UL 62091

STANDARD FOR SAFETY

Low-Voltage Switchgear and Controlgear – Controllers for Drivers of Stationary Fire Pumps

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Controllers for Drivers of Stationary Fire Pumps, UL 62091

First Edition, Dated September 30, 2020

Summary of Topics

This First Edition of ANSI/UL 62091, the common ANCE, CSA Group and UL (trinational) standard that is an adoption of IEC 62091, Standard for Low-Voltage Switchgear and Controlgear – Controllers for Drivers of Stationary Fire Pumps (IEC 62091, Edition 1:2007.)

The new requirements are substantially in accordance with Proposal(s) on this subject dated April 3, 2020.

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NMX-J-XXXX
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CSA C22.2 No. 62091:20
First Edition
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Underwriters Laboratories Inc.
UL 62091
First Edition

Low-Voltage Switchgear and Controlgear – Controllers for Drivers of Stationary Fire Pumps

September 30, 2020

This national standard is based on publication IEC 62091, First Edition (2007).

ANSI/UL 62091-2020

Commitment for Amendments

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

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquiries@csagroup. org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 62091 as an American National Standard (ANSI) occurred on September 30, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

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

To purchase UL Standards, visit UL's Standards Sales Site at http://www. shopulstandards. com/HowToOrder.aspx or call toll-free 1-888-853-3503.

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PREFACE

This is the harmonized ANCE, CSA Group, and UL Standard for Low-Voltage Switchgear and Controlgear – Controllers for Drivers of Stationary Fire Pumps. It is the First edition of NMX-J-XXXX, CSA C22.2 No. 62091, and UL 62091.

This harmonized standard is based on IEC Publication 62091: First Edition, Low-voltage switchgear and controlgear – Controllers for drivers of stationary fire pumps, issued January 2007, and the requirements pertaining to fire pump controllers from the 2019 and past editions of NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection. This document is intended to replace NMX-J-626-ANCE-2015/UL 218/CSA C22.2 No. 263-15, published in September 2015, to provide globally accepted requirements for fire pump controllers. IEC 62091 is copyrighted by the IEC.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Subcommittee, Fire Pump Controllers, CANENA THSC 121A-62091 on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

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

The present Mexican Standard was reviewed and approved by the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE.

This standard was reviewed by the CSA Subcommittee on Fire Pump Controllers, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

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

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

Level of Harmonization

This standard adopts the IEC text with national differences.

This standard is published as an equivalent standard for ANCE, CSA Group and UL.

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

All national differences from the IEC text are included in the ANCE, CSA Group, and UL versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

Reasons for Differences From IEC

Differences from the IEC are being added in order to address safety and regulatory situations present in Mexico, the US and Canada.

Interpretations

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

IEC Copyright

For ANCE, the text, figures, and tables of International Electrotechnical Commission Publication 62091, Low-voltage switchgear and controlgear – Controllers for drivers of stationary fire pumps, issued 01-2007, are used in this Standard according to the guidelines provided in the ISO/IEC/POCOSA.

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 62091, *Low-voltage switchgear and controlgear – Controllers for drivers of stationary fire pumps*, copyright 2007, are used in this standard with the consent of the International Electrotechnical Commission. The IEC Foreword and Introduction are not a part of the requirements of this standard but are included for information purposes only.

NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 62091, Low-voltage switchgear and controlgear – Controllers for drivers of stationary fire pumps, copyright 2007, are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62091 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This first edition cancels and replaces the technical specification published in 2003. It constitutes a technical revision and now has the status of an International Standard.

The text of this standard is based on the following documents:

FDIS	Report on voting
17B/1527/FDIS	17B/1536/RVD

Full information on the voting for the approval of this standard 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 the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• 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 task will increase fire damage to the building, its contents and people therein.

These controllers 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 standard 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.

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 FPC-overcurrent protective devices (short-circuit protective and locked rotor protective devices) 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) When an automatic or manual signal to start/run exists, (except under TEST) the controller should not shut down the engine for any reason except OVERSPEED. When in TEST mode, the controller may shut down under low oil pressure and high engine temperature conditions. The two conditions mentioned illustrate the sacrificial nature while fighting a fire.

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

An installation with two fire pumps will increase the reliability and safety of the installation, especially if the two fire pumps are supplied from two different power supplies. This is especially true during maintenance or repairing of a single controller, as fire protection is still being maintained by the other fire pump.

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

1 Scope and object

This International Standard 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), alarms, signals, indicators, and the proper operation of battery chargers.

The most significant purpose of this standard 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 standard, this procedure is described as the “fire pump controller test protocol”.

The object of this standard is to state the following:

a) the unique characteristics of fire pump controllers, their associated equipment and their operational functions;

b) the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;

c) the information to be given with the equipment, or in the manufacturer's literature.

In this context, this standard gives the requirements for all of the electrical functions associated with both the electric motor-driven and the diesel engine-driven fire pumps. Special applications such as explosive atmospheres, nuclear installations, ships, aircraft, etc. are not covered by this standard. Referring to electric power sources, the requirements of this standard apply only to the extent that they place limits on the nature, behaviour and characteristics of the electrical energy that is supplied to the service entrance (see IEC 60364-5-55).

The requirements of this standard apply neither to the method nor to the means by which the electrical energy is generated. In addition, they do not apply 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 standard 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 standard, and

b) for diesel engine fire pump controllers, d.c. batteries are the intended source of electrical control power.

1DV D2 ***Modification to Clause 1 by adding the following:***

1DV.1 This equipment includes limited service and medium voltage. Controllers may be suitable for use as service equipment. This equipment is for installation in non-hazardous locations in accordance with Annex DVA, item 2.

1DV.2 Controllers for electric motor driven, centrifugal fire pumps and positive displacement pumps are intended for use with squirrel cage or wound rotor motors. Controllers for squirrel cage motors may be for across-the-line or reduced inrush current starting.

1DV.3 Variable speed fire pump controllers for electric motor driven, centrifugal fire pumps and positive displacement pumps are intended for use with squirrel cage induction, inverter duty rated, motors, and rated for 50 Hz or 60 Hz.

1DV.4 Limited service controllers are intended for across-the-line starting of squirrel cage motors rated 22 kW (30 hp) or less, 600 V or less.

1DV.5 Medium voltage fire pump controllers are intended for use with squirrel cage motors rated 601 V – 7.2 kV AC.

1DV.6 Residential fire pump controllers are intended for use with single-phase squirrel cage motors rated 240 V or less. Residential fire pump controllers are intended to be used in one or two family dwelling units in accordance with the requirements of item 35 in Annex DVA.

1DV.7 Diesel engine fire pump controllers rated nominal 24 V DC or less are intended for use with fire pump engines. Where required, AC Voltage is limited to 600 V AC or less.

1DV.8 An automatic transfer switch intended to be used in fire pump circuits, and that is provided separate from a controller, is covered by the requirements of item 11, Annex DVA.

2 Normative references

The following referenced documents are indispensable for the application of this document. 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*;
Amendment 1 (2004)

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*;
Amendment 1 (1999)

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*;
Amendment 1(2000);
Amendment 2 (2002)

IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*;
Amendment 1 (2003)

IEC 60947-1:2004, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:2006, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-3:1999, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*;
Amendment 1 (2001);
Amendment 2 (2005)

IEC 60947-4-1:2000, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*;
Amendment 1 (2002);
Amendment 2 (2005)

IEC 60947-4-2:1999, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters*;
Amendment 1 (2001)

IEC 60947-6-1:2005, *Low-voltage switchgear and controlgear – Part 6-1: Multiple function equipment – Transfer switching equipment*

IEC 61000-3-12:2004, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*;
Amendment 1 (1998);
Amendment 2 (2000)

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*;
Amendment 1 (2004);
Amendment 2 (2006)

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

CISPR 11:2003, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*;
Amendment 1 (2004);
Amendment 2 (2006)

2DV D2 *Modification to Clause 2 by adding the following:*

2DV.1 See Annex DVA for normative references and Annex DVB for component standards.

2DV.2 The normative references listed in Annex DVA contain provisions which, through reference in this text, constitute provisions of this Standard. For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the standard was approved.

2DV.3 In Canada, general requirements applicable to this standard are given in the latest edition of item 17 of Annex DVA. In addition the requirements of Annex DVA item 18 also apply unless specifically modified by this standard.

3 Terms and definitions

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

Alphabetical index of definitions

3.1
fire pump controller (FPC)
controller intended to control a fire pump electric motor or a fire pump diesel engine

3.2
controller

device or equipment that serves to control, in some predetermined manner, the electric power delivered to the apparatus to which it is connected

3.3
fire pump
pump dedicated to delivering a specified rate of water flow at a specified pressure to the fire extinguishing system of a premises

3.4
fire pump controller test protocol
procedure for exercising fire pump controllers to verify their compliance with the requirements of this standard

3.5
foam pump
pump dedicated to delivering a specified rate of foam concentrate to the system proportioner in the water fire extinguishing system of a premises

3.6
system proportioner
device or coordinated group of devices which introduces foam concentrate in a prescribed proportion into the fire water stream

3.7
foam pump controller
controller intended to control a foam concentrate pump for use in fire suppression

3.8
driver
electric motor or diesel engine that drives the fire pump

3.9
pumping unit
pump, driver and controller

3.10
diesel engine fire pump controller
controller intended to control a diesel engine-driven fire pump

3.11
diesel engine foam pump controller
controller intended to control a diesel engine-driven foam concentrate pump

3.12
electric fire pump controller
controller intended to control an electric motor-driven fire pump

3.13
residential fire pump controller
controller intended to control an electric motor-driven residential fire pump

NOTE Residential fire pumps are fire pumps intended for use primarily in domestic residences. They are typically limited to one- and two-family units, and are generally single-phase devices.

3.14
electric foam pump controller
controller intended to control an electric motor-driven foam concentrate pump

3.15
automatic control
control of an operation without human intervention

3.16
non-automatic control
control of an operation by human intervention

3.17
externally operable
capable of being operated without the need to remove covers or open an enclosure

3.18
lockout feature
externally accessible means to preclude an automatic controller from responding to a start signal

3.19
over-current
current exceeding the rated current

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

3.20
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

3.21
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

3.22
electromagnetic contactor
contactor in which the force for closing the normally open main contacts or opening the normally closed main contacts is provided by an electromagnet (see IEC 60947-4-1)

3.23
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)

3.24
disconnector
mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

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

[IEV 441-14-05]

3.25
short-circuit protective device
SCPD
device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

3.26
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]

3.27
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]

3.28
electromagnetic compatibility
EMC (abbreviation)
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]

3.29
emission (electromagnetic)
phenomenon by which electromagnetic energy emanates from a source

[IEV 161-01-08]

3.30
radio (frequency) disturbance
electromagnetic disturbance having components in the radio frequency range

[IEV 161-01-13]

3.31
radio frequency interference
RFI (abbreviation)
degradation of the reception of a wanted signal caused by radio frequency disturbance

NOTE The English words "interference" and "disturbance" are often used indiscriminately. The expression “radio frequency interference” is also commonly applied to a radio-frequency disturbance of an unwanted signal.

[IEV 161-01-14]

3.32
immunity (to an electromagnetic disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

3.33
transient (adjective and noun)
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

[IEV 161-02-01]

3.34
burst (of pulses or oscillations)
sequence of a limited number of distinct pulses or an oscillation of limited duration

[IEV 161-02-07]

3.35
voltage surge
transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage

[IEV 161-08-11]

3.36DV D1 *Add the following:*

3.36DV.1
AUXILIARY CIRCUIT
Circuits not essential for the performance of the fire pump controller.

3.36DV.2
CENTRIFUGAL PUMP
A pump in which the pressure is developed principally by the action of centrifugal force.

3.36DV.3
CIRCUIT-BREAKERS

Circuit-Breaker (as applied to fire pump controllers) – For the purposes of this standard, the term “circuit-breaker (disconnecting means)” refers to either thermal-magnetic or inverse time circuit-breakers (for residential fire pump controllers only) or to instantaneous-only circuit-breakers.

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

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

Instantaneous Trip (as applied to circuit breakers) – A qualifying term indicating that no delay is purposely introduced in the tripping action of the circuit breaker.

Inverse Time (as applied to circuit breakers) – A qualifying term indicating that there is a purposely introduced delay in the tripping action of the circuit breaker, which delay decreases as the magnitude of the current increases.

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

3.36DV.4
CONTROL CIRCUIT
A circuit that carries the electric signals directing the performance of a fire pump controller, but which does not carry the main power circuit. A control circuit is generally limited to 15 A.

3.36DV.5
CONTROLLER (Electric motor)
A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

3.36DV.6
CONTROLLER (Diesel engine)
A device or group of devices that serves to govern, in some predetermined manner, the engine power delivered to the apparatus to which it is connected.

3.36DV.7
CONTROLLER – LIMITED SERVICE
A controller, as defined in 1DV.1, that is limited in application when approved by the authority having jurisdiction.

3.36DV.8
CURRENT LIMITERS
Melting link-type devices that, when used as an integral part of a circuit breaker, limit the current during a short-circuit to less than the interrupting capacity of the circuit breaker.

3.36DV.9
DISCONNECTING MEANS
A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

3.36DV.10
DROP-OUT RELAY
A relay that, when de-energized, initiates the control function.

3.36DV.11
ENCLOSURE
The case or housing of apparatus constructed to provide a degree of protection against incidental contact with the enclosed equipment, and to provide a degree of protection against specified environmental conditions.

3.36DV.12
ISOLATING SWITCH
A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

3.36DV.13
MEDIUM VOLTAGE
(For Mexico and the United States)
An AC voltage in the range of 1501 to 7200 V.

For Canada
An AC voltage in the range of 751 to 7200 V.

3.36DV.14
READILY ACCESSIBLE
Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth.

3.36DV.15
SERVICE BOX
(For Canada)
An approved assembly consisting of a metal box or enclosure constructed so that it may be effectually locked or sealed, containing either service fuses and a service switch or a circuit breaker, and of such design that either the switch or circuit breaker may be manually operated when the box is closed.

3.36DV.16
SERVICE EQUIPMENT
(For Mexico and the United States)
The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

In Canada, this definition does not apply.

3.36DV.17
SERVICE EQUIPMENT
(For Canada)
In addition to the specifications of 3.36DV.15, the service circuit breaker or fused switch is located in a service box.

3.36DV.18
TRANSFER SWITCH (AUTOMATIC)
Self-acting equipment for transferring the connected load from one power source to another power source.

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). See 8.4.7 and 8.4.8.

4.2 Residential fire pump controller (pump 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 (pump driven either by an electric motor or by a diesel engine)

Special electric fire pump controllers or special diesel engine fire pump controllers intended for the unique requirements of 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, Figure 2, Figure 3 or Figure 4;

f) initiates a periodic test of the system, e.g. weekly.

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

5.3.2 Standard equipment

The electric fire pump controller shall comprise the following 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) periodic test timer (e.g. weekly) or other safe and reliable means providing a minimum running time.

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 Residential fire pump controller

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

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

5.5 Diesel engine fire pump controller

5.5.1 General

A diesel engine is the pump driver for this class of fire pump controller. Starting of the diesel engine is made by means of a controlled signal to initiate starting using auxiliary power other than from the main electrical power circuit, e.g. battery.

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 periodic test of the system, e.g. weekly.

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) periodic test timer (e.g. weekly) or other safe and reliable means providing a minimum running time.

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 8.6.5 and 8.13.

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;

b) rated operational current (or rated operational power if dedicated to a particular motor);

c) rated frequency/frequencies or the indication “d.c.” or the symbol ⎓;

d) rated conditional short-circuit current;

e) maximum water sensing pressure.

6.1.1DV D2 *Modification to Clause 6 by adding the following:*

6.1.1DV.1 In Canada and the United States, controllers driving electric motor fire pumps shall be rated in volts, horsepower, or kilowatts and full load amperes complying with Table 8DV and Table 9DV, frequency, and short-circuit current in amperes rms symmetrical. The rating shall indicate whether the equipment is for direct or alternating current. The rating of alternating-current equipment shall include the number of phases.

6.1.1DV.2 In Mexico, controllers driving electric motor fire pumps shall be rated in volts, kilowatts, and full load amperes complying with Table 8DV and Table 9DV, frequency, and short-circuit current in amperes rms symmetrical. The rating shall indicate whether the equipment is for direct or alternating current. The rating of alternating-current equipment shall include the number of phases.

Note: The rating of equipment obviously intended for single-phase use only is not required to include the number of phases.

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

Markings shall be indelible and easily legible.

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

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

a) on equipment for use on three-phase – four-wire systems, by both the value of phase-to-earth voltage and that of phase-to-phase voltage, e.g. 277/480 V;

b) on equipment for use on three-phase – three-wire systems, by the value of phase-to-phase voltage, e.g. 480 V.

The following information shall also be marked and visible after installation:

– direction of movement of the actuator (see 8.5.1.2 c) and d)), if applicable;

– indication of the position of the actuator (see 8.5.1.2 c) and d));

– approval or certification mark, if applicable;

– terminal identification and marking.

6.2.1DV D2 *Modification of Clause 6.2.1 by adding the following:*

6.2.1DV.1 All markings shall be in the appropriate language (or symbols as noted in this standard), as necessary, for the country in which the fire pump controller will be installed. A manufacturer may choose to utilize multiple languages on a fire pump controller.

Note 1DV: In Canada, there are two official languages, English and French, and in Mexico, the official language is Spanish. Annex DVC provides translations in French and Spanish of the English markings specified in this standard. Markings required by this standard could be required in other languages to conform to the language requirements of the country where the product is to be used.

6.2.1DV.2 All fire pump controllers shall be provided with a warning marking to alert qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

6.2.2 Identification

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

a) enclosure IP rating;

b) reference “IEC 62091”, if the manufacturer claims compliance with this standard;

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

d) 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 provide the user with additional application information.

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

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

f) that only those devices indicated on the controller diagram(s) shall be connected to the controller;

g) EMC rating for environment A, B or A and B (see 7.5);

h) type of system earthing for which the assembly is designed;

i) short-circuit withstand rating (see 6.2.4).

6.2.2DV D2 *Modification of Clause 6.2.2 by adding the following:*

Controllers shall also be marked where visible after installation with the following:

a) an enclosure type number, indicating the external environmental conditions for which it is intended. See 8.2.12DV.

Clause 6.2.2 a) does not apply. An enclosure type designation is required and in addition, it shall be permitted to be marked with an ingress protection (IP) designation;

b) rated operating pressure;

c) rated ambient temperature range;

d) 6.2.2 b) does not apply; and

e) Suitable for use in EMC Immunity Environment A and Emission Environment B Environments.

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.

6.2.3DV D2 *Modification of 6.2.3 by adding the following:*

6.2.3DV.1 If a fuse used to determine compliance with item 3 of Table 21DV is a Class G or K, there shall be a marking near the fuseholder specifying the class of the replacement fuse.

6.2.3DV.2 An electrical schematic/field connection diagram, indicating all internal wiring, circuits, test terminals, provisions for alarm circuits, all power sources, and other components, shall be permanently attached to the inside of the controller enclosure.

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 Disconnector

A 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 DISCONNECTOR
WHILE THE FPC-SHORT-CIRCUIT PROTECTIVE DEVICE IS IN THE CLOSED POSITION"

If the disconnector is rated with sufficient fault-make, load-break capacity or when the disconnector is prevented from being either opened or closed while the FPC-short-circuit protective device is closed, the warning label is not required.

6.2.5.1DV D2 ***Modification of 6.2.5.1 by adding the following:***

6.2.5.1DV.1 With reference to 8.4.3DV.1, and except as permitted by 6.2.5.1DV.2, an isolating switch shall be marked on the outside of the enclosure adjacent to the operating handle with the signal word "WARNING" and the following or equivalent statement:

"RISK OF ELECTRIC SHOCK – DO NOT OPEN OR CLOSE THIS SWITCH WHILE THE CIRCUIT BREAKER (DISCONNECTING MEANS) IS IN THE CLOSED POSITION."

6.2.5.1DV.2 when the isolating switch and the circuit breaker are so interlocked that the isolating switch can neither be opened nor closed while the circuit breaker is closed, the warning label described in 6.2.5.1DV.1 is not required. When omitted, the label shall be replaced with an instruction label which directs the order of operation.

6.2.5.2 FPC-short-circuit protective device (FPC-SCPD)

The short-circuit protective device (see 8.4.4) shall be provided with an information plate with the legend in letters not less than 10 mm high:

"FPC-SHORT-CIRCUIT PROTECTIVE DEVICE – SWITCHING MEANS"

The information plate shall be located on the outside of the controller enclosure adjacent to the switching means, if provided, for operating the FPC-short-circuit protective device.

6.2.5.2DV D2 ***Modification to 6.2.5.2 by adding the following:***

6.2.5.2DV.1 The circuit breaker defined in 8.4.4.2DV shall be provided with a nameplate with the legend "CIRCUIT BREAKER – DISCONNECTING MEANS" in letters not less than 10 mm (3/8 in) high, located on the outside of the controller enclosure adjacent to the means for operating the circuit breaker.

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 device.

