UL 218

Underwriters Laboratories Inc.

Standard for Safety

Fire Pump Controllers

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UL Standard for Safety for Fire Pump Controllers, UL 218

Second Edition, Dated September 28, 2009

Summary of Topics

This document is the Second Edition of UL 218, the common ANCE, CSA and UL (trinational) standard for Fire Pump Controllers, covering requirements for Mexico, Canada, and the United States. Some of the differences from the first edition are:

1. Clarification of the scope to allow a combination of a controller/automatic transfer switch;

2. Addition of definitions;

3. Separation of requirements for motor starting into full and reduced voltage types;

4. Clarification of requirements for short circuit testing;

5. Inclusion of requirements for: pressure switch/transducer tests, locked rotor overcurrent protection test, barrier dielectric strength test, temperature test, dielectric voltage withstand test, and coated printed circuit board performance tests;

6. Change in classification of controllers for foam concentrate pump motors to controllers for electric motor driven additive pumps;

7. Deletion of the reference to stand-alone upstream automatic transfer switch;

8. Addition of requirements for Metallic pressure sensing lines and fittings;

9. Replacement of the term ″Cabinet″ with ″enclosure″;

10. Revised 6.14.5 and addition of 6.14.7 to clarify that the standard allows a non-interlocked isolating switch and circuit breaker;

11. Deletion of ″Stand alone″ in 7.11.5 pertaining to meters;

12. Clarification of marking for upstream protection;

13. Addition of requirements covering Locked Rotor Overcurrent protection;

14. Addition of requirements for variable speed fire pump controllers;

15. Replacement of Table 2 into two Tables, 2 and 3, for three phase ratings and for single phase ratings and revision of kilowatt ratings;

16. Addition of references to Annex A for UL 347 and IEEE 4.

The new and/or revised requirements are substantially in accordance with Proposal(s) on this subject dated May 16, 2008 and October 17, 2008.

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Association of Standardization and Certification
NMX-J-626-ANCE-2009
First Edition

Canadian Standards Association
CSA C22.2 No. 263-09
First Edition

Underwriters Laboratories Inc.
UL 218
Second Edition

Fire Pump Controllers

September 28, 2009

ANSI/UL 218-2009

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This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (CSA), and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA, or UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA, and UL. CSA and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA and UL pages.

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ISBN 978–1–55491–140–7
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This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 218 as an American National Standard (ANSI) occurred on September 28, 2009. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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Preface

This is the harmonized ANCE, CSA, and UL standard for Fire Pump Controllers. It is the first edition of NMX-J-626-ANCE, the first edition of CSA C22.2 No. 263, and the second edition of UL 218. This edition of UL 218 supersedes the previous edition published in 1996.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (CSA), and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Fire Pump Controllers, CANENA THSC 17B WG4, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

The present Mexican Standard was developed by the CT 64 Instalaciones eléctricas y protección contra choque eléctrico from the Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, A.C., CONANCE, with the collaboration of the fire pump controllers manufactures and users.

This standard was reviewed by the CSA Subcommittee for Fire Pump Controllers, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard was reviewed and approved by the Committee de Normalizacion of ANCE (CONANCE). This standard was reviewed by UL's Standards Technical Panel (STP) for Fire Pump Controllers, STP 218.

This standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

A UL standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

Where reference is made to a specific number of specimens to be tested, the specified number is to be considered a minimum quantity.

Note: *Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.*

Level of harmonization

This standard uses the IEC format but is not based on, nor shall it be considered equivalent to, an IEC standard. This standard is published as an equivalent standard for ANCE, CSA, and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

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Reasons for differences from IEC

This standard provides requirements for fire pump controllers for use in accordance with the electrical installation codes of Canada, Mexico, and the United States. At present there is no IEC standard for fire pump controllers for use in accordance with these codes. Therefore, this standard does not employ any IEC standard for base requirements.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

ANCE effective date

The effective date for ANCE will be announced through the Diario Oficial de la Federación (Official Gazette) and is indicated on the cover page.

CSA effective date

The effective date for CSA International will be announced through CSA Informs or a CSA certification notice.

UL effective date

This standard is effective upon publication.

A UL effective date is one established by Underwriters Laboratories Inc. and is not part of the ANSI approved standard.

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INTRODUCTION

1 Scope

1.1 Products covered

1.1.1 These requirements cover controllers intended for starting and stopping centrifugal and positive displacement fire pumps, including automatic and non-automatic types for electric motor with or without transfer switch or engine driven pumps in accordance with Annex A, item 1. Types of controllers covered include diesel engine, electric motor, limited service, high voltage and residential. Controllers may be suitable for use as service equipment. This equipment is for installation in non-hazardous locations in accordance with Annex A, item 2.

