NEMA STANDARDS PUBLICATION

ICS 15

INSTRUCTIONS FOR THE HANDLING, INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRIC FIRE PUMP CONTROLLERS RATED NOT MORE THAN 600V

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

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NEMA Standards Publication ICS 15-1999

Instructions for the Handling, Installation, Operation and Maintenance of Electric Fire Pump Controllers Rated Not More Than 600V

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FOREWORD

This publication was prepared by a technical committee of the NEMA Industrial Control and Systems Section. It was approved in accordance with the bylaws of NEMA.

This Installation Guide provides practical information concerning the general technical considerations in the installation of electric fire pump controllers. It is intended to be used by specifiers, purchasers, installers, and owners of fire pump controllers.

This Installation Guide represents the result of many years of research, investigation, and experience by the members of the NEMA Industrial Control and Systems Subcommittee on Fire Pump Control. It was written as a service in response to the many questions from the user public, specifiers, and inspection authorities regarding fire pump controller installations. The intent is to pursue excellence in design, manufacture, and service of products made by NEMA member companies. It has been developed through continuing consultation among manufacturers, users, and national engineering societies. It is not intended to instruct the user of fire pump control equipment except insofar as to provide recommendations and some installation guidance.

This Installation Guide is necessarily confined to providing recommendations for a successful installation. When equipment conforming with these recommendations is properly selected and is installed in accordance with the *National Electrical Code* (NFPA 70) and the *Standard for the Installation of Centrifugal Fire Pumps* (NFPA 20) and properly maintained, the hazards to persons and property will be reduced. However, since any piece of industrial control equipment can be installed, operated, and maintained in such a manner that hazardous conditions may result, following the recommendation of this guide does not by itself assure a safe installation.

NEMA publications are subject to periodic review. They are revised frequently to reflect user input and to meet changing conditions and technical progress. Users should secure the latest editions.
Proposed revisions to this Installation Guide should be submitted to:

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1 GENERAL

1.1 SCOPE

These guidelines are provided to facilitate movement, handling, installation, and maintenance of electric fire pump controllers at the job site and to help avoid personal injury and equipment damage during these processes.

Information includes the following:

a. Handling

b. Storage

c. Installation of conduits, cables, and wires

d. Pre-energization and energization

e. Care and maintenance

1.2 PRECAUTIONS

There is a hazard of electric shock or burns to personnel whenever they are working on or near electrical equipment. Turn off power supplying this equipment before working inside the controller and lockout or tag out or both, disconnecting means in accordance with NFPA 70 E, Part II.[1] Where it is not feasible to de-energize the system, take the following precautions:

a. Persons working near exposed parts that are or may be energized should be instructed, and should use practices, including appropriate apparel, equipment, and tools in accordance with NFPA 70 E, Part II.

b. Persons working on exposed parts that are or may be energized should, in addition to (a), be qualified persons, who have been trained to work on energized circuits.

Fire pump controllers may have two sources of power supply, as well as alarm and auxiliary circuits energized from remote power supplies. When de-energizing, the controller for servicing these power sources must be considered.

1.3 QUALIFIED PERSONNEL

The proper operation of fire pump controllers is dependent upon handling, installation, operation, and maintenance by qualified personnel. Failure to follow certain fundamental installation and maintenance requirements could lead to personal injury, the failure or loss of the fire pump controller, or any combination thereof, and damage to other property.

References to the National Electrical Code are shown as (NEC) and refer to NFPA Publication No. 70.

Reference to manufacturer, unless otherwise specified, means the fire pump controller manufacturer.

1.4 QUALIFIED PERSON

For the purpose of this guide, a qualified person is one who is familiar with the installation, construction and, operation of the equipment and the hazards involved. In addition, he or she has the following qualifications:

a. Trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

b. Trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices.

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[1] Available from the National Fire Protection Association, Batterymarch Park, Quincy Ma 02269-9101.

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2 HANDLING

2.1 HANDLING GUIDELINES

2.1.1 The following guidelines are provided to help avoid personal injury and equipment damage during handling and to facilitate moving the fire pump controller at the job site.

2.1.2 Follow the manufacturer's handling instructions for the specific equipment.

2.1.3 Handle the fire pump controller with care to avoid damage to the components, to the frame, and to the enclosure or its finish.

2.1.4 Keep the fire pump controller in an upright position unless otherwise specifically permitted by the manufacturer.

2.1.5 Know the capabilities of the moving means available to handle the weight of the fire pump controller.

2.1.6 When the fire pump controller is received, unpack it sufficiently to inspect for concealed damage and to determine that the shipment is complete and correct.

