DRAFT FOR DEVELOPMENT

DD IEC TS
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# Low-voltage switchgear and controlgear — Controllers for drivers of stationary fire pumps

ICS 29.130.20



British Standards

# National foreword

This Draft for Development reproduces verbatim IEC TS 62091:2003.

**This publication is not to be regarded as a British Standard.**

It is being issued in the Draft for Development series of publications and is of a provisional nature because the subject is still under consideration by IEC SC17B. It will remain unchanged until 2005. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the international organization responsible for the Technical Specification. A review of this publication will be initiated not later than 3 years after its publication by the international organization so that a decision can be taken on its status at the end of its 3-year life. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into an international standard, to extend the life of the Technical Specification for another 3 years or to withdraw it. Comments should be sent in writing to the Secretary of BSI Subcommittee PEL/17/2, Low-voltage switchgear and controlgear, at 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

A list of organizations represented on this committee can be obtained on request to its secretary.

**Cross-references**

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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## Low-voltage switchgear and controlgear – Controllers for drivers of stationary fire pumps

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – CONTROLLERS FOR DRIVERS OF STATIONARY FIRE PUMPS

## FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62091, which is a technical specification, has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this technical specification is based on the following documents:

| Enquiry draft | Report on voting |
|---|---|
| 17B/1248/DTS | 17B/1279/RVC |

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- transformed into an International Standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

# INTRODUCTION

IEC 62091 pertains to life-safety equipment and is based in part on NFPA 20 (1996) *Standard for the Installation of Centrifugal Fire Pumps*. When called upon to work by automatic signal, manual-electric signal or manual-emergency actuation, the controller is expected to start the pump driver (motor or diesel engine) because “the building is on fire”. Failure to carry out its mission will increase fire damage to the building, its contents and people therein.

These controllers differ from other IEC 60947 [1] compliant controllers in that they default to a RUN state. 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.

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 technical specification recognizes the condition of under-exercised fire pumps by permitting up to 20 s 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 because shutdown for equipment protection could possibly permit its destruction by fire along with the building and its contents.

Several examples of the 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 are expected to 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 should not prevent operations of pumps from all other internal or other external means.

   d) External control circuits are expected to 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 should not prevent the controller(s) from starting the fire pump(s) due to causes other than these external circuits.

[1] IEC 60947 (all parts), *Low-voltage switchgear and controlgear.*

e) External automatic starting means should 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 should not be equipped with any means to accommodate remote stopping (a remote STOP button should not be used).

g) Nuisance starts are permitted in the case where a failure of internal control components might cause the motor to start running.

2) **electric motor fire pump controllers**

a) They are expected to include means for external, manual mechanical operation of the controller in the event of loss of ability to close the contactor electrically/magnetically.

b) Thermally reactive over-current protective devices should not be permitted. The controller should provide short-circuit and locked rotor protection only.

c) Releases of the power-protector device are expected to permit it to carry 300 % of rated operational motor current for an extended period of time.

3) **diesel engine fire pump controllers**

a) Should provide means to automatically exercise the engine on a weekly basis.

b) Should not prevent an engine from starting nor shutdown an engine running under demand conditions due to low oil pressure or high engine temperature.

Therefore, the most significant purpose of this technical specification is to characterize the unique features of fire pump controllers.

# LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – CONTROLLERS FOR DRIVERS OF STATIONARY FIRE PUMPS

## 1 Scope and object

This technical specification applies to controllers intended for starting, controlling and stopping stationary fire pumps, including automatic and non-automatic types for alternating current electric motor or diesel engine driven fire pumps. It is anticipated that a controller only controls a single driver.

Controllers for electric motor driven fire pumps always include suitable short-circuit protection as an integral part of the controller. These controllers may include an integral power transfer switch. These controllers are rated 1 000 V a.c. maximum.

Controllers for diesel engine driven fire pumps include electrical circuits that operate various control and supervisory functions such as remote control (starting and stopping), alarms, signals, indicators, and the proper operation of battery chargers.

The most significant purpose of this technical specification is to characterize the unique features of fire pump controllers. A further purpose is to prescribe a procedure for exercising the controllers to verify that the unique features are operative. For the purpose of this technical specification, this procedure is described as the “fire pump controller test protocol”.

The object of this technical specification is to state the following:

a) the unique characteristics of fire pump controllers, their associated equipment and their operational functions;
b) the conditions with which fire pump controllers should 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 behaviour under normal, overload and short-circuit conditions;
    6) their capability to annunciate significant events;
    7) their electromagnetic compatibility for the environment into which they are placed;
c) the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;
d) the information to be given with the equipment, or in the manufacturer's literature.

In this context, this technical specification 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 technical specification. Referring to electric power sources, the requirements of this technical specification apply only to the extent that they place limits on the nature, behaviour and characteristics of the electrical energy that is supplied to the service entrance (see IEC 60364-5-55).

The requirements of this technical specification do not apply to the method or means by which the electrical energy is generated nor to the installation between the origin of the installation and the fire pump controller, which are to be found in the IEC 60364 series. This technical specification does not apply to diesel engine driven electric generators which may be associated with a stationary fire pump installation.

EMC considerations are correlated with other IEC standards for similar products:

a) for electric fire pump controllers, EMC considerations are covered by this technical specification, and
b) for diesel engine fire pump controllers, d.c. batteries are the intended source of electrical control power.

## 2 Normative references

The following referenced documents are indispensable for the application of this technical specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60364 (all parts), *Electrical installations of buildings*

IEC 60364-5-55:2001, *Electrical installations of buildings – Part 5-55: Selection and erection of electrical equipment – Other equipment*
Amendment 1 (2001)

IEC 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

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*

IEC 60707:1999, *Flammability of solid non-metallic materials when exposed to flame sources – List of test methods*

IEC 60947-1:1999, *Low-voltage switchgear and controlgear – Part 1: General rules*
Amendment 1 (2000)
Amendment 2 (2001)

IEC 60947-2:1995, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*
Amendment 1 (1997)
Amendment 2 (2001)

IEC 60947-3:1999, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*
Amendment 1 (2001)

IEC 60947-4-1:2000, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

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)

IEC 61000-3-3:1994, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤ 16 A*
Amendment 1 (2001)

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques* – Section 2: *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 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques* – Section 4: *Electrical fast transient/burst immunity test* – Basic EMC publication
Amendment 1 (2000)
Amendment 2 (2001)

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques* – Section 5: *Surge immunity test*
Amendment 1 (2000)

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*
Amendment 1 (2000)

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques* – Section 8: *Power frequency magnetic field immunity test*
Amendment 1 (2000)

IEC 61000-4-11:1994, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques* – Section 11: *Voltage dips, short interruptions and voltage variations immunity tests*
Amendment 1 (2000)

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*

CISPR 61000-6-3:1996, *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 3: Emission standard for residential, commercial and light-industrial environments*

CISPR 11:1997, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*
Amendment 1 (1999)

## 3 Terms and definitions

For the purposes of this document, the relevant definitions given in IEC 60947-1, together with the following definitions, apply.

**3.1**
**automatic control**
control of an operation without human intervention

**3.2**
**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 supply to another (see IEC 60947-6-1)

**3.3**
**controller**
enclosed group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected

**3.4**
**diesel engine fire pump controller**
controller intended to control a diesel engine-driven fire pump

**3.5**
**diesel engine foam pump controller**
controller intended to control a diesel engine-driven foam concentrate pump

**3.6**
**disconnecting means**
device, group of devices, or other means (e.g. a power-protector device in the fire pump controller) by which the conductors of a circuit can be disconnected from their electrical supply while under load

**3.7**
**driver**
electric motor or diesel engine that drives the fire pump

**3.8**
**electric fire pump controller**
controller intended to control an electric motor-driven fire pump

**3.9**
**electric foam pump controller**
controller intended to control an electric motor-driven foam concentrate pump

**3.10**
**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

[IEV 161-01-07]

**3.11**
**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.

[IEV 161-01-05]

**3.12**
**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.

[IEV 161-01-01]

**3.13**
**emission (electromagnetic)**
phenomenon by which electromagnetic energy emanates from a source

[IEV 161-01-08]

**3.14**
**immunity (to an disturbance)**
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

**3.15**
**externally operable**
capable of being operated without the need to remove covers or open an enclosure

**3.16**
**fire pump**
pump dedicated to deliver a specified rate of water flow at a specified pressure to the fire extinguishing system of a premises

**3.17**
**fire pump controller test protocol**
procedure for exercising fire pump controllers to verify their compliance with the requirements of this technical specification

**3.18**
**foam pump**
pump dedicated to deliver a specified rate of foam concentrate to the system proportioner in the water fire extinguishing system of a premises

**3.19**
**foam pump controller**
controller intended to control a foam concentrate pump for use in fire suppression

**3.20**
**lockout feature**
externally accessible means to preclude an automatic controller from responding to a start signal

**3.21**
**manual power transfer switch**
switch, operated by direct manpower, for transferring one or more load conductor connections from one power supply to another

**3.22**
**non-automatic control**
control of an operation by human intervention

**3.23**
**over-current**
current exceeding the rated current

NOTE For the purpose of this technical specification, over-current protection includes motor locked-rotor and short-circuit protection only.

**3.24**
**power-protector device**
switching device with locked-rotor and short-circuit instantaneous trip protection that, after tripping, can be immediately externally reset without tools or replacement parts and without affecting tripping characteristics

**3.25**
**pumping unit**
pump, driver and controller

**3.26**
**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 and are typically limited to one- and two-family units.

**3.27**
**service equipment**
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

**3.28**
**switch-disconnector**
switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[IEV 441-14-12]

**3.29**
**system proportioner**
device or coordinated group of devices which introduces foam concentrate in a prescribed proportion into the fire water stream

**3.30**
**type-tested device**
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

## 4 Classification

### 4.1 Electric fire pump controller

#### 4.1.1 Automatic electric fire pump controller

##### 4.1.1.1 Pressure activated

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

##### 4.1.1.2 Non-pressure actuated

Starting of the motor is initiated by means other than by detecting a reduction in water pressure, such as deluge valve, flow switch or fire detection equipment.

#### 4.1.2 Non-automatic electric fire pump controller

Starting of the motor is initiated by manual electrical means (e.g. push button) or manual mechanical means (e.g. emergency-run mechanical control, see 8.5.1.2).

#### 4.1.3 Electric fire pump controller with or without power transfer switch

Controllers may be provided for one or two sources of electrical power.

#### 4.1.4 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).

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

Controllers may be provided as single or dual pump configuration.

### 4.3 Diesel engine fire pump controller

#### 4.3.1 Pressure actuated

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

#### 4.3.2 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.

### 4.4 Foam pump controller (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 foam concentrate pumps.

## 5 Characteristics

### 5.1 Electrical quantities

#### 5.1.1 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.

#### 5.1.2 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.

In the case of an 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.

### 5.2 Hierarchy of importance for the various characteristics

#### 5.2.1 General

The hierarchy of importance is divided into two levels: A-priority and B-priority. A-priority functions shall override B-priority functions.

#### 5.2.2 Functions assigned to A-priority

Operations that are assigned to A-priority are designed with the capability to take over normal operations under prescribed circumstances.

For example, non-automatic control is assigned to the premier level in the hierarchy of importance. By definition, non-automatic control is characterized by manual intervention. The ability to apply manual intervention to override all other functions is of premier importance during any exercise for suppressing a fire.

