

Approval Standard

Controllers for Electric
Motor Driven and
Diesel Engine Driven
Fire Pumps

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Approval Standard for Controllers for Electric Motor Driven and Diesel Engine Driven Fire Pumps

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for electric motor and diesel engine driven fire pump controllers that start, control, monitor, and stop pump drivers for fire protection systems. These controllers must have an extended service life, throughout which they must be capable of operating reliably during emergency fire incidents, despite being idle for extended periods.
- 1.1.2 Approval criteria include, but are not limited to, structural features, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.
- 1.1.3 Approval standards are intended to verify that the product described will meet stated conditions of performance, safety and quality useful to the ends of property conservation.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for controllers for electric motor driven and diesel engine driven fire pumps used in fire pump service that are designed and installed in accordance with the applicable documents listed in Section 1.8 and the FM Global Property Loss Prevention Data Sheets. The intended operation of a fire pump controller is to initiate and sustain the operation of the fire pump driver in the event of a fire. In addition, controllers are tested under specified overload and fault conditions. To this extent the fire pump controller is unique when compared to other industrial motor controllers, and system reliability is improved by provisions for self testing and annunciation of conditions that could result in fire protection impairment.
- 1.2.2 This standard applies to controllers intended for starting, controlling and stopping stationary, centrifugal and positive displacement, fire pumps, including automatic and non-automatic types for alternating current electric motor or diesel engine driven fire pumps. For the purpose of this standard, the term “controller” indicates a full service controller. Types of controllers covered include diesel engine, electric motor, high (medium) voltage, and variable speed. It is anticipated that a controller only controls a single driver. It is also anticipated that fire pump controllers submitted for examination and certification by FM Approvals will be designed to meet the requirements of this standard which encompasses the requirements of American National Standards Institute (ANSI)/National Fire Protection Association (NFPA) 20, *Standard for the Installation of Stationary Pumps for Fire Protection* and requirements of other leading documents in the area of fire pump controllers and electrical control devices.
 - 1.2.2.1 Controllers for electric motor driven, centrifugal fire pumps are intended for use with squirrel cage induction motors or wound rotor induction motors rated 600V or less. Controllers for squirrel cage induction motors may be for across-the-line or reduced inrush starting. Controllers may be provided with integral automatic transfer switches. The design and construction of controllers for electric motor driven fire pumps shall be for use with fire pump motors specified in ANSI/NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, or the International Electrotechnical Commission (IEC) Standard IEC34-1. As a minimum, the controllers shall be suitable for National Electrical Manufacturers Association (NEMA) design “B” motors, as defined in NEMA standard MG-1, *Motors and Generators Revision 2*. Controllers shall be suitable for motor starting codes “F” or “G” (per NEMA MG-1) for motors at or above 15 hp (11 kW). Large horsepower motors, those in excess of 500 hp (375 kW), are not required to comply with NEMA MG-1. These large motors are allowed to exceed the horsepower and locked rotor current designations for NEMA design “B” motors as specified in ANSI/NFPA 20. The associated fire pump controller must be designed accordingly.

- 1.2.2.2 Limited service controllers are not FM Approved devices however the following is provided as reference for the reader since these devices do exist within the fire protection community. Limited service controllers are automatic controllers intended for across-the-line starting of squirrel cage induction motors rated 30 hp (20 kW) or less, and 600V or less. Limited service controllers may be provided with integral automatic transfer switches. Limited service controllers are intended for use with limited service pumps and were originally accepted by ANSI/NFPA 20 for specific light hazard type occupancies since at the time, full service fire pump controllers were not designed for less than 20 hp (15 kW) rated motors. Since many controller manufacturers now provide full service fire pump controllers for motors rated less than 20 hp (15 kW), there is no longer any need for limited service devices.
- 1.2.2.3 High voltage fire pump controllers (also referred to as medium voltage) are intended for use with squirrel cage induction motors rated 601V - 7.2 kV A.C. This upper range may vary by country and jurisdiction.
- 1.2.2.4 Diesel engine fire pump controllers rated nominal 24V D.C. or less are intended for use with fire pump engines, and for use with A.C. power supplies (mains) on branch circuits of 600 V A.C. or less rated for 50 Hz or 60 Hz, or both.
- 1.2.2.5 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 600V or less, and rated for 50 Hz or 60 Hz. This type of controller uses a variable frequency drive to change the speed of the electric motor and the resultant pressure and flow output of the fire pump in response to feedback from a pressure sensor on the discharge side of the fire pump. The variable speed controller maintains system design pressure by monitoring changes in pressure demand for the fire protection system and adjusting the pump speed according to that demand.
- 1.2.2.6 Variable speed devices for diesel engine drivers are not within the scope of this standard since these devices are not part of the fire pump controller. Variable speed devices for diesel engine drivers are mechanical devices that attach directly to the diesel engine fuel system. The output pressure of the fire pump is changed by controlling the fuel intake governor to the engine. This device is covered in FM Class Standard 1333, *Diesel Engine Fire Pump Drivers*. Controllers for use with these diesel engines shall provide the required system overpressure alarm per ANSI/NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, and shall also include the pressure sensor.
- 1.2.3 Controllers for electric motor driven fire pumps always include suitable short circuit protection as an integral part of the controller. This protection is typically provided by circuit breakers except for high (medium) voltage controllers. These controllers may include an integral power transfer switch. These controllers/automatic power transfer switch combinations are rated 600 V A.C. maximum in North America, and rated 1000 V A.C. maximum in Europe and Asia. Controllers combined with an automatic power transfer switch require two short circuit ratings, one for the "Normal" source power supply, and one for the "Emergency" source alternate power supply. Electric motor driven controllers shall also be suitable for use as service entrance equipment (SUSE) where so used. As such, they are required to be marked with a short circuit rating (Withstand and Interrupt Current Rating).
- 1.2.4 Controllers for diesel engine driven fire pumps include electrical circuits that operate various control and supervisory functions such as remote control (starting), alarms, signals, indicators, and the proper operation of battery chargers.
- 1.2.5 The purpose of this standard is to characterize the unique features of fire pump controllers, prescribe a procedure for exercising the controllers to verify their performance and reliability, and to ensure that effective quality controls are being implemented by the manufacturer to ensure a consistently fabricated and reliable product.

- 1.2.6 The object of this standard is to:
- a. Define the unique characteristics of fire pump controllers, their associated equipment and their operational functions;
 - b. Prescribe the conditions with which fire pump controllers shall comply with reference to:
 1. Their construction;
 2. Their critical components including the mounting, arrangement, wiring and connections;
 3. The degrees of protection provided by their enclosures;
 4. Their modes of actuation;
 5. Their operation and behavior under normal, overload and short circuit conditions;
 6. Their capability to annunciate significant events; and,
 7. Their electromagnetic compatibility for the environment into which they are placed;
 - c. Detail the performance tests for confirming that these conditions have been met, and the methods to be adopted for these tests;
 - d. Identify the information to be provided with the equipment such as markings, labels, drawings and information provided on or within the equipment.
- 1.2.7 In this context, this standard gives the requirements for all of the electrical functions associated with both the electric motor driven and the diesel engine driven fire pumps. Special applications such as explosive atmospheres, nuclear installations, ships, aircraft etc. are not covered by this standard. Referring to electric power sources, the requirements of this standard apply only to the extent that they place limits on the nature, behavior and characteristics of the electrical energy that is supplied to the service entrance (see UL 508 and UL 869A, or IEC 60364-5-55).
- 1.2.8 The requirements of this standard do not apply to the method or means by which the electrical energy is generated nor do they apply to the installation between the origin of the installation and the fire pump controller, which are to be found in ANSI/NFPA 70 NEC or the IEC 60364 series. This standard does not apply to diesel engine driven electric generators which may be associated with a stationary fire pump installation.
- 1.2.9 Electromagnetic Compatibility (EMC) considerations are correlated with other IEC standards for similar products:
- a. For electric fire pump controllers, EMC requirements are covered by this standard; and,
 - b. For diesel engine fire pump controllers, D.C. batteries are the required source of electrical power for starting and monitoring the engine. A.C. (mains) power to the controller is used for battery charging. A.C. (mains) power provided to the controller may also be used for other small devices that have dedicated factory-equipped field terminals and overcurrent protection, such as pump room space heaters, pump room dampers and engine oil heaters, at the discretion of the authority having jurisdiction (AHJ). EMC requirements for diesel engine fire pump controllers are covered by this standard.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and on the standards of other organizations. They are also based on the advice of manufacturers, users, trade associations, jurisdictions and loss control specialists.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of fire pump controllers for the purpose of obtaining Approval. Controllers having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, controllers which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate:
 - a. The suitability of the product;
 - b. The performance of the product as specified by the manufacturer and required by FM Approvals; and, as far as practical,
 - c. The durability and reliability of the product.
- 1.4.2 An initial facilities and procedures audit shall be conducted to evaluate the manufacturer's ability to consistently produce the product which was examined and tested as part of the Approval project. The audit will review the facility and in-place quality control procedures used in the manufacturing of the product. Typically areas of review are: incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures and drawing control. These examinations are repeated periodically as part of the FM Approvals' product follow-up program, (Refer to Section 6.2, Facilities and Procedures Audits).

1.5 Basis for Continued Approval

- 1.5.1 Continued Approval is based upon:
 - a. Production or availability of the product as currently FM Approved;
 - b. The continued use of acceptable quality assurance procedures;
 - c. Satisfactory field experience;
 - d. Compliance with the terms stipulated in the Master Agreement;
 - e. Satisfactory re-examination of production samples for continued conformity to requirements; and,
 - f. Satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals product follow-up program.
- 1.5.2 Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals. (Refer to Section 6.1.3 Drawing and Change Control.)

1.6 Effective Date

The effective date of an Approval Standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this standard is **October 31, 2008** for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix C lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing and Materials (ASTM) SI 10-2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*.

1.8 Applicable Documents

The following standards, test methods, and practices are referenced in this standard or are beneficial in understanding this standard:

American National Standards Institute (ANSI)/IEEE C62.1-1989, *Surge Arrestors for Alternating-Current Power Circuits*

ANSI/IEEE C62.11-1993, *Metal-Oxide Surge Arrestors for Alternating Current Power Circuits*

ANSI/IEEE C62.41-1991, *Surge Voltages in Low-Voltage AC Power Circuits*

ANSI/The Instrumentation, Systems, and Automation Society (ISA) MC96.1 - 1982, *Temperature Measurement Thermocouples*

ANSI/National Electrical Manufacturers Association (NEMA) ICS 2 - 2000, *Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC*

ANSI/NEMA 250 - 2003, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

ANSI/National Fire Protection Association (NFPA) 20 - 2007, *Standard for the Installation of Stationary Pumps for Fire Protection*

ANSI/NFPA 70 - 2005, *National Electric Code 2002*

ANSI/Underwriters Laboratories (UL) 50 - 2003, *Standard for Enclosures for Electrical Equipment*

ANSI/UL 50E - 1995, *Standard for Enclosures for Electrical Equipment, Environmental Considerations*

ANSI/UL 62 - 2006, *Flexible Cord and Fixture Wire*

ANSI/UL 83 - 2003, *Thermoplastic-Insulated Wires and Cables*

ANSI/UL 98 - 2006, *Standard for Enclosed and Dead-Front Switches*

ANSI/UL 218 - 2006, *Fire Pump Controllers*

ANSI/UL 347 - 2000, *Standard for Safety for High Voltage Industrial Control Equipment*

ANSI/UL 486A-486B - 2006, *Standard for Wire Connectors*

ANSI/UL 486C - 2006, *Standard for Splicing Wire Connectors*

ANSI/UL 486E - 2000, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

ANSI/UL 489 - 2006, *Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*

ANSI/UL 508 - 2005, *Industrial Control Equipment*

ANSI/UL 508C - 2005, *Standard for Safety for Power Conversion Equipment*

ANSI/UL 840 - 2004, *Standard for Safety for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

