controller Design.

(a) Each controller shall be capable of starting and stopping the motor which it controls, and for an alternating-current motor shall be capable of interrupting the stalled-rotor current of the motor.

(b) Autotransformer. An autotransformer starter shall provide an off position, a running position, and at least one starting position. It shall be so designed that it cannot rest in the starting position, or in any position which will render inoperative the overcurrent protective device in the circuit.

(c) Rheostats. Rheostats shall conform to the following:

(1) Internal Connections. Motor-starting rheostats shall be so designed that the contact arm cannot be left on intermediate segments. The point or plate on which the arm rests when in the starting position shall have no electrical connection with the resistor.

(2) Under-voltage Release, Direct-Current Motors. Motor-starting rheostats for direct-current motors operated from a constant voltage supply shall be equipped with automatic devices which will interrupt the supply before the speed of the motor has fallen to less than one-third its normal value.

430-83. Rating. The controller shall have a horsepower rating, which shall not be lower than the horsepower rating of the motor, except as follows:

Exception No. 1. Stationary Motor of 2 Horsepower or Less. For a stationary motor rated at 2 horsepower or less, and 300 volts or less, the controller may be a general-use switch having an ampere rating at least twice the full-load current rating of the motor.

On AC circuits, general use snap switches suitable only for use on AC (not general use AC-DC snap switches) may be used to control a motor rated at 2 horsepower or less and 300 volts or less having a full-load current rating not exceeding 80 per cent of the ampere rating of the switch.

Exception No. 2. Circuit Breaker as Controller. A branch circuit circuit breaker, rated in amperes only, may be used as a controller. Where this circuit breaker is also used for overcurrent protection, it shall conform to the appropriate provisions of this Article governing overcurrent protection.

Exception No. 3. Sealed (Hermetic-type) Refrigeration Compressor Motors. The motor controller shall have both a continuous duty full-load current rating, and a locked-rotor current rating, not less than the nameplate full-load current and locked-rotor current, respectively, of the compressor. Ins case the motor controller is rated in horsepower, but is without one or both of the foregoing current ratings, equivalent currents shall be determined from the rating as follows: Use Tables 430-148, 430-149, or 430-150 to determine the equivalent full-load current rating. Use Table 430-151 to determine the equivalent locked-rotor current rating.

A motor controller controlling more than one motor, or a motor an other loads, shall have a continuous duty full-load current rating and a locked-rotor current rating not less than the combined load as determined in accordance with Section 430-110(d).

Exception No. 4. Torque Motors. The motor controller shall have a continuous duty full-load current rating not less than the nameplate current of the motor. In case the motor controller is rated in horsepower, but is without the foregoing current rating, the equivalent current rating shall be determined from the horsepower rating by using Tables 430-147, 430-148, 430-149, or 430-150.

430-84. Need Not Open All Conductors. Except when it serves also as a disconnecting means (see Section 430-111), the controller need not open all conductors to the motor.

430-84. In Grounded Conductors. One pole of the controller may be placed in a permanently grounded conductor provided the controller is so designed that the pole in the grounded conductor cannot be opened without simultaneously opening all conductors of the circuit.

430-86. Motor Not in Sight from Controller. Where a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following conditions:

(a) The controller disconnecting means is capable of being locked in the open position.

(b) A manually operable switch which will disconnect the motor from its source of supply is placed within sight from the motor location.

430-87. Number of Motors Served by Each Controller. Each motor shall be provided with an individual controller.

Exception: For motors of 600 volts or less a single controller rated at not less than the sum of the horsepower ratings of all of the motors of the group may serve the group of motors under any one of the following conditions:

(a) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, hoists, and similar apparatus.

(b) Where a group of motors is under the protection of one over-current device as permitted in Section 430-53(a).

(c) Where a group of motors is located in a single room within sight from the controller location.

430-88. Adjustable-Speed Motors. Adjustable-speed motors that are controlled by means of field regulation shall be so equipped and connected that they cannot be started under weakened field, unless the motor is designed for such starting.

430-89. Speed Limitation. Machines of the following types shall be provided with speed limiting devices:

(a) Separately excited direct-current motors.

(b) Series motors.

(c) Motor-generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

Exception No. 1. Unless the inherent characteristics of the machines, the system, or the load and the mechanical connection thereto, are such as to safely limit the speed.

