# NORMA EUROPEA

# UNI EN 17451

FEBBRAIO 2025

## Installazioni fisse antincendio – Sistemi automatici a sprinkler – Progettazione, montaggio, installazione e messa in servizio di gruppi pompa

Fixed firefighting systems – Automatic sprinkler systems – Design, assembly, installation and commissioning of pump sets

**TESTO INGLESE**

La presente norma è la versione ufficiale in lingua inglese della norma europea EN 17451 (edizione dicembre 2024).

ICS 13.220.20

UNI
UN MONDO FATTO BENE

## SOMMARIO

Il presente documento specifica i requisiti di progettazione, assemblaggio, installazione e messa in servizio per gruppi di pompe da utilizzare in sistemi sprinkler conformi alla EN 12845:2015+A1:2019.

## PREMESSA NAZIONALE

La presente norma costituisce il recepimento, in lingua inglese, della norma europea EN 17451 (edizione dicembre 2024), che assume così lo status di norma nazionale italiana.

La presente norma è stata elaborata sotto la competenza della Commissione Tecnica UNI

**Protezione attiva contro gli incendi**

La presente norma è stata ratificata dal Presidente dell'UNI ed è entrata a far parte del corpo normativo nazionale il 20 febbraio 2025.

# EUROPEAN STANDARD
# NORME EUROPÉENNE
# EUROPÄISCHE NORM

**EN 17451**

December 2024

ICS 13.220.20

English Version

# Fixed firefighting systems - Automatic sprinkler systems - Design, assembly, installation and commissioning of pump sets

Installations fixes de lutte contre l'incendie - Systèmes d'extinction automatique de type sprinkleur - Conception, assemblage, installation et mise en service des groupes motopompes

Ortsfeste Brandbekämpfungsanlagen - Automatische Sprinkleranlagen - Projektierung, Zusammenbau, Montage und Inbetriebnahme von Pumpenaggregaten

This European Standard was approved by CEN on 4 November 2024.

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Ref. No. EN 17451:2024 E

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# European foreword

This document (EN 17451:2024) has been prepared by Technical Committee CEN/TC 191 “Fixed firefighting systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2025, and conflicting national standards shall be withdrawn at the latest by June 2025.

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

This document is related to the following European standards:

CEN/TS 14816, *Fixed firefighting systems — Water spray systems — Design, installation and maintenance*;

EN 671 (all parts), *Fixed firefighting systems — Hose systems*;

EN 12094 (all parts), *Fixed firefighting systems — Components for gas extinguishing systems*;

EN 12101 (all parts), *Smoke and heat control systems*;

EN 12259 (all parts), *Fixed firefighting systems — Components for sprinkler and water spray systems*;

EN 12416 (all parts), *Fixed firefighting systems — Powder systems*;

EN 12845 (all parts), *Fixed firefighting systems — Automatic sprinkler systems*;

EN 13565 (all parts), *Fixed firefighting systems — Foam systems*;

EN 14972 (all parts), *Fixed firefighting systems — Water mist systems*.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

# Introduction

This document covers:

— the design and assembly of the pump set in accordance with the requirements of EN 12845:2015+A1:2019;

— identification of essential pump set components;

— the performance characteristics for components used within a pump set;

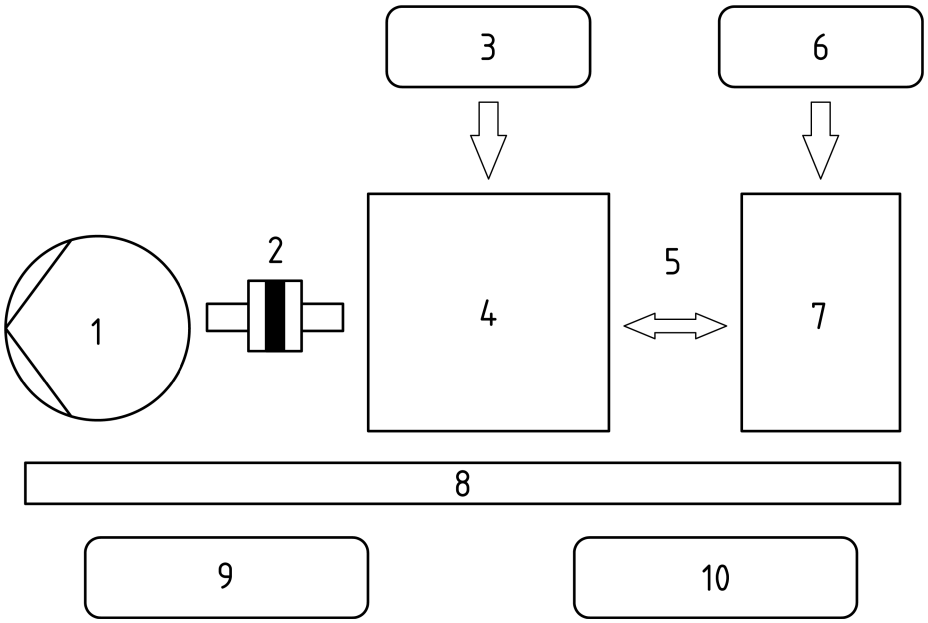
— performance testing requirements for diesel and electric driven pump sets;

— testing, commissioning and handover;

— documentation.

This document can be applied with the current edition of EN 12845:2015+A1:2019. Any conflicting requirements that arise by application to other standards would need to be resolved through the contracts and specifications in each case.

Figure 1 identifies the typical pump set components covered by this document.




**Key**

| | | | |
|---|---|---|---|
| 1 | pump | 6 | pressure loss detection |
| 2 | coupling | 7 | pump set control panel |
| 3 | fuel and fuel tank for diesel driver | 8 | frame |
| 4 | driver | 9 | test system |
| 5 | wiring | 10 | auxiliary items, e.g. exhaust and cooling pipe |

**Figure 1 — Example of a typical pump set assembly for a diesel driven unit**

# 1 Scope

This document specifies design, assembly, installation and commissioning requirements for pump sets for use in sprinkler systems conforming to EN 12845:2015+A1:2019.

Where applicable, this document can also be used for pump sets for other water based fixed firefighting systems.

# 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 12259-5:2002, *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 5: Water flow detectors*

EN 12259-12:2023, *Fixed firefighting systems — Components for sprinkler and water spray systems — Part 12: Pumps*

EN 12845:2015+A1:2019, *Fixed firefighting systems — Automatic sprinkler systems — Design, installation and maintenance*

EN 12845-2:2024, *Fixed firefighting systems — Automatic sprinkler systems — Part 2: Design and installation of ESFR and CMSA sprinkler systems*

EN 12845-3, *Fixed firefighting systems — Automatic sprinkler systems — Part 3: Guidance for earthquake bracing*

EN 50342-1, *Lead-acid starter batteries — Part 1: General requirements and methods of test*

EN 50342-2, *Lead-acid starter batteries — Part 2: Dimensions of batteries and marking of terminals*

EN 60529:1991,[1] *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Vented nickel-cadmium prismatic rechargeable single cells (IEC 60623)*

EN 60034-1, *Rotating electrical machines — Part 1: Rating and performance (IEC 60034-1)*

EN IEC 60947-1:2021,[2] *Low-voltage switchgear and controlgear — Part 1: General rules (IEC 60947-1: 2020)*

EN IEC 60947-3:2021,[3] *Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units (IEC 60947-3:2020)*

EN IEC 60947-4-1:2019,[4] *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2018)*

ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

[1] As impacted by EN 60529:1991/A1:2000 and EN 60529:1991/A2:2013.
[2] As impacted by EN IEC 60947-1:2021/AC:2023-01 and EN IEC 60947-1:2021/AC:2024-05.
[3] As impacted by EN IEC 60947-3:2021/AC:2023-01 and EN IEC 60947-1:2021/AC:2024-05.
[4] As impacted by EN IEC 60947-4-1:2019/AC:2020-05 and EN IEC 60947-4-1:2019/AC:2021-04.

ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*

NEMA MG1-2016, *Motors and Generators*

# 3 Terms, definitions, symbols and abbreviated terms

## 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12845 (all parts) and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1.1**
**assembly**
design, production and testing of the pump set

**3.1.2**
**coupling**
device to transmit torque and power from the driver to the pump

**3.1.3**
**coupling safety factor**
safety margin specified by coupling manufacturers to address uncertainties in design

Note 1 to entry: See 5.2.

Note 2 to entry: The abbreviation for coupling safety factor is *SFk*.

**3.1.4**
**all-elastomeric coupling**
linkage that relies solely on an elastomeric material for power transmission

**3.1.5**
**electric motor service factor**
design margin to account for higher torque loadings which can be encountered under certain operating conditions

**3.1.6**
**fail-safe coupling**
integrated unit which provides power transmission, damping and flexibility from the driver to the pump, designed so that the wear or failure of the elastomeric components (if present) of the coupling does not interrupt the transmission of full torque from the driver to the pump

Note 1 to entry: Examples of fail-safe elastomeric couplings include: gimbal, universal drive shaft, spacer coupling, claw couplings and flexible couplings.

**3.1.7**
**installation**
mounting and commissioning of the pump set in its final location of use in accordance with the pump set manufacturer's installation manual and procedures

**3.1.8**
**maintenance**
work performed to keep pump sets operable including repairs where required

**3.1.9**
**pressure sensor**
element which generates an electrical signal that is transmitted to the pump set control panel according to the pressure at the point where it is hydraulically connected

**3.1.10**
**pump set**
assembled machine which is intended to supply water to automatic sprinkler, water spray and wet riser systems, typically comprising of pump, electric motor or diesel engine, control panel, partial wiring loom, drive coupling, mounting frame, baseplate and where required batteries and a fuel tank

**3.1.11**
**pump set installer**
entity who is responsible for integrating the fire pump set into the automatic sprinkler, water spray or wet riser systemin accordance with the pump set manufacturer installation manual and procedures

**3.1.12**
**pump set manufacturer**
entity responsible for the design, assembly and build of the pump set

Note 1 to entry: It can be necessary for the pump set manufacturer to establish and manage technical and commercial relationships with key sub-component or sub-system suppliers.