ANSI/UL 863 - 1993, *Time-Indicating and -Recording Appliances*

ANSI/UL 869A - 2006, *Reference Standard for Service Equipment*

ANSI/UL 1008 - 1996, *Standard for Transfer Switch Equipment*

ANSI/UL 1059 - 2001, *Standard for Terminal Blocks*

ANSI/UL 1236 - 1995, *Battery Chargers for Charging Engine-Starter Batteries*

ANSI/UL 1437 - 2006, *Standard for Electrical Analog Instruments - Panel Board Types*

ASTM D 3874 - 2004, *Standard Test Method for Ignition of Materials by Hot Wire Source*

Canadian Electrical Code, Part I (20th Edition) - 2006, *Safety Standard for Electrical Installations*

CSA 22.2 No. 0.12 - 2003, *Wiring Space and Wire Bending Space in Enclosures*

- CSA 22.2 No. 14 - Pending Publication, *High Voltage Industrial Control Equipment*
- Council for Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA) 218 - July 2005: *Fire Pump Controllers*
- FM Approvals' Approval Standard 1333 - 2004, *Diesel Engine Fire Pump Drivers*
- FM Approvals' Approval Standard 3510 - 1998, *Flow and Pressure Safety Switches*
- FM Approvals' Approval Standard 3810 - 1989, *Electrical and Electronic Test, Measuring and Process Control Equipment*
- FM Global Property Loss Prevention Data Sheets
- International Electrotechnical Commission (IEC) 60364 (all parts) - 2001, *Electrical installations of buildings*
- IEC 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies Amendment 1 (2004)*
- IEC 60529:1989, *Degrees of protection provided by enclosures (IP code) Amendment 1 (1999)*
- IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods Amendment 1 (2003)*
- IEC 60947-1:2004, *Low-Voltage Switchgear and Controlgear - Part 1: General rules*
- IEC 60947-2:2003, *Low-Voltage Switchgear and Controlgear - Part 2: Circuit-breakers*
- IEC 60947-3:1999, *Low-Voltage Switchgear and Controlgear - Part 3: Switches, Disconnectors, Switch-Disconnectors and Fuse-Combination Units Amendment 1 (2001), Amendment 2 (2005)*
- IEC 60947-4-1:2000, *Low-Voltage Switchgear and Controlgear - Part 4-1: Electromagnetic Contactors and Motor-Starters - Electromechanical Electromagnetic Contactors and Motor-Starters. Amendment 1 (2002)*
- IEC 60947-4-2:1999, *Low-Voltage Switchgear and Controlgear - Part 4-2: Electromagnetic Contactors And Motor-Starters - AC Semiconductor Motor Controllers And Starters. Amendment 1 (2001)*
- IEC 60947-6-1:1989, *Low-Voltage Switchgear and Controlgear - Part 6-1: Multiple Function Equipment - Automatic Transfer Switching Equipment. Amendment 1 (1994), Amendment 2 (1997)*
- IEC 61000-3-2:2000, *Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits for Harmonic Current Emissions (Equipment Input Current = 16 A per Phase). Amendment 1 (2001) Amendment 2 (2004)*
- IEC 61000-3-3:1994, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low-Voltage Supply Systems, for Equipment With Rated Current = 16 A per Phase and Not Subject to Conditional Connection Amendment 1 (2001)*
- IEC 61000-4-2:1995, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test. Amendment 1 (1998), Amendment 2 (2000)*
- IEC 61000-4-3:2002, *Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test. Amendment 1 (2002)*
- IEC 61000-4-4:2004, *Electromagnetic Compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test*
- IEC 61000-4-5:1995, *Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test. Amendment 1 (2000)*
- IEC 61000-4-6:2003, *Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields Amendment 1 (2004)*
- IEC 61000-4-8:1993, *Electromagnetic Compatibility (EMC) – Part 4-8: Testing and Measurement Techniques – Power Frequency Magnetic Field Immunity Test. Amendment 1 (2000)*

- IEC 61000-4-11:2004, *Electromagnetic Compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests*
- IEC 61000-4-13:2002, *Electromagnetic Compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at A.C. Power Ports, Low-Frequency Immunity Tests*
- IEC 62091 Ed.1:2006-11-03, *Low-Voltage Switchgear and Controlgear - Controllers for Drivers of Stationary Fire Pumps*
- IEEE/ASTM SI 10 - 2002, *Standard for Use of the International System of Units (SI): The Modern Metric System*
- International Special Committee on Radio Interference (CISPR) 61000-6-3:1996, *Electromagnetic Compatibility (EMC) – Part 6: Generic Standards – Section 3: Emission Standard for Residential, Commercial and Light-Industrial Environments*
- CISPR 11:2003, *Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment – Electromagnetic Disturbance Characteristics – Limits and Methods of Measurement, Amendment 1 (2004)*
- NEMA ICS 14-2004, *Industrial Control and Systems: Application Guide for Electric Fire Pump Controllers*
- NEMA ICS 15-1999, *Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of Electric Fire Pump Controllers Rated Not More than 600V*
- NEMA Standard MG-1 - 2006, *Motors and Generators Revision 2*
- UL 869A - November 2006, *Reference Standard for Service Equipment*
- UL 891 - July 2005, *Standard for Safety for Switchboards*

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. When the authority is FM Global, such locations are termed “FM Global Accepted.” Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Across-the-Line Motor (ATL) Starting

Full voltage motor starting method. See Direct-on-Line.

Additive/Foam Pump

Pump dedicated to deliver a specified rate of foam concentrate to the system proportioner in the water fire extinguishing system of a facility.

Additive/Foam Pump Controller

A specially designed electric fire pump controller or diesel engine fire pump controller intended to control the unique requirements of an additive/foam concentrate pump for use in fire suppression.

Alternate Power Supply

Alternative term for the Emergency Power Supply for Dual Source combination motor driven fire pump controllers (or fire pump transfer switches). (See Emergency Power Supply).

Ampacity

The continuous current-carrying capacity of a conductor or a device.

Automatic Control

Control of an operation without human intervention

Automatic Transfer Switching Equipment (automatic power transfer switch)

Self-acting equipment containing the transfer switching device(s) and other necessary devices for monitoring supply circuits and for transferring one or more load circuits from one power supply to another

Auxiliary Circuit

Circuits not essential for the performance of the fire pump controller.

Battery

A packaged collection of battery cells. Usually six cells for lead acid batteries.

Battery Unit

One or more batteries used to start and run diesel fire pump engines. Two are required.

Branch Circuit

The circuit conductors between the final overcurrent device protecting the circuit and the utilization equipment.

Centrifugal Pump

A pump in which the pressure is developed principally by the action of centrifugal force.

Circuit-Breakers***Circuit-Breaker***

An automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. For the purposes of this standard, the term circuit-breaker (disconnecting means) refers to instantaneous-only circuit-breakers for full service controllers under 600 Volts AC.

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. These devices are not allowed in FM Approved fire pump controllers.

Instantaneous-only Circuit-Breaker

One intended to provide short circuit protection only.

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 15A.

Control Power Transformer (CPT)

A step down transformer, single or multi-phase, to supply power to controller circuitry at less than line voltage. Also referred to as “controller transformer” and/or “rectifier transformer”. Two or more transformers may be used in cascade, especially in high (medium) voltage controllers.

Controller

Device or equipment that serves to control, in some predetermined manner, the electric power delivered to the apparatus to which it is connected. Usually comprised of a cabinet, motor starter, circuit breaker and isolating switch, and other control devices for control of electric motor or diesel engine driven pumps.

Controller – Limited Service

Controllers for use with 30 hp (20 kW) or less rated electric motors for driving limited service pumps. These may be for single phase or for three phase limited service motors. This device is limited in application where acceptable to the authority having jurisdiction (AHJ). It does not have a manually operated isolation switch. It uses an inverse time nonadjustable circuit breaker, and has limited locked rotor overcurrent protection. See Fire Pump Controllers. Limited Service Controllers are not FM Approved by FM Approvals.

Controller - With Automatic Power Transfer Switch

Electric fire pump controller with integral automatic transfer switch for normal power supply and alternate power supply to the controller where required by the authority having jurisdiction (AHJ), or where the normal power supply is unreliable.

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.

Demand, Pump Demand

A requirement for fire water. Also called “call to start”.

Diesel Engine

An internal combustion engine in which the fuel is ignited entirely by the heat resulting from the compression of the air supplied for combustion. The oil-diesel engine, which operates on fuel injected after compression is practically completed, is the type usually used as a fire pump driver.

Diesel Engine Fire Pump Controller

Controller intended to control a diesel engine-driven fire pump.

Diesel Engine Additive/Foam Pump Controller

Controller intended to control a diesel engine-driven additive/foam concentrate pump.

Direct-on-Line Motor (DOL) Starting

Full voltage motor starting method. See Across-the-Line.

Disconnecting Means

A device, group of devices, or other means (i.e., the circuit-breaker in the fire pump controller) by which the conductors of a circuit can be disconnected from their source of supply while under load.

Disconnecter (Isolating Switch)

Mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements.

Note: A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

Driver

Electric motor or diesel engine that drives the fire pump.

Drop-Out Relay

A relay that, when de-energized, initiates the control function.

Dual Source Fire Pump Controller

Controllers for motor driven fire pumps which accept two sources of A.C. (Mains) power.

Electric Fire Pump Controller

Controller intended to control an electric motor-driven fire pump.

Electric Additive/Foam Pump Controller

Controller intended to control an electric motor-driven additive/foam concentrate pump

Electromagnetic Compatibility - EMC

Ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Electronic (EMC or ECU) Controlled Engine

Engines which incorporate Electronic Control Modules (Units) for control of fuel and fuel injection. This is as opposed to “mechanical fuel injection”. Control modules may also control engine speed in lieu of a separate speed governor.

Electromagnetic Contactor

Electromagnetic contactor in which the force for closing the normally open main contacts or opening the electromagnetic normally closed main contacts is provided by an electromagnet.

Electromagnetic Disturbance

Any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter.

Note: An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

Electromagnetic Environment

Totality of electromagnetic phenomena existing at a given location.

Note: In general, the electromagnetic environment is time dependent and its description may need a statistical approach.

Emergency Power Supply

The Emergency Power Supply for Dual Source combination motor driven fire pump controllers (or fire pump transfer switches). Also known as Alternate, Stand-by or Back-up Supply.

Emission (electromagnetic)

Phenomenon by which electromagnetic energy emanates from a source

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.

Externally Operable

Capable of being operated without the need to remove covers or open an enclosure, and without exposing the operator to contact with live parts.

Feeder

All circuit conductors between the service equipment or the source of a separately derived electrical system and the final branch-circuit overcurrent device.

Fire Pump

Pump dedicated to deliver a specified rate of water flow at a specified pressure to the fire extinguishing system of a premises.

Fire Pump Controller (FPC)

Also referred to as “Full Service” fire pump controller. For the purpose of this Approval standard, an enclosed group of electrical and mechanical devices that serve to govern, in some predetermined manner, the starting and stopping of the fire pump driver (electric motor or diesel engine) as well as monitoring and signaling the status and condition of the fire pump unit. Typically comprised of a steel cabinet, motor starter, circuit breaker, isolating switch, and other control devices. Controllers for electric motor driven fire pumps are designed for three phase NEMA Design “B” motors or equivalent. Controllers for diesel engine driven fire pumps are used with FM Approved diesel engine drivers per FM Approvals’ Approval Standard Class 1333.

Fire Pump Controller Test Protocol

Procedure for exercising fire pump controllers to verify their compliance with the requirements of this standard.

Fire Pump Unit

An assembled unit consisting of a fire pump, driver, controller, and accessories.

FM Approvals Certification Mark

The FM Approvals Certification Mark is detailed in Appendix F. Its use is mandatory on all units of FM Approved Controllers for Electric Motor Driven and Diesel Engine Driven Fire Pumps. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, a publication of FM Approvals, issued annually, or its supplements. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. These forms obligate the manufacturer to allow re-examination of the product and audit of facilities and procedures at FM Approval’s discretion. It further requires the manufacturer not to deviate from the as-FM Approved configuration of the product without review by and agreement of FM Approvals.

Full Voltage or Reduced Voltage Starting

Electric motor controllers may be configured for direct on-line starting (full voltage) or for starting with reduced motor starting current (reduced voltage).