Exception No. 2. Unless the machine is always under the manual control of a qualified operator.

430-90. Combination Fuseholder and Switch as Controller. The rating of a combination fuseholder and switch used as a motor-controller shall be such that the fuseholder will accommodate the size of the fuse specified in Part C, of Article 430, for motor-running overcurrent protection.

Exception: Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in Part C, of Article 430 may be used.

H. Disconnecting Means

430-101. General. The provisions of Part H are intended to require disconnecting means capable of disconnecting motors and controllers from the circuit.
See Diagram in Section 430-1.

430-102. In Sight from Controller Location. A disconnecting means shall be located in sight from the controller location, except as recognized in Section 422-26.

430-103. To Disconnect Both Motor and Controller. The disconnecting means shall disconnect the motor and the controller from all ungrounded supply conductors and shall be so designed that no pole can be operated independently. The disconnecting means may be in the same enclosure with the controller. See Section 430-113.

430-104. To Be Indicating. The disconnecting means shall plainly indicate whether it is in the open or closed position.

430-105. Grounded Conductors. One pole of the disconnecting means may disconnect a permanently grounded conductor, provided the disconnecting means is so designed that the pole in the grounded conductor cannot be opened without simultaneously disconnecting all conductors of the circuit.

430-106. Service Switch as Disconnecting Means. Where an installation consists of a single motor, the service switch may serve as the disconnecting means, provided it conforms to the requirements of this Article, and is within sight from the controller location, except as recognized in Section 422-26.

430-107. Readily Accessible. One of the disconnecting means shall be readily accessible.

430-108. Every Switch. Every switch in the motor branch circuit within sight from the controller location shall comply with the requirements of Part H.

430-109. Type. The disconnecting means shall be a motor-circuit switch, rated in horsepower, or a circuit breaker, except as follows:

Exception No. 1. One-Eight Horsepower or Less. For stationary motors of 1/8 horsepower or less, the branch-circuit overcurrent device may serve as the disconnecting means.

Exception No. 2. Two Horsepower or Less. For stationary motors rated at 2 horsepower or less and 300 volts or less, the disconnecting means may be a general-use switch having an ampere rating not less than twice the full-load current rating of the motor.

On AC circuits, general use snap switches suitable only for

use on AC (not general use AC-DC snap switches) may be used to disconnect a motor having a full-load current rating not exceeding 80 per cent of the ampere rating of the switch.

Exception No. 3. Over Two Horsepower to and Including 50 Horsepower. The separate disconnecting means required for a motor with an autotransformer type of controller may be a general-use switch where all of the following provisions are complied with:

(a) The motor drives a generator which is provided with overcurrent protection.

(b) The controller (1) is capable of interrupting the stalled-rotor current of the motor, (2) is provided with a no-voltage release, and (3) is provided with running-over-current protection not exceeding 125 per cent of the motor full-load current rating.

(c) Separate fuses or a circuit breaker, rated or set at not more than 150 per cent of the motor full-load current, are provided in the motor branch circuit.

Exception No. 4. Exceeding 50 Horsepower. For stationary motors rated at more than 50 horsepower, the disconnecting means may be a motor-circuit switch also rated in amperes, a general-use switch, or an isolating switch.

Isolation switches for motors exceeding 50 horsepower, not capable of interrupting stalled-rotor currents, shall be plainly marked "Do not open under load."

Exception No. 5. Portable Motors. For portable motors an attachment plug and receptacle may serve as the disconnecting means.

Exception No. 6. Room Air-Conditioners. For room air-conditioners, see Section 422-43.

430-110. Ampacity and Interrupting Capacity.

(a) The disconnecting means shall have an ampacity of at least 115 per cent of the full-load current rating of the motor.

(b) The disconnecting means for sealed (hermetic-type) refrigeration compressors shall be selected on the basis of the nameplate full-load current and locked-rotor current, respectively of the compressor motor as follows:

(1) The ampacity shall be at least 115 per cent of the nameplate full-load current.

