b. The overcurrent protective device shall not open with a re-start transient of 24 times the full-load current of the fire pump motor(s).
c. The overcurrent protective device shall not open within 10 minutes at 300 percent of the full-load current of the fire pump motor(s).
d. The trip point for circuit breakers shall not be field adjustable. [**20:**9.2.3.4.1]

(b) *On-Site Standby Generators.* Overcurrent protective devices between an on-site standby generator and a fire pump controller shall be selected and sized to allow for instantaneous pickup of the full pump room load, but shall not be larger than the value selected to comply with 430.62 to provide short-circuit protection only. [**20:**9.6.1.1]

This requirement correlates with 695.3(D)(1) covering the required capacity of an on-site standby generator. OCPDs supplied by an on-site standby generator are not required to be sized to carry the locked-rotor current (LRC) of the fire pump(s) indefinitely. The on-site standby generator is not limited to supplying only the fire pump. Where other pump room loads such as lights or fans are supplied, the generator must have sufficient capacity to instantaneously carry the entire load supplied. The OCPDs are not required to provide overload protection and are required to be sized per 430.62.

(3) Disconnecting Means. All disconnecting devices that are unique to the fire pump loads shall comply with items 695.4(B)(3)(a) through (B)(3)(e).

(a) *Features and Location — Normal Power Source.* The disconnecting means for the normal power source shall comply with all of the following: [**20:**9.2.3.1]

(1) Be identified as suitable for use as service equipment.
(2) Be lockable in the closed position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed.
(3) Not be located within the same enclosure, panelboard, switchboard, switchgear, or motor control center, with or without common bus, that supplies loads other than the fire pump.
(4) Be located sufficiently remote from other building or other fire pump source disconnecting means such that inadvertent operation at the same time would be unlikely.

Exception to 695.4(B)(3)(a): For a multibuilding campus-style complex(s) installed under the provisions of 695.3(C), only the requirements in 695.4(B)(3)(a)(2) shall apply for normal power source disconnects.

A disconnecting means supplied by one of the individual sources specified in 695.3(A) cannot be installed in distribution equipment that supplies other than fire pump loads. Although Article 700 permits separate switchboard sections for other standby loads, 695.4(B)(3)(a)(3) does not permit it for fire pump source disconnecting means.

(b) *Features and Location — On-Site Standby Generator.* The disconnecting means for an on-site standby generator(s) used as the alternate power source shall be installed in accordance with 700.10(B)(6) for emergency circuits and shall be lockable in the closed position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed.

A disconnecting means supplied by an on-site standby generator is permitted to be installed in equipment that supplies other loads. However, compliance with 700.10(B)(6) is required. The effect of this requirement is that a fire pump feeder cannot be supplied from equipment in which the fire pump conductors are installed in the same enclosure or vertical switchboard section with conductors supplying loads that are designated or classed as legally required standby (Article 701) or optional standby (Article 702) loads. To help minimize inadvertent opening of the fire pump circuit, the disconnecting means is required to be capable of being locked in the closed (on) position.

(c) *Disconnect Marking.* The disconnecting means shall be marked "Fire Pump Disconnecting Means." The letters shall be at least 25 mm (1 in.) in height, and they shall be visible without opening enclosure doors or covers. [**20:**9.2.3.1(5)]

(d) *Controller Marking.* A placard shall be placed adjacent to the fire pump controller, stating the location of this disconnecting means and the location of the key (if the disconnecting means is locked). [**20:**9.2.3.2]

(e) *Supervision.* The disconnecting means shall be supervised in the closed position by one of the following methods:

(1) Central station, proprietary, or remote station signal device
(2) Local signaling service that causes the sounding of an audible signal at a constantly attended point
(3) Locking the disconnecting means in the closed position

(f) Sealing of disconnecting means and approved weekly recorded inspections when the disconnecting means are located within fenced enclosures or in buildings under the control of the owner [**20:**9.2.3.3]

Supervision of the disconnecting means is required to ensure an uninterrupted power supply to the fire pump. Ideally, power supply conductors are run directly to the listed fire pump control and/or transfer equipment without the need for an additional service disconnecting means and overcurrent protection. However, this arrangement is not always possible; therefore, the single disconnecting means in 695.4(B) is permitted, provided it is locked in the closed position or monitored to ensure that it remains in the closed position.