6.2.5.3DV D2 *Modification to 6.2.5.3 by adding the following:*

In Mexico and the United States, with reference to 8.2.3.1DV.1, controllers shall be marked "Suitable for Use as Service Equipment" on the outside of the controller enclosure. The marking shall be provided separately or as part of the nameplate containing the manufacturer's name or trademark, and other ratings. When provided on a separate label, the marking shall include the manufacturer's name or trademark.

In Canada, controllers are not permitted to be utilized as service equipment.

In the United States controllers marked "Suitable for Use as Service Equipment" shall be additionally marked to reference Article 230 of the National Electrical Code for installation requirements.

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.

6.2.5.4DV D2 *Modification to 6.2.5.4 by adding the following:*

6.2.5.4DV.1 Each accessible enclosure surface in excess of the maximum temperatures specified in Table 23DV shall be marked "WARNING – HOT SURFACE – RISK OF BURN", or the equivalent.

6.2.5.4DV.2 The enclosure of a controller shall be marked with the enclosure Type designation. In addition, it shall be permitted to be marked with an ingress protection (IP) designation.

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 field wiring terminals provided in the controller shall be plainly marked to correspond with the field connection diagram provided with the controller.

6.2.5.5DV D2 *Modification to 6.2.5.5 by adding the following:*

6.2.5.5DV.1 In Mexico and the United States, a field-wiring pressure wire connector intended to be used only with copper conductors in accordance with 6.4.5(a) shall be marked to indicate the use of copper conductors only.

In Canada, this requirement does not apply.

6.2.5.5DV.2 In Canada, a field-wiring pressure wire connector shall be used only with copper conductors. No marking is required to identify this condition.

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

6.2.5.5DV.3 For external diesel engine connections, the field connection terminals shall be commonly numbered between the controller and engine terminals.

6.2.5.5DV.4 Controllers shall be marked to indicate the temperature rating (60°C only, 60/75 or 75°C only) of the field installed conductors for which the equipment has been investigated. A field-wiring terminal need not be marked to indicate the temperature rating if it is intended for the connection of a control circuit conductor only.

6.2.5.5DV.5 Field wiring terminals shall comply with 8.2.8DV.2 and shall be suitable for the field wiring of stranded type conductors.

6.2.5.6 Electric fire pump controller

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

6.2.5.7 Residential fire pump controller

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

6.2.5.7DV D2 *Modification to 6.2.5.7 by replacing with the following:*

A controller with this classification shall be marked "Residential Fire Pump Controller – for installation in one- and two-family dwellings and manufactured homes in accordance with NFPA 13D".

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 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.

6.2.5.8DV D2 *Modification to 6.2.5.8 by adding the following:*

A combination fire pump controller/transfer switch of a design such that it is not compatible for use with both a generator and second utility shall be marked to indicate that the alternate source shall be provided by a second utility power source.

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”.

6.2.5.10.1DV D2 *Modification to 6.2.5.10.1 by adding the following:*

Controllers shall be marked where visible after installation with: "Limited Service Additive Pump Controller" or "Electric Additive 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.

6.2.6.2DV D2 *Modification to 6.2.6.2 by adding the following:*

The emergency run mechanical control described in 8.4.8.4DV.1, shall be marked as to function and operation.

6.3 Instructions for installation, operation and maintenance

The requirements of 5.3 of IEC 60947-1 apply.

In addition, 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 together with information necessary for the maintenance of EMC compliance with the declared equipment class and immunity levels (see 7.3.2 of IEC 60947-1).

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 environment.

7.5 EMC considerations

Fire pump controllers shall be suitable for use in environment A or/and B (see 7.3.1 of IEC 60947-1).

Information shall be provided by the manufacturer to advise the user on the measures to be taken concerning EMC.

7.5DV D2 ***Modification to 7.5 by replacing the first paragraph with the following:***

Fire pump controllers shall be suitable for use in EMC Immunity Environment A and Emissions Environment B.

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) FPC-overcurrent protective devices (SCPD and locked rotor protective device) (8.4.4);

d) full voltage starting means (8.4.7);

e) reduced voltage starting means (8.4.8);

f) power transfer switch (8.6.9);

g) battery charger (8.8.4.1).

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

8.1DV D2 *Modification to 8.1 by adding the following:*

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

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) enclosures for controllers shall be as defined in 8.2.12;

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.

8.2.1DV D2 *Modification of 8.2.1 by replacing with the following:*

8.2.1DV.1 The distance between the end of a pressure wire connector or terminal block for connection of a field installed wire and the wall of the enclosure toward which the wire is directed shall be not less than that indicated in Table 10DV. The distance shall be measured in a straight line from the center of the opening in the connector, in the direction in which the wire leaves the terminal, perpendicular to the enclosure wall.

8.2.1DV.2 In Canada, for equipment rated 1000 V or less, the wire bending space required by 8.2.1DV.1 shall be determined by Annex DVA, item 20.

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

8.2.1DV.3 The required bending space shall be based on the size of field wire to be connected to the connector or terminal in accordance with 8.2.8DV.1.

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 noncombustible materials. The assessment criteria for non-combustible materials, in accordance with IEC 60695-11-10, 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.

8.2.3DV D2 ***Modification to 8.2.3 by adding the following:***

8.2.3DV.1 Insulated conductors shall be suitable for the service intended with respect to voltage, temperature, and grouping. Conductors shall be copper and shall be not smaller than 0.2 mm^2 (24 AWG). The temperature rating shall be not less than 90°C (194°F) unless investigation proves the suitability of other conductors.

8.2.3DV.2 The requirements of 8.2.3DV.1 apply only to the wiring furnished on or in industrial control equipment as a part of the equipment. They do not apply to the supply wiring run to control equipment, to motors, or to other apparatus.

8.2.3DV.3 In Mexico and the United States, for motor and control-circuit applications, the use of Table 15DV as a guide in selecting the conductor sizes in a controller may obviate the need to perform a temperature test on the wire. See the temperature test in Annex DVA, item 9.

8.2.3DV.4 In Canada, for motor and control circuit applications, the use of Table 2 in Annex DVA, item 2, for selecting the conductor sizes, will obviate the need to perform a temperature test on the wire.

8.2.3DV.5 Conductors that are in a circuit only during the motor starting period are not required to be sized for continuous duty but shall be sized according to their duty cycle.

8.2.3DV.6 Notwithstanding 8.2.3DV.1, conductors smaller than 0.2 mm^2 (24 AWG) may be used for wiring of printed circuit boards and interconnecting wiring between electronic modules and subassemblies.

8.2.3DV.7 Conductors in an assembly intended for use in a complete enclosure shall be insulated for the highest voltage normally occurring between such conductors unless the wires are grouped so as to segregate the several voltages.

8.2.3DV.8 Wires shall be supported or secured or otherwise run in suitable raceways, in order that they will not come into contact with moving parts or rest on sharp edges or projections that might cause abrasion of the insulation. Wires shall be of flexible or extra-flexible construction where they make connection to electrical equipment mounted on a hinged door. If the flexing section of the wiring is liable to come in contact with grounded metal parts, that portion of the wiring shall be given additional protection with wrappings of tape or the equivalent or enclosed in nonmetallic flexible tubing or conduit.

8.2.3DV.9 Additional insulation is not required if the test described in DVE.2 is completed without evidence of damage to the wiring.

8.2.3DV.10 Internal wiring shall not be in contact with bare live parts of opposite polarity or with bare live parts of other circuits.

8.2.3DV.11 A bare conductor, including pigtails and coil leads, shall be supported so that the spacings required elsewhere in this Standard will be maintained unless covered by suitable insulating sleeving or tubing.

8.2.3DV.12 All busbars and connections shall be readily accessible after installation of the controller.

8.2.3DV.13 All busbars and connections shall be arranged so that disconnection of the external circuit conductors will not be required.

8.2.3DV.14 Fuses shall be readily accessible.

8.2.3DV.15 Clamps and guides, either metallic or nonmetallic, used for routing stationary internal wiring shall be provided with smooth, well-rounded edges. The clamping action and bearing surface shall be such that abrasion or cold flow of the insulation does not occur. Auxiliary nonconducting mechanical protection shall be provided under a metallic clamp that exerts pressure on a conductor having thermoplastic insulation less than 0.8 mm (1/32 inch) thick and having no overall braid.

8.2.3DV.16 Insulated grounding and bonding conductors shall be identified by the color green with or without one or more yellow stripes. No other leads shall be so identified in the field wiring area.

8.2.3DV.17 All splices and connections shall be mechanically secure and shall provide electrical continuity.

8.2.3DV.18 Electrical connections shall be soldered, welded, crimped, or otherwise securely connected. A soldered joint shall be mechanically secure before soldering.

8.2.3DV.19 A printed circuit board joint is not required to be mechanically secure before soldering.

8.2.3DV.20 A lead shall be considered to be mechanically secure when it is:

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

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

c) twisted with other conductors.

8.2.3DV.21 If stranded internal wiring is connected to a wire-binding screw, the construction shall be such that loose strands of wire cannot contact other uninsulated live parts not always of the same polarity as the wire, and de-energized metal parts. This may be accomplished by any acceptable means including use of machine- or tool-applied pressure terminal connectors, soldering lugs, or crimped eyelets, or soldering all strands of the wire together.

8.2.3DV.22 In Mexico and the United States, a splice shall be provided with insulation equivalent to that of the wires involved.

In Canada, splices are not allowed.

8.2.3DV.23 In determining if splice insulation consisting of coated-fabric, thermoplastic, or other types of tubing is acceptable, consideration shall be given to electrical and mechanical properties, including dielectric voltage-withstand ability, heat resistance, and moisture resistance. Thermoplastic tape shall not be wrapped over a sharp edge or connection.

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.

8.2.3.1DV D2 *Modification to 8.2.3.1 by adding the following:*

8.2.3.1DV.1 In the United States, controllers for use with electric motor-driven fire pumps and intended for use as service equipment shall comply with the requirements in Annex DVA, item 10. See 6.2.5.3DV for markings.

In Canada and Mexico, this requirement does not apply.

8.2.3.1DV.2 In Canada, a separate service box is required.

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, the earthing (bonding) connection and conductors going to the motor, 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.

8.2.4DV D2 *Modification to 8.2.4 by adding the following:*

8.2.4DV.1 Electrical spacings through air, over surface, and between uninsulated live parts and the enclosure walls shall be at least those specified in Table 7DV.

8.2.4DV.2 For printed circuit boards, the minimum spacings shall be as specified in Table 17DV.

8.2.4DV.3 The spacings at a field-wiring terminal shall be measured with wire connected to the terminal as in service. The connected wire shall be the next larger size than normally

required if the terminal will accommodate it, or if the equipment is not marked to restrict its use.

8.2.4DV.4 In Mexico and the United States, the spacings specified in Table 7DV for devices having limited rating shall apply to:

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

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

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

8.2.4DV.5 In a circuit involving voltages of 50 V or less, spacings at field-wiring terminals may be 3.2 mm (0.125 inch) through air and 6.3 mm (0.25 inch) over surface.

8.2.4DV.6 In a circuit involving voltages of 50 V or less, other than field wiring terminals, the spacings shall be 1.6 mm (0.06 inch) through air or over surface, provided that the insulation and clearances between such circuits and any circuits of more than 50 V are in accordance with the requirements for the higher voltage circuit.

8.2.4DV.7 An insulating barrier or liner used as the sole separation between uninsulated live parts and grounded dead metal parts, including the enclosure, or between uninsulated live parts of opposite polarity shall be of a material specified in Table 20DV.

8.2.4DV.8 An insulating barrier or liner that is used in addition to not less than one-half the required spacing through air shall be of a material specified in Table 20DV and shall be:

a) of a material that is intended for the support of uninsulated live parts (see Table 22DV);

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

c) held in place; and

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

8.2.4DV.9 Insulating material barriers or liners having a thickness less than that specified in Table 20DV may be used when subjected to the Barrier Dielectric Strength Test in DVE.4.10.

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.

8.2.5.2DV D2 ***Modification to 8.2.5.2 by adding the following:***

8.2.5.2DV.1 No undervoltage, phase loss, frequency sensitive, ground-fault, or other sensor(s) shall be installed that automatically or manually prohibit electrical actuation of the motor contactor.

8.2.5.2DV.2 Sensors may prevent a three-phase motor from starting under single-phase conditions. These shall not cause disconnection of the motor when running at the time of a single-phase occurrence. Such sensors shall be monitored to provide a local visible alarm in the event of malfunction of the sensors. When single-phase (loss of phase) motor protection is provided:

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

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

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

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

8.2.6 Indication of the electromagnetic 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.

8.2.8DV D2 *Modification to 8.2.8 by adding the following:*

8.2.8DV.1 A controller shall be provided with wiring terminals for connection of conductors having an ampacity or wire size not less than the following:

a) for power circuits, 125 percent of the full-load motor current specified in Table 8DV and Table 9DV for the horsepower rating or, in the case of power conversion equipment in which the input current is different from motor full-load current, 125 percent of maximum rated input current;

b) for service use, not less than 5.3 mm^2 (10 AWG); and

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

See Table 11DV for field conductor ampacities.

8.2.8DV.2 All wiring terminals intended for field connection shall:

a) be evaluated in accordance with Annex DVA, items 7 or 12, and marked for the wire size or range;

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

c) comply with the secureness and pullout requirements of 8.2.8DV.5 for the next larger size conductor than that specified in 8.2.8DV.1, unless the equipment is marked to restrict its use to only the smaller size conductor.

8.2.8DV.3 A terminal to which field wiring is to be connected shall be a pressure wire connector.

8.2.8DV.4 A terminal to which 5.3 mm^2 (10 AWG) or smaller wiring connections are to be made may consist of a clamp or wire-binding screw with a terminal plate having upturned lugs or the equivalent to hold the wire in position. See 8.2.8DV.6 – 8.2.8DV.10.

8.2.8DV.5 A field-wiring pressure wire connector provided with or specified for use with industrial control equipment shall comply with one or more of the following, as applicable:

a) the performance requirements in Annex DVA, item 6 (see 6.2.5.5DV.1);

b) the performance requirements in Annex DVA, item 7; or

c) the performance requirements in Annex DVA, item 12.

8.2.8DV.6 A wire-binding screw to which field-wiring connections are made shall be No. 8 or larger.

8.2.8DV.7 A No. 6 screw may be used at a terminal intended only for connection of a 2.1 mm^2 (14 AWG) conductor or smaller.

8.2.8DV.8 A terminal plate tapped for wire-binding screw shall be of metal not less than 0.76 mm (0.030 inch) thick for a 2.1 mm^2 (14 AWG) or smaller wire, and not less than 1.27 mm (0.050 inch) thick for a wire larger than 2.1 mm^2 (14 AWG). There shall be at least two full threads in the plate.

8.2.8DV.9 For a terminal plate formed from stock having the required thickness specified in 8.2.8DV.8, one method of complying with the thread requirement of 8.2.8DV.8 is to have the metal extruded at the tapped hole for the binding screw to provide two full threads.

8.2.8DV.10 A wire-binding screw shall thread into metal.

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.

8.2.10DV D2 *Modification to 8.2.10 by adding the following:*

8.2.10DV.1 In Mexico and the United States, all controllers shall have provisions for grounding all non-current-carrying metal parts that are exposed or that are located in a position to be contacted by persons during normal operation or adjustment of the equipment and that are capable of becoming energized.

In Canada, this requirement does not apply.

8.2.10DV.2 In Canada, the requirements for grounding and bonding as specified in Annex DVA, item 19, shall apply.

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

8.2.10DV.3 The grounding and bonding terminology used in this standard is in accordance with the UL column in Figure 6DV. The corresponding CE Code and ANCE terms are also provided.

8.2.10DV.4 Controllers shall be provided with a terminal or an equivalent means for connecting an equipment grounding conductor, except as provided in 8.2.10DV.6. A terminal shall be sized for a grounding conductor as specified in Table 13DV.

8.2.10DV.5 In Canada, the following requirements amend Table 13DV:

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

b) Footnote (c) does not apply.

In Mexico and the United States, Table 13DV is not amended.

8.2.10DV.6 A terminal need not be provided with a controller that is marked to indicate the pressure wire connector or component terminal kits that are intended for use with the controller. A wire connector of the type mentioned shall be installed in the equipment at the factory with instructions, if required, for proper connection to the conductor. A terminal kit shall be described in the instructions by model number and manufacturer's name.

8.2.10DV.7 A wire-binding screw intended for the connection of a field-installed equipment grounding conductor shall have a green colored head that is hexagonal, slotted, robertson, phillips, allen, Torx™, or any combination. See 8.2.8DV.6 – 8.2.8DV.10.

8.2.10DV.8 A terminal intended for connection of an equipment grounding conductor shall be plainly identified with the symbol ⏚ (IEC Publication 60417, Symbol 5019) or ⏚ (IEC Publication 60417, Symbol 5017) or with "G," "GR," "GRD," "Ground," "Grounding," or other equivalent marking.

8.2.11 Enclosures

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

8.2.11DV D2 *Modification to 8.2.11 by adding the following:*

8.2.11DV.1 A fire pump controller assembly shall be securely mounted in an enclosure that protects the equipment. The enclosure shall be constructed to provide the strength and rigidity required to resist the abuses to which it is subjected without total or partial collapse resulting in a risk of fire, electric shock, or injury to persons due to reduction of spacings, loosening or displacing of parts, or other serious defects.

8.2.11DV.2 Enclosures for fire pump controllers shall comply with the requirements in Annex DVA, item 9.

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.

8.2.12DV D2 *Modification of 8.2.12 by replacing with the following:*

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

8.3 Priority of operations for electric fire pump controllers

For the purpose of this standard, 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.

8.4.2DV D2 *Modification to 8.4.2 by adding the following:*

8.4.2DV.1 A surge arrester complying with Annex DVA, item 14, or Annex DVA, item 15, shall be installed from each line to ground. These devices shall be rated to suppress voltage surges above the rated line voltage of the controller.

8.4.2DV.2 Notwithstanding 8.4.2DV.1, a controller rated in excess of 600 V is not required to be provided with a voltage surge arrester.

8.4.2DV.3 Notwithstanding 8.4.2DV.1, a voltage surge arrester is not required to be provided when the controller is capable of withstanding a 10 kV impulse in accordance with Annex DVA, item 16, without damage.

8.4.3 Disconnector

The disconnector 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.

The disconnector shall be prevented from being opened or closed while the FPC-short-circuit protective device is closed.

If an over-current protective device in accordance with Annex L of IEC 60947-2 is used as a disconnector, it shall be arranged and wired such that it does not trip unless the FPC-shortcircuit protective device, in the same controller, has tripped.

If a suitably rated disconnector is used, then interlocking means with the FPC-short-circuit protective device are not required.

8.4.3DV D2 *Modification to 8.4.3 by adding the following:*

8.4.3DV.1 The isolating switch shall have an ampere rating at least 115 percent of the motor rated full load current as determined from Table 8DV and Table 9DV; and shall be a

manually operable switch that complies with Annex DVA, item 4, or a molded case switch that complies with Annex DVA, item 8. See 6.2.5.1DV.1 for marking.

8.4.3DV.2 A molded case isolating switch provided with self-protecting instantaneous short-circuit overcurrent protection complies with 8.4.3DV.1 when the switch is such that it does not trip unless the circuit breaker in the same controller trips.

8.4.3DV.3 An isolating switch shall be externally operable.

8.4.3DV.4 A horsepower or kW rated motor circuit switch complying with Annex DVA, item 8, may also be used as the isolating switch.

8.4.3DV.5 In Mexico and the United States, a non-load break rated isolating switch operating handle shall be provided with a spring latch that shall be so arranged that it requires the simultaneous releasing of the latch in order to open or close the switch and shall be marked as per 6.2.5.1DV.1.

In Canada, an isolating switch shall be interlocked with the circuit breaker and shall be marked as per 6.2.5.1DV.1.

8.4.3DV.6 For a construction with the isolating switch and the circuit breaker so interlocked that the isolating switch is not capable of being opened nor closed while the circuit breaker is closed, the latch and markings in 8.4.3DV.5 are not required.

8.4.3DV.7 When a load break rated isolating switch or a switch complying with 8.4.3DV.4 is used, the latch and markings in 8.4.3DV.5 are not required.

8.4.3DV.8 All switching equipment for manual use in isolating, connecting or disconnecting, or starting or stopping the motor shall be externally operable.

8.4.4 Over-current protective devices used within the FPC (FPC-short-circuit and locked rotor protective devices)

8.4.4.1 General

The motor circuit shall be protected by over-current protective devices in accordance with the relevant IEC product standard and this standard, 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.

8.4.4.1DV D2 *Modification to 8.4.4.1 by adding the following:*

The motor branch circuit shall be protected by a circuit breaker that complies with Annex DVA, item 8, connected directly to the load side of the isolating switch with one pole connected to each ungrounded circuit conductor.

8.4.4.2 Mechanical characteristics of the over-current-protective devices

The over-current-protective devices in the FPC shall give a fireman the “second chance under fire conditions” to quickly place the controller back into service after the over-current protective device has opened. In order to accomplish that requirement, it shall comply with all of the following:

a) manually and externally operable;

b) be externally visually-apparent of the tripped condition and be capable of quick restart by an electrically unskilled person (e.g. a fireman);

c) require no need for tools or instruments nor replacement parts to restart;

d) no thermal influence requiring waiting time for quick restart;

e) ability to quickly and safely restart in dark or smoky environments.

