Controllers for Electric Motors

Requirements and test methods

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VdS Guidelines for water extinguishing systems

Controllers for Electric Motors

Requirements and test methods

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1 General

1.1 Scope

These Guidelines specify requirements and test methods for controllers for electric motors (hereafter referred to as controllers) in sprinkler, water spray and foam extinguishing systems (hereafter referred to as extinguishing systems).

1.2 Description

The controller controls and monitors the starting and stopping of a pump actuated by an electric motor, designed for extinguishing systems. In addition, connection devices and switching, control and indicating equipment for sub-assemblies can be provided, which are required for maintaining the operational readiness of the extinguishing system. These may include the following:

- tank filling pump;
- booster pump for the pipework of the extinguishing system;
- air compressor;
- supply outlet for heaters or heating bands of low capacity (max. 3kW) to keep the sprinkler equipment room or small parts of the pipework frost-free;
- motorised valves;
- sewage pump belonging to the extinguishing system;
- lighting of the sprinkler equipment room;
- ventilation of the sprinkler equipment room;
- monitoring and control panel;
- controllers for diesel engines.

1.3 System requirement

If a sprinkler pump is supplied from more than one electrical power source, each power source shall have its own controller, electrically interlocked against each other. If a flow rate is delivered by more than one pump, each pump shall have its own controller.

If a pump is supplied from more than one electrical power source, only the controller of the first mains supply shall have one set of operating elements for the pump and for switching, control and indicating equipment for sub-assemblies. If the first power source fails, all sub-assemblies required in the case of fire, e.g. motorised valves, shall be able to continue operation.

1.4 Recognised codes of practice

The controller shall comply with the recognised codes of practice. These include the regulations published by VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V. (Association for Electrical, Electronic & Information Technologies), e.g. DIN VDE 0100 “Regulations for installing low voltage systems” and DIN EN 60439-1 (VDE 0660-500) “Low voltage controller combinations“ Part 1: “Type-tested and partially type-tested combinations“, the accident prevention regulations by Berufsgenossenschaft der Feinmechanik und Elektrotechnik

(Employers' Lia-bility Insurance Association of Precision Engineering and Electrical Engineering) BGV A3 “Electrical systems and equipment”.

1.5 Type series

1.5.1 Controllers of one type series

Type series are controllers with different power levels, such as 11-250kW, but with the same circuit diagram. Each power level shall be clearly identifiable in the type designation and comprehensively documented in the technical documentation. Equipment with power-related dimensioning can be adjusted to each power level within one type series.

1.5.2 Controllers of different type series

Different type series imply that the controllers have different:

- start-up circuits (e.g. direct start-up, star-delta, star-delta interruption-free, start-up transformer, soft start, frequency converter);
- connection voltage;
- mains changeover;
- monitoring.

1.5.3 Ancillary equipment

If a power range is provided for the individual sub-assemblies, the appropriate electrical equipment and cables shall be rated for maximum power.

The following equipment shall be adjusted to the effective power rating of the consumer:

- wiring protection devices, e.g. fuse inserts, circuit breakers, motor protection switches, and
- the thermal motor protection equipment, e.g. overload protection relays, motor protection switches.

1.6 Approval

The controllers are tested and approved in the configuration submitted. If the configuration for sub-assemblies is reduced, a renewal of the approval is not necessary. Extensions shall be submitted for testing. Controller cabinets of one type series can be combined into one approval. Controller cabinets of different type series will get separate approvals for each series.

1.7 Validity

These Guidelines will come into force on February 1, 2011. They supersede VdS Guidelines for water extinguishing systems – Controllers for electric motors – Requirements and test methods – VdS 2100-21 : 1987-02.

Note: The validity of existing approvals may be extended according to the approval period of the respective approval for another 4 years until January 31, 2011.

2 Normative references

These Guidelines incorporate dated or undated references to other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to these Guidelines only when incorporated in them by amendment or revision. For undated references the latest edition of the publication referred to applies.

BGV A3 Accident prevention regulations for electrical installations and equipment

DIN 5032-7 Light measurement classifications for illuminance and brightness measurement instruments

DIN EN 50130-4 (VDE 0830-1-4) Alarm systems – Part 4: Electromagnetic compatibility, Product family standard: Immunity requirements for components of fire, intruder and social alarm systems

DIN EN 54-2 Fire detection and fire alarm systems – Part 2: Control and indicating equipment

DIN EN 54-3 Fire detection and fire alarm systems – Part 3: Fire alarm devices – Sounders

DIN EN 60068-1 Environmental testing – Part 1: General and guidance

DIN EN 60068-2-1 Environmental testing – Part 2: Tests; Test A: Cold

DIN EN 60068-2-2 Environmental testing – Part 2: Tests; Test B: Dry heat

DIN EN 60068-2-30 Environmental testing – Part 2-30: Tests; Test Db: Damp heat, cyclic (12 + 12 hours)

