

of not less than 125 percent of the total connected load. The ampacities for busbars shall be in accordance with 366.23.

669.6 Wiring Methods. Conductors connecting the electrolyte tank equipment to the conversion equipment shall be in accordance with 669.6(A) and (B).

(A) Systems Not Exceeding 60 Volts Direct Current. Insulated conductors shall be permitted to be run without insulated support, provided they are protected from physical damage. Bare copper or aluminum conductors shall be permitted where supported on insulators.

(B) Systems Exceeding 60 Volts Direct Current. Insulated conductors shall be permitted to be run on insulated supports, provided they are protected from physical damage. Bare copper or aluminum conductors shall be permitted where supported on insulators and guarded against accidental contact up to the point of termination in accordance with 110.27.

669.7 Warning Signs. Warning signs shall be posted to indicate the presence of bare conductors. The warning sign(s) or label(s) shall comply with 110.21(B).

669.8 Disconnecting Means.

(A) More Than One Power Supply. Where more than one power supply serves the same dc system, a disconnecting means shall be provided on the dc side of each power supply.

(B) Removable Links or Conductors. Removable links or removable conductors shall be permitted to be used as the disconnecting means.

669.9 Overcurrent Protection. Direct-current conductors shall be protected from overcurrent by one or more of the following:

- (1) Fuses or circuit breakers
- (2) A current-sensing device that operates a disconnecting means
- (3) Other approved means

ARTICLE

670

Industrial Machinery

Δ **670.1 Scope.** This article covers the nameplate data for, overvoltage protection for, and the size and overcurrent protection of supply conductors to industrial machinery.

Informational Note No. 1: See NFPA 79, *Electrical Standard for Industrial Machinery*, for further information.

The equipment and wiring of industrial machinery, for which different component parts may be purchased and assembled at the location of use, must be installed in accordance with the applicable articles in the NEC®. Machinery assembled by the

manufacturer, in accordance with NFPA 79, *Electrical Standard for Industrial Machinery*, then disassembled for shipping and reassembled at its place of use, comes under only Article 670 and any NEC sections referenced herein. In this case, the machinery is treated as a package unit.

The information to be included on the nameplate allows for proper conductor sizing, overcurrent protection of the feeder or branch circuit supplying the industrial machine, and integration of the machine into the facility electrical system.

Informational Note No. 2: See 110.26 for information on the workspace requirements for equipment containing supply conductor terminals.

Informational Note No. 3: See NFPA 79, *Electrical Standard for Industrial Machinery*, for information on the workspace requirements for machine power and control equipment.

Working clearances around control equipment enclosures and compartments containing equipment operating at 1000 volts or less and that are an integral part of an industrial machine are contained in Section 11.5 in NFPA 79. The requirements of NFPA 79 closely parallel those found in 110.26(A), but some requirements in NFPA 79 allow smaller clearances under very specific conditions of operation and equipment construction.

670.3 Machine Nameplate Data.

Informational Note: See 430.22(E) and 430.26 for duty cycle requirements.

Δ **(A) Permanent Nameplate.** A permanent nameplate shall be attached to the outside of the control equipment enclosure or on the machine immediately adjacent to the main control equipment enclosure that is visible after installation. The nameplate shall include the following information:

- (1) Supply voltage, number of phases, frequency, and full-load current
- (2) Maximum ampere rating of the short-circuit and ground-fault protective device
- (3) Ampere rating of largest motor, from the motor nameplate, or load
- (4) Short-circuit current rating of the machine industrial control panel based on one of the following:
 - a. Short-circuit current rating of a listed and labeled machine control enclosure or assembly
 - b. Short-circuit current rating established using an approved method

Informational Note: See UL 508A-2017, *Industrial Control Panels, Supplement SB*, for an example of an approved method.

- (5) Electrical diagram number(s) or the number of the index to the electrical drawings

The full-load current shown on the nameplate shall not be less than the sum of the full-load currents required for all motors and other equipment that can be in operation at the same time under normal conditions of use. Where unusual type loads, duty cycles, and so forth require oversized conductors or permit

reduced-size conductors, the required capacity shall be included in the marked “full-load current.” Where more than one incoming supply circuit is to be provided, the nameplate shall state the preceding information for each circuit.

An industrial machine’s nameplate must provide the short-circuit current rating of the machine’s industrial control panel. That rating is established either as part of the listing of the control enclosure or assembly or, for assemblies that are not listed, by an approved method of determining the short-circuit current rating.

In the absence of product listing, Supplement SB to UL 508A, *Standard for Industrial Control Panels*, is referred to as one example of a method for determining the short-circuit current rating of a control panel or assembly that could be used as a basis for equipment approval.

The second paragraph of 670.3(A) recognizes that the operating characteristics of an industrial machine may permit the use of over-sized or reduced-sized feeder conductors. An example of this is an industrial machine containing motors sized for high torque but, in normal operation, run at close to no-load current values. In this case, it may be appropriate to reduce the full-load current marking on the machine nameplate.

See also

430.26, which covers feeder demand factors

(B) Overcurrent Protection. Where overcurrent protection is provided in accordance with 670.4(C), the machine shall be marked “overcurrent protection provided at machine supply terminals.”

670.4 Supply Conductors and Overcurrent Protection.

(A) Size. The size of the supply conductor shall be such as to have an ampacity not less than 125 percent of the full-load current rating of all resistance 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.

Informational Note No. 1: See Table 310.16 through Table 310.20 for ampacity of conductors rated 2000 volts and below.