The requirements for compliance with this premier role are given in 8.3 and 8.8.1.

#### 5.2.3 Functions assigned to B-priority

Operations that are assigned to B-priority are designed with the capacity to be inhibited, or to be subordinated, under prescribed circumstances.

For example, automatic control describes the capability for self-initiated action without human intervention. Therefore, all forms of automatic control shall be subordinated to any form of deliberated human intervention.

The requirements for compliance with this subordinate role are given in 8.3 and 8.8.1.

### 5.3 Electric fire pump controller

#### 5.3.1 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 over-current 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 1 or Figure 2.

The requirements for performing these functions are given in Clause 8.

#### 5.3.2 Standard equipment

The electric fire pump controller shall be comprised of the following standard equipment:

a) enclosure;
b) components (see 8.1);
c) voltage surge arrester;
d) pressure recorder, when appropriate;
e) sensors, detectors, monitoring devices, alarms and appropriate signal devices;
f) type tested devices.

The controller may include other optional equipment that is the subject of agreement between the manufacturer and the user.

The constructional, functional and performance requirements are given in 8.6.

### 5.4 Single phase fire pump controller

Single phase fire pump controllers are a sub-class of electric fire pump controllers with a restricted scope of applications (e.g. domestic residences).

The constructional, functional and performance requirements are given in 8.7.

NOTE This subclause does not preclude the use of a three-phase controller in premises, residential or otherwise, where three-phase power is available.

### 5.5 Diesel engine fire pump controller

#### 5.5.1 General

A diesel engine is the driver for this class of fire pump controller and no electrical function in the main circuit of an electrical power supply is required.

#### 5.5.2 Basic functions

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

a) controls electrical means to start 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 weekly test of the system.

The requirements for performing these functions are given in 8.8.

#### 5.5.3 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 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 charger;

f) pressure recorders, when appropriate;

g) weekly test timer including minimum run timer.

The constructional, functional and performance requirements are given in 8.8.

### 5.6 Foam pump controller

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 driven or engine driven systems apply.

The unique requirements are dictated by the fact that, unlike water, the foam concentrate is supplied in measured quantities. The result is a set of special requirements to govern the situation wherein the store of foam concentrate has been depleted during the exercise of suppressing a fire.

The requirements for foam pump controllers are given in 8.6.6 and 8.10.

### 5.7 Fire pump controller test protocol

The requirements for the fire pump controller test protocol are given in 9.1.

## 6 Product information

### 6.1 Rated values and other electrical characteristics

#### 6.1.1 Electric fire pump controller with or without fire pump power transfer switch

The following ratings and electrical characteristics apply:

a) rated operational voltage and number of phases, with symbol  , if not useful for IT systems;
b) rated operational current (or rated operational power if dedicated to a particular motor);
c) rated frequency/frequencies, or the indication “d.c.”;
d) rated conditional short-circuit current;
e) maximum water sensing pressure.

#### 6.1.2 Diesel engine fire pump controller

The following ratings and electrical characteristics apply:

a) rated operational a.c. voltage and number of phases;
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.

#### 6.1.3 Foam pump controller

Subclause 6.1.1 applies for electric foam pump controllers. Subclause 6.1.2 applies for diesel engine foam pump controllers.

#### 6.1.4 Residential fire pump controller

Subclause 6.1.1 applies to residential fire pump controllers.

## 6.2 Marking

### 6.2.1 General

Subclause 5.2 of IEC 60947-1 applies, with the additional requirement that markings shall be indelible and easily legible.

NOTE It should be taken into account that marking may be required to be read quickly in a smoky atmosphere.

### 6.2.2 Identification

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 IP rating;

d) reference "IEC 62091", if the manufacturer claims compliance with this technical specification;

e) electric fire pump controller or diesel engine fire pump controller;

f) non-pressure actuated fire pump controller (not required if not equipped with water pressure control).

These identifications shall be installed on the equipment, preferably on the nameplate.

NOTE The purpose of these identifications is to enable the user to obtain additional information from the manufacturer.

Controllers shall be provided with a marking, visible during installation, stating that

g) no ancillary apparatus (e.g. jockey (make-up) pump) shall be connected to the fire pump controller, and

h) only those devices indicated on the controller diagram(s) shall be connected to the controller.

### 6.2.3 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.

### 6.2.4 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 9.3.3.4.1.7 or, if applicable, to 9.3.3.4.1.8.

### 6.2.5 Marking for specific components and controllers

#### 6.2.5.1 Switch-disconnector

A switch-disconnector shall be marked with the signal word "WARNING" and the following statement (or equivalent):

"RISK OF ELECTRIC SHOCK – DO NOT OPEN OR CLOSE THIS SWITCH-DISCONNECTOR WHILE THE SWITCHING MEANS IS IN THE CLOSED POSITION"

If the switch-disconnector is rated with sufficient fault-make, load-break capacity or when the switch-disconnector and the power protector device are so interlocked that the switch-disconnector can be neither opened nor closed while the power protector device is closed, the warning label is not required. When omitted, the label shall be replaced with an instruction label which directs the order of operation.

#### 6.2.5.2 Power protector device

A power protector device shall be provided with an information plate with the legend in letters not less than 10 mm high:

"POWER PROTECTOR DEVICE – SWITCHING MEANS"

The information plate shall be located on the outside of the controller enclosure adjacent to the means for operating the power protector device.

#### 6.2.5.3 Service equipment

When electric fire pump controllers and fire pump power transfer switches shall be used as service equipment,

a) the equipment shall be marked on the outside of the enclosure "SUITABLE FOR USE AS SERVICE EQUIPMENT";

b) the marking shall be provided separately or as part of the nameplate containing the manufacturer's name or trademark, and other ratings;

c) when provided on a separate label, the marking shall include the manufacturer's name or trademark;

d) a separate loose label, marked "SERVICE DISCONNECT", shall be included with the controller with instructions indicating that the label shall be applied on the outside of the enclosure adjacent to the operating handle of the supply disconnecting means.

#### 6.2.5.4 Enclosure

The enclosure of a controller shall be marked with the IP code indicating the degree of protection against ingress. 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 +4 °C.

#### 6.2.5.5 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.

#### 6.2.5.6 Electric fire pump controller

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

#### 6.2.5.7 Single phase fire pump controller

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

#### 6.2.5.8 Fire pump power transfer switches

A fire pump power transfer switch shall be marked "FIRE PUMP POWER TRANSFER SWITCH". The electric fire pump controller and fire pump power transfer switch shall each be marked with a cautionary marking to indicate that the switch-disconnectors, on both the controller and fire pump power transfer switch, shall be opened before servicing the controller, fire pump power transfer switch or motor.

#### 6.2.5.9 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 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.

#### 6.2.5.10 Foam pump controllers

##### 6.2.5.10.1 Electric foam pump controllers

Electric foam pump controllers shall be marked "ELECTRIC FOAM PUMP CONTROLLER".

##### 6.2.5.10.2 Diesel engine foam pump controller

Diesel engine foam pump controllers shall be marked "DIESEL ENGINE FOAM PUMP CONTROLLER".

### 6.2.6 Electrical diagrams and instructions

#### 6.2.6.1 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.

#### 6.2.6.2 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 should be taken into account that instructions may be required to be read quickly in a smoky atmosphere.

### 6.3 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.

## 7 Normal service, mounting and transport conditions

### 7.1 General

Clause 6 of IEC 60947-1 applies with the following additional requirements.

### 7.2 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 +4 °C.

### 7.3 Humidity

Subclause 6.1.3.1 of IEC 60947-1 applies.

### 7.4 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 macro-environment.

### 7.5 EMC considerations

Fire pump controllers shall be suitable for use in environment A or B unless otherwise agreed between the manufacturer and the installer.

## 8 Constructional, functional and performance requirements

### 8.1 General

Critical components of a fire pump controller are

a) actuators (8.2.5);
b) disconnecting device (8.4.3);
c) power protector switching means (8.4.4);
d) short-circuit protective means (8.4.4);
e) over-current protective means (8.4.4);
f) full-voltage starting means (8.4.7);
g) reduced voltage starting means (8.4.8.);
h) power transfer switch (8.6.9);
i) battery charger (8.8.4.1).

All components shall comply with their own relevant IEC product standard and the additional requirements of this technical specification.

### 8.2 Constructional requirements for the type-tested devices

#### 8.2.1 General

Subclause 7.1 of IEC 60947-1 applies with the following additions:

a) controllers shall be completely assembled, wired and tested by the manufacturer before installation;

b) controllers shall be suitable for use in locations subject to a moderate degree of moisture, such as a damp basement and dripping from sweating overhead pipes;

c) the constructional requirements for the type tested device shall be verified by examining the manufacturer's records and by visual inspection during the set-up for exercising the fire pump controller test protocol;

d) the distance between the end of a pressure wire connector (or terminal block) for connection to a field installed wire and the wall of the enclosure toward which the wire is directed, shall be not less than the values given in Table 2. The distance shall be measured in a straight line from the centre of the opening in the connector in the direction in which the wire leaves the terminal, perpendicular to the enclosure wall.

#### 8.2.2 Materials

Subclause 7.1.1 of IEC 60947-1 applies with the following addition.

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 non-combustible materials. The assessment criteria for non-combustible materials, in accordance with IEC 60695-11-10 and IEC 60707, are given in Table 3.

Flammability of materials shall be verified by the procedure stated in Annex M of IEC 60947-1.

#### 8.2.3 Current-carrying parts and their connections

Subclause 7.1.2 of IEC 60947-1 applies with the following additions.

##### 8.2.3.1 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.

##### 8.2.3.2 Main circuits

All busbars and connections 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 s locked-rotor tests spaced at 1 min intervals without sustaining damage.

Fire pump controllers shall not be equipped to permit the connection of any ancillary apparatus to the fire pump controller. The fire pump controller shall be equipped to accommodate the service conductors, the earthing electrode conductor and earthing (bonding) connection as required by the national regulations of the country in which the fire pump controller is to be used.

#### 8.2.4 Clearance and creepage distances

Subclause 7.1.3 of IEC 60947-1 applies.

#### 8.2.5 Actuators

Subclause 7.1.4 of IEC 60947-1 applies with the additional requirements in 8.4 through 8.8.

##### 8.2.5.1 External controls

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

##### 8.2.5.2 Use of sensing devices

Sensing devices, such as undervoltage, phase loss, frequency sensitive, earth leakage protection, etc., shall not be connected in any manner that prevents the automatic and/or manual operation of the fire pump controller.

#### 8.2.6 Indication of the contactor position

##### 8.2.6.1 Indicating means

Subclause 7.1.5.1 of IEC 60947-1 applies with the additional requirements in 8.4 through 8.9.

##### 8.2.6.2 Indication by the actuator

Subclause 7.1.5.2 of IEC 60947-1 applies with the additional requirements in 8.4 through 8.9.

#### 8.2.7 Additional safety requirements for equipment with isolating function

Subclause 7.1.6 of IEC 60947-1 applies with the additional requirements in 8.4 through 8.9.

#### 8.2.8 Terminals

Subclause 7.1.7 of IEC 60947-1 applies with the following additions.

a) A fire pump controller shall be provided with wiring terminals or leads for connection of conductors having a continuous current-carrying capacity not less than 125 % of the rated operational motor current.

b) In the case of power conversion equipment in which the input current is different from rated operational motor current, the continuous current-carrying capacity shall be based upon 125 % of the maximum rated input current.

c) Field wiring terminals for a diesel engine fire pump controller shall be suitable for use with stranded wire.