DIN EN 60068-2-6 Environmental testing – Part 2: Tests; Test Fc: Vibration, sinusoidal

DIN EN 60068-2-75 Environmental testing – Part 2: Tests; Test Eh: Hammer tests

DIN EN 60068-2-78 Environmental testing – Part 2-78: Tests; Test Cab: Damp heat, steady state

DIN EN 60529 (VDE 0470-1) Protection class housing (IP code)

DIN EN 60695-2-10 (VDE 0471-2-10) Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow wire apparatus and common test procedure

DIN EN 60695-2-11 (VDE 0471-2-11) Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow wire flammability test method for end products

DIN EN 61672-1 Electroacoustics – Sound level meters – Part 1: Specifications

DIN EN 61672-2 Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests

IEC 60695-2-2 Needle-flame test

VdS CEA 4001 Guidelines for sprinkler systems, Planning and installation

3 Definitions

3.1 Disabled condition

The signal “Disabled condition” is given when, after automatic start-up, the pump is disabled manually via push buttons while the starting command of at least one pressure switch for automatic pump start is still present.

4 Requirements

4.1 Marking

Controllers shall be marked at the front with the following information:

- name of manufacturer;
- type designation;
- year of construction;
- power level of controllers;
- operating voltage/operating frequency;
- enclosure rating acc. DIN EN 60529;
- approval number.

The marking shall be non-detachable, permanent and well legible.

One copy of the circuit documents shall be supplied with each controller.

4.2 Configuration and design

4.2.1 Controller cabinet

The cabinet of the controller shall be made of metal.

The enclosure rating of the cabinet of the controller, electrical equipment and cable entries in the walls and doors of the controller shall be at least IP 54.

According to the operating conditions higher enclosure ratings may be required.

4.2.2 Cable entries and terminals

For external connections separate terminals shall be provided. Where possible by the nominal sizes of the terminals, series terminals shall be used. The incoming power supply can also be connected directly to the main switch (e.g. fuse switch).

Cables and lines shall lead into the controller from the bottom side.

One terminal should be connected to one conductor only. The connection of two or more conductors is permitted only if the terminals are designed for this purpose.

4.2.3 Immunity to heat and fire

The controller shall be constructed such that it can neither cause a fire nor contribute to fire spread.

Plastic insulating components shall be resistant to heat and fire.

The requirements will be fulfilled if the tests of 5.11.8 have a positive result.

4.2.4 Equipment

Switches, contactors, relays, protective equipment (fuses etc.) shall be fitted inside the controller cabinet. It shall be possible to operate any operating elements from the front side, indicators shall be readable from the front side. Sounders can be fitted either inside or at the front.

4.2.5 Operating conditions

The controller shall function in a temperature range between -5°C and +40°C and with deviations from the mains nominal voltage between +10% and -15%.

4.2.6 Main switch

The power shall be supplied via a main switch inside the controller cabinet, by means of which all series-connected equipment can be activated. Fuse switches are also classified as main switches. The main switch shall be operable only when the controller cabinet is open.

4.2.7 Usage category

In accordance with DIN EN 60947-1 main switches, contactors and motor starters shall be at least usage category AC 3 for alternating/rotary current, usage category DC 2 for direct current in consideration of the maximum start-up time of 10s.

4.2.8 Contactors and motor starters

4.2.8.1 Direct starter

The load circuit shall be able to switch on, switch off and conduct the motor currents resulting from the direct control of a squirrel-cage motor.

Reference values are:

Starting current peak:	$I_s = 2^* \sqrt{2} ^* I_{an}$
Start-up current:	$I_{an} = 4...8,4^* I_n$
Start-up time:	$t_{an} < 10s$
Reference values for minimum rating of main contactor:	100% of motor capacity

4.2.8.2 Star-delta starter

In case of a star-delta start-up the start-up current is reduced to 1/3 of the direct start-up current. This circuitry is applicable only with rotary current asynchronous motors whose motor nominal voltage in delta connection corresponds to the mains

nominal voltage and whose winding ends are routed separately on the terminal board.

Time relays shall be used with an unchangeable contact changeover time of approx. 50ms between star and delta operation to reduce the occurrence of switching peaks.

Reference values for minimum rating of contactors:

Mains contactor:	58% of motor capacity
Star contactor:	33% of motor capacity
Delta contactor:	58% of motor capacity

4.2.8.3 Star-delta starter interruption-free

With closed star-delta switching, the motor is connected to the mains after the end of the star connection without intermission via a so-called transition contactor and transition resistors in delta connection, and after approx. 50ms switched into the normal delta connection without intermission. The transition resistors shall be designed for at least ten start-ups with a one minute interval in between. This procedure shall be repeatable after one hour.