High Voltage Fire Pump Controller

Full Service Fire Pump Controllers for high voltage fire pump motors rated in excess of 600 volts. See Medium Voltage Fire Pump Controllers.

Electromagnetic Immunity

The ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

Induction Motor

Induction motors are probably the simplest and most rugged of all electric motors. They consist of two basic electrical assemblies: the wound stator and the rotor assembly. The rotor consists of laminated, cylindrical iron cores with slots for receiving the conductors. On early motors, the conductors were copper bars with ends welded to copper rings known as end rings. Viewed from the end, the rotor assembly resembles a squirrel cage; hence the name squirrel-cage motor is used to refer to induction motors. In

modern induction motors, the most common type of rotor has cast-aluminum conductors and short-circuiting end rings. The rotor turns when the moving magnetic field induces a current in the shorted conductors. The speed at which the magnetic field rotates is the synchronous speed of the motor and is determined by the number of poles in the stator and the frequency of the power supply.

Inverter Duty Motor

An A.C. polyphase induction motor that is specifically designed for use with variable frequency drives (i.e. to run at varying speeds within a speed range). This motor has windings that can withstand harmonics and higher voltages, and is also designed with proper cooling to run at lower speeds, and thermally stronger wire insulation. This motor is designed to meet the requirements of NEMA MG-1, 2006, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

Isolating Switch

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

Jockey Pump

Also known as a pressure maintenance pump, a jockey pump is a low flow pump installed on a fire protection system with the main fire pump in order to keep the system pressurized by making up for small losses in water pressure due to minor leaks and temperature changes without causing the main fire pump to turn on. A jockey pump is designed and installed so that it starts before the main fire pump and returns the system to its minimum static pressure.

Lockout Feature

Externally accessible means to preclude an automatic controller from responding to a start signal.

Manual Power Transfer Switch

Switch, operated by direct manpower, for transferring one or more load conductor connections from one power source to another. These are not used and not allowed in fire pump systems. See Transfer Switch (Automatic).

Medium Voltage Fire Pump Controller

Alternate designation for High Voltage Fire Pump Controllers. See High Voltage Fire Pump Controllers.

Motor Full Load Current (FLC) or Motor Full Load Amperes (FLA)

The current(s) drawn by the motor when delivering 100 percent of its rated power output horsepower or kilowatt. See Service Factor.

Motor Locked Rotor Current (LRC) or Motor Locked Rotor Amperes (LRA)

The current(s) drawn by the motor when full voltage is applied; but the rotor is at a standstill. Also called stalled rotor current.

Motor-Rated Output Power

A measure of power output of the motor when it is operating at its rated full load.

Non-Automatic Control

Control of an operation (i.e. starting or stopping of the pump driver) by human intervention using manual electrical or manual mechanical means.

Non-Pressure Actuated

Starting of the driver is initiated by means other than by detecting a reduction in water pressure in the sprinkler system piping, such as from a deluge valve, flow switch, temperature sensor or other fire detection equipment.

Overcurrent

Current exceeding the rated current.

Note: For the purpose of this standard, overcurrent protection includes motor locked-rotor and short circuit protection only.

Overcurrent Protection (OCP)

A means (fuses, circuit breaker or other suitable device) to limit current in a circuit. These means may include short circuit and/or overload currents and/or intermediate current protection.

Pressure Activated

Starting of the pump driver is initiated by detecting a reduction in water pressure in the sprinkler system piping.

Pressure Limiting Driver (PLD)

A variable speed diesel engine for regulating pump discharge pressure.

Pumping Unit

Pump, driver and controller, transfer switch equipment, and all necessary accessories; (gauges, pressure recorder, water relief valves, flowmeter, etc.).

Rated motor speed

The speed at which the motor shaft turns under full load and is measured in revolutions per minute (rpm).

Reduced Inrush Line Motor Starting

Motor starting method whereby the voltage or the current to the motor are restricted for a period of time. Also known as “Reduced Voltage” or “Reduced Current” starting.

Residential Fire Pump Controller

Controller intended to control an electric motor-driven residential fire pump.

Note: Residential fire pumps are fire pumps intended for use primarily in domestic residences. They are typically limited to one- and two-family units, and are generally single-phase devices. These devices are not part of this standard, and are not acceptable to FM Approvals.

Service Box (For Canada)

An certified assembly consisting of a metal box or cabinet 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.

Service Entrance Equipment

Equipment examined and acceptable and suitable for connecting directly to a utility source of power without intervening disconnect means or overcurrent protection.

Note: In Canada, a separate “Service Box” is required ahead of a controller.

Service Equipment

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.

Service Factor

The service factor of an A.C. motor is a multiplier that, when applied to the rated horsepower, indicates a permissible horsepower loading that can be carried at the rated voltage, frequency, and temperature. The multiplier 1.15 indicates that the motor is permitted to be overloaded 1.15 times the rated horsepower without insulation breakdown or otherwise significantly reducing service life. (ANSI/NFPA 20 Stipulates

limits on motor current and service factor ratings. NEMA MG-1 stipulates conditions for motor service factor operation and derating requirements.) See Motor Full Load Current.

Short Circuit Protective Device

A device intended to protect a circuit or parts of a circuit against short circuit currents by interrupting them.

Short Circuit Rating

The amount of current a controller can withstand and interrupt as established by testing. Also informally called WIC (Withstand Interrupt Current) rating.

Single Source Fire Pump Controller

Controllers for motor driven fire pumps which accept only one source of A.C. (Mains) power. See Dual Source Fire Pump Controllers.

Squirrel Cage Induction Motor

A type of three phase alternating current (AC) motor whose rotor is constructed by connecting metal bars together at each end by shorting rings forming a cage-like shape. It is the most common A.C. motor type, commonly referred to “squirrel cage” or simply “induction” motor. See “Induction Motor”.

System Proportioner

A device or coordinated group of devices which introduces additive/foam concentrate in a prescribed proportion into the fire water stream.

Transfer Switch (Automatic)

A switch that is self-acting for transferring the load from one power source to another. Also referred to as Power Transfer Switch. Fire pump transfer switches must also be operable as manual transfer switches.

Type-Tested Device

A device conforming to an established type, comprised of elements (components, devices, equipment) combined and rated as a unit, replicating the constructional and performance features of the typical device which has been verified previously to be in accordance with a designated standard.

Variable Frequency Drive (VFD)

A power conversion device which supplies power to a motor at frequencies which vary from the supplied line (mains) power for the purpose of speed control. The term VFD refers to the motor drive unit itself. The term VSD, Variable Speed Drive, refers to the fire pump controller components and variable speed path items.

Variable Speed Drive (VSD)

The components that provide the interface between the electric fire pump controller, the Variable Frequency Drive and the electric inverter duty motor.

Variable Speed Electric Fire Pump Controller (VSEFPC)

A full service fire pump controller for motor driven fire pumps consisting of a full speed fire pump controller and a variable speed power path capable of running the fire pump motor at either variable speed or at full speed line frequency.

Wound Rotor Induction Motor

A three phase motor containing a rotor with windings and slip rings. This motor type permits control of rotor current by connecting external resistance in series with the rotor windings to allow control of motor output torque for acceleration control (reducing inrush starting) or for pump speed control.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 Fire Pump Controllers are intended to control drivers of pumps for fire protection. They are a critical component of a fire protection water source. They shall control and monitor the pump driver under all conditions. They shall provide a high degree of reliability to start the pump driver automatically upon sensing loss of fire protection system pressure or by other automatic fire detection equipment. The controller, circuit conductors, and driver are considered to be sacrificial (temporary and permanent damage levels are permitted) in any attempt to start or continue the operation of a distressed pump.
- 2.1.2 When called upon to function by automatic signal, manual-electric signal or manual-emergency actuation, the controller is expected to start the pump driver (electric motor or diesel engine) because “the building is on fire”. Failure to carry out its mission will increase fire damage to the building and its contents; as well as increase business interruption. Certain aspects of these controllers and fire pump installations are considered “sacrificial” in that, overcurrent and other safety aspects of this equipment is relaxed from other typical motor or engine equipment, controllers and installations. This is to allow the equipment to “run to destruction” under certain conditions to assure continuity of the water supply for the maximum amount of time. Other conditions which would result in “imminent (immediate) destruction” are meant to be protected for both safety reasons and to allow “manual intervention” to return the equipment to service, even if impaired. This equipment, then, requires extra caution and uncommon maintenance and care.
- 2.1.3 Fire pump controllers are designed to default to a RUN state or provide an audible alarm and visual indication in the event of a component or system malfunction. They are intended to be located in compliance with local requirements which generally will place them in pump rooms or pump houses that have some specified degree of fire protection. These locations often have sweating overhead pipes, are possibly sprinklered and are in the vicinity of vaults housing other building distribution equipment.
- 2.1.4 Fire pumps are intended to boost water pressure. Many sprinkler systems are assumed to have small leaks for which “Jockey Pumps” (also known as make-up pumps) are installed to maintain desired pressure in the sprinkler pipes, thus preventing the main fire pump from excessive starts and stops. Experience has shown that leakage water flowing through the fire pump (at rest) over long periods of pump inactivity can carry sand, aggregates, rocks, rust and such which collect in the fire pump. These contaminants may prevent normal starting until the pump impeller accelerates to clear the pump housing. This standard recognizes the condition of under-exercised fire pumps by permitting up to 20 seconds at locked rotor current whether the starts are “cold starts” (initial starts) or “hot starts” (restarts). Starting a distressed pump may cause temporary or permanent damage to electrical conductors, equipment and the motor, but this is preferable because pump shutdown for equipment protection could possibly permit its destruction by fire along with the building and its contents.
- 2.1.5 Several examples of the unique construction and installation applications between a fire pump controller and other controllers include the following:
1. All fire pump controllers:
 - a. The main circuit conductors and components are considered to be sacrificial (i.e. temporary and permanent damage levels are permitted) during any attempt to start a distressed motor/pump and to keep it operating.
 - b. They shall provide a high degree of reliability to start the pump driver automatically and suppress a fire upon sensing a pressure drop in the sprinkler pipe or by other automatic fire detection equipment.
 - c. Failures in external control circuits shall not prevent operations of pumps from all other internal or other external means.

- d. External control circuits shall be arranged so that failure of any external circuit (open or short circuit) will not prevent operation of pump(s) from all other internal or external means. Breakage, disconnecting, shorting of the wires or loss of power to these circuits can 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.
- e. External automatic starting means shall be accomplished by opening a normally closed contact on the external means to de-energize a normally energized control circuit in the controller.
- f. While external start buttons or other starting means are permitted, the controller shall not be equipped with any means to accommodate remote stopping (a remote STOP button shall not be used) and no terminals shall be provided inside the controller to allow an external remote stopping device.
- g. Nuisance starts are permitted in the case where a failure of internal control components might cause the motor to start running.
- h. Shall provide manual means to exercise the motor or engine on a weekly basis, and a means to disable any automatic methods used to exercise the motor or engine on a weekly basis.

2. Electric motor fire pump controllers

- a. They shall include means for external, manual mechanical operation of the controller in the event of loss of ability to close the electromagnetic contactor electrically/magnetically.
- b. Thermally reactive overcurrent protective devices are not permitted. The controller provides short circuit and locked rotor protection only. Any other overload protection is not allowed.
- c. Releases of the FPC-overcurrent protective devices (short circuit protective and locked rotor protective devices) shall permit it to carry 300 percent of rated operational motor current for an indefinite period of time, or until a fault (short circuit) condition occurs.

3. Diesel engine fire pump controllers

- a. When an automatic or manual signal to start/run exists, (except under TEST) the controller shall not shutdown the engine for any reason except OVERSPEED. When in TEST mode, the controller may shutdown under low oil pressure and high engine temperature conditions. If a Failure to Start alarm exists after the completion of the engine cranking cycle due to the controller receiving no signal from the engine speed sensor that the engine is operating the controller shall leave the fuel and water solenoids open for a minimum duration of 60 minutes unless one of the two following items is provided:
 - 1. There is supervision on the speed sensor itself to confirm that it has not lost power or become disconnected from the engine;
 - 2. There is a secondary speed switch or secondary sensor to monitor engine status, or the signal from the water pressure sensor indicates no demand to start;then the controller can secure power to the fuel and water solenoids, initiate audible alarm, and await manual intervention. These conditions mentioned illustrate the sacrificial nature while fighting a fire.
- b. Diesel engine fire pump controllers shall be provided with two independent battery chargers capable of fully recharging both battery units within 24 hours.