Supervision (monitoring) of the disconnecting means by a local (protected premises) fire alarm system, central station, proprietary supervising station, or remote supervising station

requires a connection to the premises fire alarm system. A fire alarm system initiating device circuit will generate a supervisory signal at the fire alarm control unit on loss of voltage to the fire pump controller. For more information on this interface with the fire alarm system, see *NFPA 72®, National Fire Alarm and Signaling Code®*.

Calculation Example

A fusible service disconnect switch supplies power to a 100-hp, 460-V, 3-phase fire pump and to a 1½-hp, 460-V, 3-phase jockey pump. Determine the sizes of the disconnecting means and the OCPD for the system. Also determine the minimum ampacity of the feeder conductors.

Solution

Step 1. Determine the minimum ratings of the disconnecting means and the OCPD.

According to the motor nameplates, the locked-rotor current (LRC) is 725 A for the 100-hp motor and 20 A for the 1½-hp motor. If the locked-rotor amperes are not on the nameplates, the LRCs found in Table 430.251(B) must be used. Calculate the size by summing the LRC of both motors and then going to the next larger standard-size OCPD, as follows:

100-hp, 3-phase LRC = 725 A
1½-hp, 3-phase LRC = 20 A
Total LRC = 745 A

The next larger standard-size disconnect switch and overcurrent device is 800 A. An adjustable-trip circuit breaker of 750 A also is permitted, because it, too, will carry the LRC indefinitely.

Step 2. Determine the minimum ampacity for the fire pump feeder conductor.

Even though the disconnect switch and the overcurrent device are sized according to LRCs, the feeder conductors to the fire pump and associated equipment are required to have an ampacity not less than 125 percent of the full-load current (FLC) rating of the fire pump motor(s) and pressure maintenance pump motor(s), plus 100 percent of associated accessory equipment. Calculate the size of the feeder to the fire pump controller using 430.6(A)(1) and Table 430.250 for the FLC of the motors:

100-hp, 3-phase FLC

$$124\text{ A} \times 1.25 = 155.0\text{ A}$$

1½-hp, 3-phase FLC

$$3\text{ A} \times 1.25 = 3.75\text{ A}$$

Total FLC = 158.75 A or 159 A

Thus, the minimum ampacity for the feeder conductors is 159 A. Using the 75°C column, per 110.14(C)(1)(b), from Table 310.16, a 2/0 copper conductor is the minimum size required.

695.5 Transformers. Where the service or system voltage is different from the utilization voltage of the fire pump motor, transformer(s) protected by disconnecting means and overcurrent protective devices shall be permitted to be installed between the system supply and the fire pump controller in accordance with 695.5(A) and (B), or with (C). Only transformers covered in 695.5(C) shall be permitted to supply loads not directly associated with the fire pump system.

(A) Size. Where a transformer supplies an electric motor driven fire pump, it shall be rated at a minimum of 125 percent of the sum of the fire pump motor(s) and pressure maintenance pump(s) motor loads, and 100 percent of the associated fire pump accessory equipment supplied by the transformer.

(B) Overcurrent Protection. The primary overcurrent protective device(s) shall be selected or set to carry indefinitely the sum of the locked-rotor current of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current of the associated fire pump accessory equipment when connected to this power supply. Secondary overcurrent protection shall not be permitted. The requirement to carry the locked-rotor currents indefinitely shall not apply to conductors or devices other than overcurrent devices in the fire pump motor circuit(s).

The sizing of dedicated transformers and overcurrent protection can be broken down into three basic requirements. Generally stated, they are as follows:

1. The transformer must be sized to at least 125 percent of the sum of the loads.
2. The transformer primary overcurrent device must be the sum of locked-rotor current (LRC) of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current (FLC) of the associated fire pump accessory equipment. This differs from the general requirements of sizing overcurrent protection for fire pump motors.
3. The transformer secondary must not contain any overcurrent devices.

See Exhibit 695.4 for a one-line diagram on applying the dedicated fire pump transformer overcurrent protection requirements. Alternately, the jockey pump could be supplied by a separate panelboard.

Calculation Example

A 4160/480-V, 3-phase, dedicated transformer supplies power to a 100-hp, 460-V, 3-phase, code letter G fire pump and to a 1½-hp, 460-V, 3-phase, code letter H jockey pump. Determine the sizes of the dedicated transformer and its primary overcurrent protection.