**3.1.13**
**rigid coupling**
component without flexibility which provides power transmission from diesel engines or electric motors to fire pumps that supply water to fire protection systems

**3.1.14**
**spacer coupling**
cylindrical shaped piece introduced between the pump shaft coupling hub and motor shaft coupling hub to facilitate maintenance

### 3.2 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply.

| | |
|---|---|
| AC | alternating current |
| ECM | engine control module |
| EMC | electromagnetic compatibility |
| EMF | electromagnetic fields |
| FLC | full load current |
| FLT | full load torque |
| IFN | numerical value of the fuel stop power taken as the maximum IFN value in accordance to ISO 3046-1 for the driver, expressed in kilowatt |
| IP | ingress protection, degree of protection rating as per EN 60529 classifications |
| $L_{10}$ basic rating life | time by which ten percent of a population of a product will have failed (see ISO 281 rolling bearings) |
| LRC | locked rotor current |
| NPSHr | net positive suction head required |
| NPSHa | net positive suction head available |
| *SFk* | coupling safety factor |
| VFD | variable frequency drive |

## 4 Performance of pump set

### 4.1 General design principles

The design details covered in this clause address the general principles which shall be considered for all pump set designs covered by this document. The design of pump set shall be based on the following information provided to the pump set manufacturer:

— pressure-flow demand characteristics (including any required design margins) [see 4.2.2 and 10.2.2];

— maximum possible suction pressure at pump suction flange;

— NPSHa at low water level in the water storage tank measured at the pump suction flange at the maximum possible demand flow including 1 m safety margin;

— duration of operation (e.g. for fuel tank sizing; see 4.4);

— driver type (electric or diesel);

— applicable fixed firefighting system design specification according to EN 12845:2015+A1:2019;

— hazard classification according to EN 12845:2015+A1:2019;

— water quality (potable, brackish, sea or filtered) description;

— voltage and frequency available;

— current available;

— starting method;

— type of earthing system;

— altitude of the installation;

— climatic zone with temperature and humidity;

— earthquake classification area.

## 4.2 Components

### 4.2.1 Connections

All service interface connection requirements (e.g. water, air, power and signal) shall be provided as part of the installation instructions to enable the correct installation of the pump set on-site. The connections shall be easily accessible and located in accordance with EN 12845:2015+A1:2019.

Pipes shall be supported independently of the pump.

Cooling requirements for all pump set components shall be considered.

### 4.2.2 Pumps and pump driver sizing

Pumps shall be in accordance with EN 12259-12 and shall be driven either by electric motors or diesel engines, capable of providing at least the power required to comply with the following, plus the safety margin as described for electrical motors and diesel engines respectively in Clauses 8 and 9:

a) for pumps with non-overloading power characteristic curves, the maximum power required at the peak of the power curve; or

b) for pumps with rising power characteristic curves, the maximum power for any conditions of pump load, from zero flow to a flow corresponding to a pump NPSHr equal to 16 m or maximum suction static head plus 11 m, whichever is greater.

NOTE 16 m was derived from atmospheric pressure (9,98 m atmospheric) plus 6 m (equals 16 m NPSHa), ignoring frictional losses. Typical tank height, at the time the requirement was written, was considered to be 6 m. The 11 m was later added to cater for higher suction pressure scenarios (e.g. 5 bar inlet pressure) to ensure the drive was also sized correctly in that scenario.

Some informative material on Pump H(Q) considerations is given in Annex C.

## 4.3 Cooling and by-pass flow

Arrangements, such as by-pass flows, shall be made to ensure a continuous flow of water through the pump sufficient to prevent overheating when it is operating against a closed valve (this minimum required flow rate is determined by requirements of EN 12259-12:2023, 4.2).

The by-pass system can also be required to maintain the operational temperature of the diesel drivers. Any additional flow requirements above that required by EN 12259-12, shall be specified by the pump set manufacturer and shall also be included in the total cooling flow requirement.

Any cooling system pressure regulating devices shall be provided by the pump set manufacturer.

The by-pass flow shall be taken into account in the fixed firefighting system hydraulic calculation and pump selection. This additional flow shall be provided in addition to the fixed firefighting system flow figures.

Cooling water shall be taken from the sprinkler system water supply.

NOTE The complete by-pass cooling system can or cannot be supplied as a component of the pump set, as parts of the by-pass system can be part of the wider system pipework installation in a manner similar to the supply of electrical cabling. It is essential that suitable connections, equipment and design information are provided to allow the provision of an adequate cooling system.

## 4.4 Fuel tank design

The fuel tank capacity shall be sufficient to enable the engine to run on full load, in the most unfavourable atmospheric and environmental conditions, for the required period of duty.

These durations may be increased if required by the client specification.

Minimum period of duty values, are (as per EN 12845 (all parts) minimum requirements):

— 3 h for LH;

— 4 h for OH (FH1 to FH2);

— 6 h for HHP and HHS (FH3 to FH 5 or HHS1 to HHS 5).

NOTE 1 The hazard classes in brackets are in accordance with prEN 12845-1:2021.

For installations in accordance with EN 12845-2:2024, the minimum fuel tank capacity shall be at least 4 times the required duration of operation (see EN 12845-2:2024, Table 6).

NOTE 2 Attention is drawn to local safety and environmental requirements with regards to storage, handling and use of fuels.

The fuel tank shall be of welded steel. Where there is to be more than one diesel driven pump set in a sprinkler system, there shall be a separate fuel tank and fuel feed pipes (inlet and outlet) for each pump set.

The fuel tank shall be fixed at a higher level than the engine's fuel pump to ensure a positive head, but not directly above the engine. Where the tank cannot be installed on the same baseplate or mounting frame as the pump set unit the fuel lines shall be kept to a minimum length, and installation parameters (e.g. minimum and maximum height of tank relative to pump set) shall be specified by the pump set manufacturer.

The fuel tank shall have a fuel level gauge and communicate with the pump set control panel to enable low fuel level alarms. The low fuel level alarm signal shall be triggered when the fuel level falls to less than 75% of the required minimum level.

Where required, fuel leak monitoring functionality shall be provided. Any valves in fuel feed pipes between the fuel tank and the engine shall be sited on or near the fuel tank. Valves controlling the flow of fuel to the engine shall be monitored for the correct position. They shall not be located on or near the engine. They shall have an indicator and be locked in the open position or be monitored. Fuel feed pipe joints shall not be soldered. Metallic pipes and steel hoses shall be used for fuel lines.

The feed pipes shall be situated at least 20 mm above the bottom of the fuel tank. A drain valve of at least DN15 diameter shall be fitted to the base of the tank.

The fuel tank shall be provided with a suitable vent.

### 4.5 Fuel, lubricating oil and coolant quality

The diesel fire pump driver manufacturer shall specify the required fuel (e.g. as specified in EN 590), lubricating oil and coolant characteristics.

Fuel tanks shall be marked with required fuel grade.

Fuel oils used in diesel engines can be subject to detrimental effects from prolonged storage. Therefore, it is recommended that a proper maintenance schedule is put into place to ensure the fuel remains suitable for engine operation, efficiency, and longevity.

### 4.6 Speed of rotation

The nominal driver speed shall not exceed 3 600 $min^{-1}$.

The speed of rotation shall be fixed (i.e., not variable speed), after start-up.

## 5 Couplings

### 5.1 General

All pumps and drivers shall be fitted with a failsafe (see 3.1.6) coupling.

Couplings shall be sized to meet the required rated power levels for reliable operation, despite being idle for extended periods.

All elastomeric couplings shall not be used.

Examples of typical coupling arrangements can be found in Annex D.

### 5.2 Pump coupling and mounting

The coupling between the driver and the pump shall be of a type which ensures that either can be removed independently. For all pump types except ring-section, submersible and vertical turbine pumps, this shall be possible in such a way that pump internals (e.g. bearings, seals, impellors) can be inspected or replaced without affecting suction or discharge piping and permitting access to the impeller without removing the driver or pump body.

The pump and driver shall be coupled, and the coupling shall be rated for the maximum torque of the driver. It shall be designed so that if any elastomeric element used in the coupling to absorb vibration should fail, the pump shall continue to be driven under all operating conditions, except that a right-angle gear drive can be used for vertical turbine pumps.

Maximum permissible driver size for close coupled end suction pumps shall be 55 kW. The following pump types shall not be diesel driven: close-coupled pumps, inline pumps (vertical shaft pump with inlet and outlet inline), multistage inline pumps, and submersible motor borehole pumps.

The pump set shall be designed and assembled in such a way that there a means of safe access for checking the alignment of couplings when the installation is completed.

This clause does not apply to submersible motor borehole pumps.

### 5.3 Pump coupling and mounting (submersible motor borehole pump)

Submersible motor borehole pumps shall use a rigid coupling. The rigid coupling shall be made from stainless steel suitable for the environmental conditions of operation.

Coupling for submersible motor borehole pump motors up to “8 inches” (as per the classifications of NEMA MG1-2016) shall be in accordance with NEMA MG1 motor shaft specifications (NEMA MG1-2016, Part 18, Figure 18-18, 18-19, 18-20 for motor shaft shape).

Coupling for submersible motor borehole pump motors greater than “8 inches” shall be with key seat according to the shaft key of the motor.

Rigid couplings used for submersible motor borehole pumps shall be suitable to assure adequate support for upward or downward thrusts, created by the submersible motor borehole pump in starting or running condition.

## 5.4 Coupling selection

The coupling shall be designed for adverse environmental locations.

Driveshaft bearings shall have a minimum basic life rating of $L_{10}$ as determined by the methods of ISO 281, for at least 5 000 h operating at the maximum load condition of the pump set.

EXAMPLE No more than 10 % of the population have been calculated to have failed after no less than 5 000 h operating at the maximum load condition of the pump set.

NOTE Attention is drawn to EN ISO 14120, see [10].

The sizing of the coupling shall be based on the rating of the driver not the pump, taking account of the maximum available torque provided by the driver as specified by the manufacturer.