2.1.7 If the fire pump controller is to be stored for any length of time prior to installation, restore the packing for protection during that period. Where conditions permit, leave the packing intact until the fire pump controller is at its final installation position. If the packing is removed, cover the top and openings of the controller during the construction period to protect it against dust and debris. (See Section 3.)

2.1.8 Keep the fire pump controller secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping.

2.1.9 Exercise care during any movement and placement operations to prevent falling or unintentional rolling or tipping.

2.1.10 Rod or pipe rollers with the aid of pinch bars provide a simple method of moving the fire pump controller on one floor level if there is no significant incline. Steady the load to prevent tipping.

2.1.11 A fork-lift truck may offer a more convenient method of handling the fire pump controller. It may also be used to move the fire pump controller between levels. Balance the load carefully and use a safety strap to secure the fire pump controller to the fork-lift. Fire pump controllers are often top heavy and may be front-heavy or back-heavy.

2.1.12 When a platform elevator is not available to move the fire pump controller between elevations, overhead hoisting may be used. Lifting plates and eye bolts (Figure 2-1), or channels, angles, or bars with lift holes (Figure 2-2) may have been provided as a permanent or removable part of the fire pump controller.

2.1.13 Use spreaders (Figure 2-1) to provide the vertical lift or lifting plates and the eyebolts to avoid eyebolt or plate failure or crushing or both, or otherwise damaging the fire pump controller frame or its finish.

2.1.14 To reduce the stresses on the rigging or spreaders, do not allow the angle between the lifting cables and vertical to exceed 45 degrees (Figures 2-1 and 2-2).

2.1.15 Use slings with safety hooks or shackles. Do not pass ropes or cables through the lift holes in bars, angles, or channels.

2.1.16 Select or adjust the rigging lengths to compensate for any unequal weight distribution of load and to maintain the fire pump controller in an upright position.

2.1.17 Electric fire pump controllers that contain heavy equipment such as transformers mounted within could be adversely affected by tilting.

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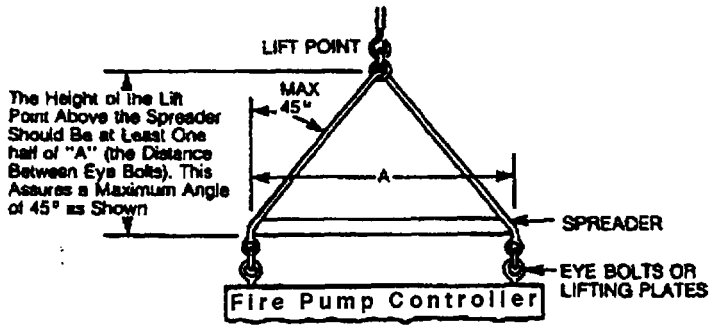


Figure 2-1
LIFTING WITH EYE BOLTS OR LIFTING PLATES

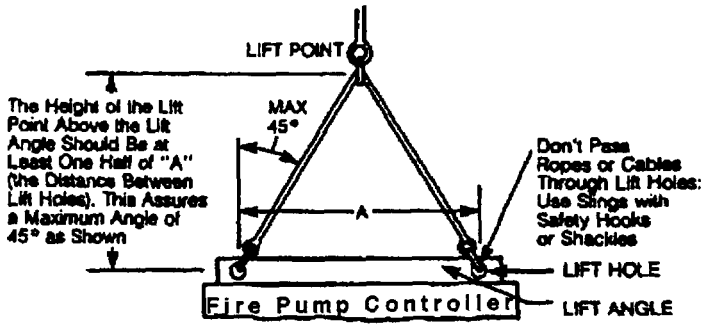


Figure 2-2
LIFTING WITH INTEGRAL LIFT ANGLE

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3 STORAGE

3.1 An indoor fire pump controller that is not installed and energized immediately should be stored in a clean, dry space where a uniform temperature prevents condensation. Preferably, it should be stored in a heated building with adequate air circulation and protected from dirt and water. Fire Pump Controllers should be stored where they are not subject to mechanical damage or corrosive atmosphere.

3.2 An indoor fire pump controller that must be stored outdoors should be securely covered for protection from weather conditions and dirt. Temporary electrical heating should be installed to prevent condensation; approximately 150 watts per controller section is adequate for the average fire pump controller size and environment. All loose packing or flammable materials should be removed before energizing space heaters.

3.3 An unenergized outdoor fire pump controller should be kept dry internally by installing temporary heating (see 3.2), or by energizing self-contained space heater(s).

4 INSTALLATION OF THE FIRE PUMP CONTROLLER

4.1 Install the fire pump controller in a neat and workmanlike manner following the manufacturer's installation instructions.