#### 8.2.9 Additional requirements for devices provided with a neutral pole

Subclause 7.1.8 of IEC 60947-1 applies where applicable.

#### 8.2.10 Provisions for earthing

Subclause 7.1.9 of IEC 60947-1 applies with the additional requirements in 8.4 through 8.9.

#### 8.2.11 Enclosures

Subclause 7.1.10 of IEC 60947-1 applies taking into account 6.2.5.4.

#### 8.2.12 Degree of protection of enclosures

The enclosure shall comply with the requirements for an IP rating of no lower than IP31 according to Annex C of IEC 60947-1 or IEC 60529.

### 8.3 Priority of operations for electric fire pump controllers

For the purpose of this technical specification, certain selected functions are assigned to a priority in order to alert the manufacturer and the user that special precautions are required, as follows:

– A-priority: operations that shall have the capability to assume normal operations under prescribed circumstances;
– B-priority: operations that shall have the capacity to be inhibited, or to be subordinated, under prescribed circumstances.

### 8.4 Functional and performance requirements for components

#### 8.4.1 General

All components required to start, run and protect the motor shall comply with their relevant IEC product standards.

#### 8.4.2 Dielectric properties

The controller shall be capable of withstanding an impulse test without damage in accordance with overvoltage category IV of Table H.1 of IEC 60947-1.

NOTE To achieve this requirement, a surge arrester may be installed electrically upstream from the switch-disconnector, from each phase to ground (see Figure 1). The surge arrester should be rated to suppress voltage surges greater than 150 % of the rated operational voltage $U_e$ of the controller.

#### 8.4.3 Disconnecting device

The disconnecting device shall be manually and externally operable (see 6.2.5.1 for special requirements on markings), and with a continuous current rating that is at least 115 % of the rated operational motor current $I_e$. This disconnecting device is not required to be capable of making or breaking.

If a circuit-breaker not fulfilling the requirements for over-current protection but in accordance with Annex L of IEC 60947-2 is used, it shall be arranged and wired such that it does not trip unless the circuit-breaker, in the same controller, has tripped.

The disconnecting device and the circuit-breaker shall be interlocked such that it shall not be possible to open or close the disconnecting device while the circuit-breaker is closed.

#### 8.4.4 Power-protector device

##### 8.4.4.1 General

The motor circuit shall be protected by a circuit-breaker in accordance with IEC 60947-2 and this technical specification, connected directly to the load side of the disconnecting device with one pole connected to each unearthed circuit conductor (see Figure 1). See 6.2.5.2 for special requirements on markings.

NOTE When the motor circuit is transferred to an alternate on-site power generator and is protected by an over-current device at the generator, the power-protector device within the fire pump controller is not required to be connected.

##### 8.4.4.2 Mechanical characteristics of the circuit-breaker

The circuit-breaker shall be manually and externally operable.

##### 8.4.4.3 Short-circuit protection

A circuit-breaker shall have a continuous current rating not less than 115 % of the rated operational current of the motor and be in compliance with all of the following:

a) the over-current sensing elements shall be of the current-sensing type with tripping characteristics not sensitive to temperature; it shall be possible to reset the device for operation immediately after tripping with the tripping characteristics thereafter remaining unchanged;

b) an instantaneous short-circuit protection shall be provided;

c) the short-circuit breaking capacity shall be compatible with the conditional short-circuit current rating of the controller;

d) the circuit-breaker shall be compatible with the normal and emergency run mechanical requirements (8.5.1.2) for starting the motor without tripping;

e) the instantaneous trip setting shall be the minimum consistent with the ability to start the motor under all foreseeable conditions without tripping.

##### 8.4.4.4 Locked rotor over-current protection

An over-current protective device shall be provided between the load side of the disconnecting device and the motor contactor, and shall be located within the fire pump controller (see Figure 1). No other over-current protective device shall be provided. It shall have the following characteristics for a squirrel-cage motor:

a) it shall be of the time delay type having a tripping time between 8 s and 20 s at 720 % of $I_e$ or the inrush current of the motor as declared by the motor manufacturer;

b) it shall have a tripping characteristic such that tripping shall not occur in less than 3 min at 300 % of $I_e$;

c) it shall provide visual means or markings on the device which clearly indicate that proper settings are installed;

d) the over-current sensing elements shall be of the current-sensing type with tripping characteristics not sensitive to temperature; it shall be possible to reset the device for operation immediately after tripping with the tripping characteristics thereafter remaining unchanged.

NOTE Shunt-trip means, or some other direct acting means, are preferred (see Figure 1).

#### 8.4.5 Control circuits

An over-current protective device shall not be provided in the control circuit.

#### 8.4.6 Short-circuit behaviour

The fire pump controller shall have the ability to make and break the rated conditional short-circuit current. The verification shall be made according to 9.3.3.4.1.7.

The only other over-current protective device that is permitted and required shall be provided between the load side of the switch-disconnector and the fire pump motor, and shall be located within the fire pump controller (see Figure 1), and it shall have the following characteristics for a squirrel-cage motor.

#### 8.4.7 Full voltage starting – motor contactor

Each controller shall be equipped with a motor contactor(s) which shall be of the magnetic type with a contact in each unearthed conductor. The contacts shall be capable of making, breaking and carrying the motor currents resulting from direct on line control of squirrel cage motors. The voltage for actuating the main contactor shall be supplied directly by the primary supply circuit (see Figure 1) or by a voltage reduction means which is only energized when the contactor is operated.

The motor contactor shall be in accordance with IEC 60947-4-1 with the following additional requirements:

a) it shall meet the requirements of utilization category AC3;

b) it shall withstand locked-rotor current as described in 9.3.3.3.5;

c) it shall withstand 300 % of $I_e$ (of the controller) for 3 min.

These requirements shall be verified by testing, see 9.3.3.3.

#### 8.4.8 Reduced voltage starting means

##### 8.4.8.1 General

Reduced voltage starting methods are

a) primary resistance;

b) primary reactor;

c) autotransformer;

d) star-delta;

e) part winding;

f) semiconductor soft start/stop.

##### 8.4.8.2 Limits for timed acceleration

For electrical operation of reduced voltage controllers, the duration of the automatically timed period of motor acceleration shall not be greater than 10 s from standstill to full speed.

#### 8.4.8.3 Requirements for starting duty

The following requirements for thermal capacity are design requirements not to be confused with the maximum limits for timed acceleration given in 8.4.8.2.

a) For controllers rated more than 150 kW (or equivalent current rating), the starting equipment shall be designed with a thermal capacity to allow three 30 s starts separated by 30 s rest intervals in each hour for 2 h.

b) The thermal capacity of starting resistors shall permit one 5 s starting operation in each 80 s for a period of not less than 1 h.

c) The thermal capacity of a starting reactor or auto-transformer shall permit one 15 s starting operation every 240 s for a period of not less than 1 h.

d) Semiconductor motor controllers shall be rated for utilization category AC-53b with no less than three starts per hour.

e) For star-delta or part winding start motors, the starting conductors shall be rated as follows:

   1) part winding: each conductor carries 50 % of the motor rated operational current;

   2) star-delta: each conductor carries 58 % of the motor rated operational current.

### 8.4.9 Alarm and signal devices

#### 8.4.9.1 Devices on the controller

Provisions shall be made to permit reading of all line currents and line-to-line voltages from the exterior of the fire pump controller. A visible indicator shall monitor the availability of power in all phases at the line terminals of the motor contactor. When the visible indicator is a pilot lamp, it shall be accessible for replacement of the bulb (lamp).

Phase reversal on the line side of the motor contactor (load side of the power protector device) shall be indicated by a visible indicator. When the visible indicator is a pilot lamp, it shall be accessible for replacement of the bulb (lamp).

When power is supplied from multiple power supplies, monitoring of each power source for phase loss and phase reversal shall be permitted at any point electrically upstream of the line terminals of the contactor.

#### 8.4.9.2 Devices remote from the controller

Controllers shall be equipped with contacts to operate alarm circuits that indicate the phase reversal on the line side of the motor contactor. A circuit rated 250 V or less with over-current protection may be provided in the fire pump controller to power the motor running and phase reversal remote alarms.

### 8.5 Priority of operations for electric fire pump controllers

#### 8.5.1 A-priority functions

##### 8.5.1.1 Manual initiated electric control at the controller

The operation of the manual initiated electric control at the controller shall comply to A-priority by the following means.

A manually operated device shall be provided on the exterior of the controller so that, when the fire pump driver is started manually, its operation is not affected by any automatic starting means. The fire pump driver shall remain in operation until manually stopped.

##### 8.5.1.2 Emergency-run control at the controller

The emergency-run control can be fulfilled either by a mechanical activation (e.g. mechanical operation of a contactor) or by a redundant electrical switching device (e.g. contactor, manual switch, etc.).

The electrical characteristics of the switching means shall be verified according to 9.3.3.3.2.1 when operated under the emergency conditions.

The emergency-run control shall comply to A-priority by the following means:

a) an emergency run device shall be provided for non-automatic start and continuous running operation of the motor;
b) the emergency run device shall be latchable in the running position. The latch shall not be automatic but shall be at the option of the operator;
c) the manual emergency actuator shall be arranged to move in one direction only from “off” to final running position;
d) the controller shall return automatically to the “off” position if the operator releases the manual emergency actuator in any but the full running latched position.

#### 8.5.2 B-priority functions

##### 8.5.2.1 Manual electric remote control

Provisions for accommodating remote control stations for causing non-automatic, continuous operation of the pumping unit, independent of the pressure-actuated control switch, shall be provided. Means shall not be provided to stop the pump driver from a remote location.

##### 8.5.2.2 Wiring and connections

Control circuits shall be designed such that when permissible external control components are connected as intended, breakage, disconnecting, shorting of the wires or loss of power to these circuits may 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.

### 8.6 Functional and performance requirements for electric controllers

#### 8.6.1 General

The functional requirements for the type-tested device shall be verified according to 9.1.

#### 8.6.2 Ratings and limits

Controllers shall be rated in terms of the rated operational voltage $U_e$, the rated operational current $I_e$ (or rated operational power, see 5.1.2), the frequency, the number of phases and the conditional short-circuit current.

Controllers shall operate satisfactorily at any value between 85 % and 110 % of their rated operational voltage, $U_e$. Where a range is declared, 85 % shall apply to the lower value and 110 % to the higher.

#### 8.6.3 Short-circuit behaviour

The fire pump controller shall have the ability to make and break the rated conditional short-circuit current. The verification shall be made according to 9.3.3.4.1.7.

#### 8.6.4 Automatic and non-automatic operations

Subclause 8.5 gives the explanation for assigning a priority to certain designated functions of automatic and non-automatic operations in electric controllers.

An automatic controller shall be operable also as a non-automatic controller.

A non-automatic controller shall be actuated by manually initiated electrical means and also by manually initiated mechanical means.

#### 8.6.5 Automatic controller – pressure actuated

##### 8.6.5.1 Water pressure control

A pressure actuated automatic controller shall be provided with a pressure actuated device having independent high and low calibrated adjustments in the controller circuit. No pressure snubber or restrictive orifice shall be employed within the pressure actuated device.