The selection of the coupling shall withstand the torque between pump and driver. The torque shall be calculated using the formula:

$$\tau = \frac{P \times 1000}{2 \times \pi \times \frac{\omega}{60}} \times SFk$$

where

$\tau$ is the numerical value of the torque between pump and driver, expressed in newton metre;

$\omega$ rotational speed; is the numerical value of the driver’s nominal speed, expressed in 1/min;

$P$ Power; for the diesel engine, is the numerical value of the fuel stop power taken as the maximum IFN value in accordance to ISO 3046-1 for the driver, expressed in kilowatt, for the electric motor nominal power in kilowatt at max frequency of the line supply;

*SFk* is the numerical value of the coupling safety factor.

*SFk* values shall be provided by the coupling manufacturer. The pump set manufacturer shall select a suitably rated coupling. The *SFk* shall not be less than specified in Table 1.

**Table 1 — Minimum SFk values**

| Pump gear box | Electric motor | Diesel engine (5 or fewer cylinders) | Diesel engine (6 cylinder) |
|---|---|---|---|
| Pump without right-angle gear box | 1,25 | 1,75 | 1,25 |
| Pump with right-angle gear box | 1,75 | 2,5 | 2,0 |

### 5.5 Coupling installation and alignment

Couplings shall be installed according to the coupling manufacturer's instructions. Alignment of the coupling and shaft shall be within the tolerances defined by supplier.

The preliminary integration (including alignment) of the pump, coupling and driver at the pump set manufacturer's premises shall be in accordance with the component suppliers' specifications.

Final alignment shall be undertaken once the pump set has been fully installed on-site (see Clause 10). This alignment shall be checked to be in accordance with the pump set manufacturer's specification after the pump baseplate or mounting frame is installed, bolted down and all pipework connected.

## 6 Baseplate or mounting frame

### 6.1 General requirements for pump set installation and fixing considerations

The mounting arrangements of the pump can require the use of baseplates or mounting frames. Where baseplates or mounting frames are required the design of the mounting shall be of sufficient strength and mass to withstand the static and dynamic forces imposed by the pump set. The primary characteristics to be considered include:

— dimensions;

— alignment;

— weight loading;

— ability to withstand vibration;

— transport;

— fixing details to meet the requirements of the pump set manufacturer's instructions.

Annex A provides guidance on some affixing scenarios.

NOTE Attention is drawn to any applicable National or European requirements. E.g. for design, structural integrity, strength and seismic performance standards such as EN 809 [3], EN 1090 (all parts) [4 to 8] and EN 12845 (all parts).

### 6.2 Load transfer – Vibration

For the load transfer the forces on the key components such as the pump set control panel, couplings, connections etc. shall be taken into account and also the influence of these units on the vibration and load transfer. Examples of baseplates or mounting frames design approaches can be seen in Figure A.1.

## 7 Pump set control

### 7.1 Pump set control panels

Each pump set shall be monitored and controlled by its dedicated control panel. Except in the case of submersible motor borehole pumps, the pump set control panel shall be in the same compartment as the pump set.

It is recommended that pump set control panels should be installed as close as practical to the equipment it controls.

Functions of the main fire pump set control panel should not be shared with other equipment (e.g. compressors, jockey pumps or trace-heating). In countries where the practice of sharing control panels with other equipment is covered by additional requirements made by authorities, the control panel of the main fire pump unit may be shared with other equipment (e.g. compressors, jockey pumps, or heat tracing). In this case, a main power cable shall be provided, from which the other equipment shall be protected by their own circuit protection after the main circuit protection device. The cables and lines in the control cabinet to the auxiliary units shall be designed to be earth-fault and short-circuit proof or dimensioned in such a way that they are protected against overload and short-circuit by the main fuse.

The pump set control panel(s) should be installed on the pump set baseplate or mounting frame or be supplied for wall or floor mounting. In all cases all (excluding those with purely mechanical functions) components and connections shall be mounted at least 200 mm above the floor.

The pump set control panel shall be easily accessible. Except in the case of submersible pumps, it is recommended that pump set controls and indicators should be visible and within reasonable reach of the controlled equipment.

The pump set control panel shall be at least IP 54 rated according to EN 60529:1991 [1].

The pump set control panel shall be installed considering environmental conditions (and within any manufacturer specified limits) for factors such as (for example):

— temperature;

— humidity;

— rates of change;

— mechanical vibration.

NOTE 1 Attention is drawn to the need to consider EMC effects associated with the operation of the pump set (both susceptibility and emissions).

The pump set control panel casing shall be constructed from metal and finished with a corrosion resistant coating (such a powder coating or paint finishes). The pump set control panel shall be fitted with tamper proof access control (e.g. a locking device) to prevent unauthorised access or use. The pump set control panel shall be marked in accordance with the labelling requirements of EN 12845:2015+A1:2019.

In the case of a submersible motor borehole pump, a plate with its characteristics shall be affixed to the pump set control panel.

NOTE 2 Attention is drawn to any applicable National or European requirements. E.g. for ergonomics and accessibility.

## 7.2 Pump set controller operational requirements

### 7.2.1 General

The activation of the pump set shall arise from an externally supplied signal in accordance with EN 12845:2015+A1:2019 as a minimum, with the option to include the use of other pressure sensing devices as detailed in 7.2.2. Each pump set control panel shall:

a) start the motor automatically on receiving an activation signal (see 7.2.2), which may take the form of either:

   1) a signal from a normally closed contact (from one or two of two independent devices), or;

2) short circuit and open circuit monitoring shall be provided for all other actuation configurations (including normally open devices);

b) start the motor on manual actuation;

c) stop the motor by manual actuation only.

Fire pump sets shall be designed to run to destruction i.e. only be stopped manually.

An identified fault signal condition on the pump set control panel shall not prevent the operation of the pump set or lead to an unwanted start.

As an exception to 7.2.1 c), the diesel engine may stop automatically as per the requirements of Annex E, if it is an ECM engine.

### 7.2.2 Pump start pressure detection

#### 7.2.2.1 General

Two pressure sensors shall be installed for each pump set. Each sensor shall be independently capable of detecting a pressure loss requiring the pump to start. The pressure sensors shall be connected to the pump set control panel via two separate lines. The lines shall be electrically monitored for short circuit and open circuit monitoring.

#### 7.2.2.2 Pressure sensors

##### 7.2.2.2.1 General

The following types of devices shall be used:

a) pressure switches, with a signal to close or open the electrical circuit when a pre-set pressure is reached; and/or

b) pressure transducer transmitting an electrical signal as a function of pressure.

##### 7.2.2.2.2 Pressure switches

Pressure switches used in pump sets shall be electrically compatible with the pump set controllers and meet the following minimum requirements:

a) be a corrosive resistant type, equivalent to EN 12259-5:2002, 4.7 and EN 12259-5:2002, Annex G;

b) measurement range suitable for the application;

c) trigger sensitivity ±0,25 bar;

d) enclosure rating IP 54 in accordance with EN 60529:1991 [1].

##### 7.2.2.2.3 Pressure transducers

Pressure transducers used in pump sets shall be electrically compatible with the pump set controllers and meet the minimum following requirements:

a) be a corrosive resistant type, equivalent to EN 12259-5:2002, 4.7 and Annex G;

b) operational pressure measurement range of at least: 0 to 1,5 times the maximum system working pressure;

c) accuracy ±0,5 % of full operational range;

d) enclosure rating IP 65 in accordance with EN 60529:1991 [1].

#### 7.2.2.3 Pressure sensor configuration

The pressure sensors shall be configured as follows:

a) 2 pressure switches connected in series with contacts normally closed above the start pressure, opening in case of pressure loss;

b) 2 pressure switches connected in parallel with contacts normally open above the start pressure, closing in case of pressure loss;

c) 1 pressure switch and 1 pressure transducer:

   1) pressure switch is configured with contact normally closed above the start pressure, opening in case of loss of pressure;

   2) transducer detects loss of pressure;

d) 2 pressure transducers, each transducer detecting the loss of pressure.

#### 7.2.2.4 Pressure monitoring and fault reporting

The pressure detection system shall be monitored by the pump set control panel for the following fault conditions:

a) short circuit occurs in any of the pressure sensor signal lines or equipment;

b) open circuit occurs in any of the pressure sensor signal lines or equipment;

c) signal out of range occurs in the transducer, including sensor disconnected;

d) difference in pressure readings across the two transducers exceeds 10 % of the pressure transducer ranges.

## 7.3 Electrical pump set operation

### 7.3.1 Electrical pump controller and short circuit interruption devices

#### 7.3.1.1 General

Electrical pump controllers can be integrated into the electrical system either as switch gear or a control cabinet. Pump sets, regardless of starting means, in accordance to this document shall be one of the following types:

— Type F – circuit protection provided by fuses;

— Type CB - circuit protection provided by circuit breakers;

— Type VFD - circuit protection provided by fuses or circuit breakers and variable frequency drive incorporated.

All components of the electrical pump controller shall be sized for at least 115 % of motor full load current of the electrical fire pump set. This includes power switching devices, switches, contactors and cables.

Semiconductor (e.g. VFD) controllers shall be sized for to drive a motor one size up of the kW rating or at least 115 % of the motor full load current (whichever is the greater) of the electrical fire pump set. Starting mechanism for all controller types shall be capable of a minimum of six start sequences per hour.

For VFD pump sets, circuit protection shall be as per the VFD manufacturer's requirements.

Only VFD pump sets with "Fire Mode" shall be used. I.e. pump set shall be designed to run to destruction and not be slowed or stopped upon detection of fault conditions.

For a squirrel cage motor, the protection device shall allow minimum 720 % of motor full load current (FLC) or the inrush current of the motor as declared by the motor manufacturer, whichever is the greater, for 5 seconds.

NOTE 1 National electrical codes usually require a coordinated electrical upstream protection for electrical sprinkler pump controllers. A short circuit, load and selectivity study is normally considered a necessary part of the design and installation documentation.

The utilization classification of contactors shall be minimum AC-3 in accordance with EN IEC 60947-4-1:2019 [4] depending on the starting method.

Isolation switches shall be sized for the utilisation classification AC-23 service in accordance with EN IEC 60947-1:2021 [2] and EN IEC 60947-3:2021 [3].

NOTE 2 See Annex B for further information and descriptions.