(2) To determine the equivalent horsepower in complying with the requirements of Section 430-109, select the horsepower rating from Table 430-148, 430-149, and 430-150 corresponding to the full-load current, and also the horsepower rating from Table 430-151 corresponding to the locked-rotor current. In case the nameplate full-load current and locked-rotor current do not correspond to the currents shown in Tables in Sections 430-148, 430-149, and 430-150, respectively, the horsepower rating corresponding to the next higher value shall be selected. In case two different horsepower ratings are obtained when applying. Tables 430-148, 430-149, 430-150, and 430-151, a horsepower rating at least equal to the larger of the two values obtained shall be selected.

(c) The disconnecting means for a torque motor shall be selected on the basis of the nameplate current as follows:

(1) The ampacity shall be at least 115 per cent of the nameplate current.

(2) To determine the equivalent horsepower in complying with the requirements of Section 430-109, select the horsepower rating from Tables 430-147, 430-148, 430-149, or 430-150 corresponding to the motor current. In case the nameplate current does not correspond to a current shown in the Table, the horsepower rating corresponding to the next higher value shall be selected.

(d) Where one or more sealed (hermetic-type) motor-compressors are used together or are used in combination with other motors and/or loads such as resistance heaters and where the combined load may be simultaneous on a single disconnecting means, the rating and ampacity of the combined load is to be determined as follows:

(1) The horsepower rating of the disconnecting means shall be determined from the summation of all currents, including resistance loads, at the full-load condition and also at the locked-rotor current so obtained shall be considered as a single motor for the purpose of this requirement as follows:

The full-load current equivalent to the horsepower rating of each motor, other than a sealed (hermetic-type) motor-compressor, shall be selected from Tables 430-148, 430-149, and 430-150. These full-load currents shall be added to the motor-compressor full-load current(s) and to the rating in amperes of other loads to obtain an equivalent full-load current for the combined load.

The locked-rotor current equivalent to the horsepower rating of each motor, other than a sealed (hermetic-type) motor compressor, shall be selected from Table 430-151. The locked-rotor currents shall be added to the motor-compressor locked-rotor current(s) and to the rating in amperes of other loads to obtain an equivalent locked-rotor current for the combined load. Where two or more motors and/or other loads cannot be started simultaneously, appropriate combinations of locked-rotor and full-load current may be employed to determine the equivalent locked-rotor current for the simultaneous combined loads.

(2) The ampacity of the disconnecting means shall be at least 115 per cent of the summation of all currents at the full-load condition determined in accordance with Section 430-110(d)(1).

(3) For small motor-compressors not having the locked-rotor current marked on the nameplate or for small motors not covered by Tables 430-147 and 430-150, the locked-rotor current shall be assumed to be six times the full-load current. See Section 430-7(c).

430-111. Switch or Circuit Breaker as Both Controller and Disconnecting Means. A switch or circuit breaker complying with the provisions of Section 430-83 may serve as both controller and disconnecting means provided it opens all ungrounded conductors to the motor, is protected by an overcurrent device (which may be the branch circuit fuses) which opens all ungrounded conductors to the switch or circuit breaker, and is of one of the following types:

(a) An air-break switch, operable directly by applying the hand to a lever or handle.

(b) A circuit breaker operable directly by applying the hand to a lever or handle.

(c) An oil switch used on a circuit whose rating does not exceed 600 volts or 100 amperes, or by special permission on a circuit exceeding this capacity where under expert supervision.

The oil switch or circuit breaker specified above may be both power and manually operable. If power operable, provision should be made to lock it in the open position.

The overcurrent device protecting the controller may be part of the controller assembly or may be separate.

An autotransformer type of controller is not included above and will require a separate disconnecting means.

430-112. Motors Served by a Single Disconnecting Means. Each motor shall be provided with individual disconnecting means.

Exception: For motors of 600 volts or less a single disconnecting means may serve a group of motors under any one of the following conditions:

(a) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, and hoists.

(b) Where a group of motors is under the protection of one set of overcurrent devices as permitted by Section 430-53(a).

(c) Where a group of motors is in a single room within sight from the location of the disconnecting means.

The disconnecting means shall have a rating not less than is required by Section 430-109 for a single motor the rating of which equals the sum of the horsepowers or currents of all the motors of the group.

430-113. Energy From More Than One Source. Equipment receiving electrical energy from more than one source shall be provided with disconnecting means from each source of electrical energy adjacent to the equipment served. Each source may have a separate disconnecting means.