- 2.1.6 An installation with two fire pumps will increase the reliability and safety of the installation especially if the two fire pumps are supplied from two different power supplies, or by different driver types (a diesel engine drive and an electric motor drive). This is especially true during maintenance or repairing of a single controller, as fire protection is still being maintained by the other fire pump.

- 2.1.7 In order to meet the intent of this standard, controllers must be examined on a model-by-model, type-by-type, manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample controllers, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Approval Application Requirements

- 2.2.1 To apply for an Approval examination the manufacturer, or its authorized representative, shall submit a request to:

Hydraulics Group Manager
FM Approvals Hydraulics Laboratory
An FM Global Enterprise
743A Reynolds Road
West Glocester, RI 02814 U.S.A.

- 2.2.2 The manufacturer shall provide, at a minimum, the following preliminary information with any request for Approval consideration:

- a. A complete list of all models, types, ratings, and options for the products being submitted for Approval consideration;
- b. A complete description of the product construction, specifically enclosure type and environmental rating, and other critical construction features identified in this standard;
- c. Product assembly drawings as follows:
 1. General schematic of the enclosure showing dimensions and electrical service data;
 2. Electrical system schematic diagram of controller;
 3. Field connections diagram;
 4. Drawing of the pressure sensing device;
 5. Logic diagram for microprocessor;
 6. Document identifying all the product options;
 7. List of components/parts for each controller;
 8. Required markings and labels; and,
 9. Pressure switch to include Pressure Transducer/Transmitter
- d. Copy of the installation/operation manual
- e. Copy of the sales literature/brochures for each controller type
- f. The number and location of manufacturing facilities.

- 2.2.3 All documents shall be controlled by the manufacturer's Quality Assurance procedures and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language documents shall be provided with English translation.

- 2.2.4 Based upon the complexity of the examination, the following documents may also need to be submitted:

2.2.4.1 Electric Motor Fire Pump Controllers - Additional Documents

- a. Power Component Tabulation: - A tabulation shall be supplied as a control drawing including the following controller information (as applicable): horsepower; voltage; full load amps (FLA); part number and rating of the following components; isolation switch, circuit breaker, contactor(s), autotransformer, resistors (primary and transition), transfer switches and power wiring.
- b. Isolation Switch: Manufacturer, manufacturer's part number, type of device (i.e. molded case switch), and all electrical ratings.

- c. Motor Control Contactor: Manufacturer, manufacturer's part number, NEMA size (if applicable), and all electrical ratings.
- d. Motor Circuit Breaker: Manufacturer, manufacturer's part number, type of protection characteristics, and all electrical ratings.
- e. Starting Resistors: Manufacturer, manufacturer's part number, NEMA ICS-2 Class Number, and all electrical ratings.
- f. Transfer Switch: Manufacturer, manufacturer's part number, and all electrical ratings.
- g. Autotransformer/Control Transformer: Manufacturer, manufacturer's part number, and all electrical ratings.
- h. Reactors: Manufacturer, manufacturer's part number, and all electrical ratings.
- i. Motor Circuit Wiring: Cross-sectional area of wire in American Wire Gauge (AWG) or circular mils (CM), conductor material, wire type designation, insulation temperature rating, and voltage rating.
- j. Components such as relays, timers, etc.: Manufacturer, manufacturer's part number, and all electrical ratings.
- k. Soft Starters: Type and electrical schematic
- l. Variable Frequency Drives and Related Components: Line Reactors, VFD Circuit Protection Coordination, cooling provisions and calculations and other parameters affecting performance, reliability and/or service life.

2.2.4.2 Diesel Engine Fire Pump Controllers - Additional Documents

- a. Control Transformer: Specification showing the manufacturer's name, manufacturer's part number, frequency, primary voltage, VA, and secondary voltage(s).
- b. Overload Protection: Such as fuse or circuit breaker if used to protect the control circuitry, provide information on manufacturer, manufacturer's part number, type and all electrical ratings.
- c. Battery Charger: Provide all details related to this device: electrical schematic(s); final assembly drawings and parts lists sufficient to detail circuit components (all), and their locations; parts/components list; enclosure/chassis drawings showing all construction details, sheet metal gauge and paint finish.

2.3 Requirements for Samples for Examination

- 2.3.1 Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements are to be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer's responsibility to submit samples representative of production. Tests shall be made to prove compliance with the requirements of this standard. Tests shall be carried out by the manufacturer at his facility, an FM Laboratory or at a recognized laboratory at the discretion of the FM Approvals Engineer. Where appropriate, and at the discretion of FM Approvals, special tests may also be performed.
- 2.3.2 Prior to any testing, the fire pump controller shall be examined to conform to the manufacturer's drawings and specifications, and to FM Approvals requirements. It shall be first verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements. Approval testing shall then only be carried out on a fully assembled, completely labeled, production quality fire pump controller. Prototype or partially assembled fire pump controllers and subsystems are not acceptable, other than for specific type testing (i.e. short circuit testing, battery charger testing, pressure switch/transducer testing). Testing equipment, configurations and calibration must meet the requirements of this standard and the FM Approvals' Engineer.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

- 3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.
- 3.1.2 The manufacturer's electrical specifications and design drawings shall fully describe the product. All critical markings shall be indicated and terminal block numbers for field connections clearly shown.
- 3.1.3 All documents pertaining to the product materials, dimensions, processing, and marking shall be controlled by the manufacturer's Quality Assurance procedures, and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language drawings shall be provided with an English translation.

3.2 Design and Functional Features

- 3.2.1 Electric fire pump controller/Automatic electric fire pump controller
 - 3.2.1.1 Controllers rated 600 Volts or less, and shall be in a fully functional "ready to start" state within 10 seconds upon application of A.C. power.
 - 3.2.1.2 Pressure activated

Starting of the motor is initiated by detecting a reduction in water pressure.
 - 3.2.1.3 Non-pressure actuated

Starting of the motor is initiated by means other than by detecting a reduction in water pressure, such as deluge valve tripping, flow switch or fire detection equipment.
 - 3.2.1.4 Non-automatic electric fire pump controller

Starting of the motor is initiated by manual electrical means (i.e. push button) or manual mechanical means (i.e. emergency-run mechanical control).
 - 3.2.1.5 Electric fire pump controller with or without power transfer switch

Controllers may be provided for one or two sources of electrical power.
 - 3.2.1.6 Full voltage or reduced voltage starting

Controllers may be provided for direct on-line starting (full voltage) or for starting with reduced motor inrush current (reduced voltage).
 - 3.2.1.7 Electric fire pump controller basic functions

An electric fire pump controller shall perform the following basic functions:

 - a. Connects (or transfers) the electric motor to the appropriate power supply (primary, alternative, second utility);
 - b. Starts, controls and stops the operations of the electric drive motor;
 - c. Provides overcurrent protection against locked rotor currents and short circuit currents;

- d. Monitors and supervises the operation of the system, and provides appropriate signals and alarms;
- e. To have a general arrangement in compliance with Figure B-1, Figure B-2, Figure B-3, Figure B-4 or Figure B-5;
- f. Means to conduct a periodic weekly test of the system.
- g. Metering: means to measure voltage and currents without opening the controller;
- h. Means to alarm if and when the motor is running under single phase conditions (motor single phasing).

3.2.1.8 Electric fire pump controller standard equipment

The electric fire pump controller shall comprise the following equipment:

- a. Enclosure;
- b. Critical components;
 - 1. Actuators;
 - 2. Disconnecting device;
 - 3. FPC-overcurrent protective devices (SCPD and LRPD);
 - 4. Full voltage starting means;
 - 5. Reduced voltage starting means;
 - 6. External means of measuring voltage and current;
 - 7. Power transfer switch; where required,
 - 8. VFD and related components, when required.

3.2.1.8.1 All components shall comply with their own relevant NEC or IEC product standard, where applicable, and the additional requirements of this standard.

- c. Voltage surge arrester, (Not required if the controller can withstand without damage a 10 kV impulse in accordance with ANSI/IEEE C62.41, or the controller is rated in excess of 600 Volts);
- d. Pressure recorder, (When appropriate to the installation or as required by the authority having jurisdiction);
- e. Sensors, detectors, monitoring devices, alarms and appropriate signal devices.
- f. Control Power Transformers;

Note: fusing is not allowed for circuitry involved with pump operation.
[Exception being High (Medium) Voltage Controllers]
- g. Door Interlocking to prevent powering up the unit with any of its doors open, and to prevent opening any of its doors while the controller is powering up. This involves either the isolating switch, or the circuit breaker with controllers rated 600 Volts or less, or the Isolating Switch in High/Medium Voltage Controllers.

The controller may include other optional equipment that is the subject of agreement between the manufacturer and the user. Such equipment must be evaluated under this standard, and must be specifically approved by the AHJ.

3.2.2 Limited Service Electric Controller

Limited service controllers are not FM Approved by FM Approvals. The following is provided as reference for the reader since these devices exist in the fire protection community.

Limited Service electric controllers must meet all the provisions of automatic full service electric fire pump controllers with the following exceptions:

- a. The locked rotor overcurrent protection may be achieved by using an inverse time nonadjustable circuit breaker having a standard rating between 150 percent and 250 percent of the motor full-load current.
- b. The manually operated isolating switch is not required.

Limited Service electric controllers are only used for across-the-line starting of squirrel cage induction motors of 30 hp (20 kW) or less, and 600 Volts or less, and where they are acceptable to the authority having jurisdiction. The limited service controller shall have a short circuit current rating not less than 10,000 Amps. Limited Service electric controllers shall not be used with additive/foam pump or additive pump motors in fire extinguishing systems.

3.2.3 High Voltage electric fire pump controller

Electric fire pump controllers that are rated in excess of 600 Volts and must meet all the provisions of automatic electric fire pump controllers, except as outlined below.

- 3.2.3.1 Disconnecting of conductors within the controller is allowed when measuring line voltages and currents with test instruments.
- 3.2.3.2 An ammeter shall be provided on the exterior of the controller with a suitable means for reading the current in each phase with an accuracy within ± 5 percent of motor nameplate current.
- 3.2.3.3 An indicating voltmeter or voltmeters, deriving power of not more than 125 Volts from a transformer or transformers connected to the high voltage supply, shall be provided on the exterior of the controller to read each phase voltage with an accuracy within ± 5 percent of motor nameplate voltage
- 3.2.3.4 The isolating switch shall be designed to prevent the switch from being opened under electrical load.
- 3.2.3.5 A load-break disconnecting means is permitted to be used in lieu of the isolating switch if the fault closing and interrupting ratings equal or exceed the requirements for disconnect (load break) switches in ANSI/UL 347, *Standard for Safety for High Voltage Industrial Control Equipment* and meet all the requirements of the installation, then the requirement of Section 3.2.3.4 is not required.
- 3.2.3.6 Special precautions shall be taken in locating the pressure-actuated switch to prevent any water leakage from coming in contact with high-voltage components.
- 3.2.3.7 The low-voltage control circuit shall be supplied from the high voltage source through a stepdown transformer or transformers protected by high-voltage fuses in each primary line. The secondary of the line supplied control power transformer(s) shall be grounded unless all external control devices are rated for the line voltage.
- 3.2.3.8 For the low-voltage control circuit, the transformer(s) power supply shall be interrupted when the isolating switch is in the open position.
- 3.2.3.9 For the low-voltage control circuit, the secondary of the transformer and control circuit that are necessary for proper operation of the controller shall not have overcurrent protective devices connected in them, and shall be permitted to be ungrounded.
- 3.2.3.10 For the low-voltage control circuit, one secondary line shall be grounded unless all control and operator devices are rated for use at the high (primary) voltage.