8.4.4.2DV D2 *Modification to 8.4.4.2 by adding the following:*

A circuit breaker shall have the following mechanical characteristics:

a) be externally operable and resettable [See 8.4.4.4DV c)];

b) be trip free of the handle; and

c) be marked in accordance with 6.2.5.2DV.1.

8.4.4.3 Short-circuit protection

The FPC-short-circuit protective device 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) it shall be possible to restart the fire pump for operation immediately after tripping with the tripping characteristics thereafter remaining unchanged;

b) a 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 FPC-short-circuit protective device shall be compatible with the normal and the emergency-run mechanical requirements (8.5.1.2) for starting the motor without opening;

e) the short-circuit protection shall be the minimum consistent with the ability to start the motor under all foreseeable conditions without opening.

8.4.4.3DV D2 *Modification to 8.4.4.3 by adding the following:*

8.4.4.3DV.1 The electrical characteristics of the circuit-breaker disconnecting means shall:

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

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

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

d) be adequate to provide the short-circuit rating of the controller, as determined by testing in accordance with 9.3.3.4.

8.4.4.3DV.2 A circuit breaker shall not trip when:

a) starting a motor from rest in the across-the-line (direct-on-line) mode, whether or not the controller is of the reduced inrush starting type; and

b) power is interrupted from a running pump motor, or if the pump motor is restarted in less than 3 s after being shut down. If a control circuit preventing a motor re-start within 3 s is provided, this requirement shall not apply.

8.4.4.4 Locked rotor over-current protection

A locked rotor protective device shall be provided on the load side of the disconnecting device, and shall be located within the fire pump controller (see Figure 1, Figure 2, Figure 3 and Figure 4). 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 so constructed that 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, Figure 2, Figure 3 and Figure 4).

e) it shall be effective under all starting means;

f) If a common locked rotor protector is used in FPCs having more than one power source, the locked rotor protector shall reset itself before receiving power from the alternate source. The locked-rotor protector trip signal shall be effective only to the circuit supplying the power.

8.4.4.4DV D2 *Modification to 8.4.4.4 by adding the following:*

8.4.4.4DV.1 Locked rotor overcurrent protection sensing shall be located within the fire pump controller between the load side of the isolating switch and the controller output terminals and have the following characteristics:

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

b) have a tripping characteristic such that tripping shall not occur within 3 min at a minimum of 300 percent of rated full-load current;

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

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

e) provide for tripping that is accomplished by opening the circuit-breaker (disconnecting means); see 8.4.4.1DV; and

f) meet the requirement that calibration (trip and hold currents) applies to all poles of the locked rotor protection.

8.4.4.4DV.2 The locked rotor overcurrent protection shall be subjected to the test described in 9.3.3.4DV.1.

8.4.4.4DV.3 No ground fault or arc fault interruption means shall be installed in any fire pump control or power circuit.

8.4.5 Control circuits

The rated current of the over-current protective device shall be at least five times the prospected load current of the circuit.

8.4.5DV D2 *Modification to 8.4.5 by adding the following:*

8.4.5DV.1 Circuits that are necessary for proper operation of the controller shall not have overcurrent protective devices connected in them.

8.4.5DV.2 The secondary of a control transformer shall be ungrounded, except as required in DVE.6.5.

8.4.5DV.3 An auxiliary circuit shall be provided with overcurrent protection in accordance with Annex DVA, item 2. Failure of auxiliary circuits shall not prevent the controller from starting the fire pump.

8.4.5DV.4 In case of a power interruption, the fire pump controller operating parameters shall be retained.

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.

8.4.7 Full voltage starting means

The fire pump controller shall be capable of making, breaking and carrying the motor current resulting from direct on-line control of squirrel cage motors.

Where an electromagnetic contactor is used, it shall be in accordance with IEC 60947-4-1 with the following additional requirements:

− it shall meet the requirements of utilization category AC-3;

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

− it shall withstand 300 % of I_e (of the fire pump controller) for 3 min;

− it shall have a thermal capacity to allow three 30 s starts separated by 30 s rest intervals in each hour for 2 h.

Where a motor semiconductor controller is used, it shall be in accordance with IEC 60947-4-2 with the following additional requirements:

− it shall meet the requirements of utilization category AC-53a;

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

− it shall withstand 300 % of I_e (of the fire pump controller) for 3 min.

These requirements shall be verified by testing, see 9.3.3.3.

8.4.7DV D2 *Modification to 8.4.7 by adding the following:*

8.4.7DV.1 A motor contactor that complies with Annex DVA, item 18, shall be of the magnetic type with a contact in each ungrounded conductor.

8.4.7DV.2 For controllers rated 600 V or less, the operating coil for the main contactor shall be supplied directly by the primary supply circuit.

8.4.8 Reduced voltage starting means

8.4.8.1 General

Reduced voltage starting means are:

a) primary resistance;

b) primary reactor;

c) autotransformer;

d) star-delta;

e) part winding;

f) semiconductor soft start/stop.

NOTE Other starting and running methods are under consideration.

The requirements of 8.4.7 apply with the following modifications.

8.4.8.1DV D2 *Modification to 8.4.8.1 by adding the following:*

A reduced voltage controller shall comply with Annex DVA, item 18.

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. After 10 s, the fire pump controller shall default to full-voltage direct on-line starting/running.

8.4.8.2DV D2 ***Modification to 8.4.8.2 by adding the following:***

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

8.4.8.3 Requirements for starting duty

The following requirements for thermal capacity are design requirements in addition to the maximum limits for timed acceleration given in 8.4.8.2.

a) 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.

b) 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.

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

d) 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.

8.4.8.3DV D2 ***Modification to 8.4.8.3 by adding the following:***

8.4.8.3DV.1 For controllers rated 600 V or less, the operating coil for the contactor(s) shall be supplied directly by the primary supply circuit.

8.4.8.3DV.2 Starting resistors shall be designed to permit one 5 s starting operation in each 80 s for a period of not less than 1 h. This requirement shall not apply to the transition resistors in a wye-delta closed transition controller.

8.4.8.3DV.3 A starting reactor or autotransformer shall permit one 15 s starting operation every 240 s for a period of not less than 1 h. Alternately, a controller over 132 kW (200 hp) may allow three 30 s starts separated by 30 s rest intervals in each hour for 2 h.

8.4.8.3DV.4 Soft start units shall be horsepower rated or specifically designed for the service.

8.4.8.3DV.5 The bypass contactor used with the soft start unit shall comply with 8.4.7DV.1.

8.4.8.3DV.6 Soft start units shall comply with the duty cycle requirements in accordance with 8.4.8.3DV.3.

8.4.8.3DV.7 A fire pump controller employing a reduced voltage starting means shall also comply with 8.4.8.4DV for emergency-run control.

8.4.8.3DV.8 For wye-delta or part winding start motors, the starting contactor shall be rated as follows:

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

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

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

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

8.4.8.3DV.9 A fire pump controller employing a wye-delta reduced voltage starting means shall be electrical and mechanically interlocked.

8.4.8.3DV.10 Running contactors shall be sized for both the locked rotor currents and the continuous running currents encountered.

8.4.8.3DV.11 Starting contactors shall be sized for both the locked rotor currents and the acceleration (starting) currents encountered.

8.4.8.4 Emergency-run control

A fire pump controller employing a reduced voltage starting means shall also comply with 8.5.1.2 for emergency-run control.

8.4.8.4DV D2 *Modification to 8.4.8.4 by adding the following:*

8.4.8.4DV.1 A controller shall be equipped with an emergency run handle or lever that operates to close the magnetic motor controller mechanism mechanically. This handle or lever shall provide for non-automatic continuous running operation of the motor(s) independent of any electric control circuits, magnets, or equivalent devices, and independent of the pressure-activated control switch. Means shall be incorporated for mechanically latching or holding of the handle or lever for manual operation in the actuated position. The mechanical latching may be automatic or manual.

8.4.8.4DV.2 The handle or lever shall be arranged to move in one direction only from "OFF" to final position.

8.4.8.4DV.3 The magnetic motor controller shall return automatically to the "OFF" position if the operator releases the handle or lever in any but the full running position.

8.4.8.4DV.4 The operating handle of the emergency run mechanical control shall be marked in accordance with 6.2.6.2DV.

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 electromagnetic 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 electromagnetic contactor (load side of the FPC-short-circuit protective devices) 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 electromagnetic contactor.

8.4.9.1DV D2 ***Modification to 8.4.9.1 by adding the following:***

8.4.9.1DV.1 Means shall be provided on the exterior of the controller to read all line currents and all phase-to-phase voltages within ±5 percent of full scale.

8.4.9.1DV.2 A visible indicator shall monitor the availability of power in all phases at the line terminals of the motor starting means. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

8.4.9.1DV.3 When power is supplied from an integral transfer switch, monitoring of the availability of power from each power source shall be permitted at any point electrically upstream of the line terminals of the contactor, provided all sources are monitored.

8.4.9.1DV.4 A visible indicator shall monitor for phase reversal at the line terminals of the motor starting means. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

8.4.9.1DV.5 When power is supplied from an integral transfer switch, monitoring for phase reversal from each power source shall be permitted at any point electrically upstream of the line terminals of the contactor, provided all sources are monitored.

8.4.9.1DV.6 Controllers shall detect the loss of any phase regardless of whether the motor is running or not. See DVE.3.

8.4.9.1DV.7 A visible and audible alarm shall be provided when the controller fails to start from the automatic mode.

8.4.9.2 Devices remote from the controller

Controllers shall be equipped with contacts to operate alarm circuits that indicate the following:

a) motor running;

b) loss of phase (power not available);

c) phase reversal on the line side of the electromagnetic contactor;

d) controller not in automatic start, if equipped with a test-manual-automatic switch.

A circuit rated 250 V or less with over-current protection may be provided in the fire pump controller to power the above alarms.

8.4.9.2DV D2 *Modification to 8.4.9.2 by adding the following:*

8.4.9.2DV.1 Controllers shall be provided with contacts (open, closed, or both) to operate alarm circuits that indicate the following conditions:

a) controller in a motor running condition;

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

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

d) controller connected to alternate source - contacts (open, closed or both), mechanically actuated by the transfer switch mechanism, shall be provided to indicate whenever the alternate source is the source supplying power to the controller. See 8.6.10.4.4DV.1(d).

8.4.9.2DV.2 The alarm contacts specified in 8.4.9.2DV.1 shall be rated at 125 V minimum and have provision for connection to an external circuit.

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.

8.5.1.1DV D2 *Modification to 8.5.1.1 by adding the following:*

An automatic controller shall not have a manually actuated selector switch for selecting between automatic and non-automatic modes of operation, nor shall the switch have an "OFF" position, such as "Auto-Off-Manual" or "Hand-Off-Auto".

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 an electromagnetic contactor) or by a redundant electrical switching device (e. g. electromagnetic

contactor, manual switch, etc.). The redundant electrical switching device shall be mechanically operable in case of a loss of control power or failure of other control circuit devices.

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 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.

8.6.5.1DV D1 ***Modification to 8.6.5.1 by adding the following:***

Pressure sensors used with multistage multiport pumps shall comply with 10.5.2.1.1.2 of Annex DVA, item 1.

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.

8.6.5.3DV D2 *Modification to 8.6.5.3 by adding the following:*

8.6.5.3DV.1 Pressure recorders used with multistage multiport pumps shall comply with 10.5.2.1.1.3 of Annex DVA, item 1.

8.6.5.3DV.2 Accessibility to recorder data shall comply with 10.5.2.1.8.7 of Annex DVA, item 1.

8.6.5.4DV D2 *Modification to 8.6.5 by adding the following:*

8.6.5.4DV.1 Automatic controller

8.6.5.4DV.1.1 An automatic controller shall comply with the requirements for a non-automatic controller specified in 8.6.7DV.

8.6.5.4DV.1.2 The controller shall be in a fully functional state within 10 s upon application of ac power.

8.6.5.4DV.1.3 An automatic water pressure controller shall be provided with a pressure-activated device having high and low calibrated set points in the controller circuit. No pressure snubber or restrictive orifice shall be employed within the pressure switch. The device shall be responsive to water pressure in the fire protection system as specified in 8.6.5.4DV.1.8.

8.6.5.4DV.1.4 There shall be no valve or other restrictions within the controller ahead of the pressure switch or pressure responsive means.

8.6.5.4DV.1.5 Each controller pressure sensing control circuit shall operate independently.

8.6.5.4DV.1.6 When an automatic controller is provided with a pressure recording device to sense and record the pressure in each fire pump controller pressure sensing line at the input to the controller, the recorder shall be capable of operating for at least 7 days without being reset or rewound.

8.6.5.4DV.1.7 The pressure recording device of 8.6.5.4DV.1.6 shall be mounted external to the controller, or in a barriered compartment, or behind a door in a barriered enclosure, or other provisions shall be made to reduce the risk of contact with uninsulated live parts during normal servicing of the pressure recording device.

8.6.5.4DV.1.8 The pressure sensing element of a pressure-activated and pressure recording device shall be capable of withstanding a momentary surge of pressure of 2,758 kPa (400 psi) or 133 percent of the fire pump controller rated operating pressure, whichever is higher, without losing its accuracy.

8.6.5.4DV.1.9 A controller that starts the motor before the pressure-activated device specified in 8.6.5.4DV.1.3, under specified conditions shall use a drop-out relay to start the motor.

8.6.5.4DV.1.10 When the controller has a means for connection of a circuit for the remote manual starting of the fire pump, this means shall be such that the fire pump motor is not capable of being stopped from the remote station.

8.6.5.4DV.1.11 For sequence starting of multiple pumps, the controller for each unit of multiple pump units shall incorporate a sequential timing device to prevent any one driver from starting simultaneously with any other driver. If water requirements call for more than one pumping unit to operate, the units shall start at intervals of 5 to 10 s. Failure of a leading driver to start shall not prevent subsequent drivers from starting.

8.6.5.4DV.1.12 Controller actuation by the pressure switch at the low adjustment setting shall initiate the pump starting sequence, unless the pump is already in operation.

8.6.5.4DV.1.13 A pressure sensing switch or transducer with internal or external amplifier shall comply with DVE.4.

8.6.5.4DV.1.14 A pressure transducer shall be permanently marked on the exterior to include the name or trademark of the manufacturer, serial and identification number, pressure range, electrical rating, and date of manufacture.

8.6.5.4DV.1.15 Instructions shall be provided for setting the start and stop pressures for the fire pump.

8.6.5.4DV.1.16 Metallic pressure sensing lines and fittings shall be brass, copper, or series 300 stainless steel pipe or tube. The fitting for connection to the external pressure sense line shall be of 1/2 inch (15 mm) nominal size.

8.6.5.4DV.1.17 The solenoid drain valve shall be a fully ported 1/2 inch (15 mm) diameter nominal pipe size and have internal passages of 1/8 inch (3.18 mm) diameter or larger.

8.6.5.4DV.1.18 External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open, ground fault, or short-circuit) shall not prevent operation of pump(s) from all other internal or external means. Breakage, disconnecting, shorting of the wires, ground fault, or loss of power to these circuits 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.

8.6.5.4DV.1.19 No undervoltage, phase loss, frequency sensitive, or other sensor(s) shall be installed that automatically or manually prohibits electrical actuation of the engine starting contactor.

8.6.5.4DV.1.20 Controllers with provision to supply special water control equipment (deluge valves, dry pipe valves, etc.) may start the driver before the pressure-activated switch(es) would do so. The controller shall be equipped with an opening of contacts to start the engine upon operation of the fire protection equipment.

8.6.5.4DV.1.21 The starting sequence of the controller shall be initiated by the opening of the control circuit loop containing the remote equipment.

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.

8.6.6DV D2 *Modification to 8.6.6 by adding the following:*

8.6.6DV.1 A non-pressure switch actuated automatic controller shall be activated by a remote sensor, such as a smoke detector, fire alarm, carbon monoxide detector, or other such device. A pressure switch shall not be required.

8.6.6DV.2 The starting sequence of the controller shall be initiated by the opening of the remote contact(s) of the device specified in 8.6.6DV.1.

8.6.6DV.3 No other means of stopping the fire pump motor shall be provided except for those on the controller.

8.6.6DV.4 Testing of controllers without pressure sensors shall comply with 10.5.3.3.2 of Annex DVA, item 1.

8.6.7 Non-automatic controller

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

8.6.7DV D2 *Modification to 8.6.7 by adding the following:*

8.6.7DV.1 A non-automatic controller shall be manually actuated by separate electrical and mechanical means.

8.6.7DV.2 The controller shall be in a fully functional state within 10 s upon application of ac power.

8.6.7DV.3 A manually operated switch shall be provided on the controller so that, when the fire pump motor is started manually, its operation is not affected by the pressure-activated switch, if provided. The fire pump motor shall remain in operation until manually stopped.

8.6.7DV.4 A controller shall be equipped with an emergency run handle or lever that operates to close the magnetic motor controller mechanism mechanically. This handle or lever shall provide for non-automatic continuous running operation of the motor(s) independent of any electric control circuits, magnets, or equivalent devices, and independent of the pressure-activated control switch. Means shall be incorporated for mechanically latching or holding of the handle or lever for manual operation in the actuated position. The mechanical latching may be automatic or manual.

8.6.7DV.5 The handle or lever shall be arranged to move in one direction only from "OFF" to final position.

8.6.7DV.6 The magnetic motor controller shall return automatically to the "OFF" position if the operator releases the handle or lever in any but the full running position.

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 all starting causes (pressure switch, flow switch, deluge valve, remote start, smoke detector, etc.) have returned to normal, a running period timer set for at least 10 min running time shall be used.

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.

8.6.8.2DV D2 ***Modification to 8.6.8.2 by adding the following:***

8.6.8.2DV.1 Stopping the fire pump motor by the controller shall be accomplished by manual operation of a stop pushbutton on the outside of the controller enclosure. In the case of an automatic controller, pressing and releasing the pushbutton shall return the controller to the automatic position.

8.6.8.2DV.2 If a controller is arranged for automatic stopping after starting causes have returned to normal, a timer set for at least 10 min operating time after initial motor activation shall be provided.

8.6.8.2DV.3 Means shall be provided to disable automatic stopping. A visible indicator shall be provided to indicate that automatic stopping is disabled or enabled.

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.

8.6.9.1DV D2 ***Modification of 8.6.9.1 by replacing with the following:***

An automatic transfer switch shall comply with the requirements for fire pump circuit applications in Annex DVA, item 11, and may be provided as part of the fire pump controller assembly housed in a barriered compartment of the controller enclosure or in a separate enclosure attached to the controller.

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.

8.6.9.2DV D2 ***Modification to 8.6.9.2 by adding the following:***

8.6.9.2DV.1 The fire pump transfer switch shall have an ampere or hp rating not less than 115 percent of the equivalent motor full-load current (refer to Table 8DV and Table 9DV) and shall also be suitable for switching the motor locked rotor current.

8.6.9.2DV.2 A transfer switch shall have a short-circuit withstand rating equal to or greater than that of the controller or be adequate to provide the short-circuit rating of the controller, as determined by testing in accordance with 9.3.3.4.

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.

8.6.10.1DV D2 ***Modification of 8.6.10.1 by replacing with the following:***

An automatic transfer switch shall comply with the requirements for fire pump circuit applications in Annex DVA, item 11 and may be provided as part of the fire pump controller assembly housed in a barriered compartment of the controller enclosure or in a separate enclosure attached to the controller.

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 FPC-short-circuit protective devices 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. Means shall be provided to prevent the tripping of the SCPD when re-transferring to the normal 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.

8.6.10.2DV D2 *Modification to 8.6.10.2 by adding the following:*

8.6.10.2DV.1 Operation of the transfer switch shall not be inhibited, in accordance with 10.8.2.1.5 of Annex DVA, item 1.

8.6.10.2DV.2 Voltage- and frequency-sensing devices shall be provided to monitor all ungrounded conductors of the alternate power source. Transfer to the alternate source shall be inhibited until there is adequate voltage and frequency to serve the fire pump load.

8.6.10.2DV.3 Where the alternate source is provided by a second utility power source and the transfer switch is of a design such that it is not compatible for use with both a generator and second utility, the combination fire pump controller/transfer switch shall be marked in accordance with 6.2.5.8DV.

8.6.10.2DV.4 Where the combination fire pump controller/transfer switch is marked to indicate that the alternate source is provided by a second utility power source, the requirements of 8.6.10.2DV.2 shall not apply, and undervoltage-sensing devices shall monitor all ungrounded conductors in lieu of a frequency-sensing device.

8.6.10.2DV.5 Two visible indicators shall be provided to indicate the power source to which the fire pump controller is connected.

8.6.10.3 Transfer between power supplies

8.6.10.3.1 Automatic retransfer

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. If the pump is running, the retransfer shall only occur if the alternate power supply fails.

8.6.10.3.1DV D2 *Modification to 8.6.10.3.1 by adding the following:*

Means shall be provided to delay retransfer from the alternate source of power to the normal source until the normal source is stabilized. This time delay shall be automatically bypassed if the alternate source 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.

8.6.10.3.2DV D2 *Modification to 8.6.10.3.2 by adding the following:*

8.6.10.3.2DV.1 Means shall be provided to prevent higher than normal inrush currents when transferring the fire pump motor from one source of supply to the other.