### 7.3.2 Monitoring and visual indications for electric pump set control panel

#### 7.3.2.1 General

The following conditions visually indicated at the pump set control panel:

— ready to operate (e.g. power supply available, in auto mode, no critical faults) [optional];

— mains supply healthy (or unhealthy, by the absence of a healthy indication);

— measured voltage available on all phases (e.g. 1 switched or 3 individual volt meters; can be analogue or digital devices);

— measured current draw amps (e.g. by an analogue or digital display);

— low voltage;

— phase fault;

— motor overload;

— pump on demand;

— pump running;

— motor running (e.g. by; correct current draw, motor windings receiving voltage or mag pick-up);

— start failure;

— automatic mode switched off.

Measuring devices shall have an accuracy of ±3 % or better.

Volt-free contacts shall be provided to allow the onward transmission of at least the following:

— pump running;

— start failure;

— common fault, to include at least the following: low voltage, phase fault, motor overload;

— automatic mode switched off.

Common faults can also include any other fault condition the manufacturer wishes to include e.g. low (less than 4 °C) or high pump house temperature.

No fault conditions shall disable the pump set.

#### 7.3.2.2 Remote alarm signal panel

The pump running, pump on demand and fault alarm signals shall be made available to a monitored remote location.

A pressure sensing device downstream of the pump shall be used to derive the pump running condition.

### 7.3.3 Cables between pump set control panel and electric motor

Cables to the terminal board of the motor or to the connection of submersible motor borehole pumps shall be laid in one piece. No junction box or interconnection shall be permitted.

## 7.4 Monitoring of diesel driven sprinkler pump sets

### 7.4.1 Monitoring and visual indications diesel pump set control panel

#### 7.4.1.1 General

The conditions specified in Table 2 shall be monitored and visually indicated on the pump set control panel.

**Table 2 — Condition monitoring and transmission arrangements**

| Conditions | Provision for onward transmission (see 7.4.1.2) |
|---|---|
| ready to operate (e.g. power supply available, in auto mode, no critical faults) (optional) | - |
| battery charger status | #1 |
| battery status | #1 |
| low jacket water temperature, or low engine temperature, or disconnection or failure of heaters (where heaters are installed) | #1 |
| engine running | - |
| pump running | #2 |
| start failure | #2 |

| Conditions | Provision for onward transmission (see 7.4.1.2) |
|---|---|
| pump on demand | #2 |
| low oil pressure | #1 |
| high water (engine coolant) temperature | #1 |
| low fuel level | #1 |
| Fuel valve closed | #1 |
| automatic mode off | #2 |
| hours run meter | - |
| tachometer | - |
| leak detection (where required) | #1 |
| test start (see 9.6.5) | - |
| engine overspeed (≥ 7,5 % overspeed) | #1 |
| ECM failure (see Annex E) | #1 |
| ECM alternate (initiate start) (see Annex E) | #1 |
| Pressure sensor (i.e. pump initiation devices and cabling) fault | #1 |
| NOTE #1 Provide a common alarm volt free contact and #2 provide a dedicated volt free contact. | |

The pump set control panel shall be equipped with a charge rate ammeter to monitor each battery set.

#### 7.4.1.2 Remote alarm signal panel

The items marked #1 or #2 in Table 2 shall be made available for connection to the monitored remote locations.

A pressure sensing device downstream of the pump shall be used to derive the pump running condition.

### 7.4.2 Batteries

At least two battery sets shall be provided, each independently capable of supporting the correct operation of the pump set.

Batteries shall be either open nickel-cadmium prismatic rechargeable cells in accordance with EN 60623 or lead-acid positive batteries in accordance with EN 50342-1 and EN 50342-2.

Batteries shall be selected, used, charged and maintained in accordance with the requirements of the battery supplier's instructions.

The batteries shall be sized to accommodate the controller for 72 h in standby mode, starting operation at the end of 72 h, plus 6 h while the engine is running. An engine mounted alternator may be provided to provide battery charging while the engine is running.

The rated voltage of the batteries and starter motor shall be no less than 12 V. Facilities shall be provided to prevent one battery having an adverse effect on the other.

### 7.4.3 Battery chargers

Each starter battery shall be provided with an independent, continuously connected, fully automatic and constant potential charger, as specified by the battery supplier. Two separate battery chargers shall be provided and shall be used for no other purpose. It shall be possible to remove either charger while leaving the other operational.

The battery charger shall be sized based on the ability of the charger to recharge a fully discharged battery within 24 h, with -15 % of mains nominal voltage 230 V AC (i.e. 195,5 V AC). The nominal charging voltage shall be suitable for local conditions (climate, regular maintenance etc.).

The boost charge (i.e. raising the float voltage) function shall be suitable for the type of battery used. Chargers for lead acid batteries shall provide a float voltage of (2,25 ± 0,05) V per cell.

Chargers for open nickel-cadmium prismatic batteries shall provide a float voltage of (1,445 ± 0,025) V per cell.

### 7.4.4 Siting of batteries and chargers

Batteries and chargers shall be located in readily accessible positions where the likelihood of contamination by oil fuel, damp, pump set cooling water or of damage by vibration is minimal.

Chargers shall not be mounted with the batteries unless the protection degree is at least IP 54 in accordance with EN 60529:1991 [1]. Battery chargers shall be located within the pump set control panel wherever possible.

Batteries shall be as close as possible to the engine starter motor, subject to the above constraints, in order to minimize voltage, drop between the battery and starter motor terminal.

The base of batteries shall not be less than 200 mm above the floor level.

NOTE Attention is drawn to the need for protection against electrolyte ejection or spillage from batteries.

### 7.4.5 Cables between control panel and diesel engine

Shielded wire or other suitable EMF protection shall be used for magnetic pickup signal wires.

The bundle of wires shall be protected in a loom and shall be routed away from hot areas of the engine.

Engine loom (excluding starter motor cables) wiring shall be minimum 2,5 $mm^2$ to reduce voltage drops and to minimize engine loom fires.

Battery cables shall be sized to carry starter motor current taking cable length into account. The cables shall be as short as possible.

The engine manufacture recommendations shall be followed with respect to above.

The battery cables shall be routed to ensure that the pump set control panel has a sufficient and reliable battery ground connection.

## 8 Electrical drivers

### 8.1 General

In all cases, the electric driver size shall be selected based on continuous power consumption required to fulfil the power demand. The electric driver shall provide at least 5 % more power than the power required by the pump at the peak power consumption demand point or 16 m NPSHr (the 5 % is applied in both scenarios; either at the peak power point or the 16 m NPSHr point).

For the electrical drive the power consumption shall be rounded up to the next higher power according to EN 60034-1 on motor powers, except for submersible motor borehole pumps where the power rating

shall be based on the applicable available motors (the closest size at or above the requirement shall be selected).

Electric motor service factor, overload values or values for short time operation which are normally specified by EN 60034-1 shall not be used.

Cooling requirements for the motor, controller and all components shall be considered.

### 8.2 Environmental conditions for motor sizing

Drivers shall be rated taking into account environmental factors such as temperature and altitude.

## 9 Diesel drivers

### 9.1 General

Except for battery charging, the automatic start and operation of the pump set shall not depend on any energy sources other than the engine and its batteries. The engine shall be capable of starting and achieving full rated power within 15 seconds, at an engine room temperature of 5 °C.

NOTE This is an engine performance criteria, not a direction that the engine room is to be maintained at 5 °C (e.g. see prEN 12845-1:2021, 22.4.2.4 and EN 12845:2015+A1:2019, 10.3.3 where a minimum of 10 °C pump room temperature for diesel pump sets is required).

The diesel driven pump set start sequence shall commence upon receiving the initiation signal. It shall be at running at full duty within 15 s, with full load (e.g. test line fully open), of the beginning of any successful engine running sequence.

Engine monitoring devices shall not cause the engine to stop, slow or reduce power output.

The diesel driver shall be provided with a governor to control the engine speed to ±5 % of its rated speed under normal load conditions. This arrangement shall be constructed so that any mechanical device fitted to the engine which could prevent the engine starting automatically, will return to the starting position.

Diesel driven vertical turbine pumps shall be fitted with an angle gear box. In case of use of right-angle gear-drive, the efficiency of the gear drive shall be considered in the sizing of engine power.

In the case of vertical turbine pumps, the gear box and line shaft losses, before safety factors, shall be accounted for when sizing the driver. All drive train power losses and consumptions (not accounted for elsewhere e.g. EN 12259-12 power requirements) shall be taken into account in power calculations.

All other diesel driven horizontal pumps shall not be fitted with a differential speed gear box.

The engine air intake shall be fitted with a suitable filter and protected from water ingress with the provision of a suitable cowling shroud.

### 9.2 Power

The diesel engine shall be capable of operating continuously at full load, at site elevation, with a rated continuous power output in accordance with ISO 3046-1. No downsizing based on intermittent power consumption shall be applied.

### 9.3 Diesel driver sizing

#### 9.3.1 General

Engines shall be designed and sized only for stationary emergency standby fire pump service.

The diesel engine shall provide at least 10 % more power than the power required by the pump at the peak power consumption demand point or 16 m NPSHr.

NOTE 1 The 10 % is applied in both scenarios; either at the peak power point or the 16 m NPSHr point.

This shall be achieved by sizing the diesel engine based on the ISO 3046-1 (IFN) fuel stop power curve, reduced (i.e. derating the power) by 10 % at the peak power consumption demand point or 16 m NPSHr of the pump.

NOTE 2 This 10 % reduction is a derating of the power output of the engine, not a reduction in the power requirement specified above.

Engines shall be rated in accordance with ISO 3046-1 at the following elevation, temperature and atmospheric pressure conditions of:

— 100 kPa atmospheric pressure; and

— 25 °C inlet air temperature; and

— 91,4 m above sea level; and

— 30 % relative humidity.

Engine power ratings shall consider environmental conditions at the destination application (see 9.3.2).

An aluminium or stainless steel (suitable for the destination environmental conditions) nameplate shall be permanently affixed (e.g. by rivets or similar) to the engine stating the speed and power available to drive the fire pump at standard temperature and pressure conditions. An additional data plate shall be added on which the stated data on the nameplate shall be de-rated accordingly (i.e. according to environmental conditions and the requirements above). The original plate shall not be removed.

### 9.3.2 Environmental conditions

If the deliverable power available from the engine needs to be reduced due to external conditions at the installation, for altitude and or ambient temperature being above standard rating conditions, the deduction rules below shall be used. When the deliverable power available from engine is reduced for site conditions, the engine rating shall be increased accordingly to compensate for the calculations.