- 3.2.3.11 A visible indicator shall be provided to indicate that power is available. The current supply for the visible indicator shall come from the secondary of the control circuit transformer through resistors or from a small-capacity stepdown transformer that shall reduce the control transformer secondary voltage to that required for the visible indicator. If the visible indicator is an incandescent pilot lamp, it shall be accessible for replacement.
- 3.2.3.12 Necessary provisions shall be made; including such interlocks as might be needed, to protect personnel from accidental contact with high voltage. The high voltage door shall be interlocked to the isolating switch. The isolating switch shall be interlocked to the motor contactor, unless it is rated as a disconnect switch, to prevent opening or closing it unless the contactor is open.
- 3.2.3.13 A contactor in combination with current-limiting motor circuit fuses, such as “R” rated fuses, shall be permitted to be used in lieu of the circuit breaker as the disconnecting means to protect the motor branch circuit, if all of the following requirements are met:
- a. Current-limiting motor circuit fuses shall be mounted in the enclosure between the isolating switch and the contactor, and shall interrupt the short circuit current available at the controller input terminals.
 - b. Current-limiting motor circuit fuses shall have an adequate interrupting rating to provide the suitability rating (available short circuit current at the line terminals) of the controller.
 - c. The current-limiting fuses shall be sized to hold 600 percent of the full-load current rating of the motor for at least 100 seconds.
 - d. A spare set of fuses of the correct rating shall be kept readily available in a compartment or rack within the controller enclosure. These spare fuses shall be provided and installed by the controller manufacturer prior to shipment, or provided by the controller manufacturer at the time of system start-up and acceptance.
- 3.2.3.14 Tripping of the locked rotor overcurrent device shall be permitted to be accomplished by opening the motor contactor coil circuit or circuits to drop out the contactor.
- 3.2.3.15 Means shall be provided to restore the controller to normal operation by an externally manually reset device.
- 3.2.3.16 The controller shall be equipped with an external emergency run handle or lever that operates to mechanically close the motor-circuit switching mechanism. This handle or lever shall provide for manual (non-automatic) continuous running operation of the motor, independent of any electrical, magnetic and pressure activated control circuits. The handle or lever must be mechanically latched or held for manual operation in the actuated position. This mechanical latching can be automatic or non-automatic, and the lever or handle must be designed to move in one direction only from the off position to the final position. The emergency run handle or lever must be located on the front exterior of the controller enclosure, and easily noticeable.
- 3.2.3.17 When the contactor is latched during emergency-run manual operation, the locked rotor overcurrent protection is not required.
- 3.2.3.18 The controller shall provide means such that both the opening and the closing of the contactor using the emergency-run manual operation shall match or exceed the speed of operation under normal electrical actuation and releasing.

3.2.4 Residential fire pump controller (pump driven by an electric motor only)

Residential fire pump controllers are a sub-class of electric fire pump controllers with a restricted scope of applications that have been introduced for residential occupancies only (i.e. NFPA 13D, single/dual family dwellings). Residential fire pump controllers are not FM Approved by FM Approvals.

3.2.5 Diesel engine fire pump controller

A diesel engine is the pump driver for this class of fire pump controller. The diesel engine controller has a general arrangement in compliance with Figure B-6. Starting of the diesel engine is made by means of a controlled signal to initiate starting using auxiliary power from a 12VDC or 24VDC battery set, and not from the main electrical power circuit.

3.2.5.1 Pressure actuated

Starting of the engine is initiated by detecting a reduction in water pressure.

3.2.5.2 Non-pressure actuated

Starting of the engine is initiated by means other than by detecting a reduction in water pressure, such as deluge valve, flow switch or fire detection equipment and/or remote start manual switch or push button.

3.2.5.3 Diesel engine fire pump controller basic functions

The diesel engine fire pump controller shall provide four basic functions:

- a. Controls electrical means to start and run and stop the engine;
- b. Monitors the engine and other system conditions and performs supervisory functions where appropriate;
- c. Maintains the electric charge on the engine starting batteries;
- d. Initiates a periodic weekly test of the system.

3.2.5.4 Diesel engine fire pump controller standard equipment

The diesel engine fire pump controller shall be equipped with the following standard equipment (the controller may include other optional equipment that is the subject of agreement between the manufacturer and user):

- a. Moisture resistant, lockable enclosure with a breakable glass panel or tamper resistant mechanism (see Section 4.7.2.2) which permits access for emergency manual start;
- b. Manually operated electrical actuators to start the engine;
- c. Visual indicators and audible alarms;
- d. Electrical contacts to initiate remote alarm;
- e. Battery chargers (one for each 12 V or 24 V battery);
- f. Pressure recorders, in pressure actuated controllers;
- g. A means to disable the periodic weekly test timer. Unless otherwise agreed upon by the building owner, FM Approvals requires that the 30 minute weekly test of the diesel fire pump system be conducted manually and not by automatic means. As provided, the operation of both manual testing and automatic test timers shall be verified, as well as the means to disable the automatic function.

3.2.6 Additive/Foam pump controller (pump driven either by an electric motor or by a diesel engine)

Special electric fire pump controllers or special diesel engine fire pump controllers intended for the unique requirements of additive/foam concentrate pumps.

3.2.6.1 This class of controller may be associated with either an electric motor driven system or a diesel engine driven system. All of the relevant requirements for electric motor driven or diesel engine driven systems apply. The unique requirements are dictated by the fact that, unlike water, the additive/foam concentrate is supplied in measured quantities. The result is a set of special requirements to govern the situation wherein the store of additive/foam concentrate has been depleted during the exercise of suppressing a fire.

3.2.6.2 The requirements for additive/foam pump controllers are identical to automatic controllers with the following additions:

- a. Automatic starting shall be accomplished by the opening of a remote contact. A pressure-actuated device described is not required.
- b. Manual stopping shall be the only method of stopping.
- c. The controller shall contain a lockout feature. This lockout shall be indicated by a visible indicator and provisions for annunciation at a remote location.

3.2.7 Variable Speed Electric Motor Driven Fire Pump Controllers

Controllers equipped with variable speed pressure limiting control are basically an automatic electric fire pump controller with an integrally mounted and wired variable frequency drive that can alter the rotational speed of the electric motor that drives the fire pump (See Figure B-9). These controllers must meet all requirements for automatic electric fire pump controllers and the requirements listed below.

3.2.7.1 The variable speed pressure limiting control shall have a horsepower rating at least equal to the motor horsepower or shall have an ampere rating not less than the motor full-load current, whichever is greater.

3.2.7.2 Upon failure of the variable speed pressure limiting control to keep the system pressure at or above the set pressure of the variable speed pressure limiting control system, the controller shall bypass and isolate the variable speed pressure limiting control system and operate the pump at rated speed.

Note: The bypass mode constitutes all of the characteristics of a non-variable speed fire pump controller.

Note: The bypass contactor shall be energized only when there is a pump demand to run and the variable speed pressure limiting control is in the fault condition, or if the mode switch is set to the fixed speed position.

3.2.7.3 If the system pressure remains below the set pressure for more than 15 seconds, the bypass operation shall occur.

3.2.7.4 If the variable speed drive indicates that it is not operational within 5 seconds, the bypass operation shall occur.

Note: Variable speed drive units (VSDs) shall have a positive means of indicating that the drive is operational within a few seconds after power application. If the VSD fails, the transfer to full speed operation shall occur immediately.

3.2.7.5 Means shall be provided to prevent higher than normal in-rush currents when transferring the fire pump motor from the variable speed mode to the bypass mode.

Note: A motor running at reduced frequency cannot be connected immediately to a source at line frequency without creating high transient currents that can cause tripping of the fire pump circuit breaker. It is also important that the controller provides a means to prevent connection of line frequency power (back feed) to the VSD since this will damage the VSD, and , more importantly, can cause the fire pump circuit breaker to trip which takes the pump out of service.

- 3.2.7.6 Once the variable speed pressure limiting control is bypassed, the unit shall remain bypassed until shutdown.
- 3.2.7.7 The bypass contactors shall be operable using the emergency-run handle or lever that provides for non-automatic continuous running operation of the motor.
- 3.2.7.8 The variable speed drive shall be line and load isolated when not in operation.
- 3.2.7.9 The variable speed drive load isolation contactor and the bypass contactor shall be mechanically and electrically interlocked to prevent simultaneous closure.
- 3.2.7.10 Separate variable speed drive circuit protection shall be provided between the line side isolating contactor for the variable speed drive and the load side of the circuit breaker that is used as the disconnecting means for the motor branch circuit. This circuit protection shall be coordinated to prevent the circuit breaker from tripping due to a fault condition in the variable speed circuitry.

Note: The intent is to prevent tripping of the fire pump controller circuit breaker due to a variable speed drive failure and thus maintain the integrity of the bypass circuit.
- 3.2.7.11 Power quality correction equipment shall be located in the variable speed circuit ahead of the VFD with a minimum provision of 5 percent line reactance.
- 3.2.7.12 Power quality coordination is not required where the system voltage does not exceed 480 Volts and cable lengths between the motor and controller do not exceed 100 ft. (30.5 meters). Where higher system voltages or longer cable lengths exist, the cable length and motor requirements shall be coordinated by all concerned parties which includes the installing pump manufacturer, controller manufacturer and end user.

Note: As the motor cable length between the controller and motor increases, the VSD high frequency switching voltage transients at the motor will increase. To prevent the transients from exceeding the motor insulation ratings, the motor manufacturer's recommended cable lengths must be followed.
- 3.2.7.13 All control and power devices and components required to keep the controller in automatic operation shall be within lockable cabinets.
- 3.2.7.14 The variable speed pressure sensing element shall be connected between the pump discharge flange and the discharge control valve, as appropriate, with a 1/2 in. (15 mm) nominal size, or larger, inside diameter pressure line. This sensing element shall only be used to control the variable speed drive.
- 3.2.7.15 Common pressure control shall not be used for multiple pump installations. Each controller pressure sensing control circuit shall operate independently.
- 3.2.7.16 Means shall be provided to manually select between variable speed and bypass mode.
- 3.2.7.17 A visible indicator shall be provided to indicate when the variable speed drive has failed.
- 3.2.7.18 A visible indicator shall be provided to indicate when the controller is in bypass mode.

- 3.2.7.19 Visible indication shall be provided on all controllers equipped with variable speed pressure limiting control to actuate at 115 percent of set pressure (over-pressure).
- 3.2.7.20 Controllers shall be equipped with contacts (open or closed) to operate circuits for the conditions of drive failure, bypass mode, and over-pressure as described above.
- 3.2.7.21 The controller shall be provided with suitable adjusting means to account for various field conditions.
Note: This allows for field adjustments to reduce hunting, excessive overshooting, or oscillating.
- 3.2.7.22 As necessary, the maximum allowed turn-down ratio shall be provided by the controller manufacturer to prevent motor overheating at reduced speed operation.
- 3.2.7.23 The maximum operating frequency shall not exceed line frequency
- 3.2.7.24 Means shall be provided and permanently attached to the inside of the controller enclosure to record the following settings:
 - a. Variable speed pressure limiting set point setting
 - b. Pump start pressure
 - c. Pump stop pressure

3.2.8 Power Transfer Switch Arrangements

For pump(s) driven by electric motor(s) where reliable power cannot be obtained from one source, or when required by the authority having jurisdiction, electric fire pump controllers are required to have an on-site electrical power transfer device that will automatically select power from one of two sources (normal and alternate supply) to maintain pump readiness and operation. Two acceptable methods are described below as Arrangement I and Arrangement II.