Reference values for minimum rating of contactors:

Mains contactor:	58% of motor capacity
Star contactor:	58% of motor capacity (starting frequency)
Delta contactor:	58% of motor capacity
Transition contactor:	26% of motor capacity

4.2.8.4 Transformer starter

During the start-up the rotary current asynchronous motor is connected to the tapping of a transformer in star economy circuit. The start-up voltage may be reduced to 65% max. of the mains nominal voltage so that it does not fall below 50% of the starting torque referring to a direct start-up.

The transformer starter shall be designed for at least ten start-ups with a one minute interval in between. This procedure shall be repeatable after one hour.

Reference values for minimum rating of contactors:

Star contactor:	33% of motor capacity
Transformer contactor:	58% of motor capacity (+ consideration of start-up power of transformer)
Motor contactor:	100% of motor capacity

4.2.8.5 Soft starter

The soft starter shall be activated via a mains contactor to prevent any unintended start-up of the motor.

If the soft starter prevents the unintended start-up of the motor, the mains contactor will not be required (e.g. via an electronic safety function with an appropriately designed control circuit).

The soft starter shall be able to activate the nominal capacity of the pump motor and the bypass contactor.

After the run-up the bypass contactor bridging the soft starter shall be switched on.

The bypass contactor shall be selected in usage category AC-3 for direct switching.

The bypass contactor shall be self-holding. In the event of a fault, e.g. caused by soft start, the bypass contactor shall not disconnect.

4.2.8.5.1 Type of soft start-up

A soft start-up can be either current run-up with current limitation, or voltage run-up without or with current limitation. The start-up type shall be specified in the documentation.

4.2.8.5.1.1 Current run-up with current limitation

In case of a current limitation, a time relay independent of the soft starter shall be fitted to switch on the bypass contactor when required. The independent time relay shall be adjusted to a value which, in failure-free run-up, is shortly after the switch-on of the bypass contactor caused by the soft starter.

Note: In failure-free operation the pump is started by the soft starter. If the bypass contactor in current limitation mode is not switched on by the soft starter, it is compulsorily switched on by the independent time relay. In accordance with VdS CEA 4001 the pump shall operate at nominal capacity within 15 s of the beginning of any starting sequence.

4.2.8.5.1.2 Voltage run-up without and with current limitation

In case of voltage run-up it shall be ensured that the bypass contactor is switched on after the run-up ramp. Evidence by the soft starter manufacturer shall be submitted.

If the voltage run-up has e.g. current limitation extending the start-up, or if a monitoring of the maximum starting time of the voltage ramp is integrated, the start-up can be cancelled by the soft starter. In case of cancelling, the bypass contactor shall be switched on. The a.m. conditions for current limitation apply.

In case of a start-up command for the pump motor and a fault signal from the soft starter preventing a run-up or immediately protecting the soft starter from destruction, the bypass contactor shall be switched on directly.

All other fault signals shall result only in signals in accordance with 4.2.14. Evidence by the soft starter manufacturer shall be submitted.

It shall be possible to activate the soft starter after mains voltage failure and mains voltage return or after a fault, i.e. the soft starter shall not have a restart lockout. Evidence by the soft starter manufacturer shall be submitted.

In case of a start-up command for the pump motor and a mains failure occurs, the pump shall be re-started automatically by the soft starter after mains stabilisation.

All adjusted parameters, such as voltage run-up, current run-up and times as well as all adjustable parameters for the soft starter, shall be included in the documentation.

All mounting and installation instructions, such as distances from and to interference suppression components by the soft starter manufacturer shall be met.

4.2.8.6 Frequency converter

The frequency converter shall be switched on via a mains contactor to prevent any unintended starting of the motor.

If the frequency converter prevents an unintended motor start, the mains contactor will not be required (e.g. via an electronic safety function with an appropriately designed control circuit).

In order that an overload of the motor be not switched off, the nominal capacity of the frequency converter shall be chosen for at least 1,2-fold the nominal capacity of the motor.

All mounting and installation instructions by the frequency converter manufacturer shall be met.

Fault warnings which do not directly serve for protecting the frequency converter from being destroyed, shall only cause an indication in accordance with 4.2.14, but no disablement. Evidence by the frequency converter manufacturer shall be submitted.

It shall be possible to switch on the frequency converter after mains voltage failure and mains voltage return, i.e. the frequency converter shall not have a restart lockout. Evidence by the frequency converter manufacturer shall be submitted.

In case of a start-up command for the pump motor and mains failure, the frequency converter shall re-start the pump automatically after mains stabilisation.

Operation of the motor protective equipment of the frequency converter shall not cause disablement, but only an indication in accordance with 4.2.14.

All adjusted and adjustable parameters of the frequency converter shall be included in the documentation.