8.6.10.3.2DV.2 The use of an "in-phase monitor" or an intentional delay by means of an open neutral position of the transfer switch to comply with the requirements of 8.6.10.3.2DV.1 shall be prohibited.

8.6.10.4 Power transfer switch for independent generator alternative supply

8.6.10.4.1 Disconnector

A 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 disconnector for the alternative supply is open. Auxiliary contacts mechanically operated by the disconnector shall be provided on the power transfer switch enclosure to indicate the position of the disconnector.

8.6.10.4.1DV D2 *Modification to 8.6.10.4.1 by adding the following:*

8.6.10.4.1DV.1 An isolating switch complying with 8.4.3DV, located within the automatic transfer switch enclosure or compartment, shall be provided on the line side of the alternate input terminals of the transfer switch and shall be suitable for the available short-circuit of the alternate source.

8.6.10.4.1DV.2 In Canada, the isolating switch provided in a fire pump transfer switch complying with Annex DVA, item 11, meets the requirement of 8.6.10.4.1DV.1.

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

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.

8.6.10.4.2DV D2 *Modification to 8.6.10.4.2 by adding the following:*

8.6.10.4.2DV.1 The fire pump transfer switch shall not have integral short-circuit, ground-fault, or overcurrent protection as part of the switching mechanism of the transfer switch.

8.6.10.4.2DV.2 A circuit breaker complying with 8.4.4.1DV and locked rotor protection complying with 8.4.4.4DV shall be provided in the alternate/emergency side.

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 alternative supply generator, 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 disconnector on the alternative supply side of the power transfer switch is open.

8.6.10.4.4DV D2 *Modification to 8.6.10.4.4 by adding the following:*

8.6.10.4.4DV.1 The following shall be provided:

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

b) a circuit loop to the alternate source generator whereby either the opening or closing of the circuit will start the alternate source generator (when commanded by the transfer switch);

c) a means to prevent sending the signal for starting of the alternate source generator (when commanded by the transfer switch), when the isolation switch or circuit breaker (if installed) on the alternate source side of the transfer switch is open; and

d) auxiliary contacts (open, closed or both), mechanically actuated by the transfer switch mechanism, to indicate whenever the alternate source is the source supplying power to the controller.

8.6.10.4.4DV.2 When the alternate isolating switch and/or alternate circuit breaker is in the open position, monitoring means shall operate an audible and visual signal on the fire pump controller/automatic transfer switch combination and provide means to actuate a signal at a remote point where required. When interlocked, monitoring of only the circuit breaker shall be required.

8.6.10.5 Power transfer switch for second utility alternative supply

8.6.10.5.1 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.

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.

8.6.10.5.4DV D2 ***Modification to 8.6.10.5.4 by adding the following:***

8.6.10.5.4DV.1 An externally operable momentary test switch shall be provided on the enclosure to simulate a normal power source failure.

8.6.11DV D2 ***Addition of the following to Clause 8.6:***

8.6.11DV.1 Weekly program timer

8.6.11DV.1.1 The controller equipment shall be arranged to automatically start and run the motor for at least 10 min once a week. A solenoid valve drain on the pressure control line shall be the initiating means.

8.6.11DV.1.2 A means to disable the timer shall be provided to permit the weekly test to be initiated manually.

8.6.11DV.1.3 The solenoid valve drain is not required to be the initiating means for non-pressure-activated controller.

8.6.11DV.1.4 An automatic pressure-activated call to start signal, or a call to start signal from a manual start device or a remote start device, shall override the weekly program timer.

8.6.11DV.1.5 The fire pump controller shall monitor the pressure sensor and provide a signal in accordance with 10.5.2.1.3.2 of Annex DVA, item 1.

8.6.11DV.1.6 During automatic testing, the fire pump controller shall activate a signal that complies with 10.5.2.1.3.1 of Annex DVA, item 1.

8.6.11DV.1.7 The fire pump controller shall monitor and provide a signal any time the transducer output is more or less than 10 percent of rated span or below its rated zero pressure output.

8.6.11DV.1.8 The controller equipment shall be capable of automatically starting, running, and shutting down the motor for a minimum of 10 min.

8.6.11DV.1.9 Automatic testing shall be verified in accordance with 10.5.2.7.2 of Annex DVA, item 1.

8.7 Residential fire pump controllers

8.7.1 General

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

8.7.1DV D2 ***Modification to 8.7.1 by adding the following:***

8.7.1DV.1 Residential fire pump controllers shall comply with the requirements specified in Clauses 1 to 8.6, 8.14 and Clause 9 as modified by 8.7.1.2DV and 8.7.3DV.1 to 8.7.3DV.12.

8.7.1.1 Ratings

A residential fire pump controller shall consist of both an automatic and a non-automatic controller intended for starting, stopping and protecting motors of maximum rated voltage of 400 V a.c, 22 kW. The standard rating of the FPC-over-current protective device shall be no less than 150 % and no greater than 250 % of the motor full-load current.

8.7.1.1DV D2 ***Modification to 8.7.1.1 by adding the following:***

A residential fire pump controller shall consist of an automatic across-the-line controller intended for starting, stopping, and protecting squirrel-cage motors rated 240 V ac single phase. These controllers shall be rated for connection to a single phase alternating current source of supply.

8.7.1.2 Over-current protection

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

NOTE A disconnector is not required.

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

8.7.1.2DV D2 ***Modification to 8.7.1.2 by adding the following:***

8.7.1.2DV.1 One method to achieve the motor overcurrent protection specified in 8.4.4.3DV.1 (b) and 8.4.4.4DV.1 for residential fire pump controllers supplied on the line side of the house main electrical disconnect is to use an inverse time nonadjustable circuit breaker evaluated in accordance with Annex DVA, item 8, having a standard rating between 150 percent and 250 percent of the motor full-load current.

8.7.1.2DV.2 Controllers supplied on the load side of the main house service, the circuit breaker, and locked rotor requirements of Clause 8.4.4.1DV and 8.4.4.4DV are not required.

8.7.1.2DV.3 The manually operated isolating switch specified in 8.4.3DV is not required.

8.7.1.2DV.4 A residential fire pump controller shall have a short-circuit rating of not less than 10,000 A.

8.7.1.2DV.5 Motor branch circuit rules limit the overload element of most combination motor controllers to 125% of motor FLA in order for motor branch circuit rules to apply. Any upstream protection need not hold locked rotor currents.

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 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 disconnector 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.

8.7.3DV D2 *Modification to 8.7.3 by adding the following:*

8.7.3DV.1 The means to read all line currents and all line voltages on the exterior of the controller, as specified in 8.4.9.1DV.1, is not required.

8.7.3DV.2 The pressure recording device specified in 8.6.5.4DV.1.6 is not required.

8.7.3DV.3 A visible indicator shall monitor the availability of power in all phases, and neutral conductor continuity when the neutral conductor is provided, at the line terminals of the motor starting means. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

8.7.3DV.4 Controllers shall detect the loss of any power phase, or neutral conductor continuity when the neutral conductor is provided, regardless of whether the motor is running or not. See DVE.3.

8.7.3DV.5 As a result of the tests specified in DVE.3.2 and DVE.3.3, the visual indicators in 8.4.9.1DV.2 shall indicate the loss of any power phase, or neutral conductor continuity when the neutral conductor is provided, and the contacts in 8.4.9.2DV.1 shall change state.

8.7.3DV.6 In Mexico and the United States, when the controller is intended to be connected on the line side of the main circuit breaker, it shall be suitable for use as service equipment.

In Canada, this requirement does not apply.

8.7.3DV.7 In Canada, a separate service box is required.

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

8.7.3DV.8 The requirements related to the system pressure switch specified in clauses 8.6.5.4DV.1.3 and 8.6.5.4DV.1.8 shall not apply.

8.7.3DV.9 A residential fire pump controller shall be provided with a pressure switch in accordance with Annex DVA, item 9.

8.7.3DV.10 Instructions for the field adjustment of the pressure switch required during set-up shall be attached to the pressure switch.

8.7.3DV.11 All control circuits shall be rated not more than 240 V.

8.7.3DV.12 A residential fire pump controller supplied on the line side of the house main electrical disconnect shall have either an enclosure door that is lockable or requires use of a tool to open, or a main disconnect or circuit breaker switch having an external handle interlocked with the door to reduce the likelihood of entrance to the enclosure without the disconnect or circuit breaker being in the off position.

8.7.3DV.13 The requirements for non-automatic controllers specified in Clauses 8.6.5.4DV.1.1 and 8.6.8.2DV.3 shall not apply.

8.7.3DV.14 A visible indicator shall be provided to indicate that power is available. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

8.7.3DV.15 A residential fire pump controller shall comply with the marking requirements specified in 6.2.1DV.1, 6.2.2DV, 6.2.3DV.1, 6.2.3DV.2, 6.2.5.2DV, 6.2.5.4DV, 6.2.5.5DV.2 and DVE.5.7.

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 5.

8.8.1.1DV D2 *Modification of 8.8.1.1 by adding the following:*

8.8.1.1DV.1 With pumping units operating singly, or in multiple, the control circuits entering or leaving the fire pump controller and intended to extend outside the fire pump control room shall be so arranged as to prevent failure to start due to fault. 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.

8.8.1.1DV.2 A diesel engine fire pump controller terminal block arrangement to facilitate connection of the controller to the engine shall include, as necessary, the terminals referenced in Figure 9DV. Also see Table 25DV.

8.8.1.2 Emergency control

Emergency control is an A-priority operation.

8.8.1.2DV D2 *Modification of 8.8.1.2 by adding the following:*

Automatic control circuits, the failure of which could prevent engine starting and running, shall be completely bypassed during manual start and run.

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.

8.8.2.1DV D2 *Modification of 8.8.2.1 by replacing with the following:*

Diesel engine fire pump controllers shall comply with Clauses 1 – 8.2 and 8.8 – 9.

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.

8.8.2.3DV D2 *Modification of 8.8.2.3 by adding the following:*

8.8.2.3DV.1 Combined manual and automatic controllers shall have a visible indicator to indicate that the controller is in the automatic position and a separate visible indicator to indicate that the controller is in the manual position. When the visible indicator is a pilot lamp, it shall be accessible for replacement.

8.8.2.3DV.2 Separate visible indicators and a common audible fire pump alarm capable of being heard while the engine is running and operable in all positions of the main switch except the off position shall be provided to immediately indicate the following conditions:

a) Critically low oil pressure in the lubrication system. The controller shall provide means for testing the low oil pressure alarms and circuit in conjunction with the engine circuit testing method.

Note: One example of testing the pressure switch is by activating the low oil pressure light while the engine is cranking without sounding the system failure alarm.

b) High engine temperature.

c) Failure of engine to start automatically.

d) Shutdown from overspeed.

e) High cooling water temperature.

f) Battery failure or missing battery. Each controller shall be provided with a separate visible indicator for each battery. The battery failure signal shall initiate at no lower than two thirds of battery nominal voltage rating (8.0 V DC on a 12 V DC system). Sensing shall be delayed to prevent nuisance signals.

g) Battery charger failure. Each controller shall be provided with a separate visible indicator for battery charger failure and shall not require the audible alarm for battery charger failure. Manual isolation of battery chargers constitutes a battery charger failure and shall be visibly alarmed.

h) Low air or hydraulic pressure. Where air or hydraulic starting is provided, each pressure tank shall provide to the controller separate visible indicators to indicate low pressure.

i) System overpressure, for engines equipped with pressure limiting controls, to actuate at 115 percent of set pressure.

j) Electronic/engine control module (ECM) selector switch in alternate position (for engines with ECM controls only).

k) Fuel injection malfunction (for engines with ECM only).

l) Low fuel level signal.

m) Low engine temperature.

n) Supervisory signal for interstitial space liquid intrusion.

o) Loss of electrical continuity through engine starting contactors.

p) Loss of DC power.

q) Low suction pressure, for engines equipped with low suction pressure limiting controls.

8.8.2.3DV.2.1 Separate visible indicators and a common audible signal capable of being heard while the engine is running and operable in all positions of the main switch except the off position shall be provided to immediately indicate the conditions described in 12.4.1.4 of Annex DVA, item 1.

8.8.2.3DV.3 A separate signal silencing switch or valve, other than the controller main switch, shall be provided for the conditions specified in 8.8.2.3DV.2.

8.8.2.3DV.3.1 The switch or valve shall allow the audible device to be silenced for up to 4 h and then re-sound repeatedly for the conditions in 8.8.2.3DV.2 (a) – (e).

8.8.2.3DV.3.2 The switch or valve shall allow the audible device to be silenced for up to 24 h and then re-sound repeatedly for the conditions in 8.8.2.3DV.2 (f) – (n).

8.8.2.3DV.3.3 The audible device shall re-sound until the condition is corrected or the main switch is placed in the off position.

8.8.2.3DV.3.4 The controller shall automatically return to the nonsilenced state when the alarm(s) have cleared (returned to normal).

8.8.2.3DV.3.5 The switch specified in 8.8.2.3DV.3 shall be clearly marked as to its function.

8.8.2.3DV.3.6 In addition to those conditions that require signals for pump controllers and engines, other optional signals may be permitted, depending upon local conditions. If provided these signals shall be silenceable. Some of these conditions are as follows, but not limited to:

a) low pump room temperature;

b) relief valve discharge;

c) flowmeter left on, bypassing the pump;

d) water level in suction supply below normal; and

e) water level in suction supply near depletion.

8.8.2.3DV.3.7 The circuit shall be arranged so that the audible signal will be actuated if the silencing switch or valve is in the silent position when the supervised conditions are normal.

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).

8.8.2.4DV D2 *Modification of 8.8.2.4 by adding the following:*

Controllers shall be equipped with contacts (open, closed, or both) to operate circuits to indicate each of the following conditions:

a) engine running;

b) the controller main switch has been turned to "off" or "manual" position;

c) trouble on the controller or engine (separate or common signals); and

d) loss of total power (a.c. and d.c.). This may be provided by contacts in either (b) or (c) above.

If d.c. battery power is lost, the relay shall be held energized and drop out to alarm. An audible alarm shall be provided and powered from the a.c. supply.

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.

8.8.3.1DV D2 *Modification of 8.8.3.1 by adding the following:*

For a manual electric control at the controller, there shall be a manually operated switch on the controller panel. This switch shall be so arranged that the operation of the engine, when manually started, is not affected by the failure of any of the automatic circuits or pressure-activated switch. The arrangement shall also be such that the unit remains in operation until manually shut down.

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).

8.8.3.3DV DR *Modification of 8.8.3.3 by adding the following:*

Controllers with provision to supply special water control equipment (deluge valves, dry pipe valves, etc.) may start the motor before the pressure-activated switch(es) would do so. The controller shall be equipped to start the engine upon operation of the fire protection equipment. The starting sequence of the controller shall be initiated by the opening of the control circuit loop containing the remote equipment.

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.

8.8.4.1DV D2 *Modification of 8.8.4.1 by adding the following:*

8.8.4.1DV.1 The dc power supplies for starting the engine shall be two separate battery banks requiring two independent charging circuits complying with Annex DVA, item 13.

8.8.4.1DV.2 Essential loads, including the engine, controller, and all pump equipment combined, shall not exceed 0.5 ampere each for a total of 1.5 amperes, on a continuous basis.

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.

8.9.1DV D2 *Modification of 8.9.1 by adding the following:*

8.9.1DV.1 The pressure-activated device and solenoid valve are not required to be provided on a non-pressure-activated controller.

8.9.1DV.2 The requirements of 8.6.5.3DV apply.

8.9.1DV.3 Pressure sensors used with multistage multiport pumps shall comply with 12.7.2.1.1.2 of Annex DVA, item 1.

8.9.2 Requirements for the pressure recorder

Subclause 8.6.5.3 applies.

8.9.2DV DR *Modification of 8.9.2 by adding the following:*

8.9.2DV.1 The controller shall be equipped with a pressure recording device to sense and record the pressure in each fire pump controller pressure sensing line at the input to the controller. The pressure recording device shall operate continuously for at least 7 d without resetting or rewinding. The pressure recording device shall not be solely dependent upon ac electric power as a power source. Upon loss of ac electric power, the pressure recording device shall be capable of at least 24 h of additional operation.

8.9.2DV.2 This device shall be responsive to water pressure in the fire protection system. The pressure sensing element of the device shall be capable of a momentary surge pressure of 2,758 kPa (400 psi) or 133 percent of fire pump controller rated operating pressure, whichever is higher, without losing its accuracy.

8.9.2DV.3 Pressure recorders used with multistage multiport pumps shall comply with 12.7.2.1.1.3 of Annex DVA, item 1.

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.

8.10.1DV D2 *Modification of 8.10.1 by adding the following:*

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

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 "starting sequence" shall be a series of six "on-load" to "off-load" cycles set for equal periods of 15 s duration. Other starting sequences can be accepted as alternatives and shall be subject to agreement between manufacturer and user (which may be an authority). If the starting sequence is expired, and if the controller does not receive a signal that the engine is running, then the controller shall stop all further starting 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 starting sequence.

8.10.2DV DR *Modification of 8.10.2 by adding the following:*

8.10.2DV.1 The controller shall be in a fully functional state within 10 s upon application of dc power.

8.10.2DV.2 Terminal 1 (see Table 25DV and Figure 9DV) power shall be energized any time the engine is operating from manual or automatic from the controller.

8.10.2DV.3 Manual crank buttons shall only be operable in manual modes.

8.11 Methods of stopping diesel engine fire pump controllers

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.

NOTE 1 The 30 min minimum run time for diesel engines is to boil off any water in the oil pan, and to prevent build-ups of water in the exhaust system.

NOTE 2 See 8.6.8.2 for automatic shutdown time after automatic start of electric fire pump controllers.

8.11.1DV DR *Modification of 8.11.1 by adding the following:*

8.11.1DV.1 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 engine is not capable of being stopped from the remote station.

8.11.1DV.2 A controller intended for use with a sprinkler or standpipe system where an automatically controlled pumping unit constitutes the sole supply shall be arranged for manual shutdown in accordance with 8.6.8.2DV.1.

8.11.1DV.3 Manual stopping shall be accomplished by either of the following:

a) operation of the main switch to the off position as located in 8.8.2.2; or

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

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. 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.

8.11.2DV DR *Modification of 8.11.2 by adding the following:*

8.11.2DV.1 Means shall be provided to disable automatic stopping. A visible indicator shall be provided to indicate that automatic stopping is disabled or enabled.

8.11.2DV.2 The engine shall not shut down automatically on high engine temperature, low oil pressure, or high cooling water temperature when any automatic starting or running cause exists. If no other starting or running cause exists during engine test, the engine shall shut down automatically on high water temperature, or low oil pressure, or high cooling water temperature. If after shutdown a starting cause occurs, the controller shall restart the engine and override the high engine temperature, low oil pressure, or high cooling water temperature shutdowns for the remainder of the test period.

8.11.2DV.3 Automatic shutdown shall be permitted only during the conditions described in 12.7.5.2.1 of Annex DVA, item 1.

8.12 Testing of diesel engine fire pump controllers

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.

8.12.1DV D2 ***Modification of 8.12.1 by adding the following:***

8.12.1DV.1 The fire pump controller shall monitor the pressure sensor and provide a signal in accordance with 12.7.2.1.3.2 of Annex DVA, item 1.

8.12.1DV.2 During automatic testing, the fire pump controller shall activate a signal that complies with 12.7.2.1.3.1 of Annex DVA, item 1.

8.12.1DV.3 The fire pump controller shall monitor for and provide a signal any time the transducer output is more or less than 10 percent of rated span or below its rated zero pressure output.

8.12.1DV.4 The controller equipment shall be capable of automatically starting, running, and shutting down the motor for a minimum of 30 min.

8.12.2 Periodic (e.g. weekly) program timer

The equipment in the controller shall be arranged so it is possible to automatically start and run the engine periodically (e.g. weekly) 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 periodic (e.g. 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 periodic (e.g. weekly) test may be initiated by means other than a solenoid valve.

8.12.2DV DR ***Modification of 8.12.2 by adding the following:***

Means shall be permitted within the controller to manually terminate the weekly test, provided a minimum of 30 min has expired.

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.

8.13.1DV D2 ***Modification of 8.13.1 by adding the following:***

In lieu of the pressure-activated switch described in 8.6.5.4DV.1.3, an additive pump controller shall be provided with means for automatic activation by either a remote normally open contact or a remote normally closed contact.

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 that shall be indicated by a visible indicator and annunciation at a remote location.

8.13.3DV D2 ***Modification of 8.13.3 by adding the following:***

8.13.3DV.1 An additive pump controller shall comply with the requirements in Clauses 1 – 9 and with the requirements specified in Clauses 8.13.3DV.2 – 8.13.3DV.3.

8.13.3DV.2 When the additive pump controller contains a lockout feature to stop the additive pump motor, the lockout shall be indicated by a visible indicator and shall be provided with means to annunciate the condition at a remote location.

8.13.3DV.3 The controller shall provide a timing means to actuate and then close the dump valve after engine start is finished. The timing means shall actuate upon crank disconnect.

8.13.3DV.4 When the pressure-activated switch described in 8.6.5.4DV.1.3 is provided, the controller shall comply with 8.6.5.4DV.1.8 and 8.6.5.4DV.1.9.

