International Association of Oil & Gas Producers

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Supplementary Specification to IEC 62271-200 for High-voltage Switchgear and Controlgear

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
2.0	December 2022	Second Edition
1.0	October 2018	First Edition

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

This second edition cancels and replaces the first edition published in October 2018.

Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of high-voltage switchgear and controlgear in accordance with IEC 62271-200, Edition 3.0, May 2021 for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Specification

This specification is to be applied in conjunction with the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows.

IOGP S-620: Supplementary Specification to IEC 62271-200 for High-voltage Switchgear and Controlgear

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to IEC 62271-200, following the IEC 62271-200 clause structure. Clauses from IEC 62271-200 not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to IEC 62271-200 defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

IOGP S-620D: Procurement Data Sheet for High-voltage Switchgear and Controlgear (IEC)

The procurement data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The procurement data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional purchaser supplied documents may also be incorporated or referenced in the procurement data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-620L: Information Requirements for High-voltage Switchgear and Controlgear (IEC)

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

IOGP S-620Q: Quality Requirements for High-voltage Switchgear and Controlgear (IEC)

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS follows that of IEC 62271-200 and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

The procurement data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The supplementary specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser defined requirements (procurement data sheet, IRS, QRS);

d) this specification;

e) IEC 62271-200.

1 Scope

Replace fourth list item with

– indoor installation;

Replace second paragraph with

This specification covers:

– three-phase air-insulated switchgear and three-phase gas-insulated switchgear with fixed, removable or withdrawable parts or combinations thereof;

– minimum requirements for digital interfaces based on IEC 61850;

– the requirements for generator circuit-breakers.

Add after second paragraph

This specification does not cover:

– high-voltage switchgear and controlgear assemblies installed outdoors, other than bus duct and outdoor termination bushings;

– detailed user requirements for electrical control and management systems;

– integrated power semiconductor systems;

– integrated high-voltage variable (adjustable) speed drives in accordance with IEC 61800-5;

– ring main units;

– explosion protected "Ex" equipment incorporating a type of explosion protection in accordance with the IEC 60079 series;

– DC uninterruptible power supply systems for auxiliary power.

2 Normative references

Add to start of clause

The following publications are referred to in this document, the procurement data sheet (IOGP S-620D) or the IRS (IOGP S-620L) in such a way that some or all of their content constitutes requirements of this specification.

Add to clause

IEEE C37.2, *IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations*

API Specification Q2, *Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries*

IEC 60038, *IEC standard voltages*

IEC 60051-1, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

IEC 60051-2, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 2: Special requirements for ammeters and voltmeters*

IEC 60051-3, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 3: Special requirements for wattmeters and varmeters*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60092-101, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60099-4, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60255 (all parts), *Electrical relays*

IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K*

IEC 60282-1, *High-voltage fuses – Part 1: Current-limiting fuses*

IEC 60417, *Graphical symbols for use on equipment (available at http://www.graphical-symbols.info/equipment)*

IEC 60617, *Graphical Symbols for Diagrams*

IEC 60644, *Specifications for high-voltage fuse-links for motor circuit applications*

IEC 60688, *Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals*

IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC TR 61000-5-2, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling*

IEC 61511-1, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*

IEC 61554, *Panel mounted equipment – Electrical measuring instruments – Dimensions for panel mounting*

IEC 61800-5 (all parts), *Adjustable speed electrical power drive systems – Part 5 Safety requirements*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61869-1, *Instrument transformers – Part 1: General requirements*

IEC 61869-2, *Instrument transformers – Part 2: Additional requirements for current transformers*

IEC 61869-3, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*

IEC 61869-5, *Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers*

IEC 61869-6, *Instrument transformers – Part 6: Additional general requirements for low-power instrument transformers*

IEC 61869-10, *Instrument transformers – Part 10: Additional requirements for low-power passive current transformers*

IEC 61869-11, *Instrument transformers – Part 11: Additional requirements for low power passive voltage transformers*

IEC 61892-3, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*

IEC 62052-11, *Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62243-4-2, *Security for industrial automation and control systems – Part 4-2: Technical security requirements for IACS components*

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-3, *High-voltage switchgear and controlgear – Part 3: Digital interfaces based on IEC 61850*

IEC 62271-4, *High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF6) and its mixtures*

IEC TS 63107, *Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC-assemblies) according to IEC 61439-2*

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 10005, *Quality management — Guidelines for quality plans*

3 Terms, definitions and abbreviated terms

Add new subclause 3.0 before subclause 3.1

3.0 Abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC 62271-200 and the following apply.

AIS air-insulated switchgear

DCS distributed control system

DMZ demilitarized zone

ECMS electrical control and management system

GIS gas-insulated switchgear

HMI human machine interface

HSR high-availability seamless redundancy

ICSS integrated control and safety system

IED intelligent electronic device

MCB miniature circuit breaker

PMS power management system

PRP parallel redundancy protocol

SPS site pollution severity class

VDIS voltage detecting and indicating system

3.5 Parts of switchgear and controlgear

Add new term 3.5.122

3.5.122

bus coupler

functional unit that contains a mechanical switching device which electrically connects together two bus sections

Add new term 3.5.123

3.5.123

bus section

line-up of sections connected together in service by a physically continuous main busbar

4 Normal and special service conditions

Add to clause

Outdoor portions of bus ducts and bushings shall be in accordance with IEC 62271-1, 4.1.3.

5 Ratings

5.2 Rated voltage (U_r)

Add to subclause

The assembly shall be rated to withstand with a three-phase nominal system voltage variation not exceeding +/-10 % in accordance with IEC 60038.

Add to subclause

For offshore applications, the assembly shall be rated to operate with a system voltage transient variation not exceeding +/-15 % with 