Solution

Step 1. Determine the minimum standard-size transformer. First, to determine the minimum current value for use in the 3-phase power calculation, add the FLCs of the fire pump motor(s) and jockey pump motor(s). The FLCs of the two motors, using the FLC values from Table 430.250, are as follows:

100-hp, 3-phase FLC = 124 A
1½-hp, 3-phase FLC = 3 A
Total FLC = 127 A

Now, increase the sum of the fire pump motor and the jockey pump motor to 125 percent:

$$127 \text{ A} \times 1.25 = 158.75 \text{ A}$$

Then, size the transformer as follows:

$$\text{Transformer kVA} = \frac{\text{volts} \times \text{amperes} \times \sqrt{3}}{1000}$$

$$= \frac{480 \times 158.75 \times \sqrt{3}}{1000}$$

$$= 131.98 \text{ kVA}$$

The minimum-size transformer permitted is 131.98 kVA. The next larger standard-size transformer available is 150 kVA, but any larger size is permitted.

Step 2. Calculate the minimum-size primary OCPD permitted for this transformer. According to 695.5(B), the minimum primary OCPD must allow the transformer secondary to supply the LRC to the fire pump and, in this case, the jockey pump. The LRC of each motor must be individually calculated if it is not available on the motor nameplate. In this example, however, only the kVA code letters are assumed to be available. According to 430.7(B) and using the maximum values for the individual code letters per Table 430.7(B), calculate the maximum LRCs, as follows:

For the 100-hp motor, code letter G:

$$\text{LRC} = \text{motor hp} \times \text{max. code letter value} \times \frac{1000}{\text{rated motor voltage} \times \text{3-phase factor}}$$

$$= 100 \text{ hp} \times \frac{6.29 \text{ kVA}}{\text{hp}} \times \frac{1000}{460 \times \sqrt{3}} = 789.46 \text{ A}$$

For the 1½-hp motor, code letter H (using the same formula):

$$\text{LCR} = 1\tfrac{1}{2} \text{ hp} \times \frac{7.09 \text{ kVA}}{\text{hp}} \times \frac{1000}{460 \times \sqrt{3}} = 13.35 \text{ A}$$

For the total LRC:

100-hp LRC = 789.46 A
1½-hp LRC = 13.35 A
Total LRC = 802.81 A or 803 A

Now, calculate the equivalent LRC on the primary side of the transformer, based on the calculated LRC of the secondary of the transformer, as follows:

$$\text{LRC}_{\text{primary}} = \frac{\text{secondary voltage}}{\text{primary voltage}} \times \text{LRC}_{\text{secondary}}$$

$$= \frac{480 \text{ V}}{4160 \text{ V}} \times 803 \text{ A}$$

$$= 92.65 \text{ A or } 93 \text{ A}$$

This 93 A represents the secondary LRC reflected to the primary side of the transformer. Because this value is the absolute smallest OCPD permitted, the next larger standard size, according to 240.6, is 100 A.

Conclusions.

1. The smallest standard-size transformer that is permitted is 150 kVA.
2. The smallest standard-size OCPD permitted on the primary of the transformer is 100 A.
3. A secondary OCPD is not permitted.

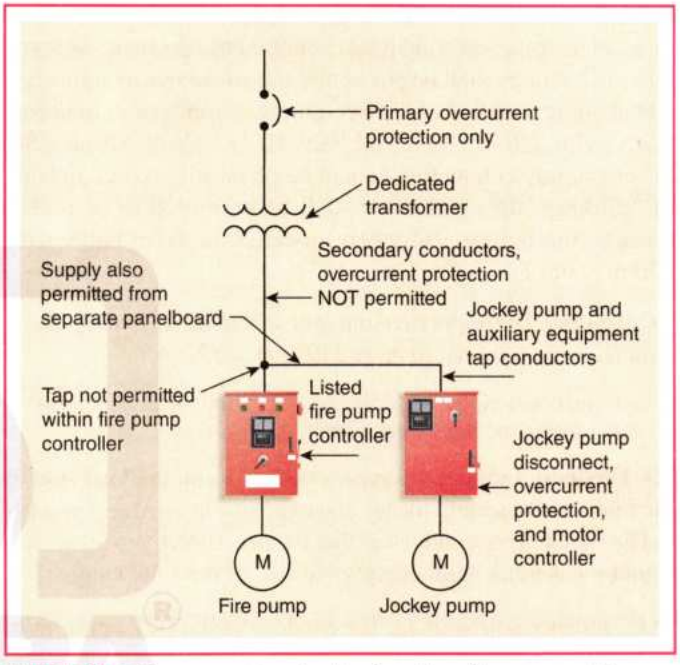

EXHIBIT 695.4 Overcurrent protection for a transformer supplying a fire pump and associated equipment. The transformer primary OCPD must be capable of carrying LRCs of the fire pump motor and the jockey pump motor indefinitely.