Any measures taken for an EMC-compatible configuration of the electric drive system of controller and motor line shall be included in the documentation, e.g.:

- lengths, construction types of cables and lines (shielding);
- connection of the shield to the PE rail;
- interference suppression components of e.g. contactors, relays and solenoid valves.

Filter fans for ventilation of the controller with sufficient air capacity shall be fitted to drain off the heat generated at maximum power dissipation inside the cabinet. Maintenance intervals for the filters shall be specified in the documentation in accordance with the manufacturers' specifications. A fuse blow shall be indicated as a fault as specified in 4.2.14.

4.2.9 Control transformer

A control transformer may be fitted in the control circuit for voltage adjustment.

The short-term power of the control transformer shall be at least as great as the pick-up power and holding power of the contactors and consumers which have been or are being activated simultaneously when the pump starts.

The continuous power of the control transformer shall be at least as great as the sum of the holding powers of all contactors and consumers activated simultaneously.

As the additional stray fields of a star-star circuit (Yy) mainly close via ferromagnetic construction parts (e.g. transformer tanks), a loading of the output neutral conductor 2N is permitted at 10% of the nominal current only. This is due to the additional losses dissipated as heat.

For protective equipment for the control transformer see 4.2.11.4.

4.2.10 Remote control panel

The controller may have provision for the connection of a remote control panel.

With a remote control panel the function and functional condition of the controller can be controlled while located elsewhere.

The following requirements apply to non-monitored and monitored controllers as specified in these guidelines.

Open or short circuits in cables or lines to the remote control panel shall not affect the function of the pump.

At least the following control elements and indicators shall be provided:

- ON and OFF push button for pump;
- optical light indicators “Operation”, “Fault” and “Disabled condition” of pump.

Indicators shall be in accordance with 4.2.14 and control elements with 4.2.13. They should be wired with separate cables and lines between remote control panel and controller.

The cross sections and maximum lengths of these cables and lines shall be specified in the documentation.

Cables and lines to the control elements for activating and deactivating the pump shall be monitored for open and short circuit. Open and short circuit shall be indicated as faults in accordance with 4.2.14, but shall not enable or disable the pump.

The requirements are fulfilled, if the tests of 5.6 are passed.

4.2.11 Protective equipment

4.2.11.1 Main fuses

The main fuses in the controller shall have slow response behaviour and be designed such that they can resist the current of a blocked motor for at least 75% of the time until the coils fail. After that it shall be possible to apply normal current plus 100% for at least 5h.

This may also be realised by fitting the controller with high power fuses which are so designed that they can hold the start-up current for at least 20s. The nominal current of the protective equipment shall exceed the operating current of the circuit.

Upstream of the main fuse no outgoing lines shall be fitted. Main circuits of sub-assemblies shall have their own protective equipment downstream of the main fuse.

Note: It is permitted to have overvoltage protection upstream of the main fuse inside the controller (only by agreement with the controller manufacturer) or outside the controller. In this case the cable to the overvoltage protection equipment shall be short circuit proof and short circuit protected, or else it shall be so dimensioned that it is protected by the upstream fuse.

If overvoltage protection is fitted in a separate cabinet at the same place of installation as the controller, the separate cabinet provided for overvoltage protection shall fulfil the requirements for the controller cabinet (see 4.2.1 and 4.2.2).

4.2.11.2 Motor protective equipment

Motor protective equipment in the circuit of the pump and of other sub-assemblies necessary for the extinguishing function shall only lead to the indication of faults in accordance with 4.2.14, but not to disablement. Motor protective equipment of other sub-assemblies shall lead to disablement.

Sub-assemblies not required for maintaining the extinguishing function, should be disabled when the pump starts.

4.2.11.3 Sub-assemblies necessary for the extinguishing function

Controls of sub-assemblies, such as motorised valves or foam concentrate pump, which are indispensable for the extinguishing function, are subject to the same requirements as the controls of the pump.

The documentation shall specify whether these sub-assemblies are required for the extinguishing function or not.

4.2.11.4 Control circuit

The control circuit of the pump shall have its own line protection equipment, independent of the other control circuits.

This circuit may include the following equipment:

- the required contactors and auxiliary contactors;
- ON and OFF push button;
- pressure switch for automatic pump start;
- control transformer.

The nominal current of the line protection fuse for the control circuit shall be rated such that during continuous operation, switch-on or return of the supply voltage of the controller the a.m. equipment does not activate the controller accidentally.

Protective equipment for the control transformer upon overload shall only lead to the indication of faults in accordance with 4.2.14, but not to disablement. The adjustment of the protective equipment for the control transformer shall be specified in the circuit diagram and in the documentation.

Protective equipment for protecting the control transformer in case of short circuit shall not be fitted.

Note: This does not apply to upstream line protection fuses (see 4.2.11.5).