3.2.8.1 Arrangement I, Listed Combination Fire Pump Controller and Power Transfer Switch

- 3.2.8.1.1 Where the power transfer switch consists of a self-contained power switching assembly, this assembly shall be housed in a barriered compartment of the fire pump controller or in a separate enclosure attached to the controller and marked "Fire Pump Power Transfer Switch".
- 3.2.8.1.2 The isolating switch located within the power transfer switch enclosure or compartment shall be provided ahead of the alternate input terminals of the transfer switch, and meet the construction requirements in Section 4 of this standard.
- 3.2.8.1.3 The isolating switch shall be supervised to indicate when it is open. This supervision shall operate an audible and visible signal on the fire pump controller/automatic transfer switch combination, and permit monitoring at a remote point where required by the authority having jurisdiction.
- 3.2.8.1.4 The isolating switch shall be suitable for the available short circuit of the alternate source as described below:
 - a. Where the alternate source is provided by a second utility power source, the transfer switch emergency side shall be provided with an isolation switch and circuit breaker complying with the construction requirements in Section 4 of this standard.

- b. Where the alternate source is supplied by one or more upstream transfer switches that can singly or in combination feed utility or on-site generated power to the fire pump controller, the controller shall be equipped with the alternate side circuit breaker and isolating switch that comply with the construction requirements in Section 4 of this standard.
- c. Where the alternate source is supplied by a generator whose capacity exceeds 225 percent of the fire pump motor's rated full-load current, the controller shall be equipped with the alternate side circuit breaker and isolating switch that comply with the construction requirements in Section 4 of this standard.

3.2.8.2 Arrangement II, Individually Listed Fire Pump Controller and Power Transfer Switch

- 3.2.8.2.1 The stand alone power transfer switch must be located within the pump room for applications of power transfer between the normal supply and one alternate supply. It must be FM Approved for the service. It shall include marked short circuit ratings for both the normal source circuit and the emergency (alternate) source circuit.
- 3.2.8.2.2 An isolating switch, or service disconnect shall be provided ahead of the normal and alternate input terminals of the transfer switch. The isolating switch shall comply with the requirements in Section 4 of this standard.
- 3.2.8.2.3 Where the alternate source is provided by a second utility power source, the transfer switch emergency side shall be provided with an isolation switch and circuit breaker complying with the construction requirements in Section 4 of this standard. This circuit breaker shall provide overcurrent protection for the transfer switch (see Section 3.2.8.2.5.f.) and shall be selected or set to indefinitely carry the locked rotor current of the fire pump motor.
- 3.2.8.2.4 Where the alternate source is provided by an on-site generator set, the transfer switch emergency side shall be provided with an isolation switch and optional circuit breaker complying with the construction requirements in Section 4 of this standard.
- 3.2.8.2.5 The isolating switch ahead of the alternate source input terminals of the transfer switch shall meet the following requirements:
 - a. The isolation switch shall be lockable in the "ON" position (closed position).
 - b. A placard shall be externally installed on the isolating switch stating "Fire Pump Isolating Switch" with letters at least 1 in. (25 mm) in height.
 - c. A placard shall be placed adjacent to the fire pump controller stating the location of the isolating switch and the location of the key (if the isolating switch is locked).
 - d. The isolating switch shall be supervised with an audible and visible signal on the transfer switch enclosure and permit monitoring at a remote point where required, to indicate when it is not closed, by one of the following methods:
 - 1. Central station, proprietary, or remote station signal service
 - 2. Local signaling service that will cause the sounding of an audible signal at a constantly attended point.
 - 3. Locking the isolating switch closed
 - 4. Sealing of isolating switches and weekly recorded inspections where isolating switches are located within fenced enclosures or in buildings under the control of the owner

- e. Each fire pump controller requires a dedicated transfer switch. Each transfer switch shall supply only one fire pump controller.
- f. The overcurrent protection of Section 3.2.8.2.3 shall be coordinated with the short circuit rating restrictions of the transfer switch. When required, the size (ampere rating) of the transfer switch shall be increased (up-sized) to achieve said coordination.

Note: Manufacturers of transfer switches shall publish charts or tables that restricts the maximum size (ampere rating) of the overcurrent protection for various devices (fuses and breakers) and which still maintain the required short circuit ratings.

- g. The transfer switch shall be so equipped so as to meet all of the requirements of Section 3.2.8.3, including phase reversal circuitry, isolating switch supervision, labeling provisions, lockout circuitry, motor inrush current protection and alarm circuitry.
- h. The transfer switch enclosure, and the enclosure for any related equipment, shall be no less than NEMA Type 2 or IEC Code IP31.
- i. Any external components, devices, equipment or circuitry must be FM Approved for fire pump service and be specifically accepted by the AHJ.

3.2.8.3 Automatic Power Transfer Switch Requirements for Arrangement I and Arrangement II Configurations

- 3.2.8.3.1 Manual transfer switches shall not be used to transfer power between the normal supply and the alternate supply of power to the fire pump controller.
- 3.2.8.3.2 No remote device(s) shall be installed that will prevent automatic operation of the transfer switch.
- 3.2.8.3.3 Each fire pump shall have its own dedicated power transfer switch, when an emergency/alternate power source is required.
- 3.2.8.3.4 The power transfer switch shall be specifically listed for fire pump service, and meet the requirements of Section 5.14, Locked Rotor Overcurrent Protection Test.
- 3.2.8.3.5 The power transfer switch shall be suitable for the available short circuit currents at the transfer switch normal and alternate input terminals.
- 3.2.8.3.6 The power transfer switch shall be electrically operated and mechanically held.
- 3.2.8.3.7 The power transfer switch shall have an ampere rating not less than 115 percent of the motor full-load current and also capable of switching the motor locked rotor current.
- 3.2.8.3.8 A means for safe manual (non-electrical) operation of the power transfer switch shall be provided. This manual means is not required to be externally operable.
- 3.2.8.3.9 The following applies when the power transfer switch is electrically downstream of the fire pump controller circuit breaker:
 - a. Turning off the normal source isolating switch or the normal source circuit breaker will not inhibit the transfer switch from operating.
 - b. The power transfer switch shall be provided with undervoltage-sensing devices to monitor all ungrounded lines of the normal power source.

- c. Where the voltage on any phase at the load terminals of the circuit breaker within the fire pump controller falls below 85 percent of motor-rated voltage, the power transfer switch shall automatically initiate starting of the standby generator, if provided and not running, and initiate transfer to the alternate source.
 - d. Where the voltage on all phases of the normal source returns to within acceptable limits, the fire pump controller shall be permitted to be retransferred to the normal source.
 - e. Phase reversal of the normal source power (connected to line terminals of the motor contactor) shall cause a simulated normal source power failure upon sensing phase reversal, and shall be indicated by a visible indicator.
- 3.2.8.3.10 Where the power transfer switch is electrically upstream of the fire pump controller circuit breaker, the voltage can be sensed at the input to the power transfer switch instead of at the load terminals of the fire pump circuit breaker.
- 3.2.8.3.11 Voltage and frequency sensing devices shall be provided to monitor at least one ungrounded conductor of the alternate power source, except where the alternate source is provided by a second utility power source, then the undervoltage sensing devices shall monitor all ungrounded conductors instead of a frequency sensing device.
- 3.2.8.3.12 Transfer to the alternate source shall be inhibited until there is adequate voltage and frequency to serve the fire pump load, except where the alternate source is provided by a second utility power source.
- 3.2.8.3.13 Two visible indicators shall be provided to externally indicate the power source to which the fire pump controller is connected.
- 3.2.8.3.14 Means shall be provided to delay retransfer from the alternate power source to the normal source until the normal source is stabilized. This time delay shall be automatically bypassed if the alternate source fails.
- 3.2.8.3.15 Means shall be provided to prevent higher than normal in-rush currents when transferring the fire pump motor from one source to the other.
- 3.2.8.3.16 The power transfer switch shall not have integral short circuit or overcurrent protection.
- 3.2.8.3.17 When the alternate power source is an on-site generator set, the power transfer switch shall have a device to delay starting of the alternate source generator to prevent nuisance starting in the event of momentary dips and interruptions of the normal source.
- 3.2.8.3.18 When the alternate power source is an on-site generator set, the power transfer switch shall be tied into a circuit loop to the alternate source generator whereby either the opening or closing of the circuit will start the alternate source generator, when commanded by the power transfer switch.
- 3.2.8.3.19 When the alternate power source is an on-site generator set, and the alternate isolating switch or the alternate circuit breaker (circuit breaker is optional for Arrangement II configuration) is in the open or tripped position, there shall be a means to prevent the power transfer switch from sending the signal for starting the alternate source generator. Also, the alternate isolating switch and the alternate circuit breaker shall be monitored to indicate when one of them is in the open or tripped position, except when the alternate isolation switch and the alternate circuit breaker are both installed and interlocked.

3.2.8.3.20 A momentary test switch, externally operable, shall be provided on the enclosure that will simulate a normal power source failure.

3.2.8.3.21 Auxiliary open or closed contacts mechanically operated by the fire pump power transfer switch mechanism shall be provided for remote indication where two sources of power are required due to the normal source being unreliable. This signal shall indicate whenever the transfer switch is in the alternate source position. This signal circuit shall be energized by a separate, reliable, supervised power source. The resultant power provided to energize the signal circuit shall be a maximum of 125 Volts AC.

3.2.9 Electrical Characteristics

3.2.9.1 Rated operational voltage (U_e)

The rated operational voltage for a fire pump controller is a value of voltage which, combined with a rated operational current, determines the application of the equipment and to which relevant tests are referred.

3.2.9.2 Rated operational current (I_e) or rated operational power

The rated operational current for an electric fire pump controller is a value of current which is dictated by the rated operational current of the electric motor which drives the fire pump. The rated operational A.C. input current for a diesel engine fire pump controller is a value of current which is dictated by the maximum load current of the battery charger(s) supply within the controller. The rated D.C. voltage of a diesel engine fire pump controller is the nominal voltage of the battery units. The D.C. current drawn by the controller is its standby current draw or the engine running current draw. These are measured under single battery conditions and with the battery charger A.C. power supply (mains) disconnected and with the engine alternator disconnected. The D.C. output current rating for engine terminals and alarm contact ratings must be both rated and marked on the required wiring diagram.

In the case of equipment for direct switching of individual electric motors, the indication of a rated operational current may be replaced (or supplemented) by an indication of the maximum rated power output, at the rated operational voltage of the motor for which the equipment is intended to be connected.

3.2.10 Pressure Sensing Elements

A pressure sensing element is a critical component of a pressure switch that is used to signal the controller to start or stop the fire pump in response to water pressure changes in the fire protection system, or used to control the pressure regulation in variable speed or pressure limiting controllers or drivers. The fire pump controller shall provide adequate control means (i.e. voltage, current and/or power) for the pressure sensing element to operate under foreseeable abnormal conditions.

3.2.10.1 These devices are typically, but not limited to, pressure transducers, pressure transmitters, or mechanical pressure switches of the bourdon tube type. Bourdon tube devices may be of the snap acting switch type or the more common mercury contact type devices.

3.2.10.2 Pressure transducers shall be of the internal or external amplifier type. External amplifier types are typically solid state strain gage element devices. Internal amplifiers types can be either voltage or current output type.