A deduction of 3 % from engine power rating at the conditions given in 9.3.1 shall be made for diesel engines for each 300 m altitude above 91 m.

A deduction of 1 % from engine power rating as corrected to conditions given in 9.3.1 shall be made for diesel engines for every 5,5 °C above 25 °C ambient temperature.

## 9.4 Cooling system

### 9.4.1 General

The cooling system shall be one of the types described in 9.4.2, 9.4.3 or 9.4.4.

NOTE See 4.3.

In all cases, the pump set manufacturer shall provide sufficient information to allow the designer of the pump house to achieve satisfactory arrangements for the provision of sufficient fresh air cooling and combustion.

### 9.4.2 Heat exchanger

The heat exchanger bypass shall be sized to provide sufficient cooling across the entire range of expected pressure and flow conditions. 120 % of the closed valve pressure, including tank height, shall be used. The pump set manufacturer shall specify the required parameters for the cooling circuit and flow.

A heat exchanger shall be provided such that the water is taken from the discharge side of the pump set, via a pressure reducing device (if necessary), in accordance with the heat exchanger and engine supplier's specifications.

An auxiliary pump driven by the engine shall circulate the water in the closed circuit (the primary cooling circuit of the engine; not the secondary circuit from the pump set to the water tank and back to the pump). If the auxiliary pump is belt driven, there shall be multiple belts such that even if up to half the belts are broken, the remaining belt(s) are able to drive the pump. The capacity of the closed circuit shall conform to the value specified by the engine supplier.

Water in the raw (i.e. dirty) side of the heat exchanger shall be taken from the fixed firefighting system water source. This water shall be discharged to drain or in the case of a tank, where possible returned to the tank.

NOTE 1 The pump set design intention is that cooling water be returned to tanks when possible, to conserve water. However, it is acknowledged it is not always be possible or appropriate to do so (e.g. where required cooling system performance cannot be achieved, or where the increase in temperature of water in the tank would be problematic). In which case, discharging the water to drain cannot reasonably be avoided.

Where cooling water is sent to a drain, the water consumption shall be specified, so that it can be added to the system total store water requirement.

Water in the engine closed cooling circuit shall be of the quality specified by the engine manufacturer.

The following shall be considered and specified by the pump set manufacturer:

— cooling loop sizing;

— cooling line bypass;

— piping shall be taken from the discharge side of the pump, upstream of (i.e. before) the pump discharge valves;

— material specification and minimum pressure rating;

— cooling water lines to the heat exchanger should be a minimum DN 20.

The piping shall incorporate:

— a strainer of at least one pipe size larger than the pipe work;

— a pressure regulator (if necessary);

— pressure gauges;

— automatic flow valve (if necessary) [normally closed; automatically opens upon engine operation].

NOTE 2 In the event of a serious fire, after the scheduled operating time, there can be no more water available for cooling. This can lead to destruction of the pump set.

### 9.4.3 Air cooled radiator

An air-cooled radiator with a fan shall be driven by multiple belts from the engine. If half the belts break, the remaining belts shall be capable of driving the fan.

An auxiliary pump driven by the engine shall circulate the water in the closed engine cooling circuit. If the auxiliary pump is belt driven, there shall also be multiple belts such that even if half the belts are broken, the remaining belts are able to drive the pump.

The capacity of the closed circuit shall conform to the value specified by the engine supplier.

NOTE Multi-v-belts are considered multiple belts as per the intention of this clause, provided they are sized at ≥ 200 % of the required rating.

#### 9.4.4 Air cooled engine

An air-cooled engine with a direct fan, direct air cooling of the engine by means of a multiple belt driven fan. When half the belts are broken the remaining belts shall be capable of driving the fan.

The pump set manufacturer shall provide sufficient information to allow the designer of the pump house to achieve satisfactory arrangements for the provision of sufficient fresh air cooling, combustion and exhaust.

### 9.5 Exhaust system

The exhaust pipe shall be fitted with a suitable silencer and the total back pressure shall not exceed the supplier's recommendation.

Other requirements for exhaust system (e.g. length, protection from ingress of water, birds and any other extraneous matter) are specified in EN 12845:2015+A1:2019.

In all cases, the pump set manufacturer shall provide sufficient information to allow the designer of the pump house to achieve satisfactory arrangements for the provision adequate exhaust (e.g. sizing of pipe, routing of pipe or removal of products of combustion).

### 9.6 Starting mechanism

#### 9.6.1 General

The pump set control panel shall be provided with automatic and manual starting systems. In addition, an emergency manual starting system external and independent of the pump set control panel shall be provided (see 9.6.3). The engine starter contactors and conductors (i.e. the solenoid) shall be installed separate from the pump set control panel and as close as possible to the starter motor and batteries to minimise voltage drop.

The engine starter contactors and conductors shall be rated for at least 200 % of the expected maximum current draw.

It shall be possible to start the diesel engine both automatically, upon receipt of a signal from the pressure sensors and manually by means of one or more push button(s) on the pump set control panel. Unless the engine is equipped with and ECM unit (see Annex E), it shall only be possible to shut down the diesel engine manually.

#### 9.6.2 Automatic starting

The automatic starting sequence shall make six attempts to start the engine, each one of 7,5 s to 15 s duration, with a maximum pause of 10 s between each attempt. It shall function independently of the line power supply.

The automatic starting system shall switch over automatically to the other battery after each starting attempt. The control voltage shall be drawn from both batteries simultaneously.

#### 9.6.3 Emergency manual start

Independent emergency manual start facilities (mechanical or electrical) shall be provided to start the diesel engine manually, even if the pump set control panel is out of order.

The emergency manual start device shall be protected from unwanted actuation by a design requiring two positive actions to operate. For example, a hinged cover or frangible element.

For emergency starting, the batteries shall be split with a power contactor or solenoid dedicated to each battery.

### 9.6.4 Manual stop

The engine shall normally be stopped by fuel interruption. This can be achieved by a fuel solenoid (i.e. stop solenoid). This can be electrically actuated (by a button on the control panel which is disabled in the automatic mode and 'on demand' condition) or mechanically (i.e. manually) actuated.

When the diesel driver is to be stopped by a fuel solenoid (i.e. stop solenoid), the solenoid shall be configured so that energy is required to perform the stop function.

ECM engines may be configured as 'energised to run' (i.e. the ECM shall be energised in order for the engine to run) [see Annex E]

### 9.6.5 Periodic manual start test provision

NOTE The test interval is specified in EN 12845.

These tests shall demonstrate that the engine, both battery sets, both start solenoids and the automatic circuits within the control panel should operate as required in the event of a fire condition.

During these tests the engine shall be started twice, once from each battery set using only the automatic circuits in the control panel. These tests should not be performed using the 'emergency manual start' button as this button typically does not test the automatic circuits that are used in the event of a fire start.

The first engine test run; the "Automatic pump starting test" shall be initiated by simulating a fire condition by dropping the system water pressure. The engine shall then run for 30 minutes.

When the engine is stopped after the first test run, the 'test start function' mode shall then become active to allow the 'diesel engine restarting test' to be performed. A green 'manual test start' push button shall be provided on the control panel. The 'test start function' mode being active shall be indicated by an indicator with the following wording:

'MANUAL TEST START' BUTTON IS OPERABLE IF LAMP IS LIT

The 'manual test start' push button is only active when this indicator is lit. When this push button is pressed, it shall activate the automatic cranking sequence. The first engine crank shall be from the battery set that did not start the engine from the first engine test run. Once the engine has been started by the 'manual test start' button the test start function indicator is extinguished and the test start push button made inactive.

### 9.6.6 Starter motor

The electric starter motor shall incorporate a moveable pinion, which engages automatically with the flywheel gear rim. To avoid shock loading, the system shall not apply full power to the starting motor until the pinion is fully engaged. The pinion shall not be ejected from engagement by spasmodic engine firing. There shall be a means to prevent attempted engagement when the engine is rotating.

The starter motor shall cease to operate and should return to the rest position if the pinion fails to engage with the flywheel gear ring. After the first failure to engage, the starter motor shall automatically make up to five further attempts to achieve engagement.

When the engine starts the starter motor pinion shall withdraw from the flywheel gear ring automatically by means of a speed sensor. Pressure switches, for example on the engine lubrication system or water pump outlet or alternator output, shall not be used as a means of de-energizing the starter motor.

Speed sensors shall have a direct coupling to, or be gear-driven by, the engine. Flexible drives shall not be used.

### 9.7 Pump set engine supplier pre-dispatch testing of diesel engine

#### 9.7.1 General

Where ECM functionality is included, testing shall be conducted with the ECM functionality configured as required in 7.2.1, 7.4.1, 9.6.1, 9.6.4 and Annex E.

#### 9.7.2 Test procedure

Before being applied to a fire pump, every engine shall have a 1 h dynamometer test as follows:

— 15 min warm up cycle;

— a minimum of 30 min at corrected power, equal to or greater than 110 % of the engine's power rating, for the speed that it is to be applied;

— 15 min cool down cycle, during which:

  — no problems or leaks shall be experienced;

  — conformance of speed regulation by the governor requirement is demonstrated by measuring the speed change between minimum dynamometer load and the engine's power rating starting at the rated speed and load.

#### 9.7.3 Test report

The engine manufacturer shall provide a test report with each engine. Test reports shall be supplied by the engine manufacturer to the pump set manufacturer for their retention.

The test report shall require information to be given on at least the following aspects of the test:

— sample;

— standard used including the publication date;

— method used if several are included in the standard;

— result(s), including a reference to the clause which explains how the results were calculated;

— any deviations from the procedure;

— any unusual features observed;

— date of the test.

## 10 Handover, installation and commissioning

### 10.1 General

The pump set shall be installed and commissioned in accordance with both the pump set manufacturer's requirements and EN 12845:2015+A1:2019.

For diesel driven pump set the following spare parts shall be provided as a minimum: injector nozzles, oil and air filters, fuel filter and cylinder head gaskets.

For electric driven pump set motor protection fuses (where used) shall be provided as a minimum.

For all pumps the following spare parts shall be provided as a minimum: shaft seals and pump body gasket seal.