4.2 Locate the fire pump controller in the area shown on the building floor plans. If the location is wet, protect the fire pump controller to prevent water from entering the enclosure. Recommended clearances or working spaces are as follows:

4.2.1 Clearance from walls (not rear accessible)—minimum of 1/2 inch for indoor and 6 inches for outdoor or wet locations.

4.2.2 Clearance from front (working space). (See NEC 110-16(a).)

4.2.3 Fire Pump Controllers installed on combustible surfaces should be equipped with steel bottom plates.

NOTE—The above space(s) should not be used for storage; working spaces should have adequate lighting.

4.3 Securely fasten the fire pump controller to a level surface. Be sure the lowest live part is 12" (minimum) off the floor. If the fire pump controller is to be used in a seismic environment, be sure to follow the instructions of the engineers responsible for the installation for possible extra mounting, bracing, and damping requirements.

4.4 For bottom entry, position the fire pump controller so as to locate the conduit stubs or floor openings in the area specified on the manufacturer's drawing. In the absence of drawings, locate the fire pump controller over the conduits or floor openings so as to provide cable bending space and clearances to live parts. (See NEC table 430-10(b).)

4.5 Install the fire pump controller in its final position, progressively leveling and bolting together, if the controller is shipped in separate sections. If necessary, and permitted by the manufacturer, secure the fire pump controller to walls or other supporting surfaces. Do not depend for security on wooden plugs driven into holes in masonry, concrete, plaster, or similar materials. (See NEC: 110-13.)

4.6 Connect power supply conductors in accordance with Section 5.

4.7 If the fire pump controller is shipped in sections, provide adequate bonding between the sections that are joined at the job site.

4.8 Ground and bond the fire pump controller as follows:

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4.8.1 If the fire pump controller is used as service equipment, connect a grounding electrode conductor having a size in accordance with the *National Electrical Code,* Article 250, from the grounding electrode to the fire pump controller ground terminal designated by the manufacturer.

4.8.1.1 If the main bonding jumper is not installed at the factory, install it from the incoming grounded conductor (neutral), (if supplied) to the designated grounding pad provided by the manufacturer.

4.8.1.2 Steps 4.8.1.1 and 4.8.1.2 should effectively connect together the grounding electrode, the fire pump controller enclosure (or frame), all outgoing equipment grounding conductors, and the incoming neutral conductor (if a neutral is part of the power supply).

4.8.1.3 Do not make any connection to ground on the load side of any neutral disconnecting link (if supplied). Do not install any sensor for ground fault protection. Ground Fault Protection is prohibited from use in fire pump controllers (see NFPA 20).

4.8.1.4 When the fire pump controller is fed from two power sources, special precautions are necessary to accomplish proper bonding and grounding. Follow the manufacturer's instructions.

4.8.2 Fire pump controllers used as service equipment for an ungrounded system:

4.8.2.1 Connect a grounding electrode conductor sized in accordance with *National Electrical Code*, Article 250, from the grounding electrode to the fire pump controller ground terminal designated by the manufacturer. (See NEC: 250-91(a) and 250-92(a).)

4.8.2.2 If the power supply system is grounded at any point ahead of the fire pump controller, the grounded conductor must be connected to the fire pump controller in accordance with the *National Electrical Code*, Article 250 and connected to the bonded grounding terminal in the fire pump controller designated by the manufacturer.

4.8.2.3 Steps 4.8.2.1 and 4.8.2.2 should effectively connect together the grounding electrode, the fire pump controller enclosure/frame, all outgoing equipment grounding conductors, and any grounded conductor which is connected to the fire pump controller as described in 4.8.2.2.

4.8.3 Fire Pump Controllers *not* used as service equipment and used on either a grounded or ungrounded system:

4.8.3.1 Ground the fire pump controller enclosure/frame and any ground terminal provided by means of equipment grounding conductors sized in accordance with NEC: 250-95. Run with the main supply conductors or bond to the raceway enclosing the main supply conductors in accordance with the *National Electrical Code*, Article 250.

4.9 Close all unused openings in accordance with the requirements for the fire pump controller enclosure type.

4.10 In damp indoor locations, shield the fire pump controller to prevent moisture and water from entering and accumulating.

CAUTION: Hydrocarbon spray propellant and hydrocarbon-based sprays or compounds may cause degradation of certain plastics. Contact the fire pump controller manufacturer before using these products to clean, dry, or lubricate components during installation and maintenance.

4.11 Unless the fire pump controller has been designed for other than usual service conditions, it should not be located where it will be exposed to ambient temperatures above 40°C (104°F), below 5°C (40°F), in corrosive or explosive fumes, dust, vapors, standing water, salt laden air, abnormal vibration, shock or tilting, or other unusual conditions.