4.2.11.5 Overload and short circuit protection of cables and lines

Cables and lines shall be protected against overload and short circuit.

4.2.12 Wiring

Multi-wire, fine-wire and extra fine-wire plastic-insulated conductors according to the specified operating voltages shall be used, at least in design H05V-R (multi-wire conductors), H05V-K (fine-wire conductors) and H05V-S (extra fine-wire conductors).

The minimum cross section for:

– main circuits is 1,5 mm^2 Cu

– control / auxiliary circuits is 1,0 mm^2 Cu

Power rails are also permitted inside the controller.

The wiring shall be well arranged in wiring ducts or similar systems. This does not apply to terminal ends.

Insulated conductors shall not touch bare active parts of other potential or sharp edges; they shall be fixed appropriately.

The connecting lines of movable parts shall have plastic protective tubes or similar.

Cables and lines shall have no mends or soldering points between two terminals. The soldering of terminal ends is not permitted.

4.2.13 Operating elements

It shall be possible to activate and deactivate the pump and the sub-assemblies (sub-assemblies whose control is inside the controller) individually via push buttons at the controller.

For sub-assemblies which may be switched on and switched off both manually and automatically via threshold value sensors the additional requirements of 4.3.2 apply.

For resetting audible indications a push button shall be provided. The visible indication shall remain until the fault has been rectified.

For push buttons the following colours shall be used:

green or white	Pump “ON”;	Electrical consumers “ON”
red	Pump “OFF”;	Electrical consumers “OFF”
black	Sounder “OFF”	
black	Lamp test	

The push buttons “Pump OFF”, “Electrical consumers OFF” and “Sounder OFF” shall not be latching.

4.2.14 Indicators

With monitored controllers the functional conditions “Mains voltage ON”, “Operation of pump” and “Disabled condition of pump” shall be indicated visibly. Fault warnings shall be indicated both visibly and audibly. The visible fault warning indication shall remain until the fault has been rectified, even if the push button “Sounder OFF” has been operated. In the event of a mains failure neither the audible nor the visible fault warning indication is required.

With non-monitored controllers the functional conditions “Operation of pump” and “Disabled condition of pump” shall be indicated visibly. Fault warning indications shall be indicated both visibly and audibly. The visible fault warning indication shall remain until the fault has been rectified, even if the push button “Sounder OFF” has been operated. In the event of a mains failure neither the audible nor the visible fault warning indication is required. The functional condition “Mains voltage ON” can be indicated by means of the integrated voltmeter and the measuring point selector.

4.2.14.1 Indications

Indications shall be given with steady light in the following manner:

- mains voltage ON: (white)
- operation of pump: (white)
- fault of pump motor and fault of electronic starting circuits, such as soft starter and frequency converter: (yellow)
- disabled condition of pump: (blue)
- operation of sub-assemblies: (white)
- fault of sub-assemblies: (yellow)
- disabled condition of automatically operated sub-assemblies: (blue)
- water level in pump priming tank sunk to 2/3 of normal level: (yellow)

The indicators shall be clearly arranged and unambiguously marked, e.g. with labelling and symbols.

The medium service life of the indicators (e.g. lamps, LEDs) shall be at least 5000 hours. One control element shall be provided for testing the indicators.

Indications shall be legible at an ambient light intensity up to 500lx, measured by means of a measuring device in accordance with DIN 5032-7 Class B at an angle up to 22,5° from a line through the centre of the active indicator perpendicular to its mounting surface at a distance of 3m.

The sound level of sounders measured by means of a sound level meter in accordance with DIN EN 61672-1 and -2 under free field conditions in accordance with DIN EN 54-3 at a distance of 1m from the controller shall be at least 75dB (A).

4.2.14.2 Transmission of signals

For the transmission of signals representing functional conditions, potential-free contacts (at least one N/O contact and one N/C contact or one changeover contact) shall be provided as follows:

Pump (individual indications):

- mains voltage ON;
- response of a pressure switch;
- operation of pump (at least two N/O contacts and two N/C contacts or two changeover contacts shall be provided);
- fault of pump (motor monitoring equipment);
- disabled condition of pump.

Sub-assemblies (at least as general indication) for the following functional conditions:

- operation;
- disabled condition (with automatically operated sub-assemblies);
- fault (motor monitoring equipment).

Pump priming tank (individual indication):

- water level in pump priming tank sunk to 2/3 of normal level.

Backup power generator (individual indication):

- voltage failure at controller or
- voltage failure at controller and response of one of the pressure switches for the backup power supply, if these are fitted inside the controller.

Faults of monitored extinguishing systems (individual indication):

- fault of transmission paths in accordance with 4.3.5.1 and
- fault of mains and control voltage in accordance with 4.3.5.2.

4.2.15 Measuring equipment

For each pump motor, measuring equipment of Class 1,5 shall be installed for measuring the current of at least one phase.