(C) Feeder Source. Where a feeder source is provided in accordance with 695.3(C), transformers supplying the fire pump system shall be permitted to supply other loads. All other loads shall be calculated in accordance with Article 220, including demand factors as applicable.

(1) Size. Transformers shall be rated at a minimum of 125 percent of the sum of the fire pump motor(s) and pressure maintenance pump(s) motor loads, and 100 percent of the remaining load supplied by the transformer.

(2) Overcurrent Protection. The transformer size, the feeder size, and the overcurrent protective device(s) shall be coordinated such that overcurrent protection is provided for the transformer in accordance with 450.3 and for the feeder in accordance with 215.3, and such that the overcurrent protective device(s) is selected or set to carry indefinitely the sum of the locked-rotor current of the fire pump motor(s), the pressure maintenance pump

motor(s), the full-load current of the associated fire pump accessory equipment, and 100 percent of the remaining loads supplied by the transformer. The requirement to carry the locked-rotor currents indefinitely shall not apply to conductors or devices other than overcurrent devices in the fire pump motor circuit(s).

695.6 Power Wiring. Power circuits and wiring methods shall comply with the requirements in 695.6(A) through (J), and as permitted in 230.90(A), Exception No. 4; 230.94, Exception No. 4; 240.13; 230.208; 240.4(A); and 430.31.

(A) Supply Conductors.

(1) Services and On-Site Power Production Facilities. Service conductors and conductors supplied by on-site power production facilities shall be physically routed outside a building(s) and shall be installed as service-entrance conductors in accordance with 230.6, 230.9, and Parts III and IV of Article 230. Where supply conductors cannot be physically routed outside of buildings, the conductors shall be permitted to be routed through the building(s) where installed in accordance with 230.6(1) or (2).

Exception: The supply conductors within the fire pump room shall not be required to meet 230.6(1) or (2).

Informational Note: See 250.24(C) for routing the grounded conductor to the service equipment.

Δ **(2) Feeders.** Fire pump supply conductors on the load side of the final disconnecting means and overcurrent device(s) permitted by 695.4(B) or conductors that connect directly to an on-site standby generator shall comply with all of the following:

(1) *Independent Routing.* The conductors shall be kept entirely independent of all other wiring.
(2) *Associated Fire Pump Loads.* The conductors shall supply only loads that are directly associated with the fire pump system.
(3) *Protection from Potential Damage.* The conductors shall be protected from potential damage by fire, structural failure, or operational accident.
(4) *Inside of a Building.* Where routed through a building, the conductors shall be protected from fire for 2 hours using one of the following methods:

a. The cable or raceway is encased in a minimum 50 mm (2 in.) of concrete.
b. The cable or raceway is part of a listed fire-resistive cable system.

Informational Note No. 1: See UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, for one method of defining a fire-resistive cable system.

Informational Note No. 2: See UL *Guide Information for Electrical Circuit Integrity Systems* (FHIT) for identifying the system and its installation limitations to maintain a minimum 2-hour fire-resistive rating.

Informational Note No. 3: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

c. The cable or raceway is protected by a listed electrical circuit protective system.

Informational Note No. 4: See UL 1724, *Fire Tests for Electrical Circuit Protective Systems*, for one method of defining an electrical circuit protective system.

Informational Note No. 5: See UL *Guide Information for Electrical Circuit Integrity Systems* (FHIT) for identifying the system and its installation limitations to maintain a minimum 2-hour fire-resistive rating.

Informational Note No. 6: The listing organization provides information for electrical circuit protective systems on proper installation requirements to maintain the fire rating.

Exception to 695.6(A)(2)(4): The supply conductors located in the electrical equipment room where they originate and in the fire pump room shall not be required to have the minimum 2-hour fire separation or fire-resistance rating unless otherwise required by 700.10(D) of this Code.