8.13.3DV.5 When a diesel driver is used in conjunction with a positive displacement pump having an electrically operated dump valve, the controller shall provide a means to activate and then close the dump valve after successful engine start has been attained.

8.13.3DV.6 The means shall consist of circuitry and terminals for connecting the dump valve solenoid coil.

8.13.3DV.7 The dump valve solenoid shall be energized by engine battery power.

8.13.3DV.8 The controller circuitry shall cause the dump valve to open to unload the pump, prior to or concurrent with the first engine cranking cycle.

8.13.3DV.9 When an electric motor driver is used in conjunction with a positive displacement pump having an electrically operated dump valve, the controller shall provide a means to activate and then close the dump valve after the motor has full voltage.

8.13.3DV.10 The means shall consist of circuitry and terminals for connecting the dump valve solenoid coil.

8.13.3DV.11 The controller shall provide suitable voltage for the dump valve solenoid. The voltage shall not exceed 240 V a.c.

8.13.3DV.12 The controller circuitry shall cause the dump valve to open to unload the pump, prior to or concurrent with motor power being applied.

8.13.3DV.13 The controller circuitry shall allow the motor to reach full speed and full power capability before closing the dump valve.

8.13.3DV.14 When a controller is arranged for automatic stopping as described in 8.6.8.2DV.2, the timer shall be set to less than 10 min but not less than 1 min for an additive pump controller.

8.13.3DV.15 Means shall be provided at the controller to ensure dump valve operation during manual start.

8.14 EMC requirements

8.14.1 General

Subclause 7.3.1 of IEC 60947-1 applies.

Fire pump controllers are complex devices which must be interconnected with other equipment such as motors, cables, etc. to form a system. Because the other equipment may not be under the control of the manufacturer of the fire pump controller, fire pump controllers shall be characterized as stand-alone devices by the tests described herein.

EMC requirements shall be verified by the tests of 9.4.

8.14.2 Immunity

Subclauses 7.3.2.1 and 7.3.2.2 of IEC 60947-1 apply with the following clarifications and modifications.

Power frequency magnetic field tests are not required because a fire pump controller is naturally submitted to such fields. Immunity is demonstrated by the successful completion of functional tests.

NOTE The careful application of decoupling practices during installation helps to minimize the external transient influences. For example, control circuit wiring should be separated from power circuit wiring. Where closely coupled wiring cannot be avoided, twisted pairs or shielded wiring should be used for control circuit connections.

The test results are specified using the performance criteria described in Table 6.

8.14.3 Emission

Subclauses 7.3.3.1 and 7.3.3.2 of IEC 60947-1 apply with the following modifications regarding limits for low-frequency emission with reference to main power frequency.

Where fire pump controllers are rated greater than 16 A but less than 75 A and connected to the public low voltage distribution network, the requirements of IEC 61000-3-12 apply. However, where controllers operate continuously in the FULL-ON state after an initial starting ramp, as in semiconductor motor controllers and starters (i. e. any power semiconductors in the main power circuits are conducting for complete cycles or half-cycles of the power wave or are bypassed after ramping), no low-frequency emission testing is required.

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.

9.1.1DV D2 ***Modification of 9.1.1 to add the following items after item (i):***

jDV) Wire flex test

Controllers in North America shall comply with the test contained in DVE.2.

kDV) Phase loss detection test

Controllers in North America shall comply with the test contained in DVE.3.

lDV) Pressure switch transducer tests

Controllers in North America shall comply with the test contained in DVE.4.

Type tests shall be carried out on a sample of a fire pump controller or on such parts of fire pump controllers manufactured to the same or a similar design of a fire pump controller, containing both type-tested and non-type-tested arrangements, provided that the latter are derived from type-tested arrangements which have complied with the relevant tests in accordance with the relevant IEC standard.

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 at the discretion of the manufacturer. 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 electromagnetic 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 test 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.

9.3.3.1.6DV D2 *Modification of 9.3.3.1.6 by adding the following:*

9.3.3.1.6DV.1 As tested under the conditions described in 9.3.3.1.6DV.2 – 9.3.3.1.6DV.30, fire pump controllers and associated equipment shall:

a) not attain a temperature at any point so high as to constitute a risk of fire or fire hazard or adversely affect any materials employed in the equipment;

b) not exceed the temperature limit for any individual component within the equipment; and

c) not exceed the temperature rise above the test ambient at specific points greater than those specified in Table 21DV and Table 23DV.

9.3.3.1.6DV.2 To determine whether a fire pump controller complies with the temperature test requirements, it shall be tested as specified in 9.3.3.1.6DV.3 – 9.3.3.1.6DV.37.

9.3.3.1.6DV.3 Fire pump controllers shall be operated under normal conditions as described in the manufacturer's installation instructions.

9.3.3.1.6DV.4 Equipment shall carry its rated current continuously.

9.3.3.1.6DV.5 The test current for a horsepower rated device shall be as specified in Table 8DV and Table 9DV.

9.3.3.1.6DV.6 An auxiliary device for controlling a contactor, a relay, or another magnetically operated device shall carry a test current that corresponds to the maximum break current consistent with the switch rating.

9.3.3.1.6DV.7 The test conditions shall be established so that each current-carrying component carries the maximum rated current of the controller. Three-phase controllers shall be tested on a three-phase current source.

9.3.3.1.6DV.8 A low-voltage source of supply may be used for temperature tests on parts other than voltage rated coils.

9.3.3.1.6DV.9 The temperature test shall be conducted with the fire pump controller mounted as intended in use.

9.3.3.1.6DV.10 The fire pump controller, or associated equipment, shall be tested in the enclosure provided by the manufacturer.

9.3.3.1.6DV.11 External field connections to the fire pump controller shall be made by one of the methods described in 9.3.3.1.6DV.12 – 9.3.3.1.6DV.16.

9.3.3.1.6DV.12 Fire pump controllers shall be tested with 1.2 m (4 ft) of copper wire attached to each field-wiring terminal.

9.3.3.1.6DV.13 The wire shall be of the smallest size having an ampacity of at least 125 percent of the maximum full-load motor-current in accordance with 9.3.3.1.6DV.5.

9.3.3.1.6DV.14 The wire size shall in accordance with Table 11DV based on the wire temperature rating marked on the equipment.

9.3.3.1.6DV.15 If the equipment is marked to limit the size of the wire, the maximum allowable wire size shall be used.

9.3.3.1.6DV.16 When there is only provision for the connection of bus bars to equipment rated at 450 A or more, 6.4 mm (1/4 inch) thick copper bus bars of the width specified in Table 24DV and at least 1.2 m (4 ft) in length shall be used.

9.3.3.1.6DV.17 The temperature test shall be conducted with plated bus bars. Black-painted bus bars shall not be used.

9.3.3.1.6DV.18 The spacing between multiple bus bars shall be 6.4 mm (1/4 inch) with no intentional wider spacing except as necessary at the individual terminals of the equipment.

9.3.3.1.6DV.19 The temperature test shall be conducted with the equipment placed in one of the following locations. The ambient temperature for the temperature test shall be based on one of the following:

a) equipment shall be placed in the rated ambient temperature;

b) equipment shall be placed in a non-air circulating test chamber with the ambient temperature of the test chamber adjusted to the rated ambient; or

c) equipment may be tested in a lower ambient temperature, provided the test results are adjusted linearly to the rated ambient temperature.

9.3.3.1.6DV.20 If reference measurements of ambient temperatures are necessary, several thermometers shall be placed at different points around the equipment at a distance of 900 – 1800 mm (35 – 70 inch). The thermometers shall be located in the path of the cooling medium, but shall be protected from drafts and abnormal heat radiation. The ambient temperature shall be the mean of the readings of the temperatures taken at equal intervals of time during the final quarter of the duration of the test.

9.3.3.1.6DV.21 The tests on all parts shall be made simultaneously, as the heating of one part can affect the heating of another part.

9.3.3.1.6DV.22 The temperature test shall be conducted until temperatures are constant.

9.3.3.1.6DV.23 A temperature rise shall be considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but not less than 10 min intervals), are constant within 1°C (1.8°F).

9.3.3.1.6DV.24 Temperatures shall be measured by thermocouple method or by resistance method, as described in 9.3.3.1.6DV.25 to 9.3.3.1.6DV.30.

9.3.3.1.6DV.25 The thermocouple method shall consist of the determination of temperature by the application of thermocouples to the hottest accessible parts with measurement by a suitable calibrated instrument.

9.3.3.1.6DV.26 The thermocouples shall be made of wires not larger than 0.21 mm^2 (24 AWG). The thermocouples and related instruments shall be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire shall conform with the requirements for special tolerance thermocouples specified in Annex DVA, item 23.

9.3.3.1.6DV.27 A thermocouple junction and adjacent thermocouple lead wire shall be securely held in good thermal contact with the surface of the material on which the temperature is being measured. In most cases, adequate thermal contact will result from securely taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal might be necessary.

9.3.3.1.6DV.28 The preferred method of measuring the temperature of a coil shall be the resistance method, but temperature measurements by either the thermocouple or resistance method are acceptable. The thermocouple method shall not be employed for a temperature measurement at any point at which supplementary insulation is employed.

9.3.3.1.6DV.29 The resistance method for temperature measurement as specified in Table 21DV and Table 23DV consists of the calculation of the temperature rise of a winding using the equation:

$$\Delta T = \frac{r_2}{r_1}(k + t_1) - (k + t_2)$$

where:

Δt is the temperature rise of the winding in degrees C;

r_2 is the resistance of the coil at the end of the test in ohms;

r_1 is the resistance of the coil at the beginning of the test in ohms;

t_1 is the room temperature in degrees C at the beginning of the test;

t_2 is the room temperature in degrees C at the end of the test; and

k is 234.5 for copper, 225.0 for electrical conductor grade (EC) aluminum; values of the constant for other conductors are to be determined.

9.3.3.1.6DV.30 As it is generally necessary to deenergize the winding before measuring resistance, the value of resistance at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time shall be plotted and extrapolated to give the value of resistance at shutdown.

9.3.3.1.6DV.31 At the conclusion of the test, the temperature rise of each material or component shall comply with 9.3.3.1.6DV.1.

9.3.3.1.6DV.32 The temperature rise of a material or component is the difference between its stabilized test temperature and the test ambient.

9.3.3.1.6DV.33 Protective devices or circuitry shall not trip during the test.

9.3.3.1.6DV.34 All values for temperature rises specified in Table 21DV and Table 23DV apply to equipment intended for use in a maximum consistent ambient temperature of 40°C (104°F).

9.3.3.1.6DV.35 The suitability of insulating materials, other than those in Table 21DV and Table 23DV, shall be determined with respect to properties such as flammability, arc resistance, and the like, based on an operating temperature equal to 40°C (104°F) plus the measured temperature rise.

9.3.3.1.6DV.36 For equipment rated above 40°C (104°F), the allowable temperature rise for this elevated ambient shall be calculated in accordance with the following formula:

$$TR = TT - [TM - 40°\,C\,(104°\,F)]$$

where:

TR is the allowable temperature rise;

TT is the maximum temperature rise allowed by Table 21DV and Table 23DV; and

TM is the elevated ambient temperature marked on the equipment.

9.3.3.1.6DV.37 For equipment rated below 40°C (104°F), the allowable temperature rise for this reduced ambient shall be calculated in accordance with the following formula:

$$TR = TT + [40°\,C\,(104°\,F) - TM]$$

where:

TR is the allowable temperature rise;

TT is the maximum temperature rise allowed by Table 21DV and Table 23DV; and

TM is the reduced ambient temperature marked on the equipment.

9.3.3.1.6DV.38 Immediately following the temperature test, equipment shall be subjected to the dielectric voltage withstand test in Clause 9.3.3.2.1DV.

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.

9.3.3.2.1DV D2 *Modification of 9.3.3.2.1 by adding the following:*

9.3.3.2.1DV.1 While at its maximum normal operating temperature, fire pump control equipment shall withstand for 1 min without breakdown the application of a 60 Hz essentially sinusoidal potential or a direct-current potential:

a) between uninsulated live parts and the enclosure with the contacts open and closed;

b) between terminals of opposite polarity with the contacts closed; and

c) between uninsulated live parts of different circuits.

9.3.3.2.1DV.2 The test potential shall be the following values for alternating-current, or 1.414 times the following values for direct-current:

a) 500 V – For fire pump control equipment rated not more than 50 V;

b) 1000 V plus twice the rated voltage of the equipment – For fire pump control equipment rated 51 – 600 V; or

c) 2000 V plus 2.25 times maximum rated voltage – For fire pump control equipment rated 601 – 1500 V.

9.3.3.2.1DV.3 A transformer, a coil, an electronic part, or a similar device normally connected between lines of opposite polarity shall be disconnected from one side of the line during the test described in 9.3.3.2.1DV.1(b).

9.3.3.2.1DV.4 If the equipment has a meter or meters, they shall be disconnected from the circuit for the dielectric voltage-withstand test described in 9.3.3.2.1DV.1 and 9.3.3.2.1DV.2.

9.3.3.2.1DV.5 Panel meters shall then be tested separately for dielectric strength with an applied voltage of:

a) 1000 V in the case of an ammeter;

b) 1000 V plus twice the rated voltage in the case of any other instrument having a potential circuit;

c) 500 V for meters in circuits operated at 50 V or less (no test requirements are specified for circuits operated at 30 V or less); and

d) 2000 V a.c. plus 2.25 times the maximum rated voltage for devices rated above 750 V applied between power supply circuits and any non-current-carrying metal parts.

9.3.3.2.1DV.6 To determine whether equipment complies with the requirements in 9.3.3.2.1DV, it shall be tested by means of a transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential shall be increased from zero to the required value at a substantially uniform rate and as rapidly as is consistent with its value being correctly indicated by a voltmeter. The voltage shall be held at that value for 1 min.

9.3.3.2.1DV.7 The transformer in 9.3.3.2.1DV.6 shall either:

a) have a capacity of 500 VA or larger; or

b) have a capacity of less than 500 VA, provided a voltmeter is present to directly measure the applied output potential.

9.3.3.2.1DV.8 A direct-current source shall be used for a direct-current circuit.

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 standard.

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 shall 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 so as not to endanger an operator or to 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 shall be 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 the 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. electromagnetic 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 electromagnetic 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 FPC-locked-rotor protective devices trip;

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

9.3.3.4DV D2 *Modification of 9.3.3.4 by adding the following:*

9.3.3.4DV.1 When tested in accordance with 9.3.3.4DV.2 – 9.3.3.4DV.12, the locked rotor overcurrent protection feature of a fire pump controller shall:

a) not trip within 3 min at 300 percent of motor full load current;

b) trip the circuit breaker between 8 and 20 s at motor locked rotor current (600 percent of motor full load current); and

c) be able to be manually reset immediately after tripping, with the tripping characteristics unchanged. See 9.3.3.4DV.12.

9.3.3.4DV.2 The fire pump controller/locked rotor overcurrent protection shall be mounted as intended.

9.3.3.4DV.3 Wiring connections shall be made as described in 9.3.3.4DV.10.

9.3.3.4DV.4 Any convenient voltage source may be used to provide the specified test current.

9.3.3.4DV.5 The fire pump controller/locked rotor overcurrent protection shall be tested at ambient temperatures of 25°C (77°F) and 50°C (122°F).

9.3.3.4DV.6 A test current equal to the rated motor locked rotor current (or 600 percent of the rated motor full load current) shall be generated by using any convenient test voltage and shall be sent through the fire pump controller or otherwise detected by the locked rotor overcurrent protector. The time from initial current generation to the time the locked rotor overcurrent protector trips to open the circuit shall be recorded.

9.3.3.4DV.7 Immediately after the test in 9.3.3.4DV.6, the locked rotor overcurrent protective device (circuit breaker) shall be manually reset and the test in 9.3.3.4DV.8 conducted.

9.3.3.4DV.8 A test current equal to the 300 percent of the rated motor full load current shall be generated by using any convenient test voltage and shall be sent through the fire pump controller or otherwise detected by the locked rotor overcurrent protector. The time from initial current generation to the time the locked rotor overcurrent protector trips to open the circuit shall be recorded.

9.3.3.4DV.9 Immediately after the test in 9.3.3.4DV.8, the locked rotor overcurrent protective device (circuit breaker) shall be manually reset and the process in 9.3.3.4DV.6 – 9.3.3.4DV.8 shall be repeated 3 more times (for 4 times total).

9.3.3.4DV.10 As an alternative to alternating the tests at 300 percent and at locked rotor current, all four trials may be conducted at one value (for example at 300 percent) before continuing with the tests at the remaining value, provided the same sample is used.

9.3.3.4DV.11 The same sample shall be used for all 8 trials (4 trials at 300 percent, 4 trials at locked rotor).

9.3.3.4DV.12 The results of the above test are considered to be in compliance, if, in addition to the definite-time constraints in 9.3.3.4DV.1(a) and 9.3.3.4DV.1(b), there is no more than a 10 percent variance between any one data point and the mean average for that set of data.

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.

9.3.3.4.1.1DV D2 *Modification of 9.3.3.4.1.1 by adding the following:*

9.3.3.4.1.1DV.1 The controller or combination controller/transfer switch shall be type tested to verify the short-circuit rating. The test shall be done for both standard-fault currents and high-fault currents as referenced in Annex DVA, item 18.

9.3.3.4.1.1DV.2 Annex DVD, Test samples, contains information about testing components and test samples.

9.3.3.4.1.1DV.3 Three-phase tests shall be considered to cover single-phase tests for a device of the same design.

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 solid 6 mm^2 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.

NOTE This larger size of wire is not used as a detector but to establish an "earth" condition allowing the damage to be evaluated.

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.

9.3.3.4.1.4DV D2 *Modification of 9.3.3.4.1.4 by adding the following:*

9.3.3.4.1.4DV.1 Standard fault test circuits shall be calibrated to the values specified in Table 12DV in accordance with the requirements for calibration of test circuits for the short-circuit test in Annex DVA, item 18.

9.3.3.4.1.4DV.2 High fault test circuits shall be calibrated to a value specified in Table 16DV in accordance with the requirements for calibration of test circuits for the short-circuit test in Annex DVA, item 18.

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.

9.3.3.4.1.5DV D2 *Modification of 9.3.3.4.1.5 by adding the following:*

9.3.3.4.1.5DV.1 The controller shall be mounted as intended in service and tested with 1.2 m (4 ft) of wire attached to each load and line terminal. The wire shall be the smallest size having an ampacity of at least 125 percent of the maximum full-load motor-current rating of the current element. The wire size shall be in accordance with Table 11DV based upon the

wire temperature rating marked on the equipment. When the terminal will not receive that size of wire, or the equipment is marked to limit the size of wires, the maximum wire size shall be used. The load terminal leads shall be connected together.

9.3.3.4.1.5DV.2 The enclosure of the controller shall be connected through a solid conductor without a fuse to the live pole that is judged to be least likely to strike the ground on the load side of the limiting impedance by a 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 m (4 – 6 ft) long.

9.3.3.4.1.5DV.3 The connection described in 9.3.3.4.1.5DV.2 shall be made with 3.3 or 2.1 mm^2 (12 or 14 AWG) copper wire if the branch-circuit conductors the equipment is intended to be connected to are 3.3 or 2.1 mm^2 (12 or 14 AWG), respectively.

9.3.3.4.1.5DV.4 The enclosure cover shall be held closed only by the intended latch mechanism and securement means.

9.3.3.4.1.5DV.5 Following the short-circuit testing, a controller shall be subjected to 9.3.3.4.1.5DV.6.

9.3.3.4.1.5DV.6 Following the short-circuit tests, a controller shall withstand without breakdown, a test potential of twice rated voltage, but not less than 900 V, applied for not less than 1 min as follows:

a) between line and load terminals of the circuit breaker in the open position;

b) between line and load terminals of the isolating switch, when provided, with the switch in an open position;

c) between terminals of opposite polarity with the circuit breaker and isolating switch, when provided, in an open position; and

d) between live parts and the overall enclosure with the circuit breaker and isolating switch, when provided, both opened and closed.

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. FPC-short-circuit protective devices 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.

9.3.3.4.1.7DV D2 *Modification of 9.3.3.4.1.7 by adding the following:*

The isolating switch, if provided, and the circuit breaker shall be in the fully closed position. The magnetic motor contactor shall be held closed by a separate electrical

supply. The test circuit shall be closed on the test sample as described in 9.3.3.4.1.8. See 9.3.3.4.1.8DV.1 for test set-up. Two operations ("O" shots), are required. Motor contactor contacts or the complete contactor may be replaced after the first test ("O" shot).

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.

9.3.3.4.1.8DV D2 *Modification of 9.3.3.4.1.8 by adding the following:*

9.3.3.4.1.8DV.1 Two successive operations shall be conducted:

a) by closing the test circuit on the equipment ("O" shot), using random closing; and

b) closing the equipment on the circuit ("CO" operation).

Motor contactor contacts or the complete contactor may be replaced after the first test ("O" shot).

9.3.3.4.1.8DV.2 "O" shot: The circuit breaker, isolating switch, and the contactor shall be in the fully closed position when closing the test circuit on the equipment.

9.3.3.4.1.8DV.3 The motor contactor shall be held in the closed position either mechanically or by a separate electrical circuit.