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5 INSTALLATION OF CONDUIT AND WIRES

5.1 Conductors should be selected per the manufacturer's instructions that are furnished with the fire pump controller, NEMA ICS 14 (1998) and Article 110 of the *National Electrical Code*.

NOTE—Fire pump controllers are phase-sequence sensitive.

5.2 Install conduits so that they do not provide a means for water to enter the enclosure. Bond all conduits (including stubs) to the fire pump controller. Locate all conduits in the areas recommended by the manufacturer to avoid cable interference with structural and operational members or internal equipment. If conduit entrance is from the top, watertight conduit hubs must be used. ALWAYS PROTECT INTERNAL EQUIPMENT FROM METAL CHIPS DUE TO DRILLING/PUNCHING THROUGH THE ENCLOSURE. Be sure that the environmental rating of the enclosure is not compromised as a result of the installation of conduits or piping.

NOTE—Fire pump controllers are type 2 minimum.

5.3 Verify that the lugs which have been provided are suitable for use with the type, size, and numbers of cables being installed in the fire pump controller.

5.4 Incoming cable sizes are to consider requirement of Article 695 of the *National Electrical Code*. Follow recommendations of NEMA Standards Publication ICS 14 and the specifications of the engineer responsible for the installation.

5.5 Care should be exercised in stripping insulation from the conductors to prevent nicking or ringing the conductor. Make sure insulation strippings do not fall inside electrical devices within the fire pump controller. For aluminum, clean all oxide from the stripped portion immediately, apply oxide inhibiting compound, and tighten all screw lugs to the manufacturer's torque values. If the manufacturer does not provide this information, use the torque values shown in Tables 7-1, 7-2, and 7-3. Ensure that equipment is marked as being suitable for aluminum conductors.

5.6 Provisions should be made to locate conductors in the fire pump controller to avoid physical damage and overheating. Secure the conductors in order to withstand available short-circuit currents. Follow the manufacturer's instructions for lacing or bracing cables. The largest practical bending radii should be used to avoid damaging the insulation. Form the conductors to minimize stress on the terminals.

5.7 Make wiring connections in accordance with the field connection diagram and manufacturer's instructions.

DO NOT USE THE FIRE PUMP CONTROLLER AS A JUNCTION BOX TO SUPPLY OTHER EQUIPMENT. SEE NEC 695-8(d).

5.8 Installation should be done at temperatures above freezing to prevent conductor insulation from cracking or splitting. As an alternative, use conductors that are suitable for installation at temperatures below freezing. See 4.11.

6 INSTALLATION OF THE FIRE PUMP CONTROLLER

6.1 Carefully remove and study all documents provided in the document pocket. Replace documents after reading.

6.2 Study and understand all instructions that are adhered on the inside of the door of the fire pump controller.

6.3 Carefully study and understand all operating instructions that are on the outside of the fire pump controller.

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6.4 Remove all shipping wedges from equipment such as pressure switch (when provided) and electromechanical devices (when so used).

6.5 Study all internal tags and follow instructions thereon.

6.6 Bring in piping for the pressure switch (when provided) and pressure recorder (when provided). Follow instructions provided by the manufacturer and as required in NFPA 20, 7-5.2.1. Refer to installation sketches in NFPA 20 Appendix A.

7 STEPS TO BE TAKEN BEFORE ENERGIZING

7.1 FOLLOW MANUFACTURER'S INSTRUCTIONS

Because of the diversity of components which may be supplied, the manufacturer's instructions should be followed.

7.2 RETIGHTEN ALL ELECTRICAL CONNECTIONS

7.2.1 Retighten all accessible electrical connections to the manufacturer's torque values, if furnished. If the manufacturer does not provide this information, tighten steel hardware parts (except pressure wire connectors and conical spring washers (Belleville)) to the values given in Table 7-1 for metal-to-metal connections.

7.2.2 Retighten the wire clamping members of all accessible mechanical (pressure wire) type connectors to the values specified by the manufacturer, if provided, or to the torque value (pound-inches) for the largest wire size the connectors will accept as given in Tables 7-2 and 7-3. According to Article 430-9 (c) of the National Electrical Code (NFPA 70), control circuit devices with screw-type pressure terminals used with No. 14 AWG or smaller copper conductors are to be torqued to a minimum of seven pound-inches (0.79N-m) unless identified for a different torque value.

7.2.3 Retighten conical spring washers (Belleville) according to the manufacturer's instructions, if provided. If not provided, retighten until the washer is flat, plus 1/4 turn.

7.3 Check the enclosure to see that it has not been damaged so as to reduce electrical spacings.

7.4 Verify that field wiring is adequately separated from live parts. Physically secure the field wiring to withstand the effects of fault currents.