## 10.2 Pre-commissioning tests

### 10.2.1 General

The performance of the pump set shall be verified as per the tests and checks of 10.2.2. The tests and checks of 10.2 and 10.4 may be conducted at the same time (e.g. at the destination) or it may be necessary to perform them separately (e.g. at the factory and at the destination).

The tests are to be conducted using suitable equipment, calibrated and traceable to standards, suitable facilities and competent personnel.

### 10.2.2 Verification of performance

All pump sets shall be tested:

— diesel driven pump sets shall be tested for no less than 1,5 h at the rated flow;

— electric driven pump sets shall be tested for no less than 0,5 h at the rated flow.

The following shall be recorded:

— hydraulic characteristic curve of the assembled pump set to include at least data at: closed valve (tested at or corrected to maximum inlet pressure), maximum flow demand [i.e. $Q_{\max}$ as per EN 12845:2015+A1:2019, 3.42 or prEN 12845-1:2021, Clause 25; as applicable (where available)] (tested at or corrected to maximum inlet pressure), 100 % flow point ($Q_{100}$ according to prEN 12845-1:2021) and 1,4 times the $Q_{100}$ flow;

NOTE Some informative material on Pump H($Q$) considerations is given in Annex C.

— driver speed with the pump churning;

— driver speed with the pump delivering water at the rated flow;

— suction head at the pump inlet;

— pump outlet pressure at the rated flow downstream of any outlet orifice plate;

— ambient temperature;

— diesel engine cooling water temperature rise at the end of the 1,5 h run;

— diesel bypass cooling water flow rate (see 9.4);

— pump bypass cooling water flow rate (see 4.3);

— electric driven pump sets: voltage, running current and frequency;

— lubrication oil temperature rise at the end of the test run;

— where the driver is fitted with a heat exchanger the initial temperature and the temperature rise of the engine closed circuit cooling water.

## 10.3 Documentation

Each pump set shall be supplied with a set of comprehensive documentation. This may include integration of system sub-component requirements.

Where installation, service or maintenance operations described are sequential, this shall be identified and each stage shall be presented in the correct sequential order.

NOTE 1 It is preferable for the information to be divided up between different sets of documents (e.g. user manual, installer manual and service manual).

The following items identify general headings and specific items of critical importance which shall be clearly presented in the pump set manufacturers' documentation (but not a complete listing of all topics):

— commissioning and operation;

— maintenance and service;

— faults and remedial action;

— pump set dimensions;

— pump set connections;

— pump set sections and parts list;

— any necessary technical information for the design of the pump house.

EXAMPLE Air requirements (for combustion, heat rejection), minimum or maximum ambient operating temperature allowed by the manufacturer, any drainage requirements, architecture and location of the various components (critical distances to be observed).

In addition, the following shall be provided:

— coupling misalignment tolerance dimensional limits (in x, y, z plane and angular);

— details of requirements of any by-pass cooling and associated arrangement;

— transport, handling and storage procedures;

— site assembly and installation of pump set (specifically the following items shall be included as part of a pre-commissioning checklist):

  — foundation and mounting plinth details for pump set baseplates or mounting frames (dimensions, material and reinforcing rod details);

  — foundation bolt hole size and positioning and bolt fixing (if applicable);

    NOTE 2 How a foundation has to be executed depends on each specific site and structural considerations for the installation. A pump set supplier is expected to give minimum requirements of length, width and required concrete as part of his documentation of the supplied pump set to the sprinkler installer.

  — positioning and mounting instructions for pump set baseplates or mounting frames with initial levelling and alignment instructions;

- details of all shimming (temporary or permanent; where used), packing or wedge materials, sizes and exact positioning (with diagrams);
- bolt requirements (size and type);
- bolt grouting requirements (if applicable);
- fixing baseplates or mounting frames to plinth [bolt tightening procedure (sequence and torque)];
- connection of suction and delivery piping (including maximum allowable misalignment which can be tolerated by the pump set);
- final alignment and levelling instructions (if applicable);
- grouting the baseplates or mounting frames at the relevant stage (if applicable);

— operating and maintenance instructions shall include all aspects of the servicing and maintenance of the pump set and have a declaration of life expectancy for specified loading conditions and degrees of misalignment;

— required fuel characteristics (e.g. as specified in EN 590), lubricating oil and coolant type for the diesel driver.

— a suitable fuel maintenance schedule to ensure the fuel shall not degrade and impair engine performance.

— statement that the cooling water flow for each pump set shall be verifiable by observation of discharge or an in-line visual indicator.

The hydraulic characteristic curve (to include impeller diameter, speed of rotation, flow and pressure, absorbed power and NPSHr) for the pump shall be provided by the pump manufacturer with the pump set. The hydraulic characteristic curve of the assembled pump set (see 10.2.2) shall be supplied.

The pump set manufacturers' data sheet showing the following for each automatic pump set shall be provided:

— generated head graph;

— power absorption graph, up to 16 m NPSHr or clear non-overloading power consumption;

— net positive suction head (NPSHr) graph;

— a statement of the power output of each driver;

— minimum submergence depth (with respect to tank low water level 'X') in m for submersible pumps and vertical turbine pumps;

— pump set type (type F, type CB or type VFD; see 7.3.1.1).

## 10.4 Installers' pre-commissioning checks

The pump set installer shall confirm and document, where applicable, the following prior to commissioning:

— pipe-work to and from pump and pipework supports are adequate, to specification and securely fitted;

— fuel lines including fuel tank and fittings are fit for purpose;

— exhaust pipe arrangement;

— pump set has been fitted and aligned to the pump set manufacturer specified tolerances on the baseplate, any steel packers are secure and pull-down grout bolts are set to pump set manufacturer specified torque;

— drain and flow pipes are connected and operational;

— AC electricity supply installed as required;

— batteries are filled and charged ready for use;

— ensure engine has correct level of oil;

— ensure engine cooling line is connected correctly.

### 10.5 Diesel set commissioning

The commissioning of the pump set shall be undertaken in accordance with the pump set manufacturer's instructions and include at least the following procedural steps:

— prior to working on the pump set control panel, it shall be ensured that the circuit breakers are switched off;

— the main lead to starter motor shall be removed to prevent the engine starting, this shall be left isolated for the duration of the commissioning up until the engine requires running;

— ensure batteries are filled and charged;

— connect battery leads if not already carried out;

— energize circuit breakers to bring panel on line;

— check voltage to panel is correct using test meter to IP2X terminals in accordance to EN 60529:1991 [1] using multi-meter with probes, all voltage checks shall be carried out on live terminals;

— energize circuit breakers to battery chargers;

— check float voltage of battery chargers using test meter;

— test high water and low oil temperature switches by shorting to earth using jumper wire;

— when starter motor cable is reconnected, the six attempts to start test shall be performed (see 9.6.2). The test shall be performed using cranking durations of 7,5 s to 15 s; as per the pump set manufacturer's specified design cranking duration for this test. The alarm 'failure to start' shall then operate;

NOTE This test is achieved by depriving the engine of fuel by restricting the supply of fuel (which can be achieved by a variety of means). The fuel lines can require bleeding after this operation to ensure no air remains in fuel lines.

— fuel supply shall than be restored and the engine shall start when the manual start test button is operated;

— set pressure sensors as per customer requirements, these are tested to earth using test meter;

— charge pump with water and check for leaks;

— ensure pump oil level is correct where applicable;

— carry out manual test start checking cooling water flow and engine run signal are operating correctly;

— carry out auto start from pressure drop;

— carry out a duty test for 30 min on all outlets at full load (e.g. typically $Q_{max}$ as per EN 12845:2015+A1:2019, 3.42) and record results using on site flow measuring equipment, pump gauges. check bearing temperatures and gland leakage, where applicable. Check pump bearing temperatures and gland leakage, where applicable;

— check panel indicators are functioning correctly.

### 10.6 Electrical set commissioning

The commissioning of the pump set shall be undertaken in accordance with the pump set manufacturers instructions and include at least the following procedural steps:

— after ensuring pump set is electrically disconnected by the isolation switch and all forms of energy are disabled, remove the coupling (if necessary) and check alignment of pump to motor to check for pipe strain;

— check electrical installation of wiring to starter panel and from starter to motor by putting test meter on cables to check for any short circuits;

— restore electrical supply to panel;

— charge pump with water and check for leaks by opening suction valves;

— carry out a test to check motor rotation is correct (e.g. momentary application of power);

— ensure pump oil level is correct, where applicable;

— carry out manual test start of pump checking cooling water flow is as required;

— carry out auto start from pressure drop;

— carry out a duty test for 30 minutes on all outlets at full load (e.g. typically $Q_{max}$ as per EN 12845:2015+A1:2019, 3.42) and record results using on site flow measuring equipment, pump gauges and panel ammeters; also check bearing temperatures and gland leakage, where applicable;

— check bearing temperatures and gland leakage, where applicable;

— check panel indicators are functioning correctly.

## 11 Maintenance programme

Generic maintenance requirements for pumps are given in EN 12845:2015+A1:2019. The pump set manufacturer shall provide a maintenance schedule to suit the equipment, and a suitable log book.

# Annex A
(informative)

# Pump set installation and fixing considerations; examples

Pump set installations are typically in accordance with the pump set manufacturers' recommendations, specified in the pump set data sheet, pump commissioning instructions or equivalent document.

The design of the pump set foundations, supports and housing is not specified in detail in this document, these are nevertheless important aspects as well as the physical requirements to support the pump set in service. This may necessitate reference to other local codes and standards.

This annex provides examples of typical and effective means of fixing. Other suitable means of pump set installation and fixing may be effective, as specified by the pump set supplier.