9.3.3.4.1.8DV.4 "CO" shot: The circuit breaker and isolating switch shall be in the fully closed position. The contactor shall be closed onto the test circuit by a separate electrical signal.

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 FPC-short-circuit protective devices or/and the 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 electromagnetic 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 in accordance with Table 5. The test voltage shall be applied for 5 s to the incoming supply terminals, with the FPC-short-circuit protective devices or the 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.

9.3.3.4.1.9DV D2 *Modification of 9.3.3.4.1.9 by adding the following:*

After completing the test specified in 7.2 and 7.3, and after the circuit breaker has cleared the fault, a controller shall comply with the following:

a) There shall be no discharge of parts. The contactor contacts may weld or completely disintegrate.

b) There shall be no damage to a conductor or terminal connector, and no conductor shall pull out of a terminal connector.

c) There shall be no breakage of insulating bases to the extent that the integrity of the mounting of live parts is impaired.

d) The door or cover shall not be blown open, and it shall be possible to open the door or cover. Deformation of the enclosure shall not result in the accessibility of live parts as determined by the use of the finger probe specified in Annex DVA, item 9.

e) The circuit breaker and isolating switch, when provided, of the controller shall be capable of being opened manually with its operating handle.

f) The solid wire connected between the live pole and the enclosure shall not open.

g) Neither end of the circuit breaker or isolation switch, when provided, shall be completely separated from the mounting means, and the line terminals of the circuit-breaker or isolating switch shall not bridge from the mounting means to dead-metal.

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 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 items 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 is equal to 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 tests

9.4.1 General

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

9.4.2 Immunity tests

9.4.2.1 Electrostatic discharges

Fire pump controllers shall be tested using the methods of IEC 61000-4-2.

The test levels of Table 23 of IEC 60947-1 shall be used with 10 positive and 10 negative pulses applied to each selected point, the time interval between each successive single discharge being 1 s.

Tests are not required on power terminals. Discharges shall be applied only to points that are accessible during normal usage.

The fire pump controller shall comply with performance criterion 2 of Table 6.

9.4.2.2 Radiated radio-frequency electromagnetic fields

Fire pump controllers shall be tested using the methods of IEC 61000-4-3.

The test level shall be as in Table 23 of IEC 60947-1 for ranges 80 MHz to 1 000 MHz and 1,4 GHz to 2 GHz.

The fire pump controller shall comply with performance criterion 1 of Table 6.

9.4.2.3 Electrical fast transients/burst

Fire pump controllers shall be tested using the methods of IEC 61000-4-4.

The test levels shall be as given in Table 23 of IEC 60947-1 via the coupling/decoupling network. The test voltage shall be applied for 1 min.

Terminals for control and auxiliary circuits intended for the connection of conductors which extend more than 3 m shall be tested at 2,0 kV/5,0 kHz by means of the coupling clamp.

The fire pump controller shall comply with performance criterion 2 of Table 6.

9.4.2.4 Surges

Fire pump controllers shall be tested using the methods of IEC 61000-4-5.

The test level for power terminals shall be as given in Table 23 of IEC 60947-1.

The repetition rate shall be one per minute, with the number of pulses being five positive and five negative.

The fire pump controller shall comply with performance criterion 2 of Table 6.

9.4.2.5 Conducted disturbances induced by radio-frequency fields

Fire pump controllers shall be tested using the methods of IEC 61000-4-6.

The test level shall be as in Table 23 of IEC 60947-1.

The fire pump controller shall comply with performance criterion 1 of Table 6.

9.4.2.6 Harmonics and commutation notches

No test requirements.

NOTE Future tests are under consideration.

9.4.2.7 Voltage dips and short-time interruptions

Fire pump controllers shall be tested using the methods of IEC 61000-4-11.

The test levels shall be as given in Table 23 of IEC 60947-1

The fire pump controller shall comply with performance criterion 2 of Table 6.

9.4.3 Emission tests

9.4.3.1 Conducted radio frequency emission test

Descriptions of the test, the test method and the test set-up are given in CISPR 11.

In the case of a range of fire pump controllers of different power ratings, it shall be sufficient to test two samples representing the highest and lowest power ratings of the range.

The emission shall not exceed the levels given in CISPR 11, group 1, class A or B as appropriate.

The addition of high-frequency common mode filtering in the main power connections may cause unacceptable reductions in motor starting torque, or render invalid the concept of unearthed or high impedance earthed distribution systems, as employed within process industries, with implications for system safety.

If filters are not used for the above reasons, other means shall ensure that the emission levels are not exceeded.

9.4.3.2 Radiated radio frequency emission test

Descriptions of the test, the test method and the test set-up are given in CISPR 11.

In the case of a range of fire pump controllers of different power ratings, it shall be sufficient to test two samples representing the highest and lowest power ratings of the range.

The emission shall not exceed the levels given in CISPR 11, group 1, class A or B as appropriate.

NOTE In the USA, digital devices with power consumption less than 6 nW are exempt from RF emission tests.

9.5 Routine tests

9.5.1 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 standard and 8.3.1 of IEC 60439-1.

9.5.2 Verification of dielectric properties

Dielectric integrity shall be verified according to 8.3.2 of IEC 60439-1.

9.5.2DV D2 ***Modification of 9.5.2 by adding the following:***

Dielectric withstand testing shall be conducted on 100 percent of production units in accordance with 9.3.3.4.1.5DV.6.

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
301	ECM B – ECM (Electronic Control Module) selector switch is in alternate ECM position
302	FIM − Fuel Injection Malfunction
303	ECM Engine future use

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	–	–

Table 2 Continued on Next Page

Table 2 Continued

Size of wire		Minimum bending space, terminal to wall mm		
mm ^{2}	AWG or kcmil	Wires per terminal		
		1	2	3
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
–	780 – 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 φ	
10	1,05	0,45	3

Table 5
Dielectric test voltage corresponding to the rated insulation voltage

Rated insulation voltage U_i V	a.c. test voltage (r.m.s.) V	d.c. test voltage [b, c] V
$U_i \leq 60$	1 000	1 415
$60 < U_i \leq 300$	1 500	2 120
$300 < U_i \leq 690$	1 890	2 670

Table 5 Continued on Next Page

Table 5 Continued

Rated insulation voltage U_i V	a.c. test voltage (r.m.s.) V	d.c. test voltage [b, c] V
690 < U_i ≤ 800	2 000	2 830
800 < U_i ≤ 1 000	2 200	3 110
1 000 < U_i ≤ 1 500 a	–	3 820

[a] For d.c. only.

[b] Test voltages based on 4.1.2.3.1 of IEC 60664-1.

[c] A direct current test voltage may be used only if an alternating test voltage cannot be applied. See also 8.3.3.4.1, item 3) b) ii) of IEC 60947-1.

Table 6
Acceptance criteria when electromagnetic disturbances are present (performance criteria during tests)

Item		1	2	3
A	Overall performance	No noticeable changes of the operating characteristic Operating as intended	Noticeable changes (visual or audible) of the operating characteristic Self-recoverable	Changes in operating characteristic Triggering of protective devices. Not self-recoverable
B	Operation of power and driving circuits	No maloperation	Temporary maloperation which cannot cause tripping, or erratic and audible changes in motor torque	Shut down Triggering of protective devices Not self-recoverable
C	Operation of displays and control panels	No changes to visible display information Only slight light intensity fluctuation of LEDs, or slight movement of characters	Temporary visible changes or loss of information Undesired LED illumination	Shut down Permanent loss of display or wrong information Unpermitted operating mode Not self-recoverable
D	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 Loss of data and/or information Errors in communication Not self-recoverable

Table 7DV D2 *Addition:*

Table 7DV
Minimum acceptable spacings

(See 8.2.4DV)

Potential involved volts rms a.c. or d.c.		Minimum spacings, mm (inch)											
		General equipment						Devices having limited rating (Clause 6.2.4)					
		51 – 150		151 – 300		301 – 600		51 – 150		151 – 300		301 – 600	
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part	Through air or oil	3.0[a]	(1/8)	6.3	(1/4)	9.4	(3/8)	1.5[a]	(1/16)	1.5[a]	(1/16)	4.6[a]	(3/16)
	Over surface	6.3	(1/4)	9.4	(3/8)	12.7	(1/2)	3.0[a]	(1/8)	3.0[a]	(1/8)	9.4	(3/8)
Between any uninsulated live part and the walls of a metal enclosure including fittings for conduit or armoured cable[b]	Shortest distance	12.7	(1/2)	12.7	(1/2)	12.7	(1/2)	6.3	(1/4)	6.3	(1/4)	12.7	(1/2)

NOTES

1 A slot, groove, or the like, 0.33 mm (0.013 inch) wide or less in the contour of insulating material shall be disregarded.

2 An air space of 0.33 mm (0.013 inch) or less between a live part and an insulating surface shall be disregarded for the purpose of measuring over surface spacings.

[a] The spacing between field wiring terminals of opposite polarity and the spacing between a field wiring terminal and a grounded dead metal part shall be at least 6.3 mm (1/4 inch) if short-circuiting or grounding of such terminals can result from projecting strands of wire. For circuits involving no potential greater than 50 V rms a.c. or d.c., spacings at field wiring terminals may be 3.0 mm (1/8 inch) through air and 6.3 mm (1/4 inch) over surface.

[b] For the purpose of this requirement, a metal piece attached to the enclosure is considered to be a part of the enclosure if deformation of the enclosure is likely to reduce the spacings between the metal piece and uninsulated live parts.

Table 8DV DR *Addition:*

Table 8DV
Full-load motor-running currents in amperes corresponding to three-phase a.c. kilowatt and horsepower motors

(See 6.1.1DV, 8.2.8DV.1, 8.4.3DV.1, 8.6.9.2DV.1, and 9.3.3.1.6DV.5.)

Rated operational power kW[d] hp[e]		Guide values of rated operational currents at										
		110 – 120V	200V	208V	230V	220 – 240V[a]	380 – 415V[b,c]	400V	440 – 480V	500 V	550 – 600V	690 V
kW	hp	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase
0.06	–	–	–	–	0.35	–	–	0.20	–	0.16	–	0.12
0.9	–	–	–	–	0.52	–	–	0.30	–	0.24	–	0.17
0.12	–	–	–	–	0.70	–	–	0.44	–	0.32	–	0.28
0.18	–	–	–	–	1.0	–	–	0.60	–	0.48	–	0.35
0.25	–	–	–	–	1.5	–	–	0.85	–	0.68	–	0.49
0.37	–	–	–	–	1.9	–	–	1.10	–	0.88	–	0.64
–	1/2	4.4	2.5	2.4	–	2.2	1.3	–	1.1	–	0.9	–
0.55	–	–	–	–	2.6	–	–	1.5	–	1.2	–	0.87
–	3/4	6.4	3.7	3.5	–	3.2	1.9	–	1.6	–	1.3	–
–	1	8.4	4.8	4.6	–	4.2	2.5	–	2.1	–	1.7	–
0.75	–	–	–	–	3.3	–	–	1.9	–	1.5	–	1.1
1.1	–	–	–	–	4.7	–	–	2.7	–	2.2	–	1.6
–	1-1/2	12.0	6.9	6.6	–	6.0	3.6	–	3.0	–	2.4	–
–	2	13.6	7.8	7.5	–	6.8	4.1	–	3.4	–	2.7	–
1.5	–	–	–	–	6.3	–	–	3.6	–	2.9	–	2.1
2.2	–	–	–	–	8.5	–	–	4.9	–	3.9	–	2.8
–	3	19.2	11.0	10.6	–	9.6	5.8	–	4.8	–	3.9	–
3.0	–	–	–	–	11.3	–	–	6.5	–	5.2	–	3.8
4	–	–	–	–	15	–	–	8.5	–	6.8	–	4.9
–	5	30.4	17.5	16.7	–	15.2	9.2	–	7.6	–	6.1	–
5.5	–	–	–	–	20	–	–	11.5	–	9.2	–	6.7
–	7-1/2	44.0	25.3	24.2	–	22.0	13.3	–	11.0	–	9.0	-
–	10	56.0	32.2	30.8	–	28.0	16.9	–	14.0	–	11.0	–
7.5	–	–	–	–	27	–	–	15.5	–	12.4	–	8.9
11	–	–	–	–	38.0	–	–	22.0	–	17.6	–	12.8
–	15	84	48.3	46.2	–	42.0	25.4	–	21.0	–	17.0	–
–	20	108	62.1	59.4	–	54.0	32.7	–	27.0	–	22.0	–
15	–	–	–	–	51	–	–	29	–	23	–	17
18.5	–	–	–	–	61	–	–	35	–	28	–	21
–	25	136	78.2	74.8	–	68	41.1	–	34	–	27	–
22	–	–	–	–	72	–	–	41	–	33	–	24
–	30	160	92	88	–	80	48.4	–	40	–	32	–
–	40	208	120	114	–	104	62.9	–	52	–	41	–
30	–	–	–	–	96	–	–	55	–	44	–	32
37	–	–	–	–	115	–	–	66	–	53	–	39
–	50	260	150	143	–	130	78.7	–	65	–	52	–

Table 8DV Continued on Next Page

Table 8DV Continued

Rated operational power kW[d] hp[e]		Guide values of rated operational currents at										
		110 – 120V	200V	208V	230V	220 – 240V[a]	380 – 415V[b,c]	400V	440 – 480V	500 V	550 – 600V	690 V
kW	hp	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase
–	60	–	177	169	–	154	93.2	–	77.0	–	62.0	–
45	–	–	–	–	140	–	–	80	–	64	–	47
55	–	–	–	–	169	–	–	97	–	78	–	57
–	75	–	221	221	–	192	116	–	96	–	77	–
–	100	–	285	273	–	248	150	–	124	–	99	–
75	–	–	–	–	230	–	–	132	–	106	–	77
90	–	–	–	–	278	–	–	160	–	128	–	93
–	125	–	359	343	–	312	189	–	156	–	125	–
110	–	–	–	–	340	–	–	195	–	156	–	113
–	150	–	414	396	–	360	218	–	180	–	144	–
132	–	–	–	–	400	–	–	230	–	184	–	134
–	200	–	552	528	–	480	290	–	240	–	192	–
150	–	–	–	–	–	–	–	–	–	–	–	–
160	–	–	–	–	487	–	–	280	–	224	–	162
185	–	–	–	–	–	–	–	–	–	–	–	–
–	250	–	–	–	–	604	365	–	302	–	242	–
200	–	–	–	–	609	–	–	350	–	280	–	203
220	–	–	–	–	–	–	–	–	–	–	–	–
–	300	–	–	–	–	722	437	–	361	–	289	–
250	–	–	–	–	748	–	–	430	–	344	–	250
280	–	–	–	–	–	–	–	–	–	–	–	–
–	350	–	–	–	–	828	501	–	414	–	336	–
–	400	–	–	–	–	954	577	–	477	–	382	–
300	–	–	–	–	–	–	–	–	–	–	–	–
315	–	–	–	–	940	–	–	540	–	432	–	313
–	450	–	–	–	–	1,030	623	–	515	–	412	–
335	–	–	–	–	–	–	–	–	–	–	–	–
355	–	–	–	–	1,061	–	–	610	–	488	–	354
–	500	–	–	–	–	1,180	714	–	590	–	472	–
375	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	1,200	–	–	690	–	552	–	400
425	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–
475	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	1,478	–	–	850	–	680	–	493
530	–	–	–	–	–	–	–	–	–	–	–	–
560	–	–	–	–	1,652	–	–	950	–	760	–	551
600	–	–	–	–	–	–	–	–	–	–	–	–
630	–	–	–	–	1,844	–	–	1,060	–	848	–	615
670	–	–	–	–	–	–	–	–	–	–	–	–
710	–	–	–	–	2,070	–	–	1,190	–	952	–	690

Table 8DV Continued on Next Page

Table 8DV Continued

Rated operational power kW[d] hp[e]		Guide values of rated operational currents at										
		110 – 120V	200V	208V	230V	220 – 240V[a]	380 – 415V[b,c]	400V	440 – 480V	500 V	550 – 600V	690 V
kW	hp	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase	3 phase
750	–	–	–	–	–	–	–	–	–	–	–	–
800	–	–	–	–	2,340	–	–	1,346	–	1,076	–	780
850	–	–	–	–	–	–	–	–	–	–	–	–
900	–	–	–	–	2,640	–	–	1,518	–	1,214	–	880
950	–	–	–	–	–	–	–	–	–	–	–	–
1,000	–	–	–	–	2,910	–	–	1,673	–	1,339	–	970

[a] To obtain full-load currents for 265 and 277 V motors, decrease corresponding 220 – 240 V ratings by 13 and 17 percent, respectively.

[b] These voltages are not used in North America, and are provided for reference only.

[c] Current values shown are applicable for NEMA Design B motors with starting codes F and G only. For all other motors further investigation is required.

[d] Preferred rated values according to item 39 in Annex DVA.

[e] Horsepower and currents values according to item 9 in Annex DVA, (60 Hz).

Table 9DV DR *Addition:*

Table 9DV
Full-load motor-running currents in amperes corresponding to single-phase a.c. kilowatt and horsepower motors

(See 6.1.1DV, 8.2.8DV.1, 8.4.3DV.1, 8.6.9.2DV.1, and 9.3.3.1.6DV.5.)

Rated operational power kW[d] hp[e]		Guide values of rated operational currents at										
		110 – 120V	200V	208V	230V	220 – 240V[a]	380 – 415V-[b,c]	400V	440 – 480V	500 V	550 – 600V	690 V
kW	hp	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase
0.06	–	–	–	–	–	–	–	–	–	–	–	–
0.9	–	–	–	–	–	–	–	–	–	–	–	–
0.12	–	–	–	–	–	–	–	–	–	–	–	–
0.18	–	–	–	–	–	–	–	–	–	–	–	–
0.25	–	–	–	–	–	–	–	–	–	–	–	–
0.37	–	–	–	–	–	–	–	–	–	–	–	–
–	1/2	9.8	5.6	5.4	–	4.9	3.0	–	2.5	–	2.0	–
0.55	–	–	–	–	–	–	–	–	–	–	–	–
–	3/4	13.8	7.9	7.6	–	6.9	4.2	–	3.5	–	2.8	–
–	1	16.0	9.2	8.8	–	8.0	4.8	–	4.0	–	3.2	–
0.75	–	–	–	–	–	–	–	–	–	–	–	–
1.1	–	–	–	–	–	–	–	–	–	–	–	–
–	1-1/2	20.0	11.5	11.0	–	10.0	6.1	–	5.0	–	4.0	–
–	2	24.0	13.8	13.2	–	12.0	7.3	–	6.0	–	4.8	–

Table 9DV Continued on Next Page

Table 9DV Continued

Rated operational power kW[d] hp[e]		Guide values of rated operational currents at										
		110 – 120V	200V	208V	230V	220 – 240V[a]	380 – 415V-[b,c]	400V	440 – 480V	500 V	550 – 600V	690 V
kW	hp	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase	1 phase
1.5	–	–	–	–	–	–	–	–	–	–	–	–
2.2	–	–	–	–	–	–	–	–	–	–	–	–
–	3	34.0	19.6	18.7	–	17.0	10.3	–	8.5	–	6.8	–
3.0	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–
–	5	56.0	32.2	30.8	–	28.0	16.9	–	14.0	–	11.2	–
5.5	–	–	–	–	–	–	–	–	–	–	–	–
–	7-1/2	80.0	46.0	44.0	–	40.0	25.4	–	21.0	–	16.0	-
–	10	100.0	57.5	55.0	–	50.0	31.5	–	26.0	–	20.0	–
7.5	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–
–	15	135	–	–	–	68.0	41.1	–	34.0	–	27.0	–
–	20	–	–	–	–	88.0	53.2	–	44.0	–	35.0	–
15	–	–	–	–	–	–	–	–	–	–	–	–
18.5	–	–	–	–	–	–	–	–	–	–	–	–
–	25	–	–	–	–	110	66.6	–	55	–	44	–
22	–	–	–	–	–	–	–	–	–	–	–	–
–	30	–	–	–	–	136	82.3	–	68	–	54	–
–	40	–	–	–	–	176	106	–	88	–	70	–
30	–	–	–	–	–	–	–	–	–	–	–	–
37	–	–	–	–	–	–	–	–	–	–	–	–
–	50	–	–	–	–	216	131	–	108	–	86	–

[a] To obtain full-load currents for 265 and 277 V motors, decrease corresponding 220 – 240 V ratings by 13 and 17 percent, respectively.

[b] These voltages are not used in North America, and are provided for reference only.

[c] Current values shown are applicable for NEMA Design B motors with starting codes F and G only. For all other motors further investigation is required.

[d] Preferred rated values according to item 39 in Annex DVA.

[e] Horsepower and currents values according to the item 22 in Annex DVA, (60 Hz).