J. Requirements for Over 600 Volts

430-121. General. The provisions of Part J recognize the additional hazard due to the use of high voltage. They are in addition to or amendatory of the other provisions of this article. Other requirements for circuits and equipment operating at more than 600 volts are in Article 710.

430-122. More Than 7500 Volts. Motors operating at more than 7500 volts between conductors shall be installed in fire-resistant motor rooms.

430-123. Motor Running Overcurrent (Overload) Protection. Running overcurrent protection for a motor of over 600 volts shall consist either of a circuit breaker, or of overcurrent units integral with the controller which shall simultaneously open all ungrounded conductors to the motor. The overcurrent device shall have a setting as specified elsewhere in this Article for motor-running overcurrent (overload) protection.

430-124. Short Circuit and Ground Fault Protection. Each motor branch circuit and feeder of more than 600 volts shall be protected against overcurrent by one of the following means:

(a) A circuit breaker of suitable rating so arranged that it can be serviced without hazard.

(b) Fuses of the oil-filled or other suitable type. Fuses shall be used with suitable disconnecting means or they shall be of a type which can also serve as the disconnecting means. They shall be so arranged that they cannot be re-fused or replaced while they are energized.

(c) Differential protection may be employed to protect an alternating-current motor, the motor control apparatus, and the branch-circuit conductors against overcurrent due to short circuits or grounds. When all these elements are included within the protected zone of a differential protective system, the ratings or settings specified in Section 430-52 do not apply.

Differential Protective System (definition): A differential protective system is a combination of two or more sets of current transformers and a relay or relays energized from their interconnected secondaries.

The primaries of the current transformers are connected on both sides of the equipment to be protected, both ends of the motor phase windings being brought out for this purpose. All of the apparatus and circuits included between the sets of current transformer primaries constitute the protected zone. The current transformer secondaries and the relay elements are so interconnected that the relay elements respond only to a predetermined difference between the currents entering and leaving the protected zone. When actuated, the relay or relays serve to trip the branch-circuit circuit breaker, thus disconnecting the motor, control apparatus in the motor circuit and the branch-circuit conductors from the source of power and, in the case of a synchronous motor, de-energizing its field circuit.

430-126. Disconnecting Means. The circuit breaker or the fuses specified in Section 430-124 may constitute the disconnecting means if they conform to the other applicable requirements of this Article.

K. Protection of Live Parts - All Voltages

430-131. General. The provisions of Part K specify that live parts shall be protected in a manner judged adequate to the hazard involved.

430-132. Where Required. Exposed live parts of motors and controllers operating at 50 volts or more between terminals, shall be guarded against accidental contact by enclosure, or by location as follows:

(a) By installation in a room or enclosure which is accessible only to qualified persons;

(b) By installation on a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified

persons;

(c) By elevation 8 feet or more above the floor;

(d) So that it will be protected by a guard rail when the motor operates at 600 volts or less.

Exception: Stationary motors having commutators, collectors and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground.

430-133. Guards for Attendants. Where the live parts of motors or controllers operating at more than 150 volts to ground are guarded against accidental contact only by location as specified in Section 430-132, and where adjustment or other attendance may be necessary during the operating of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms. Where necessary, steps and hand-rails should be installed on or about large machines to afford safe access to parts which must be examined or adjusted during operation.

L. Grounding

430-141. General. The provisions of Part L specify the grounding of motor and controller frames to prevent a potential above ground in the event of accidental contact between live parts and frames. Insulation, isolation, or guarding are suitable alternatives to grounding of motors under certain conditions.

430-142. Stationary Motors. The frames of stationary motors shall be grounded where any of the following conditions exist:

(a) supplied by means of metal-enclosed wiring.

(b) located in a wet place and not isolated nor guarded.

(c) in a hazardous location. (See Articles f500 to 517 inclusive.)

(d) the motor operates with any terminal at more than 150 volts to ground.

Grounding of the motor frame is preferable, but where the frame of the motor is not grounded, it shall be permanently and effectively insulated from the ground.

430-143. Portable Motors. The frames of portable motors which operate at more than 150 volts to ground shall be guarded or grounded. See Section 250-45(d) on grounding of portable appliances in other than residential occupancies.

