Where close proximity does not cause excessive heating, parts of the same polarity at switches, enclosed fuses, and so forth shall be permitted to be placed as close together as convenience in handling will allow.

Exception: The distance shall be permitted to be less than that specified in Table 408.56 at circuit breakers and switches and in listed components installed in switchboards, switchgear, and panelboards.

Δ ***TABLE 408.56*** *Minimum Spacings Between Bare Metal Parts*

	Opposite Polarity Where Mounted on the Same Surface		Opposite Polarity Where Held Free in Air		Live Parts to Ground*	
AC or DC Voltage	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
Not over 125 volts, nominal	19.1	¾	12.7	½	12.7	½
Not over 250 volts, nominal	31.8	1¼	19.1	¾	12.7	½
Not over 1000 volts, nominal	50.8	2	25.4	1	25.4	1

*For spacing between live parts and doors of cabinets, the dimensions in 312.101(A) shall apply.

408.58 Panelboard Marking. Panelboards shall be durably marked by the manufacturer with the voltage and the current rating and the number of ac phases or dc buses for which they are designed and with the manufacturer's name or trademark in such a manner so as to be visible after installation, without disturbing the interior parts or wiring.

ARTICLE
409 Industrial Control Panels

Part I. General

Δ **409.1 Scope.** This article covers industrial control panels intended for general use and operating at 1000 volts or less.

Informational Note: See ANSI/UL 508A, *Standard for Industrial Control Panels*, a safety standard for industrial control panels.

Field- and factory-assembled control panels are used for the control and operation of many processes, from a sewage pump station to an industrial process line. Similar in function to motor control centers in some regards, control panels also contain control, overcurrent protection, and power distribution equipment for operation of industrial heating processes, robotics, spray painting and powder coating lines, and so forth.

Δ **409.3 Other Articles.** In addition to the requirements of this article, industrial control panels that contain branch circuits for specific loads or components, or are for control of specific types of equipment addressed in other articles of this *Code*, shall be constructed and installed in accordance with the applicable requirements from those articles.

Part II. Installation

409.20 Conductor — Minimum Size and Ampacity. The size of the industrial control panel supply conductor shall have an ampacity not less than 125 percent of the full-load current rating of all heating loads plus 125 percent of the full-load current rating of the highest rated motor plus the sum of the full-load current ratings of all other connected motors and apparatus based on their duty cycle that may be in operation at the same time.

409.21 Overcurrent Protection.

(A) General. Industrial control panels shall be provided with overcurrent protection in accordance with Parts I and II of Article 240.

(B) Location. This protection shall be provided for each incoming supply circuit by either of the following:

(1) An overcurrent protective device located ahead of the industrial control panel.
(2) A single main overcurrent protective device located within the industrial control panel. Where overcurrent protection is provided as part of the industrial control panel, the supply conductors shall be considered as either feeders or taps as covered by 240.21.

(C) Rating. The rating or setting of the overcurrent protective device for the circuit supplying the industrial control panel shall not be greater than the sum of the largest rating or setting of the branch-circuit short-circuit and ground-fault protective device provided with the industrial control panel, plus 125 percent of the full-load current rating of all resistance heating loads, plus the sum of the full-load currents of all other motors and apparatus that could be in operation at the same time.

Exception: Where one or more instantaneous trip circuit breakers or motor short-circuit protectors are used for motor branch-circuit short-circuit and ground-fault protection as permitted by 430.52(C), the procedure specified above for determining the maximum rating of the protective device for the circuit supplying the industrial control panel shall apply with the following provision: For the purpose of the calculation, each instantaneous trip circuit breaker or motor short-circuit protector shall be assumed to have a rating not exceeding the maximum percentage of motor full-load current permitted by Table 430.52(C)(1) for the type of control panel supply circuit protective device employed.