- a. At the controller rated input voltage, voltage output type transducers shall be supplied by the controller with the power supply voltage within the range of the voltage power input rating of the transducer. The same shall be true when the controller is supplied

- with 85 percent of its rated input voltage; and when the controller is supplied with 110 percent of its rated input voltage.
- b. Current output types shall be supplied by the controller with at least 125 percent of the minimum compliance voltage rating of the transducer. The output burden (sensing resistor) shall be no higher than 80 percent of the rated maximum burden resistance. This shall also be met when the controller is supplied with 85 percent of its rated input voltage; and when it is supplied with 110 percent of its rated input voltage.
- 3.2.10.3 The minimum diameter orifice size of a pressure sensing element in contact with water shall be 1/8 in. (3.2 mm). This is necessary to prevent water particulates from clogging the inlet to the sensor and interfering with the pressure sensing operation.
 - 3.2.10.4 Pressure transducers are for factory installation only in FM Approved fire pump controllers. The controller instruction manual shall provide instructions for setting the start and stop pressures for the fire pump.
 - 3.2.10.5 The pressure transducer or transmitter shall be field replaceable.
 - 3.2.10.6 Suitable provision shall be made for relieving pressure to the pressure-actuated switch to allow testing of the operation of the controller and the pumping unit.
 - 3.2.10.7 For all pump installations, each fire pump controller shall have its own individual pressure sensing line. When used, each pressure maintenance (jockey) pump controller shall have its own individual pressure sensing line.
 - 3.2.10.8 The pressure-sensing line connection for each pump shall be made between that pump's discharge check valve and discharge control valve, as follows:
 - a. All pressure components, fittings, connection and piping shall be brass, rigid copper or Series 300 Stainless Steel pipe or tube and the fittings shall be 1/2 in. (15 mm) nominal size.
 - b. There shall be two check valves installed in the pressure-sensing line at least 5 ft. (1.5 m) apart with a nominal 0.094 in. (2.4 mm) hole drilled in the clapper to serve as dampening. The use of two ground face union orifices per ANSI/NFPA 20, in lieu of drilled check valves, is not recommended.
 - c. For variable speed pressure limiting control, a 1/2 in. (15 mm) nominal size inside diameter pressure line shall be connected between the pump discharge flange and the discharge control valve.
 - 3.2.10.9 There shall be no shutoff valve in the pressure-sensing line.
 - 3.2.10.10 The controller shall have an external means for connecting the 1/2 in. (15 mm) nominal pressure sensing line.
 - 3.2.10.11 There shall be no shutoff devices in the controller. This includes the entire path between the external pressure-sensing line connection and the pressure switch or transducer. This includes any and all valves and solenoids. Three way solenoid valves which include the path to the pressure switch or controller are allowed under the following conditions:
 - a. Three way valve must be wired such that the failure of the solenoid circuit does not prevent normal controller starting and operation;
 - b. Three way valve must be fully ported 1/2 inch (15 mm) diameter nominal pipe size and have internal passages of 1/8 inch (5 mm) diameter or larger, and;
 - c. Three way valve must be constructed of corrosion resistant material.

3.2.10.12 Diesel drive controllers shall include a test drain solenoid to accomplish both weekly and manual hydraulic pressure loss simulated starting.

3.2.10.13 Pressure switch actuation at the low adjustment setting shall initiate pump starting sequence, if the pump is not already in operation.

3.2.11 Shipping Fire Pump Controllers

All fire pump controllers shall be tested at the factory as one complete unit by the manufacturer, and transported and installed at the final destination as one complete unit with the following exception:

If access to the pump room is too small to accommodate the complete fire pump controller unit, the controller manufacturer, under special agreement with the end user, (not the installing contractor), may transport the unit in no more than three separate and self-contained pieces in accordance with UL 891, *Standard for Safety for Switchboards* and reassemble the complete unit on-site. The controller manufacturer must provide factory trained and certified personnel to reassemble the complete controller unit in the field. Field agents outside the direct employment of the controller manufacturer are not allowed. The separate controller pieces must be specifically designed for field reassembly and the complete controller unit must be tested in the field by factory trained and certified personnel after reassembly.

3.3 Markings

3.3.1 General

3.3.1.1 All markings shall be indelible and easily legible. All markings shall be in the appropriate language, as necessary, for the country in which the fire pump controller will be installed.

3.3.1.2 Marking of the manufacturer's name or trade mark and type designation or serial number is mandatory on the equipment and preferably on the nameplate, if any, in order to permit the complete data to be obtained from the manufacturer.

Note: In the USA and Canada, the rated operational voltage U_e may be marked as follows:

- a. on equipment for use on three-phase – four-wire systems, by both the value of phase-to-earth voltage and that of phase-to-phase voltage, i.e. 277/480 V;
- b. on equipment for use on three-phase – three-wire systems, by the value of phase-to-phase voltage, i.e. 480 V. On equipment which does not make use of a neutral, the phase-to-phase voltage marking is sufficient. The same applies to corner ground and ungrounded delta (three wire) systems. The same applies to four wire (center tapped) delta systems, such as 240/120/208 V A.C. systems.
- c. Special care is needed for controllers intended for use on corner ground or ungrounded systems. Ungrounded systems shall be considered as corner grounded systems regarding voltages seen by the controller.
- d. On corner ground or ungrounded systems or on four wire (center tapped) systems, the surge arrester circuitry shall be designed and rated for such systems on a continuous duty basis.

3.3.1.3 Controllers shall be marked, in a position visible after installation, with the following information:

- a. manufacturer's name or trade mark;
- b. Type designation or product identification number;
- c. Enclosure NEMA Type rating or IEC IP Code;
- d. Reference "IEC 62091", if the manufacturer is in compliance with this standard and as verified by FM approvals;
- e. "Electric Fire Pump Controller" or "Diesel Engine Fire Pump Controller" or "High Voltage Fire Pump Controller";
- f. Non-pressure actuated fire pump controller (not required if not equipped with water pressure control);
- g. When the electric fire pump controller is provided with an automatic power transfer switch, the label "Fire Pump Power Transfer Switch" shall be located on the transfer switch;
- h. Rated maximum operating pressure;
- i. Rated controller ambient low operating temperature, and rated maximum ambient operating temperature; and,
- j. Complete instructions covering the operation of the controller
- k. Direction of movement of the manual emergency actuator, if applicable;
- l. Indication of the position of the manual emergency actuator;
- m. FM Approvals Certification mark, and other agency certification markings if applicable; and,
- n. Terminal identification and marking.

3.3.1.3.1 The following identifications shall be installed on the controller, preferably on the nameplate and visible during installation, stating:

- a. That no ancillary apparatus (i.e. jockey (make-up) pump) shall be connected to the fire pump controller;
- b. That only those devices indicated on the controller diagram(s) shall be connected to the controller;
- c. EMC rating for environment A, B or A and B;
- d. Type of system earthing for which the assembly is designed; and,
- e. Short circuit rating (see 3.3.1.4).

Note: The purpose of these identifications is to provide the user with additional application information.

3.3.1.4 Prospective short circuit current

Electric fire pump controllers (normal and alternative power side when equipped with power transfer switch) shall be marked as follows:

"SUITABLE FOR USE ON A CIRCUIT CAPABLE OF DELIVERING NOT MORE THAN <RATED CURRENT> AMPERES RMS AT <RATED VOLTAGE> VOLTS AC"

The rated current and voltage values shall be indicated.

The prospective short circuit current marked value shall be equal to the conditional short circuit current value according to the performance requirements in this standard.

3.3.1.5 Components

Each operating component of a controller shall be marked to plainly indicate an identification symbol appearing on the electrical schematic diagram. The markings shall be visible when the enclosure is open after installation of the controller. Power components shall also be marked with the appropriate listing agency such as UL, CSA, or recognized IEC Laboratory.

3.3.2 Marking for specific components and controllers

3.3.2.1 Disconnecter (Isolating Switch)

A disconnecter shall be marked with the signal word “WARNING” and the following statement (or equivalent):

“RISK OF ELECTRIC SHOCK – DO NOT OPEN OR CLOSE THIS DISCONNECTOR WHILE THE FIRE PUMP CONTROLLER-SHORT CIRCUIT PROTECTIVE DEVICE IS IN THE CLOSED POSITION”

If the disconnecter is rated with sufficient fault-make, load-break capacity or when the disconnecter is prevented from being neither opened nor closed while the Fire Pump Controller-short circuit protective device is closed (i.e. isolating switch and circuit breaker are interlocked), the warning label shall not be required. When omitted, the label shall be replaced with an instruction label which directs the order of operation.

3.3.2.2 Fire Pump Controller-Short Circuit Protective Device (SCPD)

The short circuit protective device shall be provided with an information plate with the legend in letters not less than 10 mm high:

“FIRE PUMP CONTROLLER-SHORT CIRCUIT PROTECTIVE DEVICE – SWITCHING MEANS”

or as commonly used in North America:

“CIRCUIT BREAKER – DISCONNECTING MEANS”

The information plate shall be located on the outside of the controller enclosure adjacent to the switching means for operating the Fire Pump Controller-short circuit protective device.

3.3.2.3 Pressure Transducer or Transmitter

A pressure transducer/transmitter shall be permanently marked on the exterior of the device to include the name and address of the manufacturer, distinctive type or model number, serial number, pressure range, electrical ratings and date of manufacture. All markings shall be clearly visible, legible and durable.

3.3.2.4 Enclosure

The enclosure of a controller shall be marked with the NEMA type rating or IEC IP Code indicating the degree of protection against ingress (see Appendix E). When a water pressure actuated controller is intended for outdoor use, a marking shall be provided on the enclosure indicating that the controller shall be used only where the temperature of the water in the pressure sensing means and pressure sensing line cannot fall below +39 °F (+4 °C).

3.3.2.5 Field Wiring

Terminals for user connection intended to be used only with copper conductors shall be marked to indicate the use of copper conductors only. All the field wiring terminals provided in the controller shall be plainly marked to correspond with the field connection diagram provided with the controller.

3.3.2.6 Electric Fire Pump Controller

A controller with this classification shall be marked “ELECTRIC FIRE PUMP CONTROLLER”.

The following ratings and electrical characteristics apply for electric fire pump controller with or without a fire pump power transfer switch:

- a. Rated operational voltage and number of phases, with symbol **O** , if not useful for IT systems (IT symbol not required in North America);
- b. Rated motor power in horsepower or kilowatts and/or rated motor FLC;
- c. Rated frequency/frequencies or the indication “D.C.” or the symbol --- ;
- d. Rated conditional short circuit current for each source;
- e. Maximum water sensing pressure.

3.3.2.6.1 Controllers for use with electric motor driven fire pumps and intended for use as service equipment shall be marked “Suitable for Use as Service Equipment” on the outside of the controller enclosure. The markings shall be provided separately or as part of the nameplate containing the manufacturer’s name or trademark, and other ratings. When provided on a separate label, the markings shall include the manufacturer’s name or trademark. A separate label containing the marking “Service Disconnect” shall be shipped loosely with instructions indicating that the label is to be applied on the outside of the enclosure adjacent to the operating handle of the isolating switch, when the isolating switch is provided. When an isolating switch is not provided, the label shall be applied adjacent to the operating handle of the circuit breaker.

Note: The “Service Disconnect” label is not applicable for Canada which employs a service box ahead of the controller for this application.

3.3.2.7 Electric Fire Pump Controller Combined With Power Transfer Switch

- a. Where the power transfer switch consists of a self-contained power switching assembly, such assembly shall be housed in a barriered compartment of the fire pump controller or in a separate enclosure attached to the controller and marked “Fire Pump Power Transfer Switch”.
- b. The fire pump controller and transfer switch shall each have a cautionary marking to indicate that the isolation (disconnect) switches, on both the controller and automatic transfer switch, are to be opened before servicing the controller, transfer switch, or motor.

3.3.2.8 Reserved for future use

3.3.2.9 High Voltage Electric Fire Pump Controller

A controller with this classification shall be marked:

“HIGH VOLTAGE FIRE PUMP CONTROLLER”.

Additional marking requirements are as listed for electric fire pump controllers in Section 3.3.2.6 and 3.3.1.

3.3.2.10 Stand-Alone Fire Pump Power Transfer Switches

A fire pump power transfer switch shall be marked “FIRE PUMP POWER TRANSFER SWITCH”. The letters shall be at least 1 in. (25 mm) in height.

When a circuit breaker is not provided on the line side of the alternate input terminals of the transfer switch, the following marking is required: “CAUTION: This controller not suitable for use with alternate/second utility source or generator with current capacity greater than 225 percent of the fire pump motor full-load current rating,” or equivalent.

3.3.2.11 Diesel Engine Fire Pump Controller

A diesel engine fire pump controller shall be marked “DIESEL ENGINE FIRE PUMP CONTROLLER”.

Controller terminals shall be numbered as indicated in Table A.1.

The diesel engine fire pump controller manufacturer shall provide specifications and instructions for the size of wire and the maximum distance for the connections between the controller and the diesel engine.

The following ratings and electrical characteristics apply:

- a. Rated operational A.C. voltage;
- b. Rated operational supply current;
- c. Rated frequency/frequencies;
- d. Battery voltage;
- e. Type of battery;
- f. Engine earth polarity;
- g. Engine stopping method (energize fuel solenoid or de-energize fuel solenoid);
- h. Maximum water sensing pressure.

