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

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.)*

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

as not to damage the cable. Cable shall be supported at intervals not exceeding 1.2 m (4 ft).

(D) Fittings. Fittings shall be used at all points where irrigation cable terminates. The fittings shall be designed for use with the cable and shall be suitable for the conditions of service.

675.5 More Than Three Conductors in a Raceway or Cable. The signal and control conductors of a raceway or cable shall not be counted for the purpose of ampacity adjustment as required in 310.15(C)(1).

675.6 Marking on Main Control Panel. The main control panel shall be provided with a nameplate giving the following information:

(1) The manufacturer's name, the rated voltage, the phase, and the frequency
(2) The current rating of the machine
(3) The rating of the main disconnecting means and size of overcurrent protection required

675.7 Equivalent Current Ratings. Where intermittent duty is not involved, Article 430 shall be used for determining ratings for controllers, disconnecting means, conductors, and the like. Where irrigation machines have inherent intermittent duty, the determinations of equivalent current ratings in 675.7(A) and (B) shall be used.

(A) Continuous-Current Rating. The equivalent continuous-current rating for the selection of branch-circuit conductors and overcurrent protection shall be equal to 125 percent of the motor nameplate full-load current rating of the largest motor, plus a quantity equal to the sum of each of the motor nameplate full-load current ratings of all remaining motors on the circuit, multiplied by the maximum percent duty cycle at which they can continuously operate.

(B) Locked-Rotor Current. The equivalent locked-rotor current rating shall be equal to the numerical sum of the locked-rotor current of the two largest motors plus 100 percent of the sum of the motor nameplate full-load current ratings of all the remaining motors on the circuit.

675.8 Disconnecting Means.

(A) Main Controller. A controller that is used to start and stop the complete machine shall meet all of the following requirements:

(1) An equivalent continuous current rating not less than specified in 675.7(A) or 675.22(A)
(2) A horsepower rating not less than the value from Table 430.251(A) and Table 430.251(B), based on the equivalent locked-rotor current specified in 675.7(B) or 675.22(B)

Exception: A listed molded case switch shall not require a horsepower rating.

A listed molded case switch used as a motor controller is not required to have a horsepower rating, but it is required to have a continuous-current (ampere) rating not less than that specified by 675.7(A) or 675.22(A).

(B) Main Disconnecting Means. The main disconnecting means for the machine shall provide overcurrent protection, shall be at the point of connection of electric power to the machine, or shall be in sight from the machine, and it shall be readily accessible and lockable open in accordance with 110.25. This disconnecting means shall have a horsepower and current rating not less than required for the main controller.

Exception No. 1: Circuit breakers without marked horsepower ratings shall be permitted in accordance with 430.109.

Exception No. 2: A listed molded case switch without marked horsepower ratings shall be permitted.

The main disconnecting means is permitted to be up to 50 feet from the machine but must be in sight, readily accessible, and capable of being locked in the open position. This eliminates one set of overcurrent protective devices (OCPDs) and one disconnecting means where the circuit originates at the motor control panel for the irrigation pump and the panel is located within 50 feet of the center pivot machine. It also alleviates some potential problems with machines designed to be towed to a second site.

(C) Disconnecting Means for Individual Motors and Controllers. A disconnecting means shall be provided to simultaneously disconnect all ungrounded conductors for each motor and controller and shall be located as required by Article 430, Part IX. The disconnecting means shall not be required to be readily accessible.

675.9 Branch-Circuit Conductors. The branch-circuit conductors shall have an ampacity not less than specified in 675.7(A) or 675.22(A).

675.10 Several Motors on One Branch Circuit.

(A) Protection Required. Several motors, each not exceeding 2 hp rating, shall be permitted to be used on an irrigation machine circuit protected at not more than 30 amperes at 1000 volts, nominal, or less, provided all of the following conditions are met:

(1) The full-load rating of any motor in the circuit shall not exceed 6 amperes.
(2) Each motor in the circuit shall have individual overload protection in accordance with 430.32.
(3) Taps to individual motors shall not be smaller than 14 AWG copper and not more than 7.5 m (25 ft) in length.