1.1.2 Controllers for electric motor driven, centrifugal fire pumps are intended for use with squirrel cage or wound rotor motors rated 600 V or less. Controllers for squirrel cage motors may be for across-the-line or reduced inrush current starting. Controllers may be provided with integral automatic transfer switches.

1.1.3 Variable speed fire pump controllers for electric motor driven, centrifugal fire pumps are intended for use with squirrel cage induction, inverter duty rated, motors rated 600 V or less, and rated for 50 Hz or 60 Hz.

1.1.4 Limited service controllers are intended for across-the-line starting of squirrel cage motors rated 22 kW (30 hp) or less, 600 V or less. Controllers may be provided with integral automatic transfer switches.

1.1.5 High voltage fire pump controllers are intended for use with squirrel cage motors rated 601 V – 7.2 kV AC.

Note: Also referred to as medium voltage.

1.1.6 Residential fire pump controllers are intended for use with single-phase squirrel cage motors rated 240 V or less. Residential fire pump controllers are intended to be used in one or two family dwelling units in accordance with the requirements of item 45 in Annex A.

1.1.7 Diesel engine fire pump controllers rated nominal 24 V DC or less are intended for use with fire pump engines. Where required, AC Voltage is limited to 600 V AC or less.

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1.2 Products not covered

1.2.1 An automatic transfer switch intended to be used in fire pump circuits, that is provided separate from a controller.

Note: Stand-alone automatic transfer switches for fire pump circuits are covered by the requirements of item 15, Annex A.

2 Normative References

2.1 The normative references listed in Annex A contain provisions which, through reference in this text, constitute provisions of this Standard. For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved. For dated references to Standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the Standard was approved.

2.2 In Canada, general requirements applicable to this standard are given in the latest edition of item 23 of Annex A. In addition the requirements of Annex A item 24 also apply unless specifically modified by this standard.

In Mexico and the United States, this requirement does not apply.

3 Units of Measurement

3.1 The values given in SI (metric) units shall be normative. Any other values are for information only.

4 Components

4.1 A component of a product covered by this standard shall comply with the requirements for that component. See Annex B for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL standards as appropriate for the country where the product is to be used.

5 Definitions

5.1 For the purpose of this standard, the following definitions apply. In Canada, in addition to the definitions listed in this standard, the definitions of item 2 in Annex A also apply.

5.2 AUXILIARY CIRCUIT – Circuits not essential for the performance of the fire pump controller.

5.3 CENTRIFUGAL PUMP – A pump in which the pressure is developed principally by the action of centrifugal force.

5.4 CIRCUIT-BREAKERS

Circuit-Breaker – For the purposes of this standard, the term circuit-breaker (disconnecting means) refers to either thermal-magnetic circuit-breakers (for limited service controllers and residential fire pump controllers only) or to instantaneous-only circuit-breakers.

Thermal-Magnetic Circuit-Breaker – A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overcurrent (overload and short-circuit), without damage to itself when properly applied within its rating.

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Instantaneous-Only Circuit-Breaker – One intended to provide short-circuit protection only.

5.5 CONTROL CIRCUIT – A circuit that carries the electric signals directing the performance of a fire pump controller, but which does not carry the main power circuit. A control circuit is generally limited to 15 A.

5.6 CONTROLLER – The enclosure, motor starter, circuit breaker and isolating switch, and other control devices for the control of electric motor or engine driven pumps.

5.7 CONTROLLER – LIMITED SERVICE – A controller that is limited in application when approved by the authority having jurisdiction, as defined in 1.1.3.

5.8 CURRENT LIMITERS – Melting link-type devices that, when used as an integral part of a circuit breaker, limit the current during a short-circuit to less than the interrupting capacity of the circuit breaker.

5.9 DISCONNECTING MEANS – A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

5.10 DROP-OUT RELAY – A relay that, when de-energized, initiates the control function.

5.11 ENCLOSURE – A surrounding case constructed to provide a degree of protection against incidental contact with the enclosed equipment, and to provide a degree of protection against specified environmental conditions.

5.12 ISOLATING SWITCH – A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

5.13 READILY ACCESSIBLE – Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth.

5.14 SERVICE BOX (For Canada) – An approved assembly consisting of a metal box or enclosure constructed so that it may be effectually locked or sealed, containing either service fuses and a service switch or a circuit breaker, and of such design that either the switch or circuit breaker may be manually operated when the box is closed.