The following procedures are typically carried out before and during the pump set installation:

— the foundation is checked for position and correct dimensions before the pump set is put in place;

— the pump set is positioned and levelled on the foundation. To assist with the levelling, shims and cement grout are used under the baseplate or mounting frame, at the points specified by the pump set manufacturer. The shims or packing pieces are to support the pump set baseplate or mounting frame on at least two sides of any anchor bolt.;

— after levelling the pump set the nuts on the anchor bolts are partially tightened, systematically and evenly, but not to the final torque setting;

— grout in the anchor bolts;

— after the grout has fully cured the nuts on the anchor bolts are tightened to the torque setting recommended by the pump set manufacturer; and

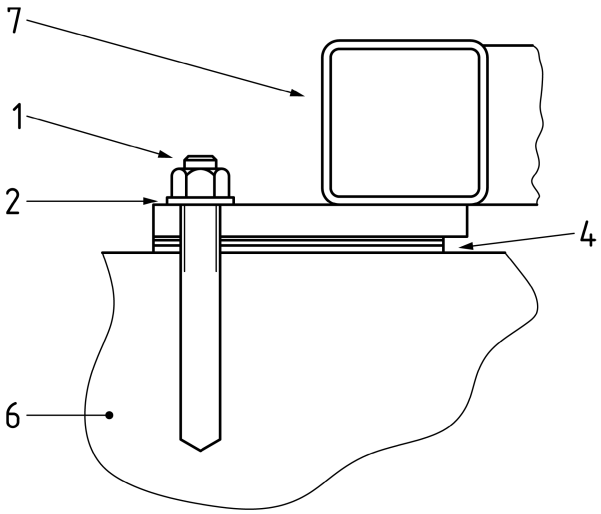
— where specified by the pump set manufacturer, the pump set baseplate or mounting frame is grouted to the foundation by filling the pump set base with grout. The shims or packing pieces are also grouted in place with grout extending along the full length of the baseplate or mounting frame.

The pump set alignment is finally checked after the pipework has been connected to the pump. The pump set is not re-shimmed or moved to accommodate misalignment of the system pipework.

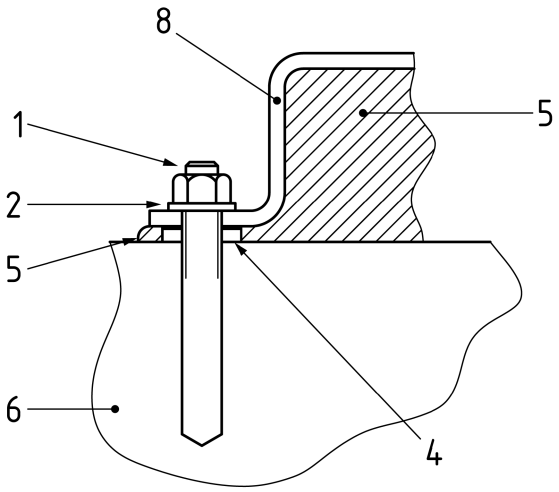
The weight of pump suction pipework, delivery pipework and valves, and any dynamic forces acting on them are carried by purpose-made pipe supports and not by the pump branches. Pump test lines are adequately anchored and restrained.

The pump set anchor bolt nut threads are fully engaged with the bolt, which extends at least two threads beyond the nut.

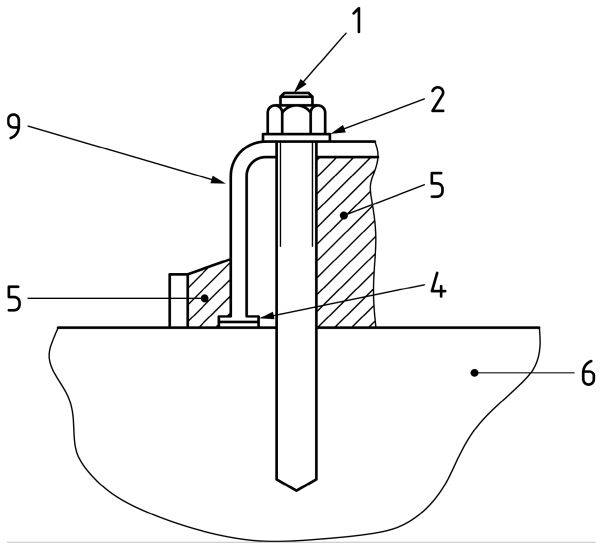
Four typical examples of pump set baseplate or mounting frame fixing are shown in Figure A.1.



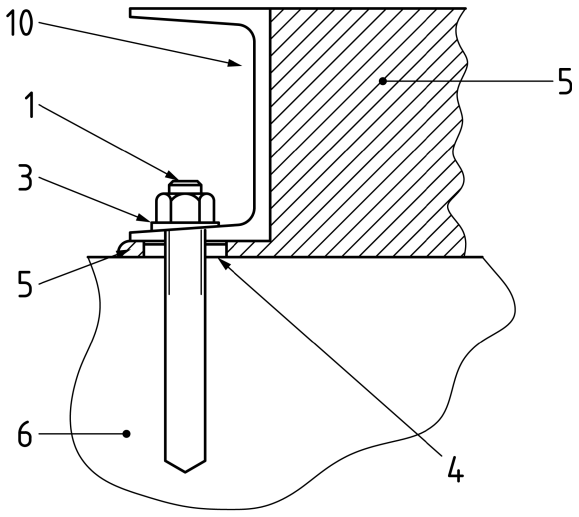

a) Square hollow section




b) Folded flange section




c) Folded section




d) 'C' channel section

**Key**

| | | | |
|---|---|---|---|
| 1 | foundation bolt | 6 | concrete foundation plinth |
| 2 | flat washer | 7 | hollow section baseplate or mounting frame |
| 3 | square taper washer | 8 | flanged folded baseplate or mounting frame |
| 4 | shims or packers | 9 | folded baseplate or mounting frame |
| 5 | grout | 10 | channel section baseplate or mounting frame |

**Figure A.1 — Typical examples of pump set baseplate or mounting frame fixing**

# Annex B
(informative)

# Information for designers, subject matter experts and to assist evaluation by authorities

## B.1 General

Sprinkler systems, their components, devices and water supplies may be required by national regulations or required by building authorities in conjunction with evaluations by fire brigade. The following technical information is compiled to help designers and authorities to evaluate the reliability and adequacy of pump sets.

## B.2 Information about electrical pump controllers

An electrical pump for a sprinkler system is oversized to cope with adverse conditions. Extra features are provided for the pump controller compared to standardised industrial equipment. Sprinkler systems and their components are a means for loss control and fire protection in buildings. National authorities may have different approaches or solutions. This document is written to describe the best industrial practice, but some European countries may need more detailed information.

For examples of industrial performance documents see the bibliography.

## B.3 Industrial practice and design hints

### B.3.1 Intent of the short circuit protection as given in IEC 62091

#### B.3.1.1 General

An electrical fire pump controller allows the locked rotor current to flow for a certain period of time to ensure that the pump can start under adverse conditions. Once started, it allows the pump not to be stopped by any tripping or protection device, thus ground fault protection with tripping is not used. The motor is seen as being dispensable and may run to destruction in an emergency.

The following parameters for a squirrel cage motor, also called an asynchronous motor, are an example and describe the intent.

#### B.3.1.2 Starting modes as given in IEC 62091

##### B.3.1.2.1 General

The following highlights the starting modes of IEC 62091.

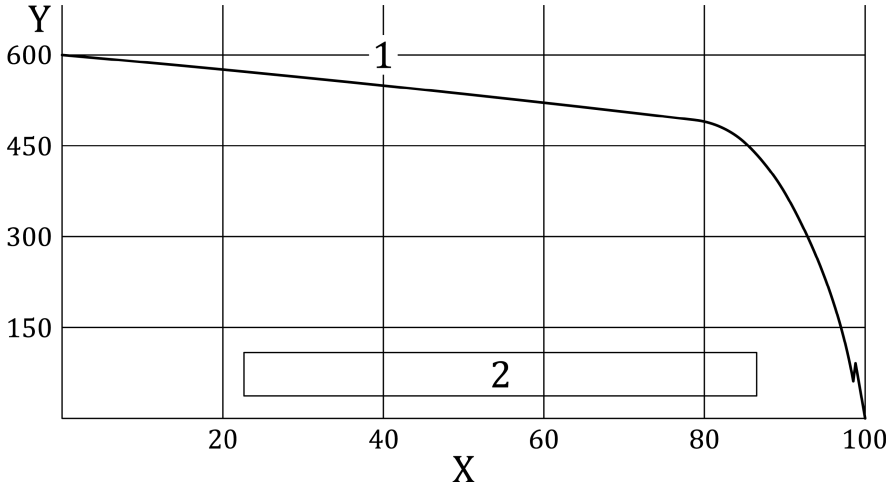
##### B.3.1.2.2 Full voltage starting mode – DOL (direct on line)

This is generally a simple method of starting an electric motor. It generally requires the fewest current carrying components. Full voltage is applied to the motor upon start activation. See Figure B.1.

NOTE This starting method can be prohibited in some jurisdictions, for some motor sizes.

| | |
|---|---|
| Starting current: | 6 to 8,5 times FLC, reducing when motor reaches 50% of full speed. |

Method: single contactor with rapid starting speed.




**Key**

| | | | |
|---|---|---|---|
| X | synchronous speed | 1 | plot of speed vs current |
| Y | % full load current | 2 | starting torque equals 100 % of full load torque |

**Figure B.1 — Example direct on-line synchronous speed versus full load current**

For full voltage direct-on-line (DOL) starting, IEC 62091 describes an electromagnetic contactor meeting the requirements of utilization category AC-3 in accordance with EN IEC 60947-4-1:2019 [4] with a thermal capacity to allow three 30 s starts separated by rest intervals of 30 s each hour for 2 hours.

#### B.3.1.2.3 Reduced voltage starting mode

Reduced voltage starting means are quite commonly used due to capacity limits or design constraints of electrical systems. These are well known industrial practices but fire pumps are designed to operate under adverse conditions and are therefore oversized for their application. The following reduced voltage starting means are listed in IEC 62091:

a) primary resistance;

b) primary reactor;

c) autotransformer;

d) star-delta;

e) part winding;

f) semiconductor controller (soft starter).