7.5 Check to determine that all grounding connections are made properly. If the fire pump controller is shipped in separate sections confirm that grounding of all sections is continuous and effective. (See 4.8.)

7.6 Check all devices for damage. Make all necessary repairs or replacements prior to energizing.

7.6 Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain that they operate freely.

7.7 Verify that the motor is connected in accordance with the motor manufacturer's connection diagram and that the motor leads are connected to the contactor in accordance with the manufacturer's field connection diagram. (These conductors are to be removed temporarily for a test described in. 8.2.)

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Table 7-1*
RECOMMENDED TORQUE VALUES FOR METAL-TO-METAL ELECTRICAL CONNECTIONS

Bolt	Diameter	Tightening torque
#8	(5/32")	15 pound-inches
#10	(3/16")	20 pound-inches
	1/4"	7 pound-feet
	5/16"	12 pound-feet
	3/8"	20 pound-feet
	1/2"	50 pound-feet
	5/8"	95 pound-feet
	3/4"	155 pound-feet

* For Fire Pump Controllers designed for use under usual service conditions as defined in NEMA Publication ICS 1 Clause 6, the torque values in Table 7-1, 7-2, and 7-3 may be used. For unusual service conditions, consult the manufacturers.

7.8 Verify that all adjustable current, time delay, and variable voltage settings on devices are in accordance with the manufacturers' instructions or drawings.

7.9 To prevent possible damage to equipment or injury to personnel, check to insure that all parts and barriers that may have been removed during wiring and installation have been properly reinstalled.

7.10 Before closing the enclosure, remove all metal chips, scrap wire, and other debris from the fire pump controller. If there is appreciable accumulation of dust or dirt, clean out the fire pump controller by using a brush, vacuum cleaner, or clean lint-free rags. **Do not use compressed air because it will redistribute contaminant on other surfaces.**

7.11 Conduct an electrical insulation resistance test to verify that the fire pump controller and field wiring are free from short circuits and grounds. Test phase to phase, phase to ground, and phase to neutral (if supplied) with switches and circuit breakers opened. Confirm that the motor Hp and voltage/frequency nameplate data agrees with that of the controller.

7.12 Install covers, close doors, and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.

7.13 Turn all circuit breakers and switches to the "OFF" position before energizing the fire pump controller.

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Table 7-2*
TORQUE VALUES, POUND-INCHES (SI UNITS) SLOTTED HEAD SCREW DRIVER No. 10 AND LARGER SCREWS

Wire Size	Slot Width 3/64 and Less	Slot Width Over 3/64	External Drive Wrench	
Installed, AWG or kcmil	Slot Length 1/4 and Less (SI Units)	Slot Length Over 1/4 (SI Units)	Split Bolt (SI Units)	Other (SI Units)
14	20 (2.3)	35 (4.0)	80 (9.0)	75 (8.5)
12	20 (2.3)	35 (4.0)	80 (9.0)	75 (8.5)
10	20 (2.3)	35 (4.0)	80 (9.0)	75 (8.5)
8	25 (2.8)	40 (4.5)	80 (9.0)	75 (8.5)
6	35 (4.0)	45 (5.1)	165 (18.6)	110 (12.4)
4	35 (4.0)	45 (5.1)	165 (18.6)	110 (12.4)
3	35 (4.0)	50 (5.6)	275 (31.1)	150 (16.9)
2	40 (4.5)	50 (5.6)	275 (31.1)	150 (16.9)
1	...	50 (5.6)	275 (31.1)	150 (16.9)
1/0	...	50 (5.6)	385 (43.5)	180 (20.3)
2/0	...	50 (5.6)	385 (43.5)	180 (20.3)
3/0	...	50 (5.6)	500 (56.5)	250 (28.2)
4/0	...	50 (5.6)	500 (56.5)	250 (28.2)
250	...	...	650 (73.5)	325 (36.7)
300	...	...	650 (73.5)	325 (36.7)
350	...	...	650 (73.5)	325 (36.7)
400	...	...	825 (93.2)	325 (36.7)
500	...	...	825 (93.2)	375 (42.4)
600	...	...	1000 (113.0)	375 (42.4)
700	...	...	1000 (113.0)	375 (42.4)
750	...	...	1000 (113.0)	375 (42.4)
800	...	...	1100 (124.3)	500 (56.5)
900	...	...	1100 (124.3)	500 (56.5)
1000	...	...	1100 (124.3)	500 (56.5)
1250	...	...	1100 (124.3)	600 (67.8)
1500	...	...	1100 (124.3)	600 (67.8)
1750	...	...	1100 (124.3)	600 (67.8)
2000	...	...	1100 (124.3)	600 (67.8)

* For fire pump controllers designed for use under usual service conditions as defined in NEMA Publication ICS 1 Clause 6, the torque values in Tables 7-1, 7-2, and 7-3 may be used. For unusual service conditions, consult the manufacturer.