Feeder conductors are those that are installed from the load side of the supervised disconnecting means permitted by 695.4(B)(1)(a), (b), or (c). In addition, conductors directly connected to the output of an on-site standby generator are also covered by 695.6(A)(2). Unlike service conductors, feeder conductors are not required to be installed on the outside of a building or structure. However, if the feeder conductors are run through a building, they are required to be protected from damage by fire to ensure that power to the fire pump is not interrupted.

The difference between a 2-hour fire rating of an electrical circuit, such as a conduit with wires, and a 2-hour fire resistance rating of a structural member, such as a wall, is that at the end of a 2-hour fire test on an electrical conduit with wires, the circuit must function electrically (no short circuits, grounds, or opens are permitted) and its insulation must be intact. A wall subjected to a 2-hour fire resistance test must only prevent a fire from passing through or past the wall, without regard to damage to the wall. All fire ratings and fire resistance ratings are based on the assumption that the structural supports for the assembly are not impaired by the effects of the fire.

The UL *Fire Resistance Directory* describes three categories of products that can be used in the fire protection of electrical circuits for fire pumps: electrical circuit integrity systems (FHIT), electrical circuit protective materials (FHIY), and fire-resistive cables (FHJR). (The four-letter codes in parentheses are the UL product category guide designations.) For information on electrical circuit protective systems, see UL 1724, *Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems*.

(B) Conductor Size.

Δ **(1) Fire Pump Motors and Other Equipment.** Conductors supplying a fire pump motor(s), pressure maintenance pumps, and associated fire pump accessory equipment shall have an ampacity of not less than the sum of the following:

(1) 125 percent of the sum of the fire pump motor(s) and pressure maintenance motor(s) full-load current(s), as determined by 430.6(A)
(2) 100 percent of the associated fire pump accessory equipment full-load current(s)

(2) Fire Pump Motors Only. Conductors supplying only a fire pump motor shall have a minimum ampacity in accordance with 430.22 and shall comply with the voltage drop requirements in 695.7.

Calculation Example

Listed fire pump controller and pump combinations are available in a wye-start, delta-run configuration as well as variable speed drive configurations. In the wye-delta configuration, six circuit conductors are run from the controller to the motor; when the motor is in the run mode, the conductors that supply each winding are connected in parallel.

See also

430.22(C) and its commentary for wye-start, delta-run operation

Determine the minimum size for the line- and load-side conductors of a controller with a fire pump with a 50-hp, 3-phase, 460-V motor. The pump motor and controller are configured for a wye-start, delta-run operation.

- Table 430.250 specifies full-load current (FLC) for a 50-hp motor as 65 A.
- Section 430.22(C) requires a controller line-side minimum conductor ampacity based on 125 percent of motor FLC.
- Section 430.22(C) requires a controller load-side minimum conductor ampacity based on 72 percent of motor FLC.

Solution

Step 1. Determine minimum conductor ampacity.

(a) Load side: 65 A × 0.72 = 47 A
(b) Line side: 65 A × 1.25 = 81 A

Step 2. Determine Type THWN copper conductor minimum size using Table 310.16 and assuming 75°C terminations in the controller.

(a) Load side: 50 A requires 8 AWG conductors. The combined ampacity of the two 8 AWG circuit conductors connected in parallel to each winding in the run mode is 100 A.
(b) Line side: 81 A requires 4 AWG conductors. The minimum size for the conductors may have to be increased to comply with the mandatory voltage-drop performance requirements in 695.7.

(C) Overload Protection. Power circuits shall not have automatic protection against overloads. Except for protection of transformer primaries provided in 695.5(C)(2), branch-circuit and feeder conductors shall be protected against short circuit only. Where a tap is made to supply a fire pump, the wiring shall be treated as service conductors in accordance with 230.6. The applicable distance and size restrictions in 240.21 shall not apply.

Exception No. 1: Conductors between storage batteries and the engine shall not require overcurrent protection or disconnecting means.

Exception No. 2: For an on-site standby generator(s) rated to produce continuous current in excess of 225 percent of the full-load amperes of the fire pump motor, the conductors between the on-site generator(s) and the combination fire pump transfer switch controller or separately mounted transfer switch shall be installed in accordance with 695.6(A)(2).

The protection provided shall be in accordance with the short-circuit current rating of the combination fire pump transfer switch controller or separately mounted transfer switch.

Δ **(D) Pump Wiring.**

N **(1) Wiring Methods.** Wiring from the controller(s) to the pump motor shall be in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, liquidtight flexible metal conduit, or liquidtight flexible nonmetallic conduit LFNC-B, listed Type MC cable with an impervious covering, or Type MI cable. [**20:**9.4.4.1]

N **(2) Fittings.** Fittings shall be listed for use in wet locations.