3.3.2.12 Additive/Foam Pump Controllers

3.3.2.12.1 Electric additive/foam pump controllers

Electric additive/foam pump controllers shall be marked either “ELECTRIC ADDITIVE PUMP CONTROLLER” or “ELECTRIC FOAM PUMP CONTROLLER” depending on the jurisdictional requirements. All other markings are per Sections 3.3.2.6 and 3.3.1.

3.3.2.12.2 Diesel engine additive/foam pump controller

Diesel engine additive/foam pump controllers shall be marked either “DIESEL ENGINE ADDITIVE PUMP CONTROLLER” or “DIESEL ENGINE FOAM PUMP CONTROLLER” depending on the jurisdictional requirements. All other markings are per Sections 3.3.2.11 and 3.3.1.

3.3.3 Variable Speed electric motor driven fire pump controller

- 3.3.3.1 In addition to the markings required for electric motor driven fire pump controllers, the variable speed controller and drive shall also be marked with the maximum ambient temperature rating. This is the temperature, as verified by the methods in this standard, which keep the VFD within its maximum rated ambient temperature rating.

Note: This rating is needed for safe and reliable operation.

- 3.3.3.2 The variable speed controller shall have a mounted plate or permanent label inside of the controller enclosure that identifies the following parameters:

- a. The system Set Point Pressure
- b. The Pump Start Pressure
- c. The Pump Stop Pressure (This setting is required whether the controller is arranged for Manual Stop or for Automatic Stop operation. FM Approved controllers shall have a means to disable and lock-out the automatic shutdown feature, and the controller shall have a clear visual indication that the automatic shutdown feature is disabled or enabled.)

Note: Whether the controller is arranged for manual stop or automatic stop, the pump start pressure determines when the pressure switch timer initiates counting down to initiate a mode change to full speed running.

3.3.4 Electrical diagrams and instructions (All Controllers)

3.3.4.1 Diagrams

An electrical schematic diagram, indicating all internal wiring, circuits, test terminals, provisions for alarm circuits, all power supplies and other components, shall be permanently attached to the inside of the controller enclosure.

- a. All the field wiring terminals provided in the controller shall be plainly marked to correspond with the field connection diagram provided with the controller.
- b. Each operating component of the controller shall be marked to plainly indicate an identifying number referenced on the electrical schematic field connection diagram. The marking shall be located so as to be visible after installation.
- c. For external diesel engine connections, the field connection terminals shall be commonly numbered between the controller and engine terminals.

3.3.4.2 Operating instructions

Instructions for starting and stopping the pump motor and for emergency operation of the fire pump shall be provided on the front of the controller in a position visible after installation.

Note: It shall be taken into account that instructions may be required to be read quickly in poor visibility environments (i.e. in a smoky atmosphere).

3.3.5 Instructions for installation, operation and maintenance

The manufacturer shall specify in his documents or catalogues the conditions for installation, operation and maintenance (including spare parts) of the controller. This information shall include, as a minimum, any specific information on connecting conductor size.

3.3.6 Normal service, mounting and transport conditions

Clause 6 of IEC 60947-1 and ANSI/UL 508 applies with the following additional requirements.

3.3.6.1 Water Temperature

When a water pressure actuated controller is intended for outdoor use, a marking shall be provided on the enclosure indicating that the controller shall be used only where the temperature of the water in the pressure sensing means and pressure sensing line cannot fall below +39 °F (+4 °C).

3.3.6.2 Humidity

For equipment intended for use within an enclosure or provided with an integral enclosure, the relative humidity of the air shall not exceed 50 percent at a maximum temperature of 104 °F (40 °C). Higher relative humidities may be permitted at lower temperatures [i.e. 90 percent humidity at 68 °F (20°C)]. Means shall be taken to avoid condensation within a controller when ever it is likely to occur, (any season or time of day). Such means may include space heaters controlled by humidistats or thermostats.

Note: Operating such heaters at half of their voltage rating improves safety and reliability of the heater.

3.3.6.3 Degrees of Pollution

Unless otherwise stated by the manufacturer, fire pump controllers are intended for use in pollution degree 3 environmental conditions, as defined in 6.1.3.2 of IEC 60947-1. However, other pollution degrees may be considered to apply depending upon the environment. For variable speed controllers, the controller shall provide no worse than the pollution degree rating of the VFD.

3.3.6.4 EMC considerations

Fire pump controllers shall be suitable for use in environment A or/and B. Information shall be provided by the manufacturer to advise the user on the measures to be taken concerning EMC.

3.4 Calibration

All equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage of the equipment. A copy of the calibration certificate for each piece of test equipment is required for FM Approvals records, indicating that the calibration was performed against working standards whose calibration is certified as traceable to the National Institute of Standards and Technology (NIST) or to other acceptable reference standards and certified by a ISO 17025 calibration laboratory. The test equipment must be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service accreditation certificate as an ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories", calibration laboratory is required for FM Approvals records.

The calibration of recently purchased new equipment is also required. Documentation indicating either the date of purchase or date of shipment, equipment description, model and serial number is required for identification. The period from the time the equipment was put into service to the date of testing must be within an interval that does not require the equipment to be calibrated as determined on the basis of the parameters mentioned above.

3.5 Tolerances

Tolerances on units of measure shall be as described in Appendix G, unless otherwise specified.

4. CONSTRUCTIONAL, FUNCTIONAL AND PERFORMANCE REQUIREMENTS

4.1 Constructional requirements for type tested devices for electric motor and diesel engine fire pump controllers

4.1.1 General

- 4.1.1.1 Controllers shall be completely assembled, wired and tested by the manufacturer before installation.
- 4.1.1.2 The constructional requirements for the type-tested device shall be verified by examining the manufacturer's certification records and by visual inspection during the set-up for exercising the fire pump controller test protocol. When certification records are not provided, testing shall be arranged for the device as prescribed by this standard.
- 4.1.1.3 Fire pump controllers shall not be used as a junction box to supply other equipment and shall not be used as service equipment for other devices or loads. An exception is allowed for diesel engine fire pump controllers as explained in Section 4.7.2.6.b.
- 4.1.1.4 All electrical power components shall comply with their own relevant NEC or IEC product standard, and shall have been examined by UL, CSA or acceptable IEC Laboratory.
- 4.1.1.5 An electric fire pump controller shall not have an externally accessible hand operated selector switch (i.e. Auto-Off-Manual or Hand-Off-Auto) that interferes with the operation of the isolation switch, circuit breaker, manual shutdown pushbutton or emergency run mechanical control when the controller is in the automatic mode.

4.1.2 Enclosures

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.

- 4.1.2.1 Enclosures for fire pump controllers shall comply with the national and jurisdictional requirements per UL 508, *Industrial Control Equipment*, CSA C22.2 No. 14, *Industrial Control Equipment*, NMX-J-235-1-ANCE, *Enclosure General Requirements*, and subclause 7.1.10 of IEC 60947-1, *Low-Voltage Switchgear and Controlgear - Part 1: General rules*.

4.1.2.2 Enclosures for fire pump controllers shall comply with the requirements for a NEMA environmental rating no lower than Type 2 per NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)* or ANSI/UL 50, *Enclosures for Electrical Equipment Non-Environmental Considerations* (see Appendix E), or with the requirements for an IP designation code of no lower than IP31 according to Annex C of IEC 60947-1, *Low-Voltage Switchgear and Controlgear - Part 1: General rules* and IEC 60529, *Degrees of protection provided by enclosures (IP code) Amendment 1 (1999)*.

4.1.2.3 The enclosure shall be so constructed so as to maintain the minimum required pollution degree protection required throughout its service life.

4.1.3 Materials

All components which are installed within the fire pump controller enclosure shall be mounted in accordance with their manufacturer's instructions on a supporting structure of noncombustible materials. The assessment criteria for non-combustible materials, in accordance with IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods Amendment 1 (2003)*, are given in Table 4.1.2 below. Flammability of materials shall be verified by the procedure stated in Annex M of IEC 60947-1 *Low-Voltage Switchgear and Controlgear - Part 1: General rules*, or ASTM D 3874, *Standard Test Method for Ignition of Materials by Hot Wire Source*.

Table 4.1.2 – Assessment criteria

<i>Test Method</i>	<i>Criteria</i>
Horizontal burning	Method A, HB40
Vertical burning	Method B, V-0
Horizontal flame (FH)	HF-1

4.1.4 Current-Carrying Parts and Their Connections

Subclause 7.1.2 of IEC 60947-1, *Low-Voltage Switchgear and Controlgear - Part 1: General rules*, applies with the following additions.

4.1.4.1 Service Equipment

Controllers for use with electric motor driven fire pumps and intended for use as service equipment shall be fitted for direct connection to incoming premises power supply conductors. Requirements for circuits supplying the controller are given in IEC 60364, *Electrical installations of buildings*, UL 508, *Industrial Control Equipment* and UL 869A, *Reference Standard for Service Equipment*. The controller shall be equipped to accommodate the service conductors, the earthing electrode conductor and earthing (bonding) connection. Means shall be made available for the additional grounding, bonding and/or earthing conductors as well as motor conductors as required by the national regulations of the country in which the fire pump controller is to be used. Said means may be by way of options or optional kits.

4.1.4.2 Main circuits

All busbars for field connection shall be readily accessible after installation of the controller and arranged so the disconnection of the external circuit conductors shall not be required for maintenance. Busbars, wiring, and wiring terminals of the main circuit shall be sized for continuous duty in accordance with the rated operational currents. Conductors that are in a circuit only during the motor starting period shall be sized according to their own intermittent duty cycle. Conductors and devices in the main circuit shall be capable of withstanding two 20 second locked-rotor tests spaced at 1 minute intervals without sustaining damage. Fire pump controllers shall not be equipped to permit the connection of any ancillary apparatus to the fire pump controller.

4.1.5 Clearance and spacing distances

- 4.1.5.1 Electrical spacings through air, over surface and between uninsulated live parts and the enclosure walls shall be at least those specified in Table A.3.
- 4.1.5.2 For printed circuit wiring boards, the minimum spacings shall be as specified in Table A.4.
- 4.1.5.3 The spacings at a field-wiring terminal are to be measured with wire connected to the terminal as in service. The connected wire is to 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.
- 4.1.5.4 The spacings specified in Table A.3 for devices having limited rating shall apply to:

Devices rated 1 hp (0.75 kW) or less; 720V•A or less (break pilot duty); or not more than 15A at 51-150V, 10A at 151-300V, or 5A at 301-600V; or any combination thereof; 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 2 hp (1.5 kW), 1440V•A, or have a current rating greater than 30A at 51-150V, 20A at 151-300V, or 10A at 301-600V, and provided also that the loading on any one pole does not exceed its marked rating.
- 4.1.5.5 In a circuit involving voltages of 50V or less spacings at field-wiring terminals shall be permitted to be 0.125 in. (3.2 mm) through air and 0.25 in. (6.3 mm) over surface.
- 4.1.5.6 In a circuit involving voltages of 50V or less, other than field wiring terminals, the spacings shall be 0.06 in. (1.6 mm) through air or over surface, provided that the insulation and clearances between such circuits and any circuits of more than 50V are in accordance with the requirements for the higher voltage circuit.

4.1.6 Insulating Barriers

- 4.1.6.1 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 that is intended for the mounting of uninsulated live parts, and shall not be less than 0.028 in. (0.71 mm) thick. An exception is fiber. Fiber less than 0.028 in. (0.71 mm) thick may be used as the sole separation between the enclosure and an uninsulated metal part electrically connected to a grounding conductor.
- 4.1.6.2 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 0.028 in. (0.71 mm) thick. When the barrier or liner is of fiber, the air space shall not be less than 1/32 in. (0.8 mm), 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. An exception is a barrier or liner that:
 - a. Is used in addition to an air space, where the air space is not less than one-half the required spacing through air;
 - b. Is not less than 0.013 in. (0.33 mm) thick;
 - c. Is of a material that is intended for the support of uninsulated live parts;
 - d. Has the mechanical strength required to withstand mechanical damage;
 - e. Is held in place; and
 - f. Is located so that it is not adversely affected by operation of the equipment in service.