For measuring the mains voltages, measuring equipment of at least Class 1,5 shall be installed to indicate the voltages between external conductors, and the voltages between external conductors and neutral (N) conductor / PEN conductor.

4.3 Function

4.3.1 Pump control

The controller shall be able to activate the pump automatically via pressure switches and manually by a singular momentary operation of a push button (≤ 1s) at the controller; the nominal capacity of the pump shall be reached within 15s from activation. During operation, even after the response of motor monitoring equipment, the pump shall be disabled only manually (push button) by interrupting the control circuit.

The controller can additionally be fitted with activation delays, e.g. in order to prevent current peaks from the simultaneous activation of two pumps. An activation delay shall not exceed 10s.

To start the pump automatically, two series-connected pressure switches shall be fitted with contacts opening in case of pressure loss, or two parallel-connected pressure switches with contacts closing in case of pressure loss. The pressure switches shall be connected via two separate lines (contactor lines). The lines can be joint inside the controller. For the connection of the two pressure switches for an automatic pump start separate terminals shall be provided for each line.

Only one auxiliary connector with a pick-up power of 100VA maximum shall be triggered.

A fault on a contactor line shall not cause failure of another line and thus prevent the starting command.

4.3.2 Sub-assemblies

It shall be possible to switch on and switch off sub-assemblies manually (manual operation). They can also be switched on and switched off automatically via threshold value sensors (automatic operation). It shall be possible to select the mode of operation by selector switch without zero position or by push button. In the latter case the mode of operation shall be indicated visibly.

Upon manual disablement in automatic operation the signal “Disabled condition” shall be given as long as an automatic starting command is present.

4.3.3 Pump priming tank

When the water level in the pump priming tank has sunk to 2/3 of the normal water level, the pump shall start.

Automatic pump start is not necessary, when the water level in the pump priming tank in accordance with Cl. 19 of VdS CEA 4001 is monitored. When the system is not monitored in accordance with Cl. 19, an additional fault warning indication shall be given at the controller, and the signal shall be transmitted via the general fault warning of the controller to a permanently manned location. The fault warning indication at the controller and the general fault warning signal shall be in accordance with 4.2.14.

4.3.4 Switchover between several power sources

When the first power source fails (symmetrical or asymmetrical failure of external conductors and neutral conductor, symmetrical or asymmetrical voltage drop greater than 10%), or the control voltage fuse of the controller for the first power source, or when a fault preventing a pump start is signalled, e.g. in case of electronic starting circuits soft starter and frequency converter in the controller for the first power source, then the supply shall be switched over automatically to the second power source.

After a switchover from the first to another power source, an automatic switching back to the first power source, once this is available again, shall be permitted during pump operation only if

- the power source in operation fails (symmetrical or asymmetrical failure of external conductors and neutral conductor, symmetrical or asymmetrical voltage drop greater than 15%) or
- a fault of electronic starting circuits such as soft starter and frequency converter in the controller with the power source in operation is signalled or

- the control voltage fuse of the controller with the power source in operation fails or
- the power source in operation is switched off.

Note: For sub-assemblies see also appropriate clauses of VdS CEA 4001.

4.3.5 Monitoring

4.3.5.1 Transmission paths

In controllers of monitored extinguishing systems, the control circuits (pressure switch lines etc.) routed outside the controller for the pump required for extinguishing operation and for automatically operated sub-assemblies, shall be monitored for open and short circuit. Open and short circuit shall be indicated as a fault in accordance with 4.2.14.

A fault of the monitoring equipment for the contactor lines for automatic start shall not prevent the automatic starting command (pressure switch). This may be achieved e.g. by assigning one monitoring equipment each, including power supply unit, to each contactor line. Each monitoring equipment shall have a selective pre-fuse for the superordinate fuse.

4.3.5.2 Mains and control voltage

The mains and control voltage shall be monitored for symmetrical and asymmetrical failure of the external conductors and the neutral conductor and for symmetrical or asymmetrical voltage drop, indicating any voltage drop greater than 10% as a “Mains voltage” fault in accordance with 4.2.14.

The monitoring of the control voltage circuits for the pump shall include the control fuses.

5 Tests

5.1 Atmospheric conditions for tests

Unless stated otherwise in the respective test procedure, all tests shall be carried out after the specimens have adapted to the following standard atmospheric conditions in accordance with DIN EN 60068-1:

a) Temperature: (15 to 35)°C;

b) Relative air humidity: (25 to 75)%;

c) Air pressure: (86 to 106)kPa.

Note: If variations of these parameters significantly influence the measurements, such variations should be limited to a minimum during a test series which is considered as one test for one specimen.

5.2 Mounting

The specimens shall be mounted by their normal means of mounting in accordance with the manufacturer’s specifications. In case of more than one possible way of mounting, the most unfavourable shall be chosen for each test.