(B) Individual Protection Not Required. Individual branch-circuit short-circuit protection for motors and motor controllers shall not be required where the requirements of 675.10(A) are met.

675.11 Collector Rings.

(A) Transmitting Current for Power Purposes. Collector rings shall have a current rating not less than 125 percent of the full-load current of the largest device served plus the full-load current of all other devices served, or as determined from 675.7(A) or 675.22(A).

(B) Control and Signal Purposes. Collector rings for control and signal purposes shall have a current rating not less than 125 percent of the full-load current of the largest device served plus the full-load current of all other devices served.

(C) Grounding. The collector ring used for grounding shall have a current rating not less than that sized in accordance with 675.11(A).

(D) Protection. Collector rings shall be protected from the expected environment and from accidental contact by means of a suitable enclosure.

Δ **675.12 Grounding.** The following equipment shall be grounded:

(1) All electrical equipment on the irrigation machine
(2) All electrical equipment associated with the irrigation machine
(3) Metal junction boxes and enclosures
(4) Control panels or control equipment that supplies or controls electrical equipment to the irrigation machine

Exception: Grounding shall not be required on machines where all of the following provisions are met:

(1) The machine is electrically controlled but not electrically driven.
(2) The control voltage is 30 volts or less.
(3) The control or signal circuits are current limited as specified in Chapter 9, Tables 11(A) and 11(B).

675.13 Methods of Grounding. Machines that require grounding shall have a non–current-carrying equipment grounding conductor provided as an integral part of each cord, cable, or raceway. This equipment grounding conductor shall be sized not less than the largest supply conductor in each cord, cable, or raceway. Feeder circuits supplying power to irrigation machines shall have an equipment grounding conductor sized according to Table 250.122.

675.14 Bonding. Where electrical grounding is required on an irrigation machine, the metallic structure of the machine, metallic conduit, or metallic sheath of cable shall be connected to the equipment grounding conductor. Metal-to-metal contact with a part that is connected to the equipment grounding conductor and the non–current-carrying parts of the machine shall be considered as an acceptable bonding path.

675.15 Lightning Protection. If an irrigation machine has a stationary point, a grounding electrode system in accordance with Article 250, Part III, shall be connected to the machine at the stationary point for lightning protection.

If the electrical power supply to irrigation machine equipment is a service, the requirements of Article 250 for grounding the system and equipment are applicable. Due to the physical location of irrigation equipment, the most likely grounding electrode is a driven ground rod or ground plate. Where lightning protection is installed, NFPA 780, *Standard for the Installation of Lightning Protection Systems*, requires an electrode for that system. In accordance with 250.60, a common electrode is not permitted to serve the dual function of grounding the electric service and grounding the lightning protection system. However, the separate electrode systems are required to be bonded together but separated from each other in accordance with NFPA 780.

675.16 Energy from More Than One Source. Equipment within an enclosure receiving electric energy from more than one source shall not be required to have a disconnecting means for the additional source if its voltage is 30 volts or less and it meets the requirements of Part II of Article 725.

675.17 Connectors. External plugs and connectors on the equipment shall be of the weatherproof type.

Unless provided solely for the connection of circuits meeting the requirements of Part II of Article 725, external plugs and connectors shall be constructed as specified in 250.124(A).

Part II. Center Pivot Irrigation Machines

675.21 General. Part II covers additional special requirements that are peculiar to center pivot irrigation machines. Article 100 for the definition of *Center Pivot Irrigation Machine*.

675.22 Equivalent Current Ratings. To establish ratings of controllers, disconnecting means, conductors, and the like, for the inherent intermittent duty of center pivot irrigation machines, the determinations in 675.22(A) and (B) shall be used.

(A) Continuous-Current Rating. The equivalent continuous-current rating for the selection of branch-circuit conductors and branch-circuit devices shall be equal to 125 percent of the motor nameplate full-load current rating of the largest motor plus 60 percent of the sum of the motor nameplate full-load current ratings of all remaining motors on the circuit.

(B) Locked-Rotor Current. The equivalent locked-rotor current rating shall be equal to the numerical sum of two times the locked-rotor current of the largest motor plus 80 percent of the sum of the motor nameplate full-load current ratings of all the remaining motors on the circuit.