In Mexico and the United States, this definition does not apply.

5.15 SERVICE EQUIPMENT (For Mexico and the United States) – The necessary equipment, usually consisting of a circuit breaker or switch and fuses and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means to cut-off the supply.

In Canada, this definition does not apply.

5.16 SERVICE EQUIPMENT (For Canada) – In addition to 5.15, the service circuit breaker or fused switch is located in a service box.

In Mexico and the United States, this definition does not apply.

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5.17 TRANSFER SWITCH (AUTOMATIC) – A switch that is self-acting for transferring the load from one power source to another.

CONSTRUCTION

6 Construction

6.1 Enclosures

6.1.1 In Mexico and the United States, a fire pump controller assembly or panel shall be securely mounted in an enclosure that protects the equipment against limited amounts of falling water and dirt. The enclosure shall be constructed to provide strength and rigidity required to resist the abuses to which it is subjected, without total or partial collapse resulting in a risk of fire, electric shock, or injury to persons due to reduction of spacings, loosening or displacement of parts, or other serious defects.

In Canada a fire pump controller assembly shall be securely mounted in an enclosure that protects the equipment. The enclosure shall be constructed to provide strength and rigidity required to resist the abuses to which it is subjected without total or partial collapse resulting in a risk of fire, electric shock, or injury to persons due to reduction of spacings, loosening or displacing of parts, or other serious defects.

6.1.2 Enclosures for fire pump controllers shall comply with the requirements in Annex A, item 13.

6.1.3 An enclosure shall comply with the requirements for an environmental rating, excluding Type 1, as specified in Annex A, item 3.

6.2 Spacings

6.2.1 Electrical spacings through air, over surface and between uninsulated live parts and the enclosure walls shall be at least those specified in Table 1.

6.2.2 For printed circuit wiring boards, the minimum spacings shall be as specified in Table 11.

6.2.3 The spacings at a field-wiring terminal shall be measured with wire connected to the terminal as in service. The connected wire shall be the next larger size than normally required if the terminal will accommodate it, or if the equipment is not marked to restrict its use.

6.2.4 In Mexico and the United States, the spacings specified in Table 1 for devices having limited rating shall apply to:

a) Devices rated 0.75 kW (1 hp) or less; 720 VA or less (break pilot duty); or not more than 15 A at 51 – 150 V, 10 A at 151 – 300 V, or 5 A at 301 – 600 V; or any combination thereof;

b) These same devices, when multipole and controlling more than one load, provided that the total load connected to the line at one time does not exceed 1.5 kW (2 hp), 1440 VA, or have a current rating greater than 30 A at 51 – 150 V, 20 A at 151 – 300 V, or 10 A at 301 – 600 V, and provided also that the loading on any one pole does not exceed its marked rating.

In Canada, reduced spacings for limited ratings are only allowed in control circuits.

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6.2.5 In a circuit involving voltages of 50 V or less, spacings at field-wiring terminals shall be permitted to be 3.2 mm (0.125 inch) through air and 6.3 mm (0.25 inch) over surface.

6.2.6 In a circuit involving voltages of 50 V or less, other than field wiring terminals, the spacings shall be 1.6 mm (0.06 inch) through air or over surface, provided that the insulation and clearances between such circuits and any circuits of more than 50 V are in accordance with the requirements for the higher voltage circuit.

6.3 Insulating barriers

6.3.1 An insulating barrier or liner used as the sole separation between uninsulated live parts and grounded dead metal parts, including the enclosure, or between uninsulated live parts of opposite polarity shall be of a material specified in Table 14 that is intended for the mounting of uninsulated live parts, and shall not be less than 0.66 mm (0.025 inch) thick.

6.3.2 In Mexico and the United States, fiber less than 0.66 mm (0.025 inch) thick may be used as the sole separation between the enclosure and an uninsulated metal part electrically connected to a grounding conductor.

In Canada, this clause does not apply.

6.3.3 An insulating barrier or liner that is used in addition to an air space in place of the required spacing through air shall be at least 0.66 mm (0.025 inch) thick. When the barrier or liner is of fiber, the air space shall not be less than 0.8 mm (1/32 inch), and when the barrier or liner is of other material that is not capable of being used for the support of uninsulated live parts, the air space provided shall be acceptable for the application.

6.3.4 A barrier or liner that is used in addition to not less than one-half the required spacing through air is not required to be at least 0.66 mm (0.025 inch) thick when it is not less than 0.33 mm (0.013 inch) thick and the barrier or liner:

a) Is of a material that is intended for the support of uninsulated live parts;

b) Has the mechanical strength required to withstand mechanical damage;

c) Is held in place; and

d) Is located so that it is not adversely affected by operation of the equipment in service.