Where no branch-circuit short-circuit and ground-fault protective device is provided with the industrial control panel for

motor or combination of motor and non-motor loads, the rating or setting of the overcurrent protective device shall be based on 430.52 and 430.53, as applicable.

409.22 Short-Circuit Current Rating.

(A) Installation. An industrial control panel shall not be installed where the available fault current exceeds its short-circuit current rating as marked in accordance with 409.110(4).

(B) Documentation. If an industrial control panel is required to be marked with a short-circuit current rating in accordance with 409.110(4), the available fault current at the industrial control panel and the date the available fault current calculation was performed shall be documented and made available to those authorized to inspect, install, or maintain the installation.

409.30 Disconnecting Means. Disconnecting means that supply motor loads shall comply with Part IX of Article 430.

409.60 Bonding. Industrial control panels shall be grounded and bonded in accordance with 409.60(A) and (B).

N **(A) Grounding.** An equipment grounding conductor sized in accordance with 250.122 shall be connected to an equipment grounding bus or to an equipment grounding termination point provided in a single-section industrial control panel.

N **(B) Bonding.** Multisection industrial control panels shall be bonded together using an equipment bonding jumper sized in accordance with 250.102(D).

N **409.70 Surge Protection.** Safety circuits for personnel protection that are subject to damage from surge events shall have surge protection installed within or immediately adjacent to the control panel.

Part III. Construction Specifications

Part III provides the AHJ with a set of requirements that can be used as a benchmark for approval of a field-constructed control panel.

409.100 Enclosures. Table 110.28 shall be used as the basis for selecting industrial control panel enclosures for use in specific locations other than hazardous (classified) locations. The enclosures are not intended to protect against conditions such as condensation, icing, corrosion, or contamination that may occur within the enclosure or enter via the conduit or unsealed openings.

Δ **409.102 Busbars.** Industrial control panels utilizing busbars shall comply with 409.102(A) and (B).

(A) Support and Arrangement. Busbars shall be protected from physical damage and be held firmly in place.

(B) Phase Arrangement. The phase arrangement on 3-phase horizontal common power and vertical buses shall be A, B, C from front to back, top to bottom, or left to right, as viewed from the front of the industrial control panel. The B phase shall be that phase having the higher voltage to ground on 3-phase, 4-wire, delta-connected systems. Other busbar arrangements shall be permitted for additions to existing installations, and the phases shall be permanently marked.

409.104 Wiring Space.

(A) General. Industrial control panel enclosures shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices or other equipment, unless the conductors fill less than 40 percent of the cross-sectional area of the wiring space. In addition, the conductors, splices, and taps shall not fill the wiring space at any cross section to more than 75 percent of the cross-sectional area of that space.

(B) Wire Bending Space. Wire bending space within industrial control panels for field wiring terminals shall be in accordance with the requirements in 430.10(B).

409.106 Spacings. Spacings in feeder circuits between uninsulated live parts of adjacent components, between uninsulated live parts of components and grounded or accessible non–current-carrying metal parts, between uninsulated live parts of components and the enclosure, and at field wiring terminals shall be as shown in Table 430.97(D).

Exception: Spacings shall be permitted to be less than those specified in Table 430.97(D) at circuit breakers and switches and in listed components installed in industrial control panels.

409.108 Service Equipment. Where used as service equipment, each industrial control panel shall be of the type that is suitable for use as service equipment.

Where a grounded conductor is provided, the industrial control panel shall be provided with a main bonding jumper, sized in accordance with 250.28(D), for connecting the grounded conductor, on its supply side, to the industrial control panel equipment ground bus or equipment ground terminal.

Δ **409.110 Marking.** An industrial control panel shall have permanent markings that are visible after installation. The markings in 409.110(2) and (3) shall be attached to the outside of the enclosure. The markings in 409.110(1), (4), (5), (6), and (7) shall be attached to either the inside or outside of the enclosure. The following markings shall be included:

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified.