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Table 7-3*
HEX SOCKET SCREWS

SOCKET SIZE (ACROSS FLATS), INCHES (MM)	TIGHTENING TORQUE POUND-INCHES (SI UNITS)
1/8 (3.2)	45 (5.1)
5/32 (4.0)	100 (11.3)
3/16 (4.8)	120 (13.6)
7/32 (5.6)	150 (16.9)
1/4 (6.4)	200 (22.6)
5/16 (7.9)	275 (31.1)
3/8 (9.5)	375 (42.4)
1/2 (12.7)	500 (56.5)
9.16 (14.3)	600 (67.8)

* For fire pump controllers designed for use under usual service conditions as defined in NEMA Publication ICS 1 Clause 6, the torque values in Table 7-1, 7-2, and 7-3 may be used. For unusual service conditions, consult the manufacturers.

8 ENERGIZING THE FIRE PUMP CONTROLLER

8.1 Energizing a fire pump controller for the first time is potentially dangerous. Therefore, only qualified personnel (see 1.3) should energize the equipment. If faults caused by damage or poor installation practices have not been detected in the checkout procedure described in Section 7, serious damage or personal injury or both can result when the power is applied to the fire pump controller and the connected motor.

8.2 In order to minimize risk of injury or damage or both, the motor should be disconnected from the fire pump controller (at the contactor) when the controller is first energized. (In order for the contactor to energize automatically, water pressure must be below the cut-in pressure set on the pressure switch. Other automatic devices such as weekly program timer or external signals such as heat or smoke sensors, central station alarm company, etc. may also initiate automatic start. If water pressure is above the set cut-in pressure the contactor may be energized manually by depressing the local START button.) After bringing power to the fire pump controller, make sure that the Power Available light is ON and that the Phases Reversed light is OFF.

8.2.1 If the Phases Reversed is ON, the proper action at this juncture is to disconnect incoming power and correct for proper phase rotation.

8.3 Energize the fire pump controller following the manufacturer's instructions located on the outside of the fire pump controller. Operate switch/circuit breaker handles with a firm, positive motion—do not attempt to "tease" into the closed or open position. For across-the-line starting, the controller relay operation and contactor operation should be complete within a second or two. For reduced voltage starting, the controller will go through an accelerating sequence which normally will require about three seconds or so. Also, start the controller with the manual-emergency handle carefully following the manufacturer's instructions located on the fire pump controller. The power transfer switch (if supplied) should not transfer to the alternate source. If automatic transfer occurs, re-check for incorrect phase sequence, or voltage or frequency outside the acceptable range. Consult the manufacturer's instructions found in the document pocket. Electrically or manually return the power transfer switch to the normal power side if it transferred to the alternate source. Fire pump controllers are built in accordance with NFPA 20. Per NFPA 20 paragraph 7-8.3.6, phase reversal of the normal source power shall cause a simulated

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normal source power failure upon sensing phase reversal and will cause automatic transfer to the alternate power source.

8.4 After satisfactory "no-load" starting, turn off the fire pump controller isolating switch and circuit breaker and re-connect the motor leads. Follow the manufacturer's field connection diagram to insure correct motor lead connection.

8.5 After the motor leads have been properly connected to the contactor, re-energize the fire pump controller while depressing the STOP button.

8.6 To check for correct motor rotation follow the controller manufacturers' instructions. In the absence of such instructions, slowly and momentarily release the stop button. If motor does not start automatically, depress the STOP button and START button and slowly release the stop button. Motor should start to run and, if turning the wrong direction, immediately re-depress the stop button. Turn off the controller isolating switch and circuit breaker while still depressing the stop button. Correct wrong rotation of across-the-line motors by interchanging any two motor load cables at the contactor. For motors being started at reduced voltage, consult the motor manufacturer. If power transfer switch transferred upon bringing power to the fire pump controller, re-confirm that the phases reversed light is off. Correct phase rotation is indicated by the lack of external "phases reversed" alarm. If it is impractical to get incoming power conductor phase sequence corrected, consult the manufacturer for alternate options.

NOTE—Individual controllers may be interconnected with other controller(s) or external electrical equipment.

9 CONFIRMING COMPLIANCE WITH NEC 695 AND NFPA 20 REQUIREMENTS

9.1 Acceptance Testing, Performance, and Maintenance requirements are documented in Chapter 11 of NFPA 20.

9.2 These tests are generally conducted in the presence of the AHJ (Authority Having Jurisdiction).

10 CARE AND MAINTENANCE

NOTE—Conduct system tests in accordance with NFPA 25 with special attention to the requirements of Chapter 7 pertaining to the controller.