6.3.5 Insulating material having a thickness less than that specified in 6.3.1 and 6.3.3 can be used when investigated subjected to the Barrier Dielectric Strength Test in 7.9 or the material is selected in accordance with Table 14.

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6.4 Field wiring terminals

6.4.1 A controller shall be provided with wiring terminals for connection of conductors having an ampacity or wire size not less than the following:

a) For power circuits, 125 percent of the full-load motor current specified in Tables 2 and 3 for the horsepower rating or, in the case of power conversion equipment in which the input current is different from motor full-load current, 125 percent of maximum rated input current,

b) For service use not less than 5.3 mm^2 (10 AWG) and

c) For control circuits not less than 2.1 mm^2 (14 AWG).

See Table 5 for field conductor ampacities.

6.4.2 All wiring terminals intended for field connection shall:

a) Be evaluated in accordance with Annex A, items 11 and 16, and marked for the wire size or range;

b) Be part of a device evaluated and marked for the wire size or range; or

c) Comply with the secureness and pullout requirements of 6.4.5 for the next larger size conductor than that specified in 6.4.1, unless the equipment is marked to restrict its use to only the smaller size conductor.

6.4.3 A terminal to which field wiring is to be connected shall be a pressure wire connector.

6.4.4 A terminal to which 5.3 mm^2 (10 AWG) or smaller wiring connections are to be made may consist of a clamp or wire-binding screw with a terminal plate having upturned lugs or the equivalent to hold the wire in position. See 6.4.6 – 6.4.10.

6.4.5 A field-wiring pressure wire connector provided with or specified for use with industrial control equipment shall comply with one or more of the following, as applicable:

a) The performance requirements in Annex A, item 8 (see 16.13); or

b) The performance requirements in Annex A, item 11; or

c) The performance requirements in Annex A, item 16.

6.4.6 A wire-binding screw to which field-wiring connections are made shall be No. 8 or larger.

6.4.7 A No. 6 screw may be used at a terminal intended only for connection of a 2.1 mm^2 (14 AWG) conductor or smaller.

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6.4.8 A terminal plate tapped for wire-binding screw shall be of metal not less than 0.76 mm (0.030 inch) thick for a 2.1 mm^2 (14 AWG) or smaller wire, and not less than 1.27 mm (0.050 inch) thick for a wire larger than 2.1 mm^2 (14 AWG). There shall be at least two full threads in the plate.

6.4.9 For a terminal plate formed from stock having the required thickness specified in 6.4.8, one method of complying with the thread requirement of 6.4.8 is to have the metal extruded at the tapped hole for the binding screw to provide two full threads.

6.4.10 A wire-binding screw shall thread into metal.

6.5 Grounding

6.5.1 In Mexico and the United States, all controllers shall have provisions for grounding all non-current-carrying metal parts that are exposed or that are located in a position to be contacted by persons during normal operation or adjustment of the equipment and that are capable of becoming energized.

In Canada, this requirement does not apply.

6.5.2 In Canada, the requirements for grounding and bonding as specified in Annex A, item 25, shall apply.

In Mexico and the United states these requirements do not apply.

6.5.3 The grounding and bonding terminology used in this standard is in accordance with the UL column in Figure 1. The corresponding CEC and ANCE terms are also provided.

6.5.4 Controllers shall be provided with a terminal or an equivalent means for connecting an equipment grounding conductor except as provided in 6.5.6. A terminal shall be sized for a grounding conductor as specified in Table 7.

6.5.5 In Canada, the following requirements amend Table 7:

a) The use of aluminum wire shall not be permitted.

b) The values in brackets [xx] for size of equipment grounding or bonding conductor shall apply.

c) Footnote (c) does not apply.

In Mexico and the United States, Table 7 is not amended.

6.5.6 A terminal need not be provided with a controller that is marked to indicate the pressure wire connector or component terminal kits that are intended for use with the controller. A wire connector of the type mentioned shall be installed in the equipment at the factory with instructions, if required, for proper connection to the conductor. A terminal kit shall be described in the instructions by model number and manufacturer's name.

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6.5.7 A wire-binding screw intended for the connection of a field-installed equipment grounding conductor shall have a green colored head that is hexagonal, slotted, robertson, phillips, allen, Torx™ or any combination. See 6.4.6 – 6.4.10.

6.5.8 A terminal intended for connection of an equipment grounding conductor shall be plainly identified with the symbol

(IEC Publication 60417, Symbol 5019)

or

(IEC Publication 60417, Symbol 5017)

or with ″G,″ ″GR,″ ″GRD,″ ″Ground,″ ″Grounding,″ or other equivalent marking.