It is recommended that the frames of motors which operate at less than 150 volts to ground be grounded where this can be readily accomplished.

See Section 250-59(b) for color of grounding conductor.

430-144. Controllers. Controller cases, except those attached to ungrounded portable equipment and except the lined covers of snap switches, shall be grounded regardless of voltage.

430-145. Method of Grounding. Grounding where required shall be done in the manner specified in Article 250.

(a) Grounding Through Terminal Housings. Where the wiring to fixed motors is in Type AC metal-clad cable or metal raceways, junction boxes to house motor terminals shall be provided, and the armor of the cable or the metal raceways shall be connected to them in the manner specified in Articles 250.

(b) Separation of Junction Box from Motor. The junction box required by Section 430-145(a) may be separated from the motor not more than 6 feet provided the leads to the motor are Type AC metal-clad cable or armored cord or arc stranded leads enclosed in flexible or rigid conduit or electrical metallic tubing not smaller than 3/8 inch electrical trade size, the armor or raceway being connected both to the motor and to the box. Where stranded leads are used, protected as specified above, they shall not be larger than No. 10, and shall comply with other requirements of the Code for conductors to be used in raceways.

(c) Grounding of Controller Mounted Devices. Instrument transformer secondaries, and exposed noncurrent-carrying metal or other conductive parts or cases of instrument transformers, meters, instruments, and relays shall be grounded as specified in Sections 250-121 through 250-125.

Table 430-147. Full-Load Currents in Amperes
Direct-Current Motors

The following values of full-load currents are for motors running at base speed.

HP	120V	240V
1/4	2.9	1.5
1/3	3.6	1.8
1/2	5.2	2.6
3/4	7.4	3.7
1	9.4	4.7
1 1/2	13.2	6.6
2	17	8.5
3	25	12.2
5	40	20
7 1/2	58	29
10	76	38
15		55
20		72
25		89
30		106
40		140
50		173
60		206
75		255
100		341
125		425
150		506
200		675

Table 430-149. Full-Load Current

Two-Phase A.C. Motors (4-wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full load current varying with speed, in which case the nameplate current rating shall be used. Current in common conductor of 2-phase, 3-wire system will be 1.41 times value given.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480 and 550 to 600 volts.

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type ‡Unity Power Factor Amperes			
HP	**115V**	**230V**	**460V**	**575V**	**2300V**	**220V**	**440V**	**550V**	**2300V**
1/2	4	2	1	.8					
3/4	4.8	2.4	1.2	1.0					
1	6.4	3.2	1.6	1.3					
1 1/2	9	4.5	2.3	1.8					
2	11.8	5.9	3	2.4					
3		8.3	4.2	3.3					
5		13.2	6.6	5.3					
7 1/2		19	9	8					
10		24	12	10					
15		36	18	14					
20		47	23	19					
25		59	29	24		47	24	19	
30		69	35	28		56	29	23	
40		90	45	36		75	37	31	
50		113	56	45		94	47	38	
60		133	67	53	14	111	56	44	11
75		166	83	66	18	140	70	57	13
100		218	109	87	23	182	93	74	17
125		270	135	108	28	228	114	93	22
150		312	156	125	32		137	110	26
200		416	208	167	43		182	145	35

‡For 90 and 80 per cent P. F. the above figures should be multiplied by 1.2 and 1.25 respectively.

Table 430-150. Full-Load Current*

Three-Phase A.C. Motors

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type ‡Unity Power Factor Amperes			
HP	**115V**	**230V**	**460V**	**575V**	**2300V**	**220V**	**440V**	**550V**	**2300V**
1/2	4	2	1	.8					
3/4	5.6	2.8	1.4	1.1					
1	7.2	3.6	1.8	1.4					
1 1/2	10.4	5.2	2.6	2.1					
2	13.6	6.8	3.4	2.7					
3		9.6	4.8	3.9					
5		15.2	7.6	6.1					
7 1/2		22	11	9					
10		28	14	11					
15		42	21	17					
20		54	27	22					
25		68	34	27		54	27	22	
30		80	40	32		65	33	26	
40		104	52	41		86	43	35	
50		130	65	52		108	54	44	
60		154	77	62	16	128	64	51	12
75		192	96	77	20	161	81	65	15
100		248	124	99	26	211	106	85	20
125		312	156	125	31	264	132	106	25
150		360	180	144	37		158	127	30
200		480	240	192	49		210	168	40

For full-load currents of 208- and 200-volt motors, increase the corresponding 230 volt motor full-load current by 10 and 15 per cent, respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full load current varying with speed, in which case the nameplate current rating shall be used.