The pressure sensing element of a pressure actuated device shall be capable of withstanding a momentary surge of pressure of 2 750 kPa or 133 % of its working range, whichever is greater, without losing its accuracy.

##### 8.6.5.2 Sequence starting of pumping units

The controller, for each driver of multiple pump units, shall incorporate a sequential timing device to reduce the likelihood of simultaneous starting of any one pump unit with any other pump unit. This device is not required for the leading pump.

If the demand for water exceeds the capacity of the fire pump, subsequent starting of additional fire pumps shall be at intervals between 5 s and 10 s.

When a leading driver does not start, subsequent pumping units shall not be prevented from starting.

#### 8.6.5.3 Pressure recorder

A recording device may be provided to sense and record the pressure in each fire pump controller pressure sensing line at the input to the controller. When provided, the recorder shall be capable of operating for at least seven days without resetting or rewinding. The pressure sensing element of the recorder shall be capable of withstanding a momentary surge pressure of at least 2 750 kPa or a maximum of 133 % of its working range, whichever is greater, without losing its accuracy.

### 8.6.6 Automatic controller – non-pressure actuated

A non-pressure actuated automatic controller shall use the opening of a remote contact to start the motor.

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

### 8.6.7 Non-automatic controller

A non-automatic controller shall be manually actuated by separate electrical and mechanical means.

### 8.6.8 Stopping methods

#### 8.6.8.1 General

Stopping the fire pump driver by the controller shall be accomplished by manual operation of a stop device on the outside of the controller enclosure. In the case of an automatic controller, manual operation of the device shall return the controller to the automatic position. If the controller is arranged for automatic shutdown after starting causes have returned to normal, a running period timer set for at least 10 min running time shall be used. For a sprinkler or standpipe system where an automatically controlled fire pump constitutes the sole supply, the controller shall remain in operation until manually stopped.

#### 8.6.8.2 Automatic shutdown after automatic start

When automatic stop is selected, the controller shall stop the fire pump only after all starting methods have returned to normal and a total operating time of 10 min has elapsed.

### 8.6.9 Functional and performance requirements for power transfer switches

#### 8.6.9.1 General

A fire pump power transfer switch is an automatic power transfer switch device that is a critical component (see 8.1). This switch shall comply with IEC 60947-6-1 and shall be located in one of the following two places: either in a separate compartment with a barrier within the controller enclosure, or in a separate enclosure attached to the controller.

A power transfer switch that operates only in manual mode shall not be used to transfer power between the normal supply and the alternative supply to the fire pump controller.

No provisions for remote device(s) shall be installed that will prevent automatic operation of the power transfer switch.

#### 8.6.9.2 Ratings and limits

A fire pump power transfer switch shall be rated in terms of the rated operational voltage, $U_e$, the rated operational current, $I_e$ (or operational motor power, see 5.1.2), the frequency, the number of phases and the conditional short-circuit current.

The combined controller and power transfer switch shall operate satisfactorily at any value between 85 % and 110 % of their rated operational voltage, $U_e$. Where a range is declared, 85 % shall apply to the lower value and 110 % to the higher.

The rated operational current of a power transfer switch which is not rated in operational motor power shall be at least 115 % of the rated full-load motor current.

### 8.6.10 Automatic transfer switching equipment

#### 8.6.10.1 General

The automatic transfer switching equipment shall be electrically operated and mechanically held in position. The automatic transfer switching equipment shall be manually operable.

NOTE This manual operation need not be capable of external operation.

The automatic transfer switching equipment shall comply with IEC 60947-6-1 class PC (see Clause 3 of IEC 60947-6-1) and the operating mechanism shall be such that the load circuit cannot remain permanently switched off from both the normal and the alternative supplies. Auxiliary contacts (open, closed or both) mechanically operated by the automatic transfer switching equipment shall be provided to indicate the position (normal or alternative) of the power transfer switch.

#### 8.6.10.2 Sensing and signal devices

A fire pump power transfer switch shall be provided with undervoltage sensing devices to monitor all unearthed lines of the normal power supply. Additional special requirements are given in 8.6.9.2. When the voltage on any phase at the load terminals of the power-protector device within the controller falls below 85 % of the motor rated voltage, the power transfer switch shall automatically initiate transfer to the alternative supply. When the voltage on all phases of the normal power supply returns to within acceptable limits, the fire pump controller may be allowed to transfer to the normal power supply. Phase reversal of the normal power supply shall cause a simulated normal power supply failure upon sensing phase reversal. An externally operable momentary test switch shall be installed on the enclosure to simulate a normal power supply failure. Two indicators shall be provided, visible to the operator, to indicate to which power supply the fire pump controller is connected.

#### 8.6.10.3 Transfer between power supplies

##### 8.6.10.3.1 Transfer delay

A time delay shall be provided to delay transfer from the alternative power supply to the normal power supply until the normal power supply is within acceptable limits. The time delay shall be adjustable between 5 min and 30 min. The time delay shall be bypassed automatically if the alternative power supply fails.

##### 8.6.10.3.2 Inrush currents

Means shall be provided to reduce the likelihood of higher than normal inrush currents when transferring the fire pump driver from one power supply to the other.

#### 8.6.10.4 Power transfer switch for independent generator alternative supply

##### 8.6.10.4.1 Switch-disconnector

A switch-disconnector located within the fire pump power transfer switch enclosure or compartment shall be provided on the line side of the alternative supply input terminals of the power transfer switch. An audible and visual signal shall be provided to indicate when the switch-disconnector for the alternative supply is open. Auxiliary contacts mechanically operated by the switch-disconnector shall be provided on the power transfer switch enclosure to indicate the position of the switch-disconnector.

##### 8.6.10.4.2 Short-circuit and over-current protective devices

When the alternate power supply is provided by an independent generating set, short-circuit and over-current protective devices for the alternative power supply to the transfer switch are not required within the power transfer switch enclosure or compartment.

The locked rotor protective device, required in 8.4.4.4, may be bypassed while the power transfer switch is connected to the alternative supply.

##### 8.6.10.4.3 Sensing devices

Voltage-sensing and frequency-sensing devices shall be provided to monitor at least one phase of the alternative power supply. Transfer to the alternative power supply shall be inhibited until the voltage and frequency are within acceptable limits for the fire pump driver.

##### 8.6.10.4.4 Accessory devices

When a power transfer switch is intended to be connected to a generator alternative supply, it shall be equipped with the following accessory devices:

a) a device to delay starting of the alternative supply generator to reduce the likelihood of nuisance starting in the event of momentary dips and interruptions of the normal supply;

b) a circuit loop to the alternative supply generator whereby either the opening or closing of the circuit will start the alternative supply generator;

c) a means to prevent sending the signal for starting of the alternative supply generator (when commanded by the power transfer switch), when the switch-disconnector on the alternative supply side of the power transfer switch is open.

#### 8.6.10.5 Power transfer switch for second utility alternative supply

##### 8.6.10.5.1 Switch-disconnector

Subclause 8.6.10.4.1 applies.

##### 8.6.10.5.2 Switching means

When the alternate power supply is provided by a second utility supply, switching means for the alternative power supply to the transfer switch is required within the power transfer switch enclosure or compartment.

##### 8.6.10.5.3 Short-circuit and over-current protective devices

When the alternate power supply is provided by a second utility supply, short-circuit and locked-rotor protection for the alternative power supply are required within the power transfer switch enclosure or compartment.

##### 8.6.10.5.4 Sensing devices

Under-voltage sensing devices shall monitor all phases. Transfer to the alternative power supply shall be inhibited until the voltages are within acceptable limits for the fire pump motor.

### 8.7 Residential fire pump controllers

#### 8.7.1 General

The requirements of 8.1 through 8.6 apply with the following modifications.

#### 8.7.1.1 Ratings

A residential fire pump controller shall consist of both an automatic and a non-automatic direct on line controller intended for starting, stopping and protecting single-phase motors of maximum rated voltage 250 V a.c. The standard rating of the power protector device shall be no less than 150 % and no greater than 250 % of the motor full-load current.

#### 8.7.1.2 Over-current protection

Over-current protection shall be achieved by the use of a resettable inverse time, non-adjustable protective device, sized to trip between 8 s and 20 s under motor locked-rotor conditions.

NOTE 1 A switch-disconnector is not required.

NOTE 2 The automatic stopping timer described in 8.6.8.2 can be set for a minimum of 3 min.

The rated conditional short-circuit current rating shall be not less than 10 000 A.

#### 8.7.1.3 Access to the enclosure

Access to the interior of the enclosure and enclosed components shall be averted via a key/tool-lockable cabinet door, or a switch-disconnector with an external handle that is interlocked with the door. When the external handle is used, it shall be installed in an arrangement that prevents access to the interior of the enclosure and enclosed components without the switch-disconnector or power-protector device being in the “off” position.

#### 8.7.2 Single residential fire pump controllers

Single residential fire pump controllers shall be used only with a single motor that derives power from a single supply.

#### 8.7.3 Dual residential pump controllers

Dual residential pump controllers shall be used with two motors that derive their power from one or two supplies. The controllers shall incorporate an adjustable timing device to allow sequential starting of the two motors. The timing device shall be factory set between 2 s and 5 s. Failure to start the first pump shall not prevent the second pump from starting.

### 8.8 Diesel engine fire-pump controllers

#### 8.8.1 Priority of operations for diesel engine fire pump controllers

##### 8.8.1.1 General

A-priority operations shall have the capability to take over normal operations under prescribed circumstances. B-priority operations shall have the capacity to be inhibited, or to be subordinated, under prescribed circumstances.

The general arrangement shall be as shown in Figure 3.

##### 8.8.1.2 Emergency control

Emergency control is an A-priority operation.

#### 8.8.2 Standard equipment

##### 8.8.2.1 Classification of equipment

A diesel engine drive controller shall be capable of both automatic and non-automatic operation.

##### 8.8.2.2 Locked enclosure

All switches required to keep the controller in the automatic position shall be located within lockable enclosures and shall only be accessible by opening the enclosure or via breakable glass panels.

##### 8.8.2.3 Alarm and signal devices

All visible indicators shall be plainly visible to the operator. Visible indication shall be provided to indicate that the controller is in the automatic position. If the visible indicator is a pilot lamp, it shall be accessible for replacement of the bulb (lamp).

Discriminating visible indication and a common audible alarm capable of being heard while the engine is running shall be provided. All alarms shall be operable in all positions of the main switch except “off”, and they shall indicate the following conditions:

a) low fuel level;

b) low engine oil pressure;

c) high engine coolant temperature;

d) failure of engine to start automatically;

e) engine overspeed shutdown;

f) battery failure.

Means shall be provided for testing the position of the contacts of the engine oil pressure switch without causing premature operation of the alarm.

The above audible alarms shall be muted by the operation of the main switch to “off”. If other optional audible alarms are provided, a mute switch may be provided to mute only the optional alarms.

Discriminating visual indication shall be provided to indicate the following conditions:

g) controller in automatic position;

h) battery charger failure.

No audible alarm silencing switch, other than the controller main switch, shall be provided for the alarms covered by this subclause. An audible alarm silencing switch may be provided for any alarms not addressed by this subclause. It shall not be possible to silence the audible alarm corresponding to any of the conditions above when the condition(s) that caused the alarm are present.