6.6 Service equipment

6.6.1 In the United States, controllers for use with electric motor driven fire pumps and intended for use as service equipment shall comply with the requirements in Annex A, item 14. See 16.10 and 16.11 for markings.

In Canada and Mexico, this requirement does not apply.

6.6.2 In Canada, a separate service box is required.

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6.7 Wire bending space

6.7.1 The distance between the end of a pressure wire connector or terminal block for connection of a field installed wire, and the wall of the enclosure toward which the wire is directed shall be not less than that indicated in Table 4. The distance shall be measured in a straight line from the center of the opening in the connector, in the direction in which the wire leaves the terminal, perpendicular to the enclosure wall.

6.7.2 In Canada, the wire bending space required by 6.7.1 shall be determined by Annex A, item 26.

In Mexico and the United States, this requirement does not apply.

6.7.3 The required bending space is based on the size of field wire to be connected to the connector or terminal in accordance with 6.4.

6.8 Internal wiring, busbars, and connections

6.8.1 Insulated conductors shall be suitable for the service intended with respect to voltage, temperature, and grouping. Conductors shall be copper and shall be not smaller than 0.2 mm^2 (24 AWG). The temperature rating shall be not less than 90°C (194°F) unless investigation proves the suitability of other conductors.

6.8.2 The requirements of 6.8.1 apply only to the wiring furnished on or in industrial control equipment as a part of the equipment. They do not apply to the supply wiring run to control equipment, to motors, or to other apparatus.

6.8.3 In Mexico and the United States, for motor and control-circuit applications, the use of Table 9 as a guide in selecting the conductor sizes in a controller may obviate the need to perform a temperature test on the wire. See temperature test in Annex A, item 13.

In Canada, for motor and control circuit applications the use of Table 2 in Annex A, item 2, for selecting the conductor sizes, will obviate the need to perform a temperature test on the wire.

6.8.4 Conductors that are in a circuit only during the motor starting period are not required to be sized for continuous duty but shall be sized according to their duty cycle.

6.8.5 Notwithstanding 6.8.1, conductors smaller than 0.2 mm^2 (24 AWG) shall be permitted for wiring of printed circuit boards and interconnecting wiring between electronic modules and subassemblies.

6.8.6 Conductors in an assembly intended for use in a complete enclosure shall be insulated for the highest voltage normally occurring between such conductors unless the wires are grouped so as to segregate the several voltages.

6.8.7 Wires shall be supported or secured or otherwise run in suitable raceways, in order that they will not come into contact with moving parts or rest on sharp edges or projections that might cause abrasion of the insulation. Wires shall be of flexible or extra-flexible construction where they make connection to electrical equipment mounted on a hinged door. If the flexing section of the wiring is liable to come in contact with grounded metal parts, that portion of the wiring shall be given additional protection with wrappings of tape or the equivalent or enclosed in nonmetallic flexible tubing or conduit.

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6.8.8 Additional insulation is not required if the test described in 7.5 is completed without evidence of damage to the wiring.

6.8.9 Internal wiring shall not be in contact with bare live parts of opposite polarity or with bare live parts of other circuits.

6.8.10 A bare conductor, including pigtails and coil leads, shall be supported so that the spacings required elsewhere in this Standard will be maintained unless covered by suitable insulating sleeving or tubing.

6.8.11 All busbars and connections shall be readily accessible after installation of the controller.

6.8.12 All busbars and connections shall be arranged so that disconnection of the external circuit conductors will not be required.

6.8.13 Fuses shall be readily accessible.

6.8.14 Clamps and guides, either metallic or nonmetallic, used for routing stationary internal wiring shall be provided with smooth, well-rounded edges. The clamping action and bearing surface shall be such that abrasion or cold flow of the insulation does not occur. Auxiliary nonconducting mechanical protection shall be provided under a metallic clamp that exerts pressure on a conductor having thermoplastic insulation less than 0.8 mm (1/32 inch) thick and having no overall braid.

6.8.15 Insulated grounding and bonding conductors shall be identified by the color green with or without one or more yellow stripes. No other leads shall be so identified in the field wiring area.

6.8.16 All splices and connections shall be mechanically secure and shall provide electrical continuity.

6.8.17 Electrical connections shall be soldered, welded, crimped, or otherwise securely connected. A soldered joint shall be mechanically secure before soldering.