Table 10DV DR *Addition:*

Table 10DV
Wire bending space at field wiring terminals[a]

(See 8.2.1DV)

Size of wire		Minimum bending space, terminal to wall, in mm and inches					
		Wires per terminal					
		1		2		3	
mm^2	AWG or MCM	mm	in	mm	in	mm	in
2.1 – 5.3	14 – 10	–	–	–	–	–	–
8.4 – 13.3	8 – 6	38	1-1/2	–	–	–	–
21.2 – 26.7	4 – 3	51	2	–	–	–	–
33.6	2	64	2-1/2	–	–	–	–
42.4	1	76	3	–	–	–	–
53.5	1/0	127	5	127	5	178	7
67.4	2/0	152	6	152	6	191	7-1/2
85.0	3/0	178	7	178	7	203	8
107.2	4/0	178	7	178	7	216	8-1/2
127	250	203	8	203	8	229	9
152	300	254	10	254	10	279	11
177	350	305	12	305	12	330	13
203	400	305	12	305	12	356	14
253	500	305	12	305	12	381	15
304	600	356	14	406	16	457	18
355	700	356	14	406	16	508	20
380 – 405	750 – 800	457	18	483	19	559	22
456	900	457	18	483	19	610	24

[a] Equipment intended for installation in Canada may comply with reference item 20 in Annex DVA.

Table 11DV DR *Addition:*

Table 11DV
Ampacity of insulated conductors for field wiring

(See 8.2.8DV.1, 9.3.3.1.6DV, and 9.3.3.4.1.5DV.1.)

Wire size		60°C		75°C	
mm^2	(AWG or kcmil)	Copper	Aluminum[a]	Copper	Aluminum[2,c]
0.20	(24)	2	–	–	–
0.32	(22)	3	–	–	–
0.52	(20)	5	–	–	–
0.82	(18)	7	–	–	–
1.3	(16)	10	–	–	–

Table 11DV Continued on Next Page

Table 11DV Continued

Wire size		60°C		75°C	
mm^2	(AWG or kcmil)	Copper	Aluminum[a]	Copper	Aluminum[2,c]
2.1	(14)	15	–	15	–
3.3	(12)	20	15	20	15
5.3	(10)	30	25	30	25
8.4	(8)	40	30	50/45[b]	40/30[b]
13.3	(6)	55	40	65	50
21.2	(4)	70	55	85	65
26.7	(3)	80	65	100	75
33.6	(2)	95/100[b]	75	115	90
42.4	(1)	110[a]	85[a]	130	100
53.5	(1/0)	–	–	150	120
67.4	(2/0)	–	–	175	135
85.0	(3/0)	–	–	200	155
107	(4/0)	–	–	230	180
127	(250)	–	–	255	205
152	(300)	–	–	285	230
177	(350)	–	–	310	250
203	(400)	–	–	335	270
253	(500)	–	–	380	310
304	(600)	–	–	420	340
355	(700)	–	–	460	375
380	(750)	–	–	475	385
405	(800)	–	–	490	395
456	(900)	–	–	520	425
506	(1,000)	–	–	545	445
633	(1,250)	–	–	590	485
760	(1,500)	–	–	625	520
887	(1,750)	–	–	650	545
1 010	(2,000)	–	–	665	560

NOTES

1 For a multiple conductor connector at a terminal, the value shall be multiplied by the number of conductors that the terminal will accommodate 53.5 mm^2 (1/0 AWG) or larger.

2 These values of ampacity apply only if not more than three conductors will be field-installed in the conduit. If four or more conductors, other than a neutral that carries the unbalanced current, will be installed in a conduit (as can occur because of the number of conduit hubs provided in an outdoor motor control centre because of the number of wires necessary in certain polyphase systems, or other reasons), the ampacity of each of those conductors shall be 80% of the value given in the table if 4 – 6 conductors are involved, 70% of that value if 7 – 24 conductors, 60% of that value if 25 – 42 conductors, and 50% of that value if 43 or more conductors.

[a] If the motor control center is marked to indicate that 75°C (167°F) wire shall be used at the terminal, the acceptable current is 130 A for a copper conductor and 100 A for an aluminum conductor.

[b] Differences are from item 2 in Annex DVA.

[c] Item 2 in Annex DVA requires copper conductors only for fire pump service.

Table 12DV D2 *Addition:*

Table 12DV
Standard short-circuit test values

(See 9.3.3.4.1.4DV)

Rating,		Test current, amperes[a]	Power factor
kW	Horsepower		
0 – 0.7	0 – 1[b]	1,000	0.70 – 0.80
1.1 – 37.3	1.5 – 50	5,000	0.70 – 0.80
39 – 149	51 – 200	10,000	0.70 – 0.80
150 – 298	201 – 400	18,000	0.25 – 0.30
299 – 447	401 – 600	30,000	0.20 or less
448 – 671	601 – 900	42,000	0.20 or less
672 – 1193	901 – 1600	85,000	0.20 or less

[a] Symmetrical rms amperes.

[b] At 300 V or less.

Table 13DV DR *Addition:*

Table 13DV
Size of bonding, equipment grounding, grounding electrode conductors, and ground bus[a]

(See 8.2.10DV)

Maximum ampere rating[b]	Size of equipment grounding or bonding conductor, minimum mm² (AWG or kcmil)[f]		Size of grounding electrode conductor, minimum mm² (AWG or kcmil)		Size of main bonding jumper, minimum mm² (AWG or kcmil)	
	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
15	2.1[c] (14[c])	3.3[c] (12[c])	–	–	–	–
20	[2.1][f] 3.3[c] ([14][f] 12[c])	[3.3][f] 5.3[c] ([12][f] 10[c])	–	–	–	–
30	[3.3][f] 5.3[c] ([12][f] 10[c])	[5.3][f] 8.4[c] ([10][f] 8[c])	–	–	–	–
40	5.3[c] (10[c])	8.4[c] (8[c])	–	–	–	–
60	5.3[c] (10[c])	8.4[c] (8[c])	–	–	–	–
90	8.4 (8)	13.3 (6)	8.4 (8)	13.3 (6)	8.4 (8)	13.3 (6)
100	8.4 (8)	13.3 (6)	13.3 (6)	21.2 (4)	13.3 (6)	21.2 (4)
150	13.3 (6)	21.2 (4)	13.3 (6)	21.2 (4)	13.3 (6)	21.2 (4)
200	13.3 (6)	21.2 (4)	21.2 (4)	33.6 (2)	21.2 (4)	33.6 (2)
300	21.2 (4)	33.6 (2)	33.6 (2)	53.5 (1/0)	33.6 (2)	53.5 (1/0)
400	26.7 (3)	42.4 (1)	53.5[d] (1/0[d])	85[d] (3/0[d])	53.5[d] (1/0[d])	85[d] (3/0[d])
500	33.6 (2)	53.5 (1/0)	53.5 (1/0)	85 (3/0)	53.5 (1/0)	85 (3/0)
600	42.4 (1)	67.4 (2/0)	67.4 (2/0)	107 (4/0)	67.4 (2/0)	107 (4/0)
800	53.5 (1/0)	85 (3/0)	67.4 (2/0)	107 (4/0)	67.4 (2/0)	107 (4/0)

Table 13DV Continued on Next Page

Table 13DV Continued

Maximum ampere rating[b]	Size of equipment grounding or bonding conductor, minimum mm² (AWG or kcmil)[f]		Size of grounding electrode conductor, minimum mm² (AWG or kcmil)		Size of main bonding jumper, minimum mm² (AWG or kcmil)	
	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
1000	67.4 (2/0)	107 (4/0)	85 (3/0)	127 (250)	85 (3/0)	127 (250)
1200	85 (3/0)	127 (250)	85 (3/0)	127 (250)	127[e] (250[e])	127 (250)
1600	107 (4/0)	177 (350)	85 (3/0)	127 (250)	152[e] (300[e])	203[e] (400[e])
2000	127 (250)	203 (400)	85 (3/0)	127 (250)	203[e] (400[e])	253[e] (500[e])
2500	177 (350)	[253][f] 304 ([500][f] 600)	85 (3/0)	127 (250)	253[e] (500[e])	355[e] (700[e])
3000	203 (400)	304 (600)	85 (3/0)	127 (250)	304[e] (600[e])	380[e] (750[e])
4000	253 (500)	405 (800)	85 (3/0)	127 (250)	380[e] (750[e])	507[e] (1000[e])
5000	355 (700)	[507][f] 608 ([1000][f] 1200)	85 (3/0)	127 (250)	456 (900)	633 (1250)
6000	405 (800)	[633][f] 608 ([1250][f] 1200)	85 (3/0)	127 (250)	633 (1250)	760 (1500)

[a] See Table 14DV for equivalent area of bus. Size of ground bus shall be in accordance with Table 14DV based on columns 1 – 3 of Table 13DV.

[b] Maximum ampere rating of centre or circuit overcurrent device ahead of equipment-grounding means.

[c] In Mexico and the United States, values are applicable to equipment-grounding conductors only. (NOTE c does not apply in Canada.)

[d] If the ampere rating is 400 and the wire terminal connectors for the main service conductors are rated for two 85 mm² (3/0 AWG) copper conductors or two 127 mm² (250 kcmil) aluminum conductors but will not accept a 304 mm² (600 kcmil) conductor, these values may be reduced to 33.6 mm² (2 AWG) copper or 53.5 mm² (1/0 AWG) aluminum.

[e] The cross-section may be reduced to 12.5% of the total cross-section of the largest main service conductor of the same material (copper or aluminum) for any phase on centres rated 1200 A and over. This applies when the cross-section of the service conductors is limited by the wire terminal connectors provided.

[f] In Canada, the values in brackets [xx] apply.

Table 14DV D1 *Addition:*

Table 14DV
Equivalent cross-sectional areas

(See Table 13DV)

Wire size mm² (AWG or kcmil)	Minimum cross-section	
	mm²	(in²)
2.1 (14)	2.08	(0.003)
3.3 (12)	3.31	(0.005)
5.3 (10)	5.26	(0.008)
8.4 (8)	8.39	(0.013)
13.3 (6)	13.55	(0.021)
21.2 (4)	21.29	(0.033)
26.7 (3)	26.45	(0.041)

Table 14DV Continued on Next Page

Table 14DV Continued

Wire size mm^2 (AWG or kcmil)	Minimum cross-section	
	mm^2	(in^2)
33.6 (2)	33.55	(0.052)
42.4 (1)	42.58	(0.066)
53.5 (1/0)	53.55	(0.083)
67.4 (2/0)	67.74	(0.105)
85 (3/0)	85.16	(0.132)
107 (4/0)	107.10	(0.166)
127 (250)	126.45	(0.196)
152 (300)	152.26	(0.236)
177 (350)	177.42	(0.275)
203 (400)	202.58	(0.314)
253 (500)	253.55	(0.393)
304 (600)	304.0	(0.471)
355 (700)	354.84	(0.550)
380 (750)	380.00	(0.589)
405 (800)	405.16	(0.628)
507 (1000)	506.45	(0.785)
608 (1200)	607.73	(0.942)
633 (1250)	632.90	(0.981)
760 (1500)	760.00	(1.178)
887 (1750)	887.00	(1.374)
1010 (2000)	1013.00	(3.100)

Table 15DV DR *Addition:*

Table 15DV
Ampacities of insulated conductors used within enclosures

(See 8.2.3DV.3)

Conductor size			Conductor size		
AWG or kcmil	(mm^2)	Ampacity	AWG or kcmil	(mm^2)	Ampacity
18	(0.82)	7	3/0	(85.0)	260
16	(1.3)	10	4/0	(107.2)	300
14	(2.1)	20	250	(127)	340
12	(3.3)	25	300	(152)	375
10	(5.3)	40	350	(177)	420
8	(8.4)	60	400	(203)	455
6	(13.3)	80	500	(253)	515
4	(21.2)	105	600	(304)	575

Table 15DV Continued on Next Page

Table 15DV Continued

Conductor size			Conductor size		
AWG or kcmil	(mm^2)	Ampacity	AWG or kcmil	(mm^2)	Ampacity
3	(26.7)	120	700	(354)	630
2	(33.6)	140	750	(380)	655
1	(42.4)	165	800	(406)	680
1/0	(53.5)	195	1000	(508)	780
2/0	(67.4)	225			

NOTES

1 For multiple-conductors of the same size (1/0 AWG or larger) at a terminal, the ampacity is equal to the value in the table for that conductor multiplied by the number of conductors that the terminal will accommodate.

2 These values of ampacity apply only if not more than three conductors are field-installed in the conduit. If four or more conductors, other than a neutral that carries the unbalanced current, are installed in a conduit (as can occur because of the number of conduit hubs provided in outdoor equipment, the number of wires necessary in certain polyphase systems, or other reasons), the ampacity of each of the conductors shall be 80 percent of these values if 4 – 6 conductors are involved, 70 percent of these values if 7 – 24 conductors are involved, 60 percent of these values if 25 – 42 conductors are involved, and 50 percent of these values if 43 or more conductors are involved.

Table 16DV D1 *Addition:*

Table 16DV
Recommended high fault short-circuit ratings

(See 9.3.3.4.1.4DV)

High fault short circuit ratings[a]		
10,000	25,000	65,000
14,000	30,000	85,000
18,000	35,000	100,000
20,000	42,000	125,000
22,000	50,000	150,000
–	–	200,000

[a] Symmetrical rms amperes.

Table 17DV D2 *Addition:*

Table 17DV
Minimum spacings between traces of opposite polarity on printed circuit boards

(See 8.2.4DV)

Volts,[a] rms or d.c.	Transient voltage no limited		Transient voltage limited[b]	
	Coated[c] mm	Uncoated mm	Coated[c] mm	Uncoated mm
10	0.08	0.4	0.025	0.04
12.5	0.09	0.42	0.025	0.04
16	0.1	0.45	0.025	0.04
20	0.11	0.48	0.025	0.04
25	0.125	0.5	0.025	0.04
32	0.14	0.53	0.025	0.04
40	0.16	0.8	0.025	0.04
50	0.18	0.85	0.025	0.04
100	0.25	1.0	0.1	0.16
125	0.28	1.05	0.16	0.25
160	0.32	1.1	0.24	0.4
200	0.42	1.4	0.40	0.63
250	0.56	1.8	0.56	1.0
320	0.75	2.2	0.75	1.6
400	1.0	2.8	1.0	2.0
500	1.3	3.6	1.3	2.5
630	1.8	4.5	1.8	3.2
800	2.4	5.6	2.4	4.0
1,000	3.2	7.1	3.2	5.0
1,250	4.2	9.0	–	–
1,600	5.6	11.0	–	–
2,000	7.5	14.0	–	–
2,500	10.0	18.0	–	–
3,200	12.5	22.0	–	–
4,000	16.0	28.0	–	–
5,000	20.0	36.0	–	–
6,300	25.0	45.0	–	–
8,000	32.0	56.0	–	–

Note:

Linear interpolation of values is permitted.

[a] Between the traces where spacing is measured.

[b] The maximum recurring peak voltage shall not exceed the applicable value specified in Table 9.3 in item 37 of Annex DVA, when tested in accordance with the Recurring Peak Voltage Determination Test, in accordance with item 37 in Annex DVA, Section 13, except a coated printed circuit board shall be tested in the uncoated condition.

[c] The coating shall comply with the requirements of Clause DVE.4.11.

Table 18DV D2 *Addition:*

Table 18DV
Test voltages for verifying clearances

(See DVE.4.10.3)

Specified minimum through-air spacing, mm	Test voltages for use at a 2000 m elevation, kV[a]	
	a.c. impulse, a.c. peak, or d.c.	a.c. rms
0.4	1.5	1.1
0.8	1.9	1.3
1.6	2.7	1.9
2.4	3.5	2.5
3.2	4.3	3.0
4.8	5.6	4.0
6.4	6.8	4.8
9.5	8.8	6.3
12.7	11.2	7.9

[a] See Table 19DV for other elevations.

Table 19DV D2 *Addition:*

Table 19DV
Test voltages for verifying clearances at altitudes other than 2000 m

(See DVE.4.10.3 and Table 18DV)

Specified minimum through-air spacing, mm	Test voltages, kV							
	a.c. impulse, a.c. peak, or d.c. Altitude, m				a.c. rms Altitude, m			
	Sea level	200	500	1000	Sea level	200	500	1000
0.4	1.7	1.7	1.7	1.6	1.2	1.2	1.2	1.2
0.8	2.2	2.1	2.1	2.0	1.5	1.5	1.5	1.4
1.6	3.3	3.3	3.2	3.0	2.4	2.3	2.3	2.1
2.4	4.4	4.3	4.1	3.9	3.1	3.0	2.9	2.8
3.2	5.3	5.2	5.0	4.8	3.7	3.7	3.6	3.4
4.8	6.9	6.8	6.6	6.2	4.9	4.8	4.7	4.4
6.4	8.3	8.2	7.9	7.5	5.9	5.9	5.6	5.3
9.5	10.9	10.7	10.3	9.8	7.7	7.7	7.3	7.0
12.7	14.0	13.7	13.2	12.5	9.9	9.7	9.3	8.9

Table 20DV D1 *Addition:*

Table 20DV
Generic material acceptable as a barrier

(See 8.2.4DV.7, 8.2.4DV.8, and 8.2.4DV.9.)

Material	Minimum barrier thickness, mm	Minimum barrier thickness, mm when used in addition to not less than one-half of the required through air spacing	Insulation Class Degree C
Electrical Grade Paper	0.66	0.33	105
Impregnated Rag Paper	0.51	0.253	105
Acetate Cloth	1.32	0.66	105
Acetate Film	0.44	0.22	105
Glassine	0.44	0.22	105
Varnished Cambric	0.4	0.198	105
Polyamide	0.33	0.165	130
Polyethylene Terephthalate Film	0.33	0.165	130
Polyester Film	0.33	0.165	130
Polybutylene Terephthalate	0.33	0.165	130
Silicon Impregnated Glass Cloth	0.66	0.33	180
Aramid Paper	0.33	0.163	220
PTFE Sheet	0.22	0.11	250
Polyimide	0.11	0.055	250
Note: In Canada, the first four materials of this table are not allowed.			

Table 21DV D1 *Addition:*

Table 21DV
Temperature test limits of materials and components

(See 6.2.3DV.1, 9.3.3.1.6DV, and Table DVE.1.)

Materials and components	°C	°F
1. Knife-switch blades and contact jaws	30	54
2. Fuse clip when tested with a dummy fuse that represents a fuse intended to provide branch-circuit protection	30	54
3. Fuse clip when tested with a fuse intended to provide branch-circuit protection	85	153
4. Rubber- or thermoplastic-insulated conductors	a	a
5. Field-wiring terminals[c,i,h]		
Equipment marked 60°C or 60/75°C supply wires	50	90

Table 21DV Continued on Next Page

Table 21DV Continued

Materials and components	°C	°F
Equipment marked 75°C supply wires	65	117
6. Buses and connecting straps or bars[d]	l	l
7. Contacts		
Solid and built-up silver, silver alloy, and silver faced	e	e
All other metals	65	117
8. Insulation systems		
Class 105 insulation system[f]		
Thermocouple method	65	117
Resistance method	85	126
Class 105(A) insulation systems on single-layer series coil with exposed surfaces either uninsulated or enameled, thermocouple method		
Class 120(E) insulation systems[f,o]		
Thermocouple method	75	135
Resistance method	95	171
Class 130(B) insulation systems[f,o]		
Thermocouple method	85	153
Resistance method	105	189
Class 155(F) insulation systems[f,o]		
Thermocouple method	95	171
Resistance method	115	207
Class 180(H) insulation systems[f,o]		
Thermocouple method	115	207
Resistance method	135	243
Class 200(N) insulation systems[f,o]		
Thermocouple method	135	243
Resistance method	155	279
Class 220(B) insulation systems[f,o]		
Thermocouple method	155	279
Resistance method	175	315
9. Insulating materials[b]	m	m
10. In the issuing air, 25.4 mm (1 inch) above the enclosure	175	315
11. On the embedding material of a resistor, a rheostat, and a wall-mounted dimmer with an embedded resistive element	300	540
12. On the embedding material of a rheostatic dimmer having embedded resistive conductors, and arranged for mounting on a switchboard, or in a noncombustible frame	350	630
13. On bare resistor material, thermocouple method	375	675
14. Capacitor	g	g
15. Power switching semiconductors	k	k
16. Printed circuit boards	l	l
17. Any component or material not specifically identified in 1 – 16	n	n

[a] For insulated conductors the maximum temperature rise shall not exceed the maximum operating temperature specified for the wire in question minus an assumed ambient (room) temperature of 40°C (104°F).