#### 8.8.2.4 Alarm contacts for remote indication

Controllers shall be equipped with contacts (open or closed) to provide for remote indication of the following alarms:

a) engine running (separate signal);

b) the controller main switch has been turned to “off” or “manual” position (separate signal);

c) abnormal conditions (such as engine overspeed, high coolant temperature, low oil pressure, failure to start, engine failure) on the controller or engine (separate or common signals).

### 8.8.3 Starting and control

#### 8.8.3.1 Normal control

An automatic controller shall also be operable as a non-automatic controller. The primary power supply for a diesel engine drive controller shall be the engine batteries. Wiring elements of the controller shall be designed on a continuous-duty basis.

#### 8.8.3.2 Sequence starting of pumping units

Subclause 8.6.5.2 applies.

#### 8.8.3.3 Manual electric remote control

The requirements of 8.5.2.1 apply. In addition, when remote control is used, the following requirements apply:

a) the controller shall be equipped to start the engine upon operation of remote push-button stations;

b) when the controller is arranged for automatic shutdown, remote stations shall not be capable of stopping the unit except through the established operation of the running period timer (see 8.6.8.1).

### 8.8.4 Batteries and battery chargers

#### 8.8.4.1 Battery chargers

Battery chargers shall comply with the following:

a) the rectifier shall be a semiconductor type;

b) the charger for a battery unit shall be a type that automatically reduces the charging rate to a rate suitable for the battery with which the charger is intended to be used;

c) the battery charger at its rated voltage shall be capable of delivering energy into a fully discharged battery in such a manner that it will not damage the battery. It shall restore to the battery 100 % of the battery's ampere-hour or reserve capacity rating within 24 h;

d) the charger shall be marked with the ampere-hour or reserve capacity rating of the largest capacity battery unit that it can recharge;

e) an ammeter with a scale not exceeding 250 % of rated charging current and an accuracy of ±5 % of full scale shall be provided for each battery bank to indicate the charging current;

f) the charger shall be designed so that it will not be damaged or open fuses during the cranking cycle of the engine when operated by an automatic or manual controller;

g) the charger shall automatically charge at the maximum rate whenever required by the state of charge of the battery unit;

h) the total discharge current shall not exceed 50 mA.

#### 8.8.4.2 Voltage measurement

A voltmeter with a scale not exceeding 250 % of rated battery voltage and an accuracy of ±5 % of full scale shall be provided for each battery bank to indicate the voltage during cranking.

## 8.9 Automatic operation of a diesel engine drive controller – pressure actuated

### 8.9.1 Requirements for the controller

Subclause 8.6.5.1 applies.

### 8.9.2 Requirements for the pressure recorder

Subclause 8.6.5.3 applies.

## 8.10 Automatic operation of a diesel engine drive controller – non-pressure actuated

### 8.10.1 General

Automatic starting of a non-pressure actuated automatic controller shall be accomplished by the opening of a contact in the external sensing device. When the controller provides a means for the remote starting of the fire pump, this means shall comply with the requirements of 8.8.3.3.

#### 8.10.2 Method of starting

The power supplies for starting the engine shall be two separate battery units. The controller shall be arranged so that manual and automatic starting of the engine can be accomplished with either battery unit. The controller shall alternate between the first battery unit and the second battery unit during successive attempts to start the engine. The changeover shall be made automatically, except for manual start. The “cranking sequence” shall be a series of six “on-load” to “off-load” cycles set for equal periods of 15 s duration. If the cranking sequence has expired, and if the controller has not received a signal that the engine is running, then the controller shall stop all further cranking and operate a visible indicator and audible alarm on the controller. If one battery unit is not operative or is missing, then the controller shall lock-in to the remaining battery unit during the cranking sequence.

As an alternative, a sequence of six operations may be made instead, each attempt between 5 s and 10 s with a minimum delay of 10 s between two attempts.

### 8.11 Methods of stopping

#### 8.11.1 Manual stopping

Manual stopping shall be accomplished by either one of the following methods:

a) operation of the main switch located inside the controller, or

b) operation of a stop push button located on the outside of the controller enclosure.

Manual stopping shall cause the engine to shut down only when all starting causes have been returned to normal. The controller shall then return to the full automatic position.

#### 8.11.2 Automatic shutdown after automatic start

When the controller is set for automatic engine stopping, the controller shall stop the engine only after all starting causes have returned to normal and a total of 30 min minimum run time has elapsed.

When the engine overspeed device operates, the controller shall remove power from the engine running devices, prevent cranking and energize the overspeed alarm until manually reset. Resetting of the overspeed circuit shall be required at the engine and by resetting the controller main switch to the “off” position. The controller shall not be capable of being reset until the engine overspeed stopping device is manually reset.

The engine shall not stop automatically on high water temperature or low oil pressure when any starting cause exists. When no other starting cause exists during engine test, stopping shall be permitted.

### 8.12 Testing

#### 8.12.1 Manual testing of automatic operation

The controller shall be arranged to manually initiate automatic starting of the engine by opening the solenoid valve drain. In a non-pressure actuated controller, the start shall be initiated by means other than a solenoid valve.

#### 8.12.2 Weekly program timer

The equipment in the controller shall be arranged to automatically start and run the engine each week for a duration agreed by the manufacturer and the user, but not less than 30 min. Means shall be permitted within the controller to manually terminate the weekly test with the provision that a minimum time of 30 min has expired. A solenoid valve drain on the pressure control line shall be the initiating means. In a non-pressure actuated controller, the weekly test may be permitted to be initiated by means other than a solenoid valve.

### 8.13 Additional functional and performance requirements for foam pump controllers

#### 8.13.1 Automatic starting

Automatic starting shall be accomplished by the opening of a remote contact.

NOTE The pressure-actuated device described in 8.6.5.1 is not required.

#### 8.13.2 Method of stopping

Manual stopping shall be the only method of stopping.

#### 8.13.3 Lockout feature

The controller shall contain a lockout feature. This lockout shall be indicated by a visible indicator and provisions for annunciation at a remote location.

### 8.14 EMC requirements

The fire pump controller manufacturer shall specify the measures to be taken, if any, with regard to EMC associated with the installation, operation and maintenance of the controllers (see 7.3.1 of IEC 60947-1).

EMC immunity requirements for environment A (low-voltage non-public networks or industrial locations) shall be applied.

EMC emissions requirements for environment B (low-voltage public networks or residential locations) shall be applied.

NOTE These requirements represent the most severe levels for immunity and emissions and thus a fire pump controller may be installed in environment A or B.

# 9 Tests

## 9.1 Kinds of test

### 9.1.1 Type tests

Type tests are intended to verify compliance of the design of fire pump controllers with the requirements of Clause 8. The type tests comprise the verification of

a) the temperature-rise;
b) dielectric properties;
c) functional and performance requirements;
d) performance under normal load and overload conditions;
e) operating limits;
f) performance under short-circuit conditions;
g) degree of protection of enclosure;
h) capability of battery chargers (diesel engine fire pump controllers only);
i) EMC.

### 9.1.2 Routine tests

Routine tests for fire pump controllers include the verification of

a) operating limits,
b) dielectric properties.

## 9.2 Compliance with construction requirements

Subclause 8.2 of IEC 60947-1 and Clause 8 of IEC 60439-1 apply.

## 9.3 Compliance with performance requirements

### 9.3.1 Test sequences

Each test sequence is performed on a new sample. More than one test sequence may be conducted on one sample. The tests shall be conducted in the order given for each sample.

The test sequences shall be as follows.

a) Test sequence I
   - verification of temperature-rise;
   - verification of dielectric properties;
   - verification of functional and performance requirement;
   - verification of performance under normal load and overload conditions;
   - verification of operating limits;
   - verification of performance of the motor contactor.

b) Test sequence II

Verification of performance under short-circuit conditions.

c) Test sequence III

Verification of degree of protection of enclosure (Annex C of IEC 60947-1).

d) Test sequence IV

Verification of capability of battery chargers (for diesel engine fire pump controllers only).

e) Test sequence V

Verification of EMC.

#### 9.3.2 General test conditions

Subclause 8.3.2 of IEC 60947-1 applies.

#### 9.3.3 Performance under no load, normal load, and overload conditions

##### 9.3.3.1 Temperature rise

###### 9.3.3.1.1 General

Subclause 8.2.1 of IEC 60439-1 applies.

###### 9.3.3.1.2 Ambient air temperature

Subclause 8.3.3.3.1 of IEC 60947-1 applies.

###### 9.3.3.1.3 Measurement of the temperature of parts

Subclause 8.3.3.3.2 of IEC 60947-1 applies.

###### 9.3.3.1.4 Temperature rise of a part

Subclause 8.3.3.3.3 of IEC 60947-1 applies.

###### 9.3.3.1.5 Temperature rise of the main circuit

Subclause 8.3.3.3.4 of IEC 60947-1 applies, with the following additions:

a) the main circuit shall be loaded with 115 % rated operational current as stated in 8.4.3;

b) if suitable for two sources, one heat tests with primary power circuit and one heat test with alternative source circuit shall be carried out.

###### 9.3.3.1.6 Temperature rise of the control circuits

Subclause 8.3.3.3.5 of IEC 60947-1 applies, with the following addition.

The temperature rise shall be measured during the test according to 8.3.3.3.4 of IEC 60947-1.

##### 9.3.3.2 Dielectric properties

###### 9.3.3.2.1 General conditions for withstand voltage tests

Subclause 8.3.3.4.1, item 1), of IEC 60947-1 applies.

#### 9.3.3.2.2 Verification of impulse withstand voltage

Subclause 8.3.3.4.1, item 2), of IEC 60947-1 applies.

#### 9.3.3.2.3 Verification of power-frequency withstand voltage of solid insulation

Subclause 8.3.3.4.1, item 3), of IEC 60947-1 applies.

### 9.3.3.3 Verification of functional and performance requirement

#### 9.3.3.3.1 General

Tests shall be made to prove compliance with the requirements of this technical specification.

Tests are as follows:

a) type tests which shall be made on representative samples of each particular equipment;
b) routine tests which shall be made on each individual fire pump controller.

Tests shall be carried out by the manufacturer, at his works or at any suitable laboratory of his choice.

Where appropriate, and as agreed between manufacturer and user, special tests may also be performed.

#### 9.3.3.3.2 Verification of performance under normal conditions

##### 9.3.3.3.2.1 General

The controller shall be loaded to attain a steady-state temperature as stated in 9.3.3.1.5, and be stopped and started by use of its normally operating means three times. All responses, sequences, signals and alarms shall operate correctly as intended (see 8.6).

When the controller is provided with an automatic power transfer switch, it shall be verified that the transfer switch responds correctly upon loss of one supply.

##### 9.3.3.3.2.2 Verification of manually activated device

Subclause 7.2.1.1 of IEC 60947-3 applies with the following additions.

The following requirements apply to the manually activated device where the closing operation is made by direct manual operation without an interposing mechanism.

The test speed for the making operations specified in 8.3.6.2 of IEC 60947-3 shall be determined as follows:

a) the equipment shall be operated 15 times manually under no-load conditions in accordance with the manufacturer's instructions, five times by each of three persons. The velocity of the hand actuator at the instant of contact closure of the last closing contact shall be determined by oscillographic or other appropriate means at any convenient part of the device;

b) the point at which the measurement is made and the velocity at the measurement point shall be stated in the test report. The mean velocity shall be determined after deleting the highest and lowest values;

c) the test apparatus shall ensure that the equipment under test fully closes and that there is no impediment to the free closing movement of the device. The actual test speed shall not exceed the mean velocity determined according to item a).