(2) Supply voltage, number of phases, frequency, and full-load current for each incoming supply circuit.
(3) Where the industrial control panel is supplied by more than one electrical source and where more than one disconnecting means is required to disconnect all circuits 50-volts or more within the control panel, marked to indicate that more than one disconnecting means is required to de-energize the equipment. The location of the means necessary to disconnect all circuits 50-volts or more shall be documented and available.

The person servicing the industrial control panel might not realize that more than one power source supplies the panel. Indication that multiple power sources are present and documentation that lists the location of all applicable disconnects help ensure the safety of service personnel. This requirement is similar to the requirement in Section 55.4 of UL 508A, *Standard for Industrial Control Panels*, which is the standard for listed industrial control panels.

(4) Short-circuit current rating of the industrial control panel based on one of the following:

a. Short-circuit current rating of a listed and labeled assembly
b. Short-circuit current rating established utilizing an approved method

Informational Note: See ANSI/UL 508A, *Standard for Industrial Control Panels*, Supplement SB, for an example of an approved method.

Exception to (4): Short-circuit current rating markings are not required for industrial control panels containing only control circuit components.

A group of components assembled in a common enclosure for the purposes of operation, control, and overcurrent protection should be able to limit and contain the effects of an internal fault (such as a short circuit or ground fault) so that the internal fault does not pose an external threat.

However, in many control panel installations, the available fault energy at the line terminals of components within the control panel is significant. In addition, there is also an interaction of the protective and control components under fault conditions that can be assessed only as part of the evaluation of the panel by a qualified testing laboratory. The panel's short-circuit current rating must be able to withstand the available short-circuit current at the panel terminals.

(5) If the industrial control panel is intended as service equipment, marked to identify it as being suitable for use as service equipment.
(6) Electrical wiring diagram, the identification number of a separate electrical wiring diagram, or a designation referenced in a separate wiring diagram.
(7) An enclosure type number.

ARTICLE 410

Luminaires, Lampholders, and Lamps

Part I. General

410.1 Scope. This article covers luminaires, portable luminaires, lampholders, pendants, incandescent filament lamps, arc lamps, electric-discharge lamps, decorative lighting products, lighting accessories for temporary seasonal and holiday use, portable flexible lighting products, and the wiring and equipment forming part of such products and lighting installations.

Δ **410.2 Reconditioned Equipment.** Reconditioned luminaires, lampholders, ballasts, LED drivers, lamps, and retrofit kits shall not be permitted. If a retrofit kit is installed in a luminaire in accordance with the installation instructions, the retrofitted luminaire shall not be considered reconditioned.

410.5 Live Parts. Luminaires, portable luminaires, lampholders, and lamps shall have no live parts normally exposed to contact. Exposed accessible terminals in lampholders and switches shall not be installed in metal luminaire canopies or in open bases of portable table or floor luminaires.

Exception: Cleat-type lampholders located at least 2.5 m (8 ft) above the floor shall be permitted to have exposed terminals.

410.6 Listing Required. All luminaires, lampholders, and retrofit kits shall be listed.

410.8 Inspection. Luminaires shall be installed such that the connections between the luminaire conductors and the circuit conductors can be inspected without requiring the disconnection of any part of the wiring unless the luminaires are connected by attachment plugs and receptacles.

Part II. Luminaire Locations

410.10 Luminaires in Specific Locations.

(A) Wet and Damp Locations. Luminaires installed in wet or damp locations shall be installed such that water cannot enter or accumulate in wiring compartments, lampholders, or other electrical parts. All luminaires installed in wet locations shall be marked as suitable for wet locations. All luminaires installed in damp locations shall be marked as suitable for wet locations or suitable for damp locations.

Correct design, construction, and installation of these luminaires will prevent the entrance of rain, snow, ice, and dust. Outdoor parks and parking lots, outdoor recreational areas, car wash areas, and building exteriors are examples of wet locations.

Luminaires in locations protected from the weather and not subject to water saturation but still exposed to moisture must be