6.8.18 A printed wiring board joint is not required to be mechanically secure before soldering.

6.8.19 A lead shall be considered to be mechanically secure when it is:

a) Wrapped at least halfway (180 degrees) around a terminal;

b) Provided with at least one right angle bend when passed through an eyelet or opening; or

c) Twisted with other conductors.

6.8.20 If stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands of wire cannot contact other uninsulated live parts not always of the same polarity as the wire, and de-energized metal parts. This can be accomplished by any acceptable means including use of machine- or tool-applied pressure terminal connectors, soldering lugs, or crimped eyelets, or soldering all strands of the wire together.

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6.8.21 In Mexico and the United States, a splice shall be provided with insulation equivalent to that of the wires involved.

In Canada, splices are not allowed.

6.8.22 In determining if splice insulation consisting of coated-fabric, thermoplastic, or other types of tubing is acceptable, consideration shall be given to electrical and mechanical properties including dielectric voltage-withstand ability, heat resistance, and moisture resistance. Thermoplastic tape shall not be wrapped over a sharp edge or connection.

6.9 Provisions for use of test instruments

6.9.1 Means shall be provided on the exterior of the controller to read all line currents and all line voltages within ±5 percent of full scale.

6.10 Control circuit

6.10.1 Circuits that are necessary for proper operation of the controller shall not have overcurrent protective devices connected in them.

6.11 Auxiliary circuits

6.11.1 An auxiliary circuit shall be provided with overcurrent protection in accordance with Annex A, item 2. Failure of auxiliary circuits shall not prevent the controller from starting the fire pump.

6.12 Manual controls

6.12.1 All switching equipment for manual use in isolating, connecting or disconnecting, or starting or stopping the motor shall be externally operable.

6.13 Surge arresters

6.13.1 A surge arrester, complying with Annex A, item 20, or Annex A, item 21, shall be installed from each line to ground. These devices shall be rated to suppress voltage surges above the rated line voltage of the controller.

6.13.2 Notwithstanding 6.13.1, a controller rated in excess of 600 V is not required to be provided with a voltage surge arrester.

6.13.3 Notwithstanding 6.13.1, a voltage surge arrester is not required to be provided when the controller is capable of withstanding a 10 kV impulse in accordance with Annex A, item 22, without damage.

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6.14 Isolating switch

6.14.1 The isolating switch shall have an ampere rating at least 115 percent of the motor rated full load current as determined from Tables 2 and 3; and shall be a manually operable switch that complies with Annex A, item 6, or a molded case switch that complies with Annex A, item 12. See 16.6 for marking.

6.14.2 A molded case isolating switch provided with self-protecting instantaneous short circuit overcurrent protection complies with 6.14.1 when the switch is such that it does not trip unless the circuit breaker in the same controller trips.

6.14.3 An isolating switch shall be externally operable.

6.14.4 A horsepower or kW rated motor circuit switch complying with Annex A, item 6, shall also be permitted to be used as the isolating switch.

6.14.5 In Mexico and the United States, a non-load break rated isolating switch operating handle shall be provided with a spring latch that shall be so arranged that it requires the simultaneous releasing of the latch in order to open or close the switch and shall be marked as per 16.6.

In Canada, an isolating switch shall be interlocked with the circuit breaker and shall be marked as per 16.6.

6.14.6 For a construction with the isolating switch and the circuit breaker so interlocked that the isolating switch is not capable of being opened nor closed while the circuit breaker is closed, the latch and markings in 6.14.5 are not required.

6.14.7 When a load break rated isolating switch or a switch complying with 6.14.4 is used, the latch and markings in 6.14.5 are not required.

6.15 Circuit breaker – disconnecting means

6.15.1 The motor branch circuit shall be protected by a circuit breaker that complies with Annex A, item 12, connected directly to the load side of the isolating switch with one pole connected to each ungrounded circuit conductor.

6.15.2 A circuit breaker shall have the following mechanical characteristics:

a) Be externally operable and resettable (See 6.16.1(c));

b) Be trip free of the handle; and

c) Be marked in accordance with 16.8.

6.15.3 The electrical characteristics of the circuit-breaker disconnecting means shall:

a) Have a continuous current rating not less than 115 percent of the rated full load current of the motor;

b) Have non-thermal type overcurrent sensing elements, if provided;

c) Be of the instantaneous-only circuit-breaker type with an instantaneous trip setting of not more than 20 times the full load current to allow normal starting or emergency run mechanical starting of the motor without tripping;

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d) Be adequate to provide the short-circuit rating of the controller, as determined by testing per 7.1.