The mass of the moving parts of the test apparatus (without the equipment under test) shall be 2 kg ± 10 %.

Verification of making capacity shall be made using the values of Table 4.

#### 9.3.3.3.2.3 Behaviour of equipment during making capacity tests

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame, and no melting of the fuse in the detection circuit.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

In case of welding, a new sample may be used to continue the test.

#### 9.3.3.3.3 Verification of performance under overload conditions

Connect the controller as intended in normal service. The test is performed at any convenient voltage, but a minimum of 100 V, and is performed with the controller at ambient temperature.

The controller shall be loaded with 7,2 times the rated current of the motor. The tripping time shall be between 8 s and 20 s. Special motor designs shall be as agreed between the user and manufacturer.

#### 9.3.3.3.4 Verification of operating limits

The controller shall be loaded to attain a steady-state temperature as stated in 9.3.3.1.6.

Operating tests shall be conducted at 85 % and 110 % of the rated control supply voltage $U_s$. Where a range is declared, 85 % shall apply to the lower value and 110 % to the higher. All responses, sequences, signals and alarms shall operate correctly as intended.

The limit for which the controller shall drop out is 75 % of the rated control supply voltage $U_s$.

#### 9.3.3.3.5 Locked-rotor withstand current test

Two tests shall be performed at any convenient voltage, but a minimum of 100 V, and with the controller at ambient temperature. The test may be carried out on a complete fire pump controller or on separate power samples (e.g. contactor or automatic transfer switching equipment) located outside of the controller and connected with the same size of wire as in normal service of the controller. Tests on separate components shall be made on two samples.

During the test, the contacts of the contactor are held in the closed position by the operating coil supplied by the rated control voltage.

The following tests shall be performed:

a) test at 7,2 times the rated motor current for 20 s (locked rotor current) or until the circuit-breaker trips;

b) test at three times the rated motor current for 3 min.

After the test, compliance is verified by the test of 9.3.3.6.6 of IEC 60947-4-1. This shall be verified by visual inspection.

#### 9.3.3.4 Verification under short-circuit conditions

##### 9.3.3.4.1 General conditions for short-circuit tests

###### 9.3.3.4.1.1 General requirement for short-circuit tests

Subclauses 8.3.4.1.1 of IEC 60947-1 and 8.2.5.1 of IEC 60947-4-1 apply.

###### 9.3.3.4.1.2 Test circuit for the verification of short-circuit ratings

Subclause 8.3.4.1.2 of IEC 60947-1 applies except that the fusible element F and the resistor $R_L$ are replaced by a 0,8 mm diameter copper wire of 1,2 m to 1,8 m in length, connected to the neutral, or with the agreement of the manufacturer, to one of the phases.

###### 9.3.3.4.1.3 Power-factor of the test circuit

Subclause 8.3.4.1.3 of IEC 60947-1 applies.

###### 9.3.3.4.1.4 Calibration of the test circuit

Subclause 8.3.4.1.5 of IEC 60947-1 applies.

###### 9.3.3.4.1.5 Test procedure

Subclause 8.3.4.1.6 of IEC 60947-1 applies with the following addition.

Connect the controller as intended in normal service using a maximum of 2,4 m of cable for each main circuit.

###### 9.3.3.4.1.6 Interpretation of records

Subclause 8.3.4.1.8 of IEC 60947-1 applies.

###### 9.3.3.4.1.7 Conditional short-circuit current of the controller

For a magnetically operated contactor, the magnet shall be held closed by a separated electrical supply at the specified control voltage. Power-protectors with adjustable current trip settings shall be set to the maximum setting. During the test, all openings of the enclosure shall be closed as in normal service and the door or cover closed by the means provided. The test shall be carried out at the minimum rated conditional short-circuit current.

The circuit shall be adjusted to the prospective current value corresponding to the rated operational current $I_e$ according to Table 12 of IEC 60947-4-1.

#### 9.3.3.4.1.8 Test at higher rated conditional short-circuit current

Subject to agreement between manufacturer and user, the test may be done at a higher conditional short-circuit current. The power factor shall be in accordance with Table 16 of IEC 60947-1.

#### 9.3.3.4.1.9 Result to be obtained

The controller shall be considered to have passed the test series O-CO-CO of IEC 60947-4-1 if the following conditions are met:

a) the fault current has been successfully interrupted by the controller and the solid connection between the enclosure and supply has not melted;

b) the door or cover of the enclosure has not been opened and it is possible to open the door or cover. Deformation of the enclosure is considered acceptable provided that the degree of protection by the enclosure is not less than IP2X;

c) there is no damage to the conductors or terminals, and the conductors have not been separated from the terminals;

d) there is no cracking or breaking of an insulating base to the extent that the integrity of mounting of live part is impaired;

e) the power-protector device or/and the switch-disconnector is capable of being opened manually by its operating means;

f) the tripping of the locked rotor protector shall be verified at a multiple of the current setting and shall conform to the tripping requirements of 8.4.4.4, both before and after the test;

g) no damage to the locked rotor protector or other parts has occurred, except that welding or complete disintegration of the contacts of the contactor is permitted;

h) the adequacy of the insulation shall be verified by a dielectric test on the controller using an essentially sinusoidal test voltage of twice the rated operational voltage $U_e$ but not less than 1 000 V. The test voltage shall be applied for 5 s to the incoming supply terminals, with the power-protector device or the switch-disconnector in the open position, as follows:

   1) between each pole and all other poles connected to the frame of the controller,

   2) between all live parts of all poles connected together and the frame of the controller,

   3) between the terminals of the line side connected together and the terminals of the load side connected together.

### 9.3.3.5 Verification of capability of battery chargers (for diesel engine fire pump controllers only)

#### 9.3.3.5.1 Temperature and charge-capacity verification – Ampere-hour

When mounted as in normal service and loaded with two battery banks discharged over a 24 h period to 1,75 V per cell at 20 °C (1,08 V per cell for NiCd), the exterior of a battery charger shall not reach a temperature exceeding 75 °C, and components shall be verified for compliance with 8.3.3.3 of IEC 60947-1.

The following test results shall be noted as being indicative of acceptable performance:

a) return 100 % of the battery ampere-hour rating or reserve capacity within 24 h without damage to the battery banks. The temperature of the battery electrolyte shall not exceed 52 °C;

b) automatically reduce the average charge current to not more than 500 mA when the battery banks reach full charge;

c) maintain the charge level in both battery banks.

During the above test, the ampere-hour input to the batteries shall be recorded using an ampere-hour recording meter.

The test duration shall be between 24 h and 48 h, to verify that the battery charger complies with b) and c) above.

The test above shall be repeated using two new discharged battery banks.

#### 9.3.3.5.2 Temperature and charge-capacity test – Reserve capacity

a) Calculate the approximate ampere-hour rating of the battery to be charged by multiplying the reserve capacity by 25 and dividing by 60. For example, if the battery has a reserve capacity rating of 480 min, the approximate ampere-hour rating would be 200 ampere-hours.

b) Determine the 20 h discharge rate by dividing the approximate ampere-hour rating by 20. For example, the 20 h rate is 10 A.

c) Discharge the battery until a terminal voltage of 1,75 V per cell (1,08 V per cell for NiCd) is measured using the 20 h rate and record the ampere-hours of discharge in 24 h.

d) Connect the charger to the battery and measure the ampere-hours of charge put back into the battery.

e) Verify that at least 100 % of the ampere-hours taken out are replaced.

f) Discharge the battery at 25 A to a terminal voltage of 1,75 V per cell (1,08 V per cell for NiCd), measured under load with the centre cell electrolyte temperature at 27 °C in 24 h.

g) The length of time to equal the rated service capacity of the battery shall be measured. The test duration shall be between 24 h and 48 h.

#### 9.3.3.5.3 Battery discharge test

Immediately following the test in 9.3.3.5.2, and with the batteries fully charged:

a) the battery charger shall be disconnected from the power supply and the discharge current shall be measured in the output circuit of the charger, with the batteries connected;

b) the total discharge current from both batteries shall not exceed 50 mA.

### 9.4 EMC

#### 9.4.1 General

Fire pump controllers are in most cases manufactured or assembled on a one-off basis, incorporating a more or less defined combination of devices.

No immunity or emission tests are required on final controllers if the following conditions are fulfilled:

a) the incorporated devices are in compliance with the specified environment of 8.14 in line with the relevant product or generic EMC standards;

b) the internal installation and wiring is carried out in accordance with the device's manufacturer's instructions (arrangement with regard to mutual influences, cable, screening, earthing, etc.).

In all cases, the EMC requirements shall be verified by tests of 9.5.

### 9.4.2 Immunity

#### 9.4.2.1 Controllers not incorporating electronic circuits

Under normal service conditions, assemblies not incorporating electronic circuits are not sensitive to electromagnetic disturbances and therefore no immunity tests are required.

#### 9.4.2.2 Controllers incorporating electronic circuits

Electronic equipment incorporated in assemblies shall comply with the immunity requirements of the relevant product or generic EMC standard.

In all cases the EMC requirements shall be verified by tests of 9.5.

The device and/or component manufacturer shall specify the specific performance criteria of their products based on the acceptance criteria given in Table A.3.

NOTE For equipment utilizing electronic circuits in which all components are passive (for example diodes, resistors, varistors, capacitors, surge suppressors, inductors), it should not be required to make tests.

### 9.4.3 Emission

#### 9.4.3.1 Controllers not incorporating electronic circuits

For controllers not incorporating electronic circuits, electromagnetic disturbances can only be generated by equipment during occasional switching operations. The duration of the disturbances is of the order of milliseconds. The frequency, level and consequences of these emissions are considered as part of the normal electromagnetic environment of low-voltage installations. Therefore, the requirements for electromagnetic emission are deemed to be satisfied, and no verification is necessary.

#### 9.4.3.2 Controllers incorporating electronic circuits

##### 9.4.3.2.1 High-frequency emissions

Controllers incorporating electronic circuits (such as switched mode power supplies, circuits incorporating microprocessors with high-frequency clocks) may generate continuous electromagnetic disturbances.

For such emissions, these shall not exceed the limits specified in Table A.1 for environment B. These tests are only required when the main and/or auxiliary circuits contain components with fundamental switching frequencies equal or greater than 9 kHz.

Tests shall be carried out according to 9.5.

#### 9.4.3.2.2 Low-frequency emissions

For controllers which generate low-frequency harmonics, the requirements of IEC 61000-3-2 apply for equipment in the scope of that standard.

For controllers which generate low-frequency voltage fluctuations, the requirements of IEC 61000-3-3 apply for equipment in the scope of that standard.

Any necessary test shall be carried out as detailed in the relevant product standard or as stated by the manufacturer.

### 9.5 Functional tests for EMC

#### 9.5.1 General

Functional units within fire pump controllers which do not fulfil the requirements of 9.4.1 a) and b) shall be subjected to the following tests, as applicable.

The emission and immunity tests shall be carried out in accordance with the relevant EMC standards (see Tables A.1 and A.2); however, the manufacturer shall specify any additional necessary measures to verify the criteria of performance for the fire pump controller (e.g. dwell times).