N **(3) Connections.** Electrical connections at motor terminal boxes shall be made with a listed means of connection. Twist-on, insulation-piercing–type, and soldered wire connectors shall not be used for this purpose. [**20:**9.4.4.2, 9.4.4.3]

(E) Loads Supplied by Controllers and Transfer Switches. A fire pump controller and fire pump power transfer switch, if provided, shall not serve any load other than the fire pump for which it is intended.

(F) Mechanical Protection. All wiring from engine controllers and batteries shall be protected against physical damage and shall be installed in accordance with the controller and engine manufacturer's instructions.

(G) Ground-Fault Protection of Equipment. Ground-fault protection of equipment shall not be installed in any fire pump power circuit. [**20:**9.1.8.1]

The continued operation of the fire pumps until the fire is extinguished is essential. Ground-fault protection of equipment is not permitted to be used to protect components of a fire pump installation. Ground-fault detection that provides only an alarm is not prohibited by this requirement.

(H) Listed Electrical Circuit Protective System to Controller Wiring. Electrical circuit protective system installation

shall comply with any restrictions provided in the listing of the electrical circuit protective system used, and the following also shall apply:

(1) A junction box shall be installed ahead of the fire pump controller a minimum of 300 mm (12 in.) beyond the fire-rated ceiling, wall, or floor bounding the fire zone.

The junction box mounted inside the fire pump room allows for a transition between solid conductors that are used in some electrical circuit protective systems (e.g., Type MI cable) and stranded conductors that are required at the supply terminals of the controller by the controller manufacturer and its listing. Splices are not permitted in the controller enclosure, in accordance with NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*. In addition, where an electrical circuit protective system employs single conductor cables, such as Type MI cable, the necessity to modify enclosures to prevent inductive heating can result in a compromise of the controller enclosure's resistance to water infiltration.

(2) Where required by the manufacturer of a listed electrical circuit protective system or by the listing, or as required elsewhere in this *Code*, the raceway between a junction box and the fire pump controller shall be sealed at the junction box end as required and in accordance with the instructions of the manufacturer. [**20:**9.8.2]

When fire-resistive cables pass through an area where there is a fire, they will likely produce flammable gases and smoke. These cables are not allowed to enter the fire pump controller, to prevent damage to the controller, and to prevent an explosion when gases are ignited by the motor contactor(s) or other sparking or arcing components, such as control relays or circuit breakers.

(3) Standard wiring between the junction box and the controller shall be permitted. [**20:**9.8.3]

(I) Junction Boxes. Where fire pump wiring to or from a fire pump controller is routed through a junction box, the following requirements shall be met:

(1) The junction box shall be securely mounted. [**20:**9.7(1)]
(2) Mounting and installing of a junction box shall not violate the enclosure type rating of the fire pump controller(s). [**20:**9.7(2)]
(3) Mounting and installing of a junction box shall not violate the integrity of the fire pump controller(s) and shall not affect the short-circuit current rating of the controller(s).
(4) As a minimum, a Type 2, drip-proof enclosure (junction box) shall be used where installed in the fire pump room. The enclosure shall be listed to match the fire pump controller enclosure type rating. [**20:**9.7(4)]

These requirements maintain the controller enclosure's environmental rating. Use of conduit hubs having the same environmental rating as the controller enclosure minimizes the entry of water or other liquids into the enclosure.

See also

110.28, Table 110.28, and associated commentary for information on environmental ratings of electrical equipment enclosures

(5) Terminals, junction blocks, wire connectors, and splices, where used, shall be listed. [**20:**9.7(5)]
(6) A fire pump controller or fire pump power transfer switch, where provided, shall not be used as a junction box to supply other equipment, including a pressure maintenance (jockey) pump(s).

(J) Terminations. Where raceways or cable are terminated at a fire pump controller, the following requirements shall be met:

(1) Raceway or cable fittings listed and identified for use in wet locations shall be used.
(2) The type rating of the raceway or cable fittings shall be at least equal to that of the fire pump controller.
(3) The installation instructions of the manufacturer of the fire pump controller shall be followed.
(4) Alterations to the fire pump controller, other than raceway or cable terminations as allowed elsewhere in this *Code*, shall be approved by the authority having jurisdiction.