6.16 Locked rotor overcurrent protection

6.16.1 Locked rotor overcurrent protection sensing shall be located within the fire pump controller between the load side of the isolating switch and the controller output terminals and have the following characteristics:

a) Be of the non-thermal time delay type having a tripping time between 8 and 20 seconds at locked rotor current. (Unless otherwise specified, this is 600 percent of rated full load current.);

b) Have a tripping characteristic such that tripping shall not occur at less than 300 percent of rated full-load current;

c) Be provided with visual means or markings that clearly indicate that proper settings have been made;

d) Be resettable for operation immediately after tripping, with the tripping characteristics unchanged;

e) Tripping shall be accomplished by opening the circuit-breaker (disconnecting means). (See 6.15).

6.16.2 The locked rotor overcurrent protection shall be subjected to the test described in 7.8.

6.17 Motor starting means

6.17.1 Full voltage starting

6.17.1.1 A motor contactor that complies with Annex A, item 24, shall be of the magnetic type with a contact in each ungrounded conductor.

6.17.1.2 For controllers rated 600 V or less, the operating coil for the main contactor shall be supplied directly by the primary supply circuit.

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6.17.2 Reduced voltage starting

6.17.2.1 A reduced voltage controller shall comply with Annex A, item 24.

6.17.2.2 For electrical operation of reduced voltage controllers, timed automatic acceleration of the motor shall be provided. The period of motor acceleration shall not exceed 10 seconds. After 10 seconds the fire pump controller shall apply full line voltage to the motor.

6.17.2.3 For controllers rated 600 V or less, the operating coil for the contactor(s) shall be supplied directly by the primary supply circuit.

6.17.2.4 Starting resistors shall be designed to permit one 5 second starting operation in each 80 seconds for a period of not less than 1 hour. This requirement shall not apply to the transition resistors in a wye-delta closed transition controller.

6.17.2.5 A starting reactor or autotransformer shall permit one 15 second starting operation every 240 seconds for a period of not less than 1 hour. Alternately, a controller over 132 kW (200 hp) shall be permitted to allow three 30 second starts separated by 30 second rest intervals in each hour for 2 hours.

6.17.2.6 Soft start units shall be horsepower rated or specifically designed for the service.

6.17.2.7 The bypass contactor shall comply with 6.17.1.1.

6.17.2.8 Soft start units shall comply with the duty cycle requirements in accordance with 6.17.2.5.

6.17.2.9 A fire pump controller employing a reduced voltage starting means shall also comply with 6.21.3 for emergency-run control.

6.17.2.10 For wye-delta or part winding start motors, the starting contactor shall be rated as follows:

a) Part winding: each contactor carries no less than 50% of the motor FLA;

b) Wye-delta: line contactors carry no less than 58% of the motor FLA. Wye contactor carries 33 percent.

c) For primary resistor, auto-transformer, primary reactor and soft start carry no less than 65% of motor FLA. Auto-transformer Neutral contactor carries no less than 25% of motor FLA.

d) Closed transition wye-delta transition contactor current is at least equal to 58% of the rated line voltage divided by the transition resistor resistance.

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6.18 Use of sensing devices

6.18.1 No undervoltage, phase loss, frequency sensitive, ground-fault or other sensor(s) shall be installed that automatically or manually prohibits electrical actuation of the motor contactor.

6.18.2 Sensors shall be permitted to prevent a three-phase motor from starting under single-phase conditions. These shall not cause disconnection of the motor when running at the time of a single-phase occurrence. Such sensors shall be monitored to provide a local visible alarm in the event of malfunction of the sensors. When single-phase (loss of phase) motor protection is provided:

a) The failure of any circuit or component whose primary function is the detection, signaling, or response to a loss of phase of the power source shall not prevent the motor from electrically starting under restored power conditions.

b) If the single phase loss condition occurs while the motor is running, any circuit or component whose primary function is the detection, signaling or response to a loss of phase of the power source shall not interrupt the power to the motor, including low rpm and locked rotor conditions.

c) The voltage threshold (drop out) for any circuit or component whose primary function is protection of the motor from a loss of phase of the power source shall not exceed 70 percent of the nominal line voltage.

d) When the motor is protected from a loss of phase of the power source, electrical starting capability shall be automatically restored within 10 seconds upon the restoration of power.

6.19 Provision for alarm and signal devices

6.19.1 A visible indicator shall monitor the availability of power in all phases at the line terminals of the motor starting means. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

6.19.2 When power is supplied from an integral transfer switch, monitoring of the availability of power from each power source shall be permitted at any point electrically upstream of the line terminals of the contactor, provided all sources are monitored.