#### 9.5.2 Immunity tests

#### 9.5.2.1 Controllers not incorporating electronic circuits

No tests are necessary.

#### 9.5.2.2 Controllers incorporating electronic circuits

The values are given in Table A.2, except where a different test level is given and justified by the electronic component manufacturer.

Performance criteria shall be stated by the controller manufacturer based on the acceptance criteria in Table A.3.

#### 9.5.3 Emission tests

#### 9.5.3.1 Controllers not incorporating electronic circuits

No tests are necessary.

#### 9.5.3.2 Controllers incorporating electronic circuits

The controller manufacturer shall specify the operating and installation conditions.

### 9.6 Routine tests

#### 9.6.1 Verification of operating limits

It shall be verified that the controller operates according to the requirements of 9.3.3.3.4 of the present technical specification and 8.3.1 of IEC 60439-1.

### 9.6.2 Verification of dielectric properties

For the verification of power frequency withstand voltage, a dielectric test on the controller shall be conducted using an essentially sinusoidal test voltage of twice the rated operational voltage $U_e$ but not less than 1 000 V. The test voltage shall be applied for 5 s to the incoming supply terminals, with the circuit-breaker and switch-disconnector in the open position. Dielectric integrity shall be verified between all poles and the frame and between each pole.

**Table 1 – Diesel fire pump controller terminal numbering**

| Terminal number | Function |
|---|---|
| 1 | Fuel/water solenoid, if used |
| 2 | Crank terminate |
| 3 | Overspeed |
| 4 | Lubricating oil pressure |
| 5 | Engine coolant temperature |
| 6 | Battery 1 anode |
| 7 | Engine alternator, if used |
| 8 | Battery 2 anode |
| 9 | Crank on battery 1 |
| 10 | Crank on battery 2 |
| 11 | Battery cathodes |
| 12 | Shutdown solenoid, if used |

**Table 2 – Wire bending space at field wiring terminals**

| Size of wire | | Minimum bending space, terminal to wall mm | | |
|---|---|---|---|---|
| $mm^2$ | AWG or kcmil | Wires per terminal | | |
| | | 1 | 2 | 3 |
| 2,5 – 6 | 14 – 10 | - | - | - |
| 10 – 16 | 8 – 6 | 38 | - | - |
| 25 | 4 – 3 | 51 | - | - |
| 35 | 2 | 64 | - | - |
| – | 1 | 76 | - | - |
| 50 | 1/0 | 127 | 127 | 178 |
| 70 | 2/0 | 152 | 152 | 191 |
| 95 | 3/0 | 178 | 178 | 203 |
| – | 4/0 | 178 | 178 | 216 |
| 120 | 250 | 203 | 203 | 229 |
| 150 | 300 | 254 | 254 | 279 |
| 185 | 350 | 305 | 305 | 330 |
| – | 400 | 305 | 305 | 356 |
| 240 | 500 | 305 | 305 | 381 |
| 300 | 600 | 356 | 406 | 457 |
| – | 700 | 356 | 406 | 508 |
| – | 750 – 800 | 457 | 483 | 559 |
| – | 900 | 457 | 483 | 610 |

**Table 3 – Assessment criteria**

| Test method | Criteria |
|---|---|
| Horizontal burning | Method A, HB40 |
| Vertical burning | Method B, V-0 |
| Horizontal flame (FH) | HF-1 |

**Table 4 – Verification of making capacity**

| Making | | | Number of operations |
|---|---|---|---|
| $I/I_e$ | $U/U_e$ | Cos $\varphi$ | |
| 10 | 1,05 | 0,45 | 3 |

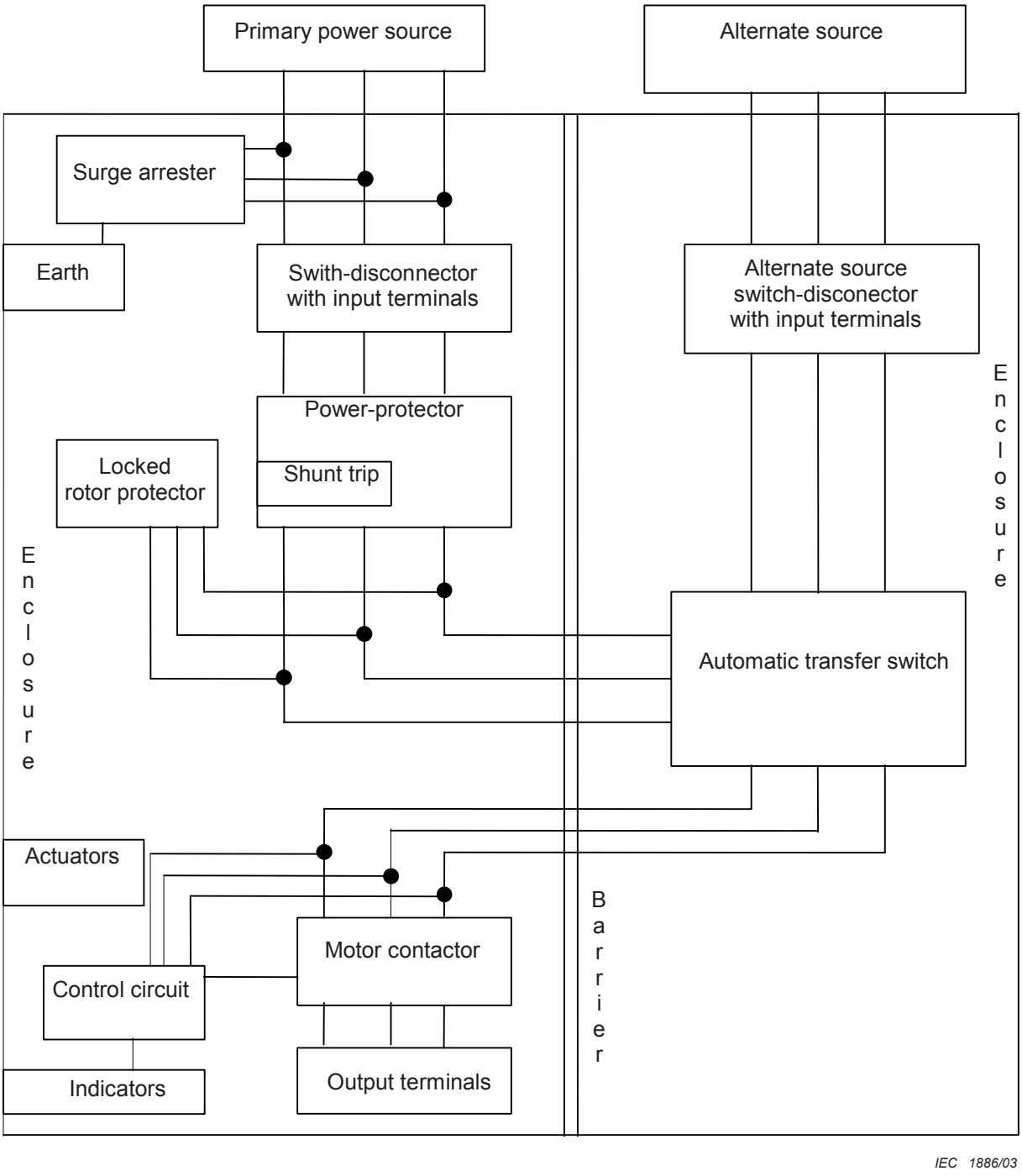


**Figure 1 – General arrangement for the electric fire pump controller suitable for two power sources, one of which is on-site standby power**