5.3 Tolerances

The tolerances for the environmental test values apply as specified in the relevant referenced standards (e.g. the relevant part of standard series DIN EN 60068), unless specified otherwise. If a requirement or test procedure does not specify any tolerance or deviation limits, deviation limits of ± 5% shall apply.

5.4 Pre-test and identification

It is checked whether the controller complies with the description in the technical documentation (drawings, parts lists, functional descriptions, operating, maintenance and installation instructions) and fulfils the requirements of these guidelines.

5.5 Functional test of controller

The specified functions of the controller in accordance with Cl. 3 are tested at 0,85-fold and 1,1-fold nominal voltage.

Afterwards, the controller is operated for 12 hours each at 0,85-fold and 1,1-fold nominal voltage and at an ambient temperature of (25 + 5)°C with the cabinet closed. Consumers such as motors etc. are not connected. When temperature stability has been reached, the functional safety shall not be impaired and the operating temperature shall not be higher than that specified in the relevant requirements or manufacturer's specifications.

5.6 Functional test of remote control panel

The functional test of the control elements and lines is carried out at 0,85-fold and 1,1-fold nominal voltage.

Lines are tested to determine at which line resistances a fault warning is given. For this purpose, the line resistance is changed from $0\ \Omega \rightarrow \infty$ simulating open wire and from $\infty \rightarrow 0\ \Omega$ simulating short circuit by means of serial or parallel resistances.

At a line resistance not yet resulting in a fault warning, the controller shall function correctly when control elements are operated.

5.7 Software test

If the controller comprises switching or control devices with software, a software test shall be carried out on the basis of Cl. 13 of DIN EN 54-2, provided that the software has been programmed by the applicant or on behalf of the applicant. The software test is not required, if the software contained in the hardware is only parameterised.

5.8 Environmental class

The environmental tests specified in 5.11 apply to indoor installation with wall-mounted controllers.

In case of special operating conditions or outdoor installation, additional tests agreed with the manufacturer shall be carried out.

5.9 Indoor installation

The ambient temperature shall not exceed +40°C.

The lower limit of the ambient temperature shall not fall below -5°C.

Occasional moderate condensation due to temperature variation shall be taken into account.

5.10 Special operating conditions

In locations with high air humidity and greatly varying temperatures, destructive condensation inside the controller shall be prevented by appropriate measures (ventilation and/or internal heating, breathers etc.). The specified protection type shall be adhered to.

5.11 Environmental tests

5.11.1 Table of environmental tests

Environmental test	Test procedure - Reference	Conditioning
Cold (operational)	Test assembly and test procedure acc. DIN EN 60068-2-1 Test Ab	Temperature: (-5 ± 3)° C Duration: 16 h
Dry heat (operational) *2 Requirement in accordance with 5.11.7	Test assembly and test procedure acc. DIN EN 60068-2-2	Temperature: (40 ± 3)° C Duration: 16 h
Damp heat, cyclic (operational)	Test assembly and test procedure acc. DIN EN 60068-2-30 Test cycle Variant 1 and regulated recovery conditions	Low temperature: (25 ± 3)° C High temperature: (40 ± 2)° C Relative air humidity: a) at low temp. ≥ 95 % b) at high temp. (93 ± 3) % Number of cycles: 2
Damp heat, steady state (endurance)	Test assembly and test procedure acc. DIN EN 60068-2-78 Test Cab	Temperature: (40 ± 2)° C Relative air humidity: (93 ± 3) % Duration: 21 days
Vibration, sinusoidal (operational)	Test assembly and test procedure acc. DIN EN 60068-2-6 Test Fc	Frequency range: (10 to 150) Hz Acceleration: 4,9 ms^{-2} (0,5 g_n) Number of axes: 3 Sweep rate: 1 octave min^{-1} Number of cycles: 1 per axis
Vibration, sinusoidal (endurance)	Test assembly and test procedure acc. DIN EN 60068-2-6 Test Fc	Frequency range: (10 to 150) Hz Acceleration: 9,81 ms^{-2}(1,0 g_n) Number of axes: 3 Sweep rate: 1 octave min^{-1} Number of cycles: 20 per axis
Impact (operational)	Test assembly and test procedure acc. DIN EN 60068-2-75 Test Eh	Impact energy: (0,5 ± 0,04) J Number of impacts per point: 3