‡For 90 and 80 per cent P. F. the above figures shall be multiplied by 1.1 and 1.25 respectively.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480 and 50 to 600 volts.

Table 430-151.

Locked-Rotor Current Conversion Table

As Determined from Horsepower and Voltage Rating
For Use Only With Section 430-83, Exception No. 3, and 430-110(b)

Conversion Table

Max HP Rating	Motor Locked-Rotor Current Amperes					
	Single Phase		Two or Three Phase			
	115 V	230 V	115 V	230 V	460 V	575 V
1/2	58.8	29.4	24	12	6	4.8
3/4	82.8	41.4	33.6	16.8	8.4	6.6
1	96	48	42	21	10.8	8.4
1 1/2	120	60	60	30	15	12
2	144	72	--	39	19.8	15.6
3	204	102	--	54	27	24
5	336	168	--	90	45	36
7 1/2	480	240	--	132	66	54
10	600	300	--	162	84	66
15	--	--	--	240	120	96
20	--	--	--	312	156	126
25	--	--	--	384	192	156
30	--	--	--	468	234	186
40	--	--	--	624	312	246
50	--	--	--	750	378	300
60	--	--	--	900	450	360
75	--	--	--	1110	558	444
100	--	--	--	1476	738	588
125	--	--	--	1860	930	744
150	--	--	--	2160	1080	864
200	--	--	--	2880	1440	1152

Table 430-152. Maximum Rating or Setting of Motor Branch Circuit Protective Devices for Motors Marked with a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
		Circuit Breaker Setting	
	Fuse Rating	Instantaneous Type	Time Limit Type
All AC single-phase and polyphase squirrel cage and synchronous motors with full-voltage, resistor or reactor starting:			
Code Letter A	150	700	150
Code Letter B to E	250	700	200
Code Letter F to V	300	700	250
All AC squirrel cage and synchronous motors with auto-transformer starting:			
Code Letter A	150	700	150
Code Letter B to E	200	700	200
Code Letter F to V	250	700	200

For certain exceptions to the values specified see Sections 430-52 and 430-54. The values given in the last column also cover the ratings of nonadjustable, time-limit types of circuit breakers which may also be modified as in Section 430-52.

Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit breaker setting in excess of 200 per cent of full-load current.

For motors not marked with a Code Letter, see Tables 430-153.

Table 430-153. Maximum Rating or Setting of Motor Branch Circuit Protective Devices for Motors not Marked with a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
		Circuit Breaker Setting	
	Fuse Rating	Instantaneous Type	Time Limit Type
Single-phase, all types	300	700	250
Squirrel-cage and synchronous (full-voltage, resistor and reactor starting)	300	700	250
Squirrel-cage and synchronous (auto-transformer starting)			
Not more than 30 amperes	250	700	200
More than 30 amperes	200	700	200
High-reactance squirrel-cage			
Not more than 30 amperes	250	700	250
More than 30 amperes	200	700	200
Wound-rotor	150	700	150
Direct-current			
Not more than 50 H.P.	150	250	150
More than 50 H.P.	150	175	150
Sealed (Hermetic Type) Refrigeration Compressor* 400 KVA locked-rotor or less		**175	**175

For certain exceptions to the values specified see Sections 430-52, and 430-59. The values given in the last column also cover the ratings of nonadjustable, time-limit types of circuit breakers which may also be modified as in Section 430-52.

Synchronous motors of the low-torque low-speed type (usually 450 RPM or lower) such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require

a fuse rating or circuit breaker setting in excess of 200 per cent of full-load current.

For motors marked with a Code Letter, see Table 430-152.

*The locked rotor KVA is the product of the motor voltage and the motor locked rotor current (LRA) given on the motor nameplate divided by 1,000 for single-phase motors, or divided by 580 for 3-phase motors.

**This value may be increased to 225 per cent if necessary to permit starting.