695.7 Voltage Drop.

Δ **(A) Motor Starting.** Unless the requirements of 695.7(B) or (C) are met, the voltage at the fire pump controller line terminals shall not drop more than 15 percent below normal (controller-rated voltage) under motor starting conditions. [**20:**9.4.1]

N **(B) Emergency Run.** The requirements of 695.7(A) shall not apply to emergency-run mechanical starting, provided a successful start can be demonstrated on the standby generator system. [**20:**9.4.2]

N **(C) Bypass Mode.** The requirements of 695.7(A) shall not apply to the bypass mode of a variable speed pressure limiting control, provided a successful start can be demonstrated on the standby gen-set. [**20:**9.4.3]

Δ **(D) Motor Running.** The voltage at the contactor load terminals to which the motor is connected shall not drop more than 5 percent below the voltage rating of the motor when the motor is operating at 115 percent of the full-load current rating of the motor. [**20:**9.4.4]

Δ **695.10 Listed Equipment.** Diesel engine fire pump controllers, electric fire pump controllers, electric motors, fire pump power transfer switches, foam pump controllers, and limited service controllers shall be listed for fire pump service. [**20:**9.5.1.1, 10.1.2.1, 12.1.3.1]

Prior to being shipped to the installation site, listed fire pump controllers should be matched with the listed electric motor(s) they will control, to ensure compatibility of the individually listed components. The combination fire pump controller and transfer switch shown in Exhibit 695.5 are examples of listed equipment.

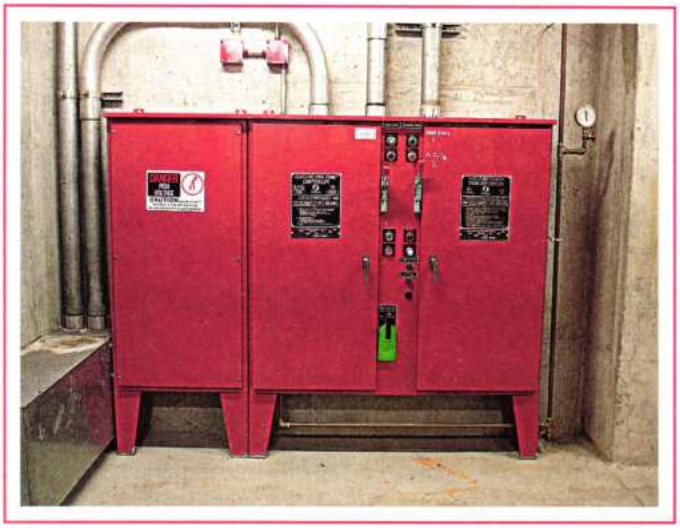

EXHIBIT 695.5 Listed combination fire pump controller and power transfer switch.

695.12 Equipment Location.

(A) Controllers and Transfer Switches. Electric motor-driven fire pump controllers and power transfer switches shall be located as close as practicable to, and within sight of, the motors that they control.

(B) Engine-Drive Controllers. Engine-drive fire pump controllers shall be located as close as is practical to, and within sight of, the engines that they control.

(C) Storage Batteries. Storage batteries for fire pump engine drives shall be supported above the floor, secured against displacement, and located where they are not subject to physical damage, flooding with water, excessive temperature, or excessive vibration.

(D) Energized Equipment. All energized equipment parts shall be located at least 300 mm (12 in.) above the floor level.

(E) Protection Against Pump Water. Fire pump controller and power transfer switches shall be located or protected so that they are not damaged by water escaping from pumps or pump connections.

(F) Mounting. All fire pump control equipment shall be mounted in a substantial manner on noncombustible supporting structures.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, specifies a suitable space for fire pump equipment. This space must be free from hazards that could impair operation of the fire pump. Neither the *NEC* nor NFPA 20 mandates a dedicated room for the fire pump.

Even though 695.12(A) requires fire pump controllers and transfer switches to be "as close as practicable" to their associated fire pump motor, the minimum working space required by 110.26 must be maintained.

Fire pump controllers are housed in enclosures suitable to protect the contents against limited amounts of falling water and dirt. In addition, all energized parts in the enclosure must be mounted at least 12 inches above the floor. Typically, the floor space for this area is equipped with a floor drain.