Table 21DV Continued on Next Page

Table 21DV Continued

Materials and components	°C	°F
[b] For compounds which have been investigated for particular temperature ratings, the maximum temperature rise shall not exceed the temperature rating minus an assumed ambient of 40°C (104°F).		
[c] The temperature on a wiring terminal or lug shall be measured at the point most likely to be contacted by the insulation of a conductor installed as in actual service.		
[d] The limit does not apply to connections to a source of heat, such as a resistor and a current element of an overload relay.		
[e] Temperature limited by the temperature limitations on the material for adjacent parts. See 9.3.3.1.6DV.35. There shall be no structural deterioration of the contact assembly, loosening of parts, cracking or flaking of materials, loss of temper of spring, annealing of parts, or other visible damage.		
[f] See 9.3.3.1.6DV.26 – 9.3.3.1.6DV.31.		
[g] For a capacitor, the maximum temperature rise is the marked temperature limit of the capacitor minus an assumed ambient temperature of 40°C (104°F).		
[h] When the rise is 50°C (90°F) or less and an aluminum bodied connector is used or aluminum wire is intended, the connector shall be marked AL7CU or AL9CU; when the terminal temperature rise exceeds 50°C and does not exceed 65°C, the connector shall be marked AL9CU.		
[i] See 6.2.3DV.1.		
[j] The limit applies only to bus bars and connecting straps used for distribution of power to industrial control devices. The limit does not apply to short pieces of copper located within industrial control devices and used for the support of stationary contact assemblies or factory or field wiring terminations. The maximum temperature rises for this type of construction shall be determined by the temperature limitations on the support material, adjacent part material, or 100°C (212°F) temperature rise on the copper material, whichever is lower. There shall be no structural deterioration of the assembly, loosening of parts, cracking or flaking of material, loss of temper of spring, annealing of parts, or other visible damage.		
[k] The maximum temperature rise on the case is the maximum case temperature for the applied power dissipation recommended by the semiconductor manufacturer minus an assumed ambient of 40°C (104°F).		
[l] The maximum temperature rise of the printed circuit board is the operating temperature of the board minus an assumed ambient of 40°C (104°F).		
[m] See Table DVE.1.		
[n] The maximum temperature rise of any component shall not exceed the temperature limit of the component minus an assumed ambient temperature of 40°C (104°F).		
[o] The insulation system shall meet the requirements of item 38 in Annex DVA.		

Table 22DV D1 *Addition:*

Table 22DV
Generic materials for direct support of uninsulated live parts

(See 8.2.4DV.8.)

Generic material	Thickness, (Inch)	Thickness, mm	RTI,°C
Diallyl Phthalate	(0.028)	0.71	105
Epoxy	(0.028)	0.71	105
Melamine	(0.028)	0.71	130
Melamine-Phenolic	(0.028)	0.71	130
Phenolic	(0.028)	0.71	150
Unfilled Nylon	(0.028)	0.71	105
Unfilled Polycarbonate	(0.028)	0.71	105

Table 22DV Continued on Next Page

Table 22DV Continued

Generic material	Thickness, (Inch)	mm	RTI,°C
Urea Formaldehyde	(0.028)	0.71	100
Ceramic, Porcelain, and Slate	No limit		No limit
Beryllium Oxide	No limit		No limit

NOTE – Each material shall be used within its minimum thickness and its Relative Thermal Index (RTI) value shall not be exceeded during the Temperature Test in 9.3.3.1.6DV.

Table 23DV D1 *Addition:*

Table 23DV
Temperature test limits of surfaces

(See 9.3.3.1.6DV)

Surface	°C	°F
1. Inaccessible parts of the enclosure (for example, the back of wall mounting enclosures) or accessible surfaces not subject to casual contact (for example, without parts intended to be touched)[a,b]	50	122
2. Accessible parts of the enclosure subject to casual contact (for example, enclosure surfaces containing parts intended to be touched)		
Nonmetallic[b]	40	104
Metal[b]	30	86
3. Parts intended to be touched (for example, operating knobs or handles of power switches and similar parts)		
Nonmetallic	25	77
Metal	15	59

[a] When the temperature rise on the side of an enclosure that is intended for mounting against building materials exceeds 50°C (122°F) per Table 23DV, when operated under normal conditions, the construction shall be such that only the points of support are in contact with a plane mounting surface, with the remainder of the equipment spaced at least 6.4 mm (0.25 in) from the mounting surface such that the temperature rise of the supporting surface does not exceed 50°C.

[b] The temperature rise of an accessible surface of an enclosure may be exceeded when provided with the marking indicated in 6.2.5.4DV.

Table 24DV D1 *Addition:*

Table 24DV
Width of copper bus bars

(See 9.3.3.1.6DV)

Product rating, Amperes	Bus bars per terminal	mm	inches
450 – 600	1	51	2
601 – 1000	1	76	3

Table 24DV Continued on Next Page

Table 24DV Continued

Product rating, Amperes	Bus bars per terminal	mm	inches
1001 – 1200	1	102	4
1201 – 1600	2	76	3
1601 – 2000	2	102	4
2001 – 2500	2	127	5
	4	64	2-1/4
2501 – 3000	3	127	5
	4	102	4

Table 25DV D1 *Addition:*

Table 25DV
Additional Notes for Figure 9DV

(See 8.8.1.1DV.2, 8.10.2DV.2, and Figure 9DV.)

Terminal	Diagram circuit function (as seen by terminal strip)	Circuit shall be designed to accommodate these amperes continuously	Terminal shall accommodate these wire sizes (for inter-connection wires to controller)
1	Receives battery positive from the fire pump controller (FPC) when the FPC acts to cause the engine to run. The FPC shall remove this battery positive upon receiving an overspeed signal on terminal #3. Optional RWS may also be connected to this terminal. (This circuit functions as a run circuit.) Note: ETR engines cannot run (except manual operation at engine) without this battery positive and will stop running when this battery positive from the FPC is removed.	10	10
2	Receives battery positive from the engine when engine speed reaches crank terminate speed. (Accomplished on increasing speed).	1	14
3	Receives battery positive from the engine when engine speed reaches an overspeed condition. This battery positive shall be maintained until a manual reset has been preformed at the engine. (Accomplished on increasing speed).	1	14
4	Receives battery negative from the engine when engine lubricating pressure falls below a minimum pressure. (Accomplished on decreasing lubricating pressure while engine is running).	1	14
5	Receives battery negative from the engine when engine reaches excessively high coolant temperature. The engine shall open this circuit when the engine in not running. (Accomplished on increasing coolant temperature).	1	14

Table 25DV Continued on Next Page

Table 25DV Continued

Terminal	Diagram circuit function (as seen by terminal strip)	Circuit shall be designed to accommodate these amperes continuously	Terminal shall accommodate these wire sizes (for inter-connection wires to controller)
6	Receives B1 battery positive from the engine. The size of the wire shall be selected for both ampacity and resistance. See Note 1(f). Note: This circuit provides battery current for FPC function and for battery charging by the FPC.	10	8
7	Reserved for future use (not shown in figure).		
8	Receives B2 battery positive from the engine. The size of the wire shall be selected for both ampacity and resistance. See Note 1(f). Note: This circuit provides battery current for FPC function and battery charging by the FPC.	10	8
9	Receives battery positive from the FPC when the FPC acts to cause the engine to crank utilizing B1. Connected to and provides battery positive to Battery Relay #1 which is used in the description for MBC1.	10	10
10	Receives battery positive from the FPC when the FPC acts to cause the engine to crank utilizing B2. Connected to and provides battery positive to Battery Relay #2 which is used in the description for MBC2.	10	10
11a	Receives common ground and common battery negative for both B1 and B2 from the engine. The size of the wire shall be selected for both ampacity and resistance. See Note 1(f).	10	8
11b	Note: This is not intended to create a fully isolated battery negative or ground system, and/or prohibit the use of a internally grounded component.	10	8
12	Receives battery positive from the FPC when the FPC acts to cause the engine to stop running. This shall be connected to the SS on engines designed for ETS.	10	10
301	Receives battery negative from the engine when the ECM selector switch is in the alternate ECM position. Accomplished when the ECMs are transferred to the alternate ECM position for engines with ECM.	1	14
302	Receives battery negative from the engine when a FIM is identified by either ECM for engines fitted with ECM. (Accomplished on fuel injection malfunction).	1	14
303	Receives battery negative from engine when a single ECM fails for engines fitted with ECM.	1	14
304	Receives battery negative from the engine when both ECM's have failed for engines fitted with ECM.	1	14
305	Receives battery negative from engine when a low suction pressure is identified. (Accomplished on decreasing suction pressure). Note: Required for optional variable speed suction limiting control on engine.	1	14

Table 25DV Continued on Next Page

Table 25DV Continued

Terminal	Diagram circuit function (as seen by terminal strip)	Circuit shall be designed to accommodate these amperes continuously	Terminal shall accommodate these wire sizes (for inter-connection wires to controller)
306 – 309	Reserved for future use (not shown in figure).		
310	Receives battery negative from engine when the raw water temperature is too high. (Accomplished on increasing raw water temperature while engine is running).	1	14
311	Receives battery negative from engine when the raw water strainer in the cooling loop becomes clogged or low flow is detected. Note: This feature is provided for some installations.	1	14
312	Receives battery negative from the engine when engine minimum temperature is not maintained. (Accomplished on decreasing engine temperature when the engine is not running).	1	14
Note 1)	a) Circuits on terminals 2, 3, 4, 5, 301, 302, 303, 304, 305, 310, 311, and 312 shall be capable of up to 1 ampere load. b) Circuits on terminals 1, 9, 10, and 12 shall be capable of up to 10 ampere load. c) Circuits 6, 8, 11a, and 11b may carry, over a 24 h period when both batteries are charging at the maximum rate of 10 amps average, up to 18 amps RMS depending on the battery charger design. d) For engines requiring more than 200 amp-hrs of battery capacity per bank, the current rating of terminals 6, 8, 11a, and 11b shall be proportionally increased to accommodate the proportional increase in the battery charger current output that is necessary to maintain a 24 h recharge requirement. e) Circuits on terminal 11a and 11b combined shall be capable of the sum of the maximum charging currents from the FPC on terminals 6 and 8. f) The average voltage drop between terminal 6 and terminals 11a and 11b, and between terminal 8 and terminals 11a and 11b, at the junction box, with a 10 amp load at the battery terminals, shall not exceed 0.2 volts on a average basis.		
Note 2)	Figure 9DV and Table 25DV include requirements and information related to the terminal connections for both diesel engines for driving stationary fire pumps and fire pump controllers. For this standard, only the requirements for fire pump controllers shall be applied.		

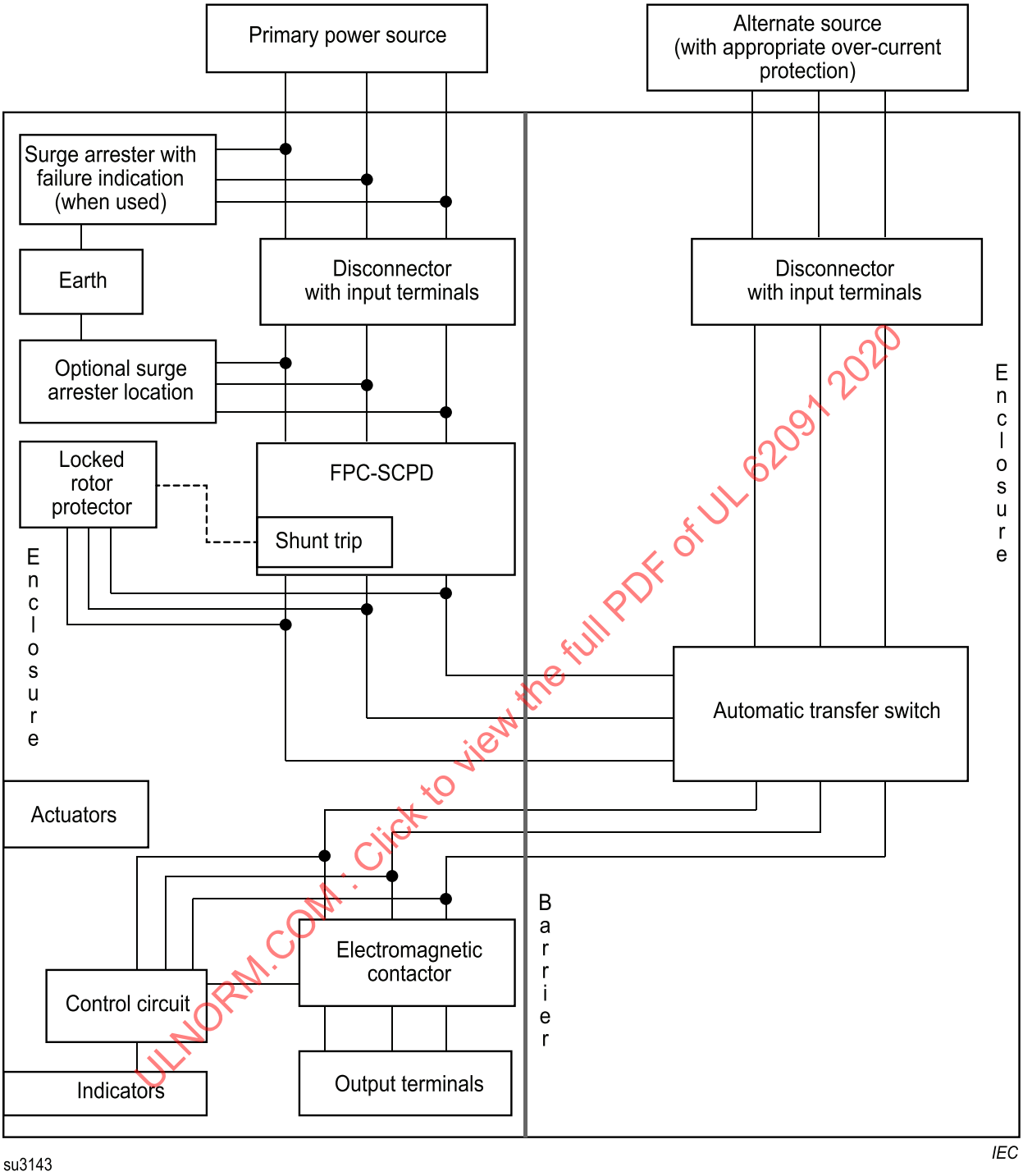

Figure 1

Example of a typical arrangement for the electric FPC suitable for two power sources, the alternate source being on-site standby power

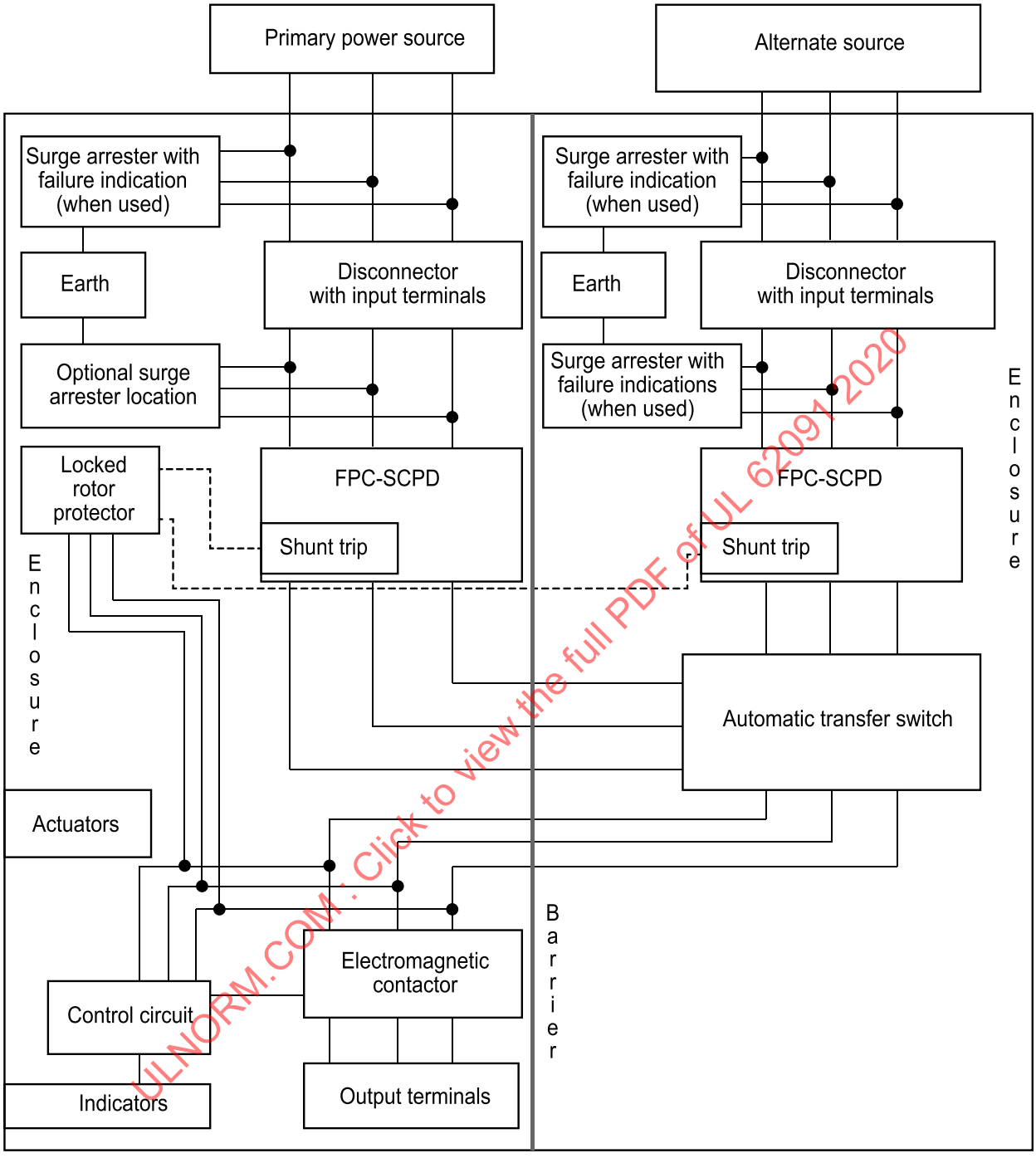

Figure 2

Example of a typical arrangement for the electric FPC suitable for two power sources, both of which are utilities (with one locked rotor protector)

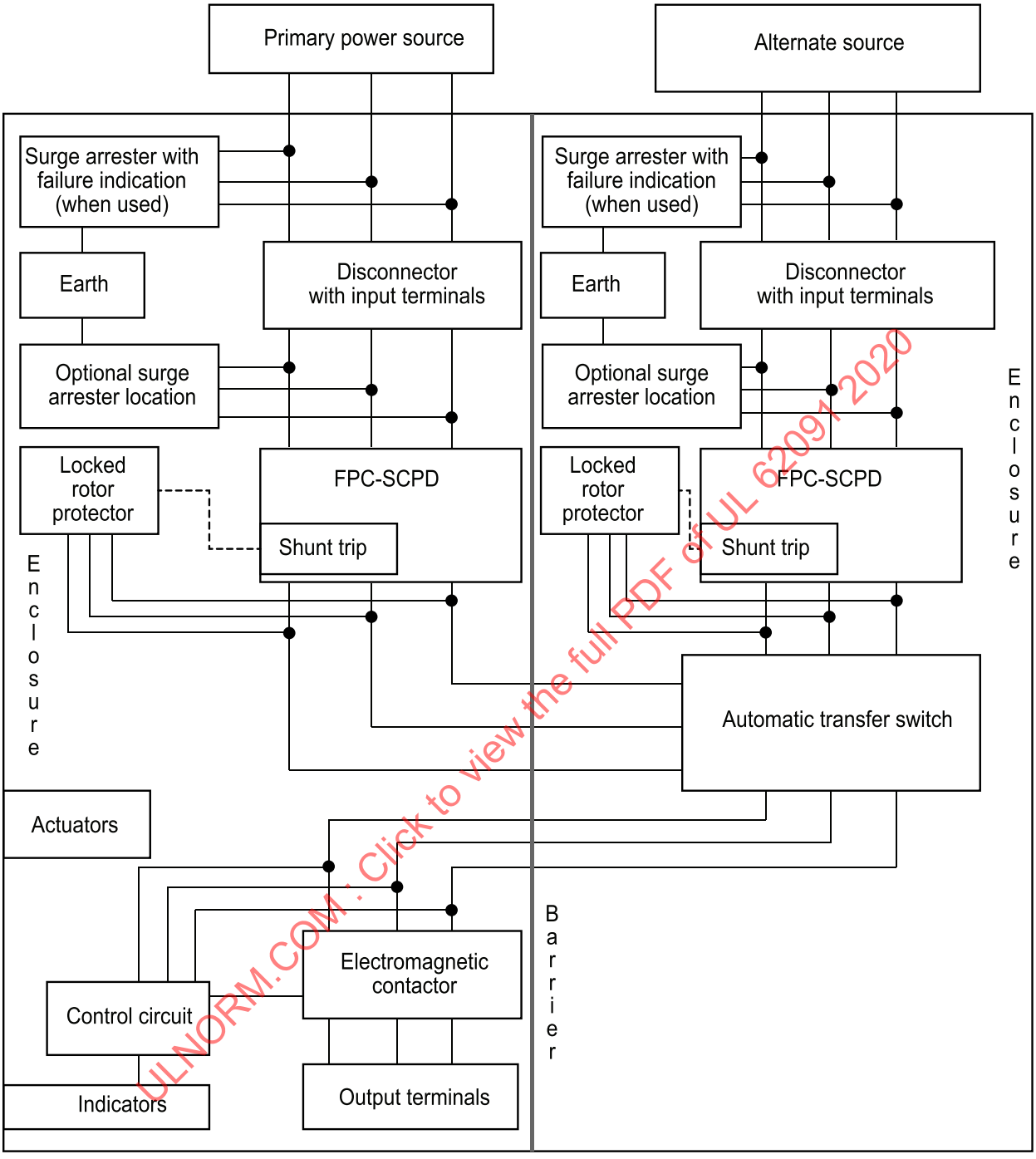

Figure 3

Example of a typical arrangement for the electric FPC suitable for two power sources, both of which are utilities (with two locked rotor protectors)