10.1 A periodic maintenance program should be established. NFPA Publication 70B (Electrical Equipment Maintenance) may be used as a guide for service conditions listed in NEMA ICS 1, Clause 6 or any other unusual service conditions (consult the manufacturer's instructions).

10.2 Because of the diversity of components which are supplied, the manufacturer's instructions should be consulted for required maintenance, wear, or degradation of components.

10.3 Carefully inspect the doors, enclosure side, and other accessible surfaces on the fire pump controller enclosure for evidence of excessive heat. As a general rule, a temperature which the palm of the hand cannot stand for about three seconds may indicate trouble.

10.4 Disconnect power ahead of the fire pump controller and lockout or tag out, or both, circuits and equipment in accordance with NFPA 70E Part II, before performing any of the following operations. Discharge capacitors, if present. Positively verify that the equipment is totally de-energized by using an appropriate instrument such as a voltmeter. When separate control circuits exist, verify that they also are de-energized. If the fire pump controller is monitored by an outside agency such as a fire department, AD, or such, proper notice should be given that the controller is out of service for a given time. Notice must again be given when the controller is placed back in service.

10.4.1 Where it is not feasible to de-energize and lockout or tag out or both circuits or equipment, the requirements of Section 1 of this guide become extremely important.

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10.4.1.1 Inspect the inside of the fire pump controller for moisture, signs of previous wetness, or dripping. Water from condensation in conduits is an occasional cause of fire pump controller failure.

CAUTION: Hydrocarbon spray propellant and hydrocarbon-based sprays or compounds may cause degradation of certain plastics. Contact the fire pump controller manufacturer before using these products to clean, dry, or lubricate components during installation and maintenance.

10.4.1.2 Seal off any conduits that have dripped condensate and provide an alternative means for the conduit to drain.

10.4.1.3 Seal off any cracks or openings which have allowed moisture to enter the enclosure.

10.4.1.4 Replace or thoroughly dry and clean any insulating material which is damp or wet or shows accumulation of deposited material from previous wettings. Conduct an electrical insulation resistance test to verify the dielectric integrity of the affected insulation.

10.4.1.5 Check devices such as contactors, circuit breakers, isolating or disconnect switches, relays, pushbuttons, etc. for wetness, contamination, or corrosion and replace or clean and dry as required and according to the manufacturer's instructions.

10.4.1.6 Be sure that the cause of any wetness or contamination has been identified and eliminated. If the cause is internal condensation, it may be necessary to provide supplementary heating. Consult the manufacturer.

10.4.1.7 In the event of water damage, i.e., flooding or sprinkler discharge, the manufacturer should be consulted before clean-up and corrective action is attempted or before the equipment is re-energized. General instructions can be found in the NEMA publication entitled "Guidelines for Handling Water Damaged Electrical Equipment."

10.4.2 Remove accumulated dust or dirt by using a brush, vacuum cleaner, or clean lint-free rags. Do not use compressed air because it will only redistribute contaminant on other surfaces.

10.4.3 Examine all accessible electrical joints and terminals in the wiring systems for signs of overheating or corrosion.

10.4.3.1 Retighten bolts and nuts at electrical joints if there is any sign of overheating or looseness. See Section 7.

10.4.3.2 If joints or terminations are badly discolored, corroded, or pitted, the parts should be disassembled and replaced or cleaned. Emery paper, sand paper, or a file should not be used to clean or dress up any position of the electrical equipment. For unplated copper bus requiring a sanding operation use aluminum oxide paper. This will not leave sand or metal particles on contact surface areas. Do not sand aluminum bus under any circumstances.

NOTE—Consult the manufacturer for cleaning procedures appropriate for the termination material used. Do not remove plating on aluminum parts in joints or terminations. Damaged aluminum parts should be replaced.

10.4.3.3 Examine all wire or cable connections for evidence of looseness or overheating. Retighten, if necessary. If major discoloration of cable insulation or if cable damage is apparent, replace the damaged portion of the cable.

10.4.3.4 Look for any signs of deterioration of insulating material or melting of the sealing compound (if used). Replace such insulating parts and assemblies where sealing compound has melted. Make sure the dielectric integrity of the affected parts has been maintained.

10.4.3.5 Be sure that the condition that caused the overheating has been corrected.

10.4.4 Check for proper operation of all mechanical components.

10.4.4.1 Check all switch operator mechanisms and external operations of circuit breakers. Make sure each operator mechanism quickly and positively throws contacts to the fully "ON" and fully "OFF" positions.

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10.4.4.2 Examine the operation of all electrical and mechanical interlocks and padlocking means. If necessary, adjust according to the manufacturer's instructions.