Informational Note No. 2: See 430.22(E) and 430.26 for duty cycle requirements.

The duty cycle of motors and apparatus must be considered when determining the minimum ampacity of a supply circuit conductor for an industrial machine. Depending on the operating characteristics of the motor, the duty cycle of the apparatus might not always result in reduction of the supply conductor ampacity. Where motors are used in other than a continuous-duty mode of operation, Table 430.22(E) provides percentages by which the full-load current of a given motor is increased or decreased for the purpose of sizing motor circuit conductors. A motor that is loaded continuously under any conditions of use is an example of a continuous-duty application.

(B) Disconnecting Means. A machine shall be considered as an individual unit and therefore shall be provided with disconnecting means. The disconnecting means shall be permitted to be supplied by branch circuits protected by either fuses or circuit breakers. The disconnecting means shall not be required to incorporate overcurrent protection.

Informational Note: See NFPA 70E, *Standard for Electrical Safety in the Workplace*, which provides guidance for creating an electrically safe work condition for performing maintenance or other work on the machine.

Regarding the machine disconnecting means, the 2021 edition of NFPA 79, *Electrical Standard for Industrial Machinery*, states, in part: “The center of the grip of the operating handle of a supply circuit disconnecting means, when in its highest position, shall be not more than 2.0 m (6 ft 7 in.) above the servicing level. A permanent operating platform, readily accessible by means of a permanent stair(s) or ladder, shall be considered the servicing level.”

The disconnecting means shall “be provided with a permanent means permitting it to be locked in the off (open) position only (e.g., by padlocks) independent of the enclosure door or enclosure cover position. When so locked, remote as well as local closing into the on position shall be prevented.”

(C) Overcurrent Protection. Where furnished as part of the machine, overcurrent protection for each supply circuit shall consist of a single circuit breaker or set of fuses, the machine shall bear the marking required in 670.3, and the supply conductors shall be considered either as feeders or as taps as covered by 240.21.

The rating or setting of the overcurrent protective device for the circuit supplying the machine 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 machine, 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 in 670.4(C) for determining the maximum rating of the protective device for the circuit supplying the machine 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 machine supply circuit protective device employed.

Where no branch-circuit short-circuit and ground-fault protective device is provided with the machine, the rating or setting of the overcurrent protective device shall be based on 430.52 and 430.53, as applicable.

The nameplate provides the necessary information to size the branch-circuit or feeder conductors, the machine disconnecting means, and overcurrent protection. The computation of motor and nonmotor loads is reflected on the nameplate as full-load amperes, and no further calculation is necessary. Sizing of circuit conductors and overcurrent protection beyond the machine disconnecting means is under the scope of NFPA 79, *Electrical Standard for Industrial Machinery*.

670.5 Short-Circuit Current Rating.

(A) Installation. Industrial machinery shall not be installed where the available fault current exceeds its short-circuit current rating as marked in accordance with 670.3(A)(4).

(B) Available Short-Circuit Current Field Marking. Industrial machinery shall be legibly marked in the field with the available fault current. The field marking(s) shall include the date the available fault current calculation was performed and be of sufficient durability to withstand the environment involved.

670.6 Overvoltage Protection. Industrial machinery with safety circuits shall have overvoltage protection.

A study commissioned by the Fire Protection Research Foundation, "Data Assessment for Electrical Surge Protection Devices," provides results of a 2013–2014 survey of facility managers concerning surge damage. It shows that 26 percent had damage to safety interlocking systems on industrial machines due to surges. Safety interlocking systems are in place to protect workers and maintenance personnel from contact with exposed live parts and electric shock. The report can be found at www.nfpa.org/news-and-research.

ARTICLE

675

Electrically Driven or Controlled Irrigation Machines

Part I. General

675.1 Scope. This article applies to electrically driven or controlled irrigation machines, and to the branch circuits and controllers for such equipment.

Electric pump motors used to supply water to irrigation machines are covered by the general requirements of the *NEC*® and not by Article 675. Exhibit 675.1 shows an electrically driven irrigation machine, which is covered by the requirements of Article 675. An example of control equipment used for an irrigation machine is shown in Exhibit 675.2.

675.4 Irrigation Cable.

(A) Construction. The cable used to interconnect enclosures on the structure of an irrigation machine shall be an assembly of stranded, insulated conductors with nonhygroscopic and



EXHIBIT 675.1 An electrically driven irrigation machine. (Courtesy of Valmont Industries, Inc.)



EXHIBIT 675.2 Example of control equipment for an irrigation machine. (Courtesy of Valmont Industries, Inc.)

nonwicking filler in a core of moisture- and flame-resistant non-metallic material overlaid with a metallic covering and jacketed with a moisture-, corrosion-, and sunlight-resistant nonmetallic material.

The conductor insulation shall be of a type listed in Table 310.4(1) for an operating temperature of 75°C (167°F) or higher and for use in wet locations. The core insulating material thickness shall not be less than 0.76 mm (30 mils), and the metallic overlay thickness shall be not less than 0.20 mm (8 mils). The jacketing material thickness shall be not less than 1.27 mm (50 mils).

A composite of power, control, and grounding conductors in the cable shall be permitted.

(B) Alternate Wiring Methods. Installation of other listed cables complying with the construction requirements of 675.4(A) shall be permitted.

(C) Supports. Irrigation cable shall be secured by straps, hangers, or similar fittings identified for the purpose and so installed