Electromagnetic compatibility *1		
Electrostatic discharge (operational)	Test procedure acc. DIN EN 50130-4	Test voltages: Air discharges: 2, 4 and 8 kV Contact discharges: 2, 4 and 6 kV Polarity: positive and negative Number of discharges per point at each voltage and polarity: 10 Interval between discharges: ≥ 1s
Radiated electromagnetic fields (operational)	Test procedure acc. DIN EN 50130-4	Frequency range: (80-2000) MHz Field strength: 10 V/m 30 V/m in the range 890 – 960 MHz Modulation: Amplitude: 80 %, 1 kHz, sinusoidal, Duration at least: 3 s
Conducted disturbances induced by electromagnetic fields (operational)	Test procedure acc. DIN EN 50130-4	Frequency range: (0,15 – 100) MHz Voltage level (EMF) Uo: 140 dBµV (10 V) Modulation: Amplitude: 80 %, 1 kHz, sinusoidal
Fast transient bursts (operational)	Test procedure acc. DIN EN 50130-4	Test voltages: 2,0 kV for mains voltage supply lines 1,0 kV for DC low voltage supply lines and other input/output, signal, data and control lines Polarity: + and – Conditionings per polarity: 1 Duration per conditioning: 1 min (+0,2; -0)
Slow high energy voltage surges (operational)	Test procedure acc. DIN EN 50130-4	Coupling mode AC mains voltage lines: line-line: 0,5 and 1 kV line-ground: 0,5; 1 and 2 kV Signal and low voltage lines: line-ground: 0,5 and 1 kV Polarity: + and - Minimum number of surges at each polarity, voltage, coupling mode and line: AC mains voltage lines: 20 Signal and low voltage lines: 5

Mains supply voltage dips and short interruptions	Test procedure acc. EN 50130-4	30 % voltage dip for: 0,5; 1; 5 and 10 periods 60 % voltage dip for: 0,5; 1; 5; 10 periods 100 % voltage dip for: 0,5; 1; 5 periods For all voltage dips the following applies: Number of dips per period: 3 Interval between dips: ≥10 s

*1 only if the controller contains equipment with electronic circuits. Equipment with electronic circuits in which all elements are passive (e.g. diodes, resistors, varistors, capacitors, overvoltage suppressors, restrictors) need not be tested.

*2 only for controllers with frequency converters

5.11.2 Condition of specimen during conditioning

Operational tests: During the conditioning period the specimen is connected to its supply and monitoring equipment.

Endurance tests: During the conditioning period the specimen is not powered.

5.11.3 Measurements during conditioning

Operational tests: The specimen shall be monitored during the conditioning period to detect any deviations from the quiescent condition. During the last hour of conditioning in the tests Cold, Damp heat steady state, and during the last half hour of the high-temperature phase of the last cycle of Damp heat, cyclic the functional test specified in 5.11.6 shall be carried out.

5.11.4 Final measurements

Operational and endurance tests: After the conditioning periods and a recovery period of at least 1h in standardised laboratory conditions the functional test of 5.11.6 shall be carried out.

5.11.5 Requirements

During the conditioning period, the specimen shall remain in the quiescent condition, unless the functional test does not require any change of the functional condition.

During the functional test the specimen shall function correctly within the manufacturer’s specifications.

5.11.6 Functional test

A load (dummy load) agreed with the manufacturer shall be switched on by the controller at the applied nominal voltage.

5.11.7 Environmental test Dry heat

The environmental test Dry heat is required for all controllers with frequency converter, as filter fans are used for cooling the electronic circuits that are necessary for the functioning of the controller. During the last 1,5 hours of the conditioning period the controller shall be operated at 37kW maximum. If the

manufacturer specifies higher output rates, the test shall still be carried out at 37kW. Any possible higher output rate shall be evaluated theoretically. The controller shall remain functional for the duration of the entire test procedure.

5.11.8 Resistance to excessive heat and fire

If resistance tests to excessive heat and fire of plastic parts such as housings of components, covers etc. are not specified in the relevant device regulations or if no test certificates by the manufacturer have been submitted, these parts shall be subjected to the following test procedures:

DIN EN 60695-2-10 and **DIN EN 60695-2-11**

Insulating parts fixing current-carrying parts shall pass the Glowing wire test at a test temperature of 960°C.

Any other insulating parts including those used for fixing the protective conductor shall fulfil the requirements of the Glowing wire test at a temperature of 650°C.

For small parts another test shall be selected (e.g. Needle-flame test acc. IEC 60695-2-2). The same procedure may be applied for other practical reasons, when the metal proportion of a part is great in comparison with the insulating proportion.

If the test cannot be carried out with a complete part, it is permitted to:

- cut out a part that includes the part to be tested, or
- cut an opening into a complete part to achieve access for the glowing wire, or
- entirely remove the part to be tested and test it separately.

The test has been passed if

- any flames or glowing have been extinguished within 30s and
- the tissue paper pad has not ignited.

If during application of the glowing wire the specimen emits flames, further needle-flame tests in accordance with IEC 60695-2-2 may have to be carried out to test those parts affected by the flames.

5.12 Other tests

Where required due to special constructions or new manufacturing processes, additional tests shall be carried out by agreement with the manufacturer.