10.4.4.3 Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear. If necessary, replace, repair, clean, lubricate, adjust, or any combinations thereof, according to the manufacturer's instructions.

10.4.5 Examine all readily accessible arc chutes and insulating parts for cracks or breakage and for arc splatter, sooty deposits, oil, or arc tracking.

10.4.5.1 Clean off arc splatter, oil, and sooty deposits and inspect for burning, charring, or carbon tracking. To determine whether such wear requires replacement, consult the manufacturer's instructions.

10.4.5.2 Replace insulating parts and arc chutes that are cracked or broken.

10.5 Operate each switch or circuit breaker several times to make sure that all mechanisms are free and in proper working order. If it is desirable to verify the performance of molded case circuit breakers, follow the manufacturer's instructions. See NEMA Standards Publication AB 4 if additional information is required.

10.6 On fire pump controllers utilizing current limiters, insure that a spare set is in the controller as required in NFPA 20.

10.7 Verify the vacuum integrity of a vacuum interrupter (where used) by performing a high potential dielectric test following the manufacturer's instructions.

CAUTION: Care should be taken not to apply a test voltage that exceeds the manufacturer's recommendation across the open contacts of a vacuum type interrupter, to avoid generating harmful x-rays.

10.8 Verify that wiring, grounding, installation, and functional adjustments for solid state (soft start) controllers are made in accordance with the manufacturer's recommendations.

10.9 Inspect to ensure that oil or grease (if used) is applied only to surfaces recommended by the manufacturer.

11 MAINTENANCE AFTER A FAULT HAS OCCURRED

11.1 PROCEDURE FOLLOWING A FAULT

After a fault has occurred, all equipment should be de-energized, disconnected, isolated, and locked-out/tagged-out to prevent accidental contact with live parts. To verify that this has been done, check voltage on all control terminals and on all line and load terminals of circuit breakers, disconnect switches and contactors before touching or working on equipment. Only qualified personnel should perform the inspection and repair procedure and all safety procedures should be observed.

11.1.1 The excessive currents occurring during a fault may cause damage to structure, components, or any combination thereof and conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. After a fault, repair the cause of the fault, inspect all equipment per NEMA Standards Publication No. ICS 2, Annex B, *Maintenance of Motor Controllers After a Fault Condition* and make repairs or replacements prior to putting the equipment in service again. Verify that all replacements (if any) are of the proper rating and are suitable for the application. If in doubt, consult the manufacturer. The following procedures are recommended for this inspection.

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11.2 ENCLOSURE

External enclosure deformation usually indicates damage within. Extensive damage will require replacement of the enclosure parts and the enclosed equipment. The procedure described below may be used to arrive at decision regarding these replacements.

In addition to inspecting the enclosure and door(s) for evidence such as deformation, displacement of parts, or burning, ensure that door-mounted equipment and safety interlocks function correctly. Confirm that hinge and latch integrity is maintained.

11.3 DISCONNECTING MEANS

11.3.1 CIRCUIT BREAKERS

11.3.1.1 Examine the circuit breaker for evidence of possible damage. If there is no apparent evidence of damage, the breaker may be reset and turned "ON" using the external handle. If it is suspected that the circuit breaker has opened several short circuits or if there are signs of possible deterioration, replace the breaker.

11.3.2 ISOLATING SWITCH

After a fault, the external operating handle should be capable of opening the switch. Replace the switch if the external operating handle fails to open it, or if visual inspection after opening indicates deterioration beyond normal wear, such as overheating, arc chute damage, contact blade or jaw pitting, charring welding, or insulation breakage.

11.3.3 OPERATING HANDLE

11.3.3.1 The disconnecting means and external operating handle should be replaced if the operating handle fails to open or close the switch or circuit breaker. The door interlock should be inspected and its proper functions verified prior to restoring the controller to service.

11.3.3.2 Operate each switch or circuit breaker several times to make sure that all mechanisms are free and in proper working order. To verify the performance of molded case circuit breakers, follow the manufacturer's instructions.

11.3.3.3 Inspect to ensure that oil or grease, if used, is applied only to surfaces recommended by the manufacturer.

11.4 TERMINALS AND INTERNAL CONDUCTORS

Replace all damaged parts which show evidence or discoloration, melting, or arcing damage.

11.5 CONTACTOR

Replace the contacts and contact springs if the contacts are welded or show heat damage, displacement of metal, evidence of binding in the guides, or wear in excess of wear allowance. If deterioration extends beyond the contacts, replace the contactor. Examples of such deterioration include evidence of arcing on the contactor moldings and insulation damage. Perform an electrical insulation resistance test to verify electrical integrity.

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