6.19.3 A visible indicator shall monitor for phase reversal at the line terminals of the motor starting means. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

6.19.4 When power is supplied from an integral transfer switch, monitoring for phase reversal from each power source shall be permitted at any point electrically upstream of the line terminals of the contactor, provided all sources are monitored.

6.19.5 Controllers shall be provided with contacts (open, closed, or both) to operate alarm circuits that indicate the following conditions:

a) Controller in a motor running condition;

b) Loss of phase on the line side of the motor contactor, in any phase, falls below 85 percent of nominal controller voltage;

c) Phase reversal on the line side of the motor contactor on a polyphase controller; and

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d) Controller connected to alternate source – contacts (open, closed or both), mechanically actuated by the transfer switch mechanism, shall be provided to indicate whenever the alternate source is the source supplying power to the controller. See 11.5.4(d).

6.19.6 The alarm contacts specified in 6.19.5 shall be rated at 125 V minimum and have provision for connection to an external circuit.

6.19.7 Controllers shall detect the loss of any phase regardless of whether the motor is running or not. See 7.6.

6.20 Automatic controllers

6.20.1 General

6.20.1.1 An automatic controller shall comply with the requirements for a non-automatic controller specified in 6.21.

6.20.1.2 The controller shall be in a fully functional state within 10 seconds upon application of ac power.

6.20.2 Water pressure control

6.20.2.1 An automatic water pressure controller shall be provided with a pressure-activated device having high and low calibrated set points in the controller circuit. No pressure snubber or restrictive orifice shall be employed within the pressure switch. The device shall be responsive to water pressure in the fire protection system as specified in 6.20.2.4.

6.20.2.2 When an automatic controller is provided with a pressure recording device to sense and record the pressure in each fire pump controller pressure sensing line at the input to the controller, the recorder shall be capable of operating for at least 7 days without being reset or rewound.

6.20.2.3 The pressure recording device of 6.20.2.2 shall be mounted external to the controller, or in a barriered compartment, or behind a door in a barriered enclosure, or other provisions shall be made to reduce the risk of contact with uninsulated live parts during normal servicing of the pressure recording device.

6.20.2.4 The pressure sensing element of a pressure-activated and pressure recording device shall be capable of withstanding a momentary surge of pressure of 2,758 kPa (400 psi) or 133 percent of the fire pump controller rated operating pressure, whichever is higher, without losing its accuracy.

6.20.2.5 A controller that starts the motor before the pressure-activated device specified in 6.20.2.1, under specified conditions shall use a drop-out relay to start the motor.

6.20.2.6 When the controller has a means for connection of a circuit for the remote manual starting of the fire pump, this means shall be such that the fire pump motor is not capable of being stopped from the remote station.

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6.20.2.7 For sequence starting of multiple pumps, the controller for each unit of multiple pump units shall incorporate a sequential timing device to prevent any one driver from starting simultaneously with any other driver. If water requirements call for more than one pumping unit to operate, the units shall start at intervals of 5 to 10 seconds. Failure of a leading driver to start shall not prevent subsequent drivers from starting.

6.20.2.8 Controller actuation by the pressure switch at the low adjustment setting shall initiate the pump starting sequence, unless the pump is already in operation.

6.20.2.9 A pressure sensing switch or transducer with internal or external amplifier shall comply with 7.7.

6.20.2.10 A pressure transducer shall be permanently marked on the exterior to include the name or trademark of the manufacturer, serial and identification number, pressure range and electrical rating.

6.20.2.11 Instructions shall be provided for setting the start and stop pressures for the fire pump.

6.20.2.12 Metallic pressure sensing lines and fittings shall be brass, copper, or series 300 stainless steel pipe or tube.

6.20.3 External circuits connected to controllers

6.20.3.1 External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open, ground fault or short circuit) shall not prevent operation of pump(s) from all other internal or external means. Breakage, disconnecting, shorting of the wires, ground fault or loss of power to these circuits shall be permitted to 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 circuits.

6.20.3.2 No undervoltage, phase loss, frequency sensitive, or other sensor(s) shall be installed that automatically or manually prohibits electrical actuation of the engine starting contactor.

6.20.4 Non-pressure switch actuated automatic controller

6.20.4.1 A non-pressure switch actuated automatic controller shall be activated by a remote sensor, such as a smoke detector, fire alarm, carbon monoxide detector, or other such device. A pressure switch shall not be required.

6.20.4.2 The starting sequence of the controller shall be initiated by the opening of the remote contact(s) of the device specified in 6.20.4.1.

6.20.4.3 No other means of stopping the fire pump motor shall be provided except for those on the controller.

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