### B.3.1.3 Most common reduced voltage starting means – star-delta

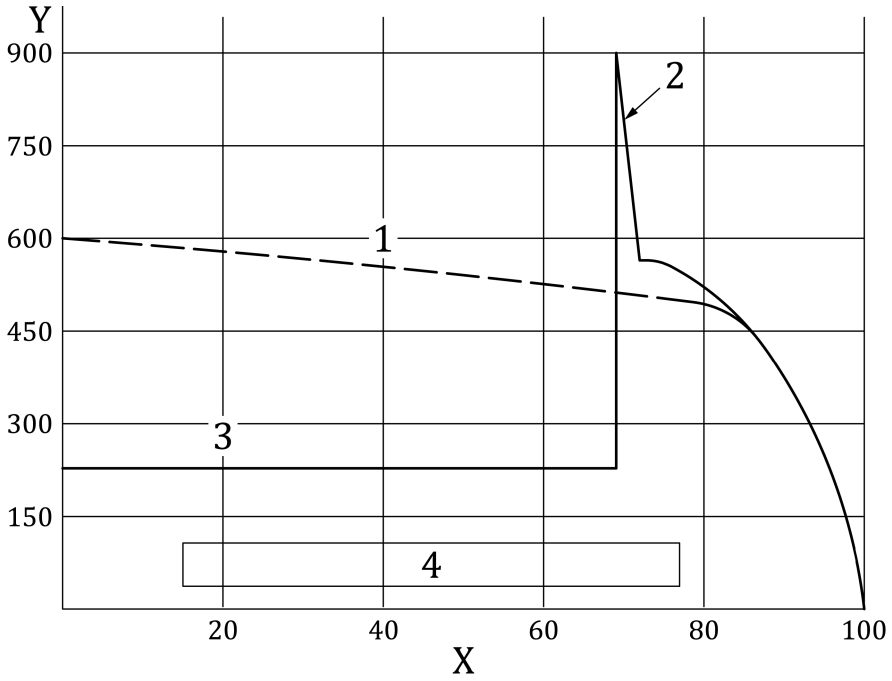
IEC 62091 suggests for star-delta that each conductor carries 58 % of the motor´s rated operational current.

The utilisation category of the magnetic contactors is the same as described for the direct on-line starting mode. The star-delta open transition means that initially the voltage is connected to the motor in a star

configuration resulting in 58 % of the nominal voltage being applied to the motor, then the full voltage is applied when the controller changes to delta connection. See Figure B.2.

| | |
|---|---|
| Starting current: | 1/3 of locked rotor current while in star, jumping to 6 times briefly. |
| Method: | three contactors reduced voltage (58 %) start system. |
| Transition current: | can be two times locked rotor current (12 to 25 times FLC). |

Transient currents when starting in star mode need to be considered as well as when switching from star to delta. The latter can be as high as two times locked rotor current and may influence other devices in the system or influence the protection device for the upstream protection. Adequate electrical design is to be considered.




**Key**

| | | | |
|---|---|---|---|
| X | synchronous speed | 2 | open transition |
| Y | % full load current | 3 | Wye-Delta start |
| 1 | full voltage start (DOL) | 4 | starting torque equals 33 % of full load torque |

**Figure B.2 — Example synchronous speed versus full load current**

In general, star-delta motors are used as dual voltage motors. When they are used in this way, the star connections have a voltage rating equal to 1,732 (square root of 3) times the voltage rating when connected in delta. Therefore, if the motor is connected in star and used on the lower voltage rating, the effect is the motor operating at 1/1,732 or 58 % of nominal rating. Typical voltages used are 400 V for delta connection and 690 V for the star connection.

The star-delta closed transition is the same as above, but resistors are momentarily switched in at the point of star to delta changeover to reduce the high transient current. These controllers are considerably higher priced than star-delta open transitions due to the power resistors and more switching components being needed, but they have fewer effects on other electrical devices.

| | |
|---|---|
| Starting current: | 2 to 3 times FLC while in star. |
| Method: | four contactor and power resistor system. |

## B.4 Information about controllers for diesel engine driven fire pumps

Diesel pump controllers have a long history in sprinkler systems and are designed using well-established guidelines. For examples of industrial performance documents see the bibliography.

## B.5 Information about flexible fire pump couplings and flexible connecting shafts for fire protection service

Flexible couplings have an above average failure rate, if designed improperly. For examples of industrial performance documents see the bibliography.

## B.6 Information about diesel engine drives

Diesel engine drives also have a long history in sprinkler systems and are designed using well-established guidelines. For examples of industrial performance documents see the bibliography.

## B.7 Information about electrical motors for fire pumps

In water supplies with multiple pumps for backup in most cases at least one fire pump is electrical. The application of electrical drives which do not rely on fossil fuels may increase for environmental reasons, particularly with the increased use of energy storage systems, which can provide power independently of the grid. The energy storage systems for electrical fire pumps is independent of the general supply and allows the electrical motor to perform per industrial performance requirements. Designers need to be aware about the performance criteria of electrical motors for fire pumps, so that their performance is not limited by the design of the electrical supply system. For examples of industrial performance documents see the bibliography.

# Annex C
(informative)

# Guidance on requirements for fire pump set H(Q) performance

This standard uses a variety of this terminology to suit various applications (e.g. Control Mode Density Area (CMDA) system designs , Early Suppression Fast Response (ESFR) system designs and Control Mode Specific Applications (CMSA) system designs). A key objective is to have a reliable water supply providing the required flow and pressure for the system with the highest demand plus some safety margin for adverse condition.

There are some differences in the way that EN 12259-12, EN 17451, EN 12845:2015+A1:2019 and prEN 12845-1:2021 describe some aspects of pump or pump set hydraulic performance. These differences may reflect the different stages in the testing, specification and design process of creating a system, or changes in design approach prescribed by the standards. For example:

— Terms such as: $Q_r$, $Q_0$, 140 % of $Q_r$ and 70 % of $Q_r$ are used in EN 12259-12 for nominal pump rating purposes.

— Terms such as: $Q_{max}$, pressure and flow required at the most favourable and unfavourable areas are used in EN 12845:2015+A1:2019 to describe the required pump curve for fully hydraulically calculated systems. Safety margins and consideration of tank water levels are also specified.

— Terms such as: $Q_{max}$, $Q_0$, $Q_{100}$, 140 % of $Q_{100}$ flow and 70 % of $Q_{100}$ pressure, pressure and flow required at the most unfavourable areas are used in prEN 12845-1:2021 to describe the required pump curve for fully hydraulically calculated systems. Safety margins and consideration of tank water levels are also specified.

This standard aims to use a variety of this terminology to suit the application as applicable.

It is important that as product progresses through the supply chain (e.g. bare shaft pump in to a pump set in to an integrated system) all elements are specified as required and to perform correctly by the specialist designers.

# Annex D
(informative)

# Typical examples of pump set coupling arrangements

Table D.1 provides examples of typical pump coupling scenarios and arrangements.

NOTE This annex provides examples only. It is not exhaustive. Other suitable designs, configurations and innovations are possible.

**Table D.1 — Examples of pump coupling scenarios**

| Pump type | Pump shaft positions | Type of driver | Example type of failsafe coupling arrangement |
|---|---|---|---|
| end suction long coupled | horizontal only | Electric motor or diesel engine | with spacer coupling |
| end suction closed coupled are:<br>pump shaft with mounted impeller which is separate to motor shaft | horizontal only | Electric motor | no spacer coupling |
| | | End suction pumps closed coupled not allowed to be used with diesel engine | |
| axial horizontal split case | horizontal | Electric motor or Diesel engine | no spacer coupling |
| | vertical | Electric motor only | |
| multistage inline pumps | vertical only | Electric motor only | no spacer coupling |
| single stage inline pumps | horizontal | Electric motor only | with or without spacer coupling |
| | vertical | | |
| ring section pumps | horizontal | Electric motor or Diesel engine | with spacer coupling |
| | vertical | Electric motor only | no spacer coupling |
| vertical turbine pumps | vertical only | Diesel engine plus angle gear box | no spacer coupling |
| | | Electric motor plus angle gear box | |
| | | Electric motor without angle gear box | |
| submersible motor borehole pumps | horizontal | Electric motor only | no spacer coupling |
| | vertical | | |
| multistage multi-outlet pumps | horizontal | Electric motor or Diesel engine | with spacer coupling |
| | vertical | Electric motor only | no spacer coupling |

# Annex E
(normative)

# Diesel engine equipped with engine control module (ECM)

NOTE This Annex outlines various expected functional requirements of ECM equipped engines. ECM equipped engines according to European Standards do not yet exist in this application in Europe, therefore, the approach remains in development. At this time, for fire protection application, this approach is to be avoided where possible due to the expected additional risks to performance. Where unavoidable, the following requirements and recommendations are made.

Where engines are fitted with ECM systems (which includes all related sensors), two complete ECM systems (including all sensors) shall be provided. They shall be configured so that the engine can produce its full rated power output in the event of a failure of the primary ECM.

The transition from the primary ECM to the alternate, or alternate to primary shall be controlled automatically by the diesel engine ECM control system. There shall be a switch to allow manual override of switching, for test purposes. The changeover between primary ECM and the alternate ECM can be done whilst the engine is running ('hot change over') or the engine may stop to allow the changeover to occur, providing that the engine is back to full speed on the alternate ECM within 35 s.

A typical procedure for a changeover system, where the engine will stop and restart, can be:

— upon the primary ECM failing, the engine will come to a complete stop, and the 'ECM failure' condition shall be sent from the engine ECM control system to the pump set control panel;

— the pump set control panel will show 'ECM Failure' alarm;

— the engine ECM control system will then automatically switch to the alternate ECM, and send an 'Alternate ECM' alarm to the pump set control panel signalling that it is ready to start again;

— the fire pump set control panel will then start the engine again under its normal automatic starting sequence.

The pump set control panel shall only restart the engine if, the ECM failure and ECM alternate conditions are set at the same time with the controller in automatic mode.

Where engine safeguards are monitored by the ECM the data can be monitored but shall not be used to instigate any engine protection measures.

Any ECM sensor necessary for the function of the ECM that affects the engine's ability to produce its rated power output shall have a redundant sensor that shall operate automatically in the event of a failure of the primary sensor. The engine shall provide information such as RPM, oil pressure, water temperature in the same way as a mechanical engine. If the engine also offers this information by digital protocols (e.g. CAN BUS or other similar protocols), this may also be used. In the standby mode, the engine batteries shall be used to power the ECM. The batteries shall be sized to accommodate the ECM during 72 h in standby mode, starting operation at the end of 72 h, plus 6 h while the engine is running. An engine mounted alternator may be provided to provide battery charging while the engine is running.

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