695.14 Control Wiring.

(A) Control Circuit Failures. External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open or short circuit) shall not prevent the operation of a pump(s) from all other internal or external means. Breakage, disconnecting, shorting of the wires, or loss of power to these circuits could cause continuous running of the fire pump but shall not prevent the controller(s) from starting the fire pump(s) due to causes other than these external control circuits. All control conductors within the fire pump room that are not fault tolerant shall be protected against physical damage. [**20:**10.5.2.6, 12.5.2.5]

NFPA 20 permits the installation of up to three interconnected fire pumps in different locations in a building, such as a high-rise. NFPA 20 requires the control wiring between those locations to be protected from fire and physical damage in the same manner as power conductors.

(B) Sensor Functioning. No undervoltage, phase-loss, frequency-sensitive, or other sensor(s) shall be installed that automatically or manually prohibits actuation of the motor contactor. [**20:**10.4.5.6]

Exception: A phase-loss sensor(s) shall be permitted only as a part of a listed fire pump controller.

(C) Remote Device(s). No remote device(s) shall be installed that will prevent automatic operation of the transfer switch. [**20:**10.8.1.3]

(D) Engine-Drive Control Wiring. All wiring between the controller and the diesel engine shall be stranded and sized to continuously carry the charging or control currents as required by the controller manufacturer. Such wiring shall be protected against physical damage. Controller manufacturer's specifications for distance and wire size shall be followed. [**20:**12.3.5.1]

(E) Electric Fire Pump Control Wiring Methods. All electric motor–driven fire pump control wiring shall be in rigid metal conduit, intermediate metal conduit, liquidtight flexible metal conduit, electrical metallic tubing, liquidtight flexible nonmetallic conduit, listed Type MC cable with an impervious covering, or Type MI cable.

Δ **(F) Generator Control Wiring Methods.** Control conductors installed between the fire pump power transfer switch and the standby generator supplying the fire pump during normal power loss shall be kept entirely independent of all other wiring. The integrity of the generator remote start circuit shall be monitored

for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).

Informational Note: See NFPA 20-2019, *Standard for the Installation of Stationary Pumps for Fire Protection*, 3.3.7.2, for more information on fault-tolerant external control circuits.

The control conductors shall be protected to resist potential damage by fire or structural failure. Where routed through a building, the conductors shall be protected from fire for 2 hours using one of the following methods:

(1) The cable or raceway is encased in a minimum 50 mm (2 in.) of concrete.
(2) The cable or raceway is part of a listed fire-resistive cable system.

Informational Note No. 1: See UL 2196-2017, *Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, for testing requirements for fire-resistive cables.

Informational Note No. 2: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

(3) The cable or raceway is protected by a listed electrical circuit protective system.

Informational Note No. 3: See UL 1724, *Fire Tests for Electrical Circuit Protection Systems*, for testing requirements for circuit protective systems.

Informational Note No. 4: Electrical circuit protective systems could include, but are not limited to, thermal barriers or a protective shaft.

Informational Note No. 5: The listing organization provides information for electrical circuit protective systems on proper installation requirements to maintain the fire rating.

Having the power wiring protected against fire damage is only one reliability consideration. For the generator to provide power, it has to receive the necessary signal to start. It is also critical to protect the control circuit wiring between the fire pump transfer switch/controller and the on-site standby generator.

695.15 Surge Protection. A listed surge protective device (SPD) shall be installed in or on the fire pump controller.

Informational Note: See UL 1449-2021, *Standard for Surge Protective Devices*, for proper application of SPD types.

Exception: Surge-protective devices shall not be required in or on a fire pump controller for diesel fire pumps.

Electronic components are used for control functions within fire pump controllers. These components are sensitive to overvoltages, and the proper operation of the electrically driven fire pump could be compromised due to component failure. As cited in the Fire Protection Research Foundation (FPRF) report *Data Assessment for Electrical Surge Protective Devices*, a survey of facility managers conducted by the National Electrical Manufacturers Association (NEMA) for the years 2013 and 2014 documented that 12 percent of the respondents indicated they had experienced surge damage to fire pump associated equipment. Considering that most electric motor-driven fire pumps and associated controllers are supplied directly by services, the exposure of such equipment to line surges due to lightning or utility switching is extremely high. The type of surge protective device (SPD) is largely driven by where the fire pump and controller are located within the electrical distribution system. The SPD for the fire pump controller can be field or factory installed.

The FPRF report can be viewed at: www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Data-Assessment-for-Electrical-Surge-Protection-Devices.

See also

Article 242 for the requirements covering types and installation of SPDs