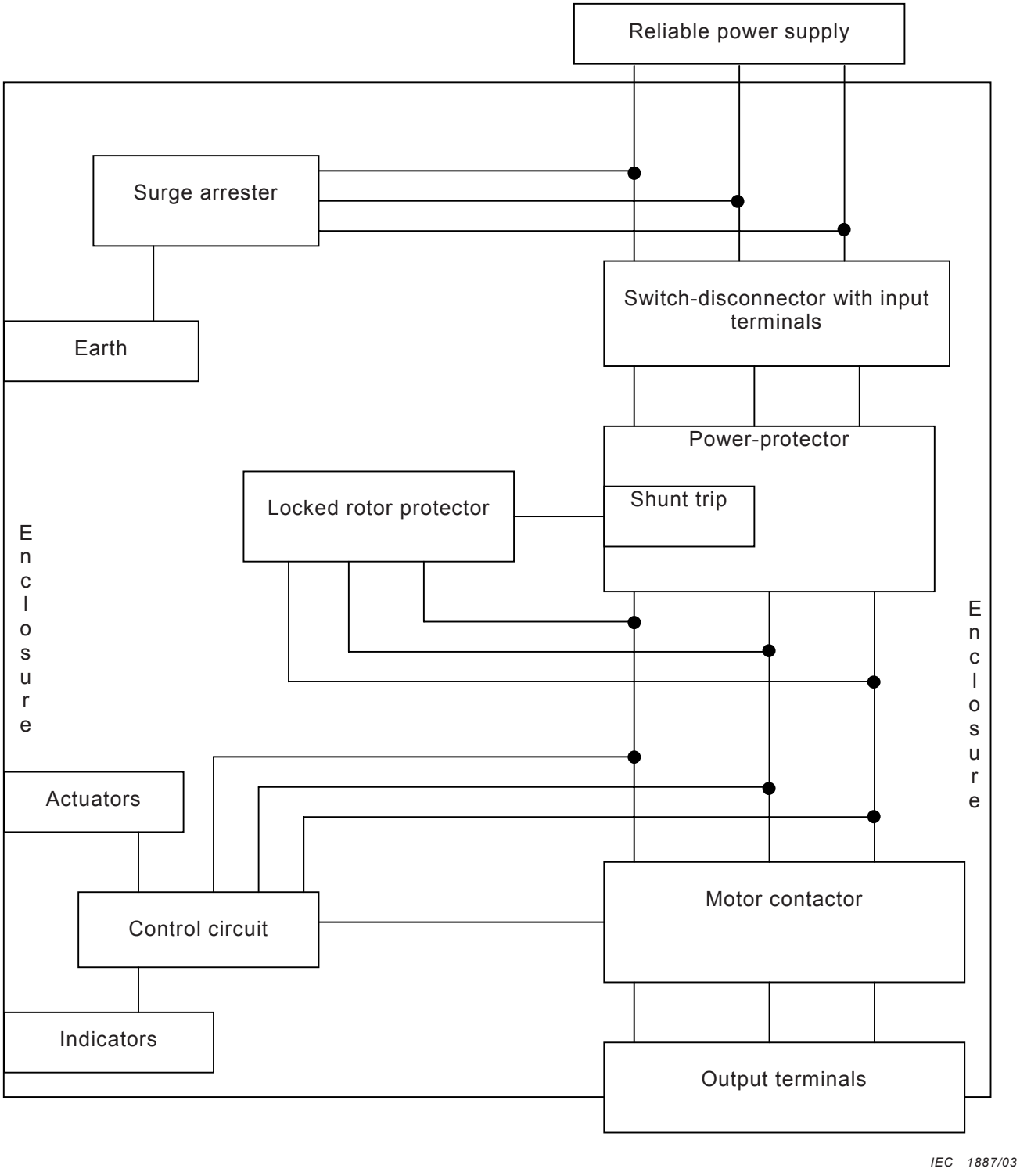


**Figure 2 – General arrangement for the electric fire pump controller suitable for a single power source**

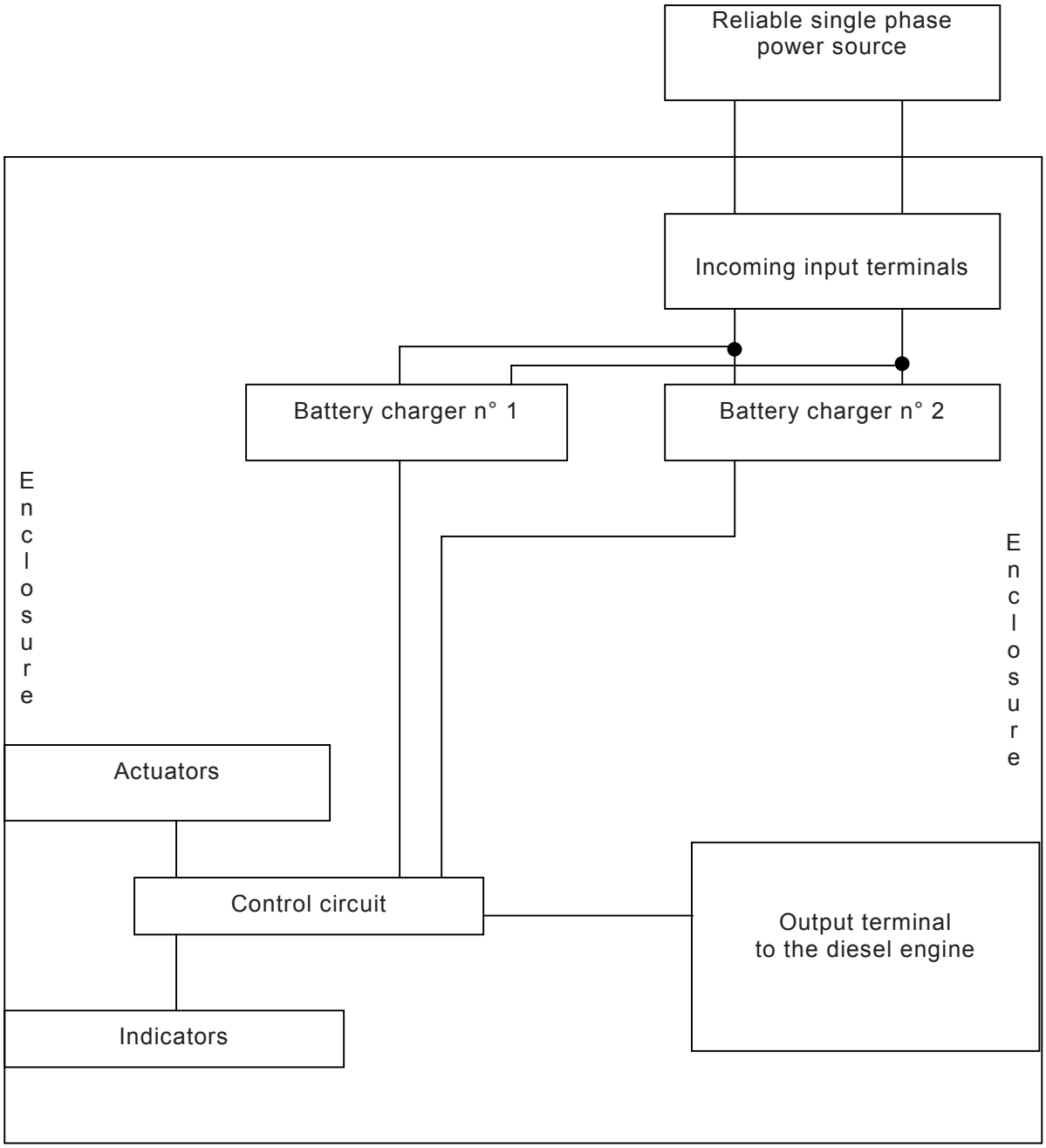


**Figure 3 – Typical block diagram for the diesel engine fire pump controller suitable for a single phase power source**

# Annex A
(normative)

# Electromagnetic compatibility

## A.1 General

This annex applies to controllers incorporating electronic circuits, which are not in compliance with 9.4.1 a) and b).

## A.2 Definitions

For the purposes of this annex, the following definitions are applicable.

**A.2.1**

**port**
particular interface of the specified apparatus with the external electromagnetic environment (see Figure A.1)

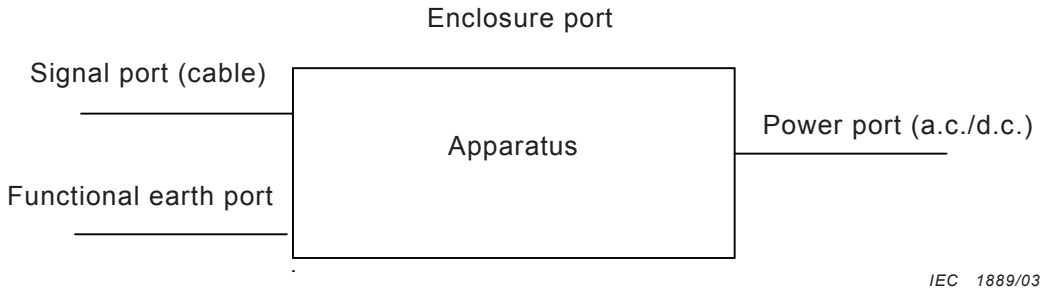


**Figure A.1 – Examples of ports**

**A.2.2**
**enclosure port**
physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

**A.2.3**
**cable port**
port at which a conductor or a cable is connected to the apparatus

NOTE Examples are signal ports used for the transfer of data.

**A.2.4**
**functional earth port**
port other than signal, control or power port, intended for connection to earth for purposes other than electrical safety

**A.2.5**
**signal port**
port at which a conductor or cable carrying information for transferring data is connected to the apparatus

NOTE Examples are data buses, communication networks, control networks.

**A.2.6**
**power port**
port at which a conductor or cable carrying the primary electrical power needed for the operation (functioning) of an apparatus or associated apparatus is connected

**Table A.1 – Emission limits for environment B**
(These limits have been copied for information only without alteration from CISPR 11)

| | **Frequency range** [1] MHz | **Limits** | **Reference standard** |
|---|---|---|---|
| Radiated emissions | 30 to 230<br>230 to 1 000 | 30 dB(μV/m) quasi-peak at 10 m<br>37 dB(μV/m) quasi-peak at 10 m<br>See note | CISPR 61000-6-3<br>or<br>CISPR 11<br>Class B, group 1 |
| Conducted emissions | 0,15 to 0,5<br>The limits decrease linearly with the log of the frequency | 66 dB(μV) to 56 dB(μV) quasi peak<br>56 dB(μV) to 46 dB(μV) average | |
| | 0,5 to 5 | 56 dB(μV) quasi-peak<br>46 dB(μV) average | |
| | 5 to 30 | 60 dB(μV) quasi-peak<br>50 dB(μV) average | |
| [1] The lower limit shall apply at the transition frequency. | | | |
| NOTE May be measured at a distance of 3 m with limits increased by 10 dB. | | | |

**Table A.2 – Immunity tests for environment A**

| Type of test | Test level required | Performance criterion |
|---|---|---|
| Electrostatic discharges<br>IEC 61000-4-2 | 8 kV / air discharge<br>or 4 kV / contact discharge | B |
| Radiated radio-frequency electromagnetic fields<br>(80 MHz to 1 GHz and 1,4 GHz to 2 GHz)<br>IEC 61000-4-3 | 10 V/m | A |
| Electrical fast transients/bursts<br>IEC 61000-4-4 | 2 kV on all ports connected to supply voltage<br>1 kV on signal ports including auxiliary circuits | B |
| Surges [1)]<br>(1,2/50 μs - 8/20 μs)<br>IEC 61000-4-5 | 2 kV (line to earth)<br>1 kV (line to line) | B |
| Conducted disturbances induced by radio-frequency fields<br>(150 kHz to 80 MHz)<br>IEC 61000-4-6 | 10 V | A |
| Power-frequency magnetic field [2)]<br>IEC 61000-4-8 | 30 A/m | A |
| Voltage dips and interruptions<br>IEC 61000-4-11 | 30 % reduction for 0,5 cycles<br>60 % reduction for 5 and 50 cycles | B<br>B |
| Harmonics in the supply<br>IEC 61000-4-13 | No requirements | |
| [1)] For equipment and/or input/output ports with a rated voltage of 24 V d.c. or less, tests are not required.<br>[2)] Applicable only to apparatus containing devices susceptible to magnetic fields. | | |
| NOTE Performance criteria are independent of the environment. | | |

**Table A.3 – Acceptance criteria when electromagnetic disturbances are present**
(performance criteria during tests)

| Item | A | B | C |
|---|---|---|---|
| Automatic and manual starting and running operations | No noticeable changes of the operating characteristic<br>Operating as intended | Temporary degradation or loss of performance which is self recoverable.<br>Unintended starting and running operation is permissible | Temporary degradation or loss of performance which requires operator intervention of system reset |
| Operation of power circuits | Starting and running capability shall be unimpaired | Temporary degradation or loss of performance which is self-recoverable | Temporary degradation or loss of performance which requires operator intervention or systems reset |
| Operation of auxiliary circuits not critical to operation of the pump [1)] | Temporary minor degradation which is self-recoverable | Temporary degradation or loss of performance which is self-recoverable | Temporary degradation or loss of performance which requires operator intervention or systems reset |
| Operation of displays and control panels | No changes to visible display information<br>Only slight light intensity fluctuation of LEDs, or slight movement of characters | Temporary visible changes or loss of information<br>Undesired LED illumination | Shut down<br>Permanent loss of display or wrong information<br>Unpermitted operating mode<br>Not self-recoverable |
| Information processing and sensing functions | Undisturbed communication and data interchange to external devices | Temporarily disturbed communication, with possible error reports of the internal and external devices | Erroneous processing of information<br>Loss of data and/or information<br>Errors in communication<br>Not self-recoverable |

[1)] Operations not involved in starting and running the driver.

# Annex B
(informative)

## Informative material

Most buildings protected by fire pumps are insured. Insurance carriers base their premiums on the risk assumption. These risks are evaluated based on compliance to their own standards or a complete evaluation which includes the reliability of the suppression system. Many global insurers publish lists of acceptable fire suppression equipment, including fire pump controllers by manufacturer's catalogue number. Besides requirements of local authorities, these insurance carriers often require witnessed tests including performance at 150 % rated flow where the motor is expected to be operating for extended periods of times at its rated service factor.

A fire pump is a safety service. Requirements for supplies to safety services are given in IEC 60364-5-55.

This technical specification anticipates that local installation requirements will favour the power supply to be via direct connection from a dedicated service or a limit of one upstream disconnector in the feeder in order to minimize the probability of unintentional disconnection under fire emergencies. Upstream over-current protection (if used) is expected to have suitable discrimination to ensure that locked rotor conditions and short-circuits in the fire pump motor circuit are cleared in the fire pump controller rather than by an upstream device which could be on the other side of the building on fire and thus could not be reached for reset or replacement (see IEC 60364-5-55).

This technical specification takes these and other special requirements into account and also requires markings and instructions expected to be read and followed by non-qualified personnel under emergency conditions in smoky environments.

## Bibliography

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Switchgear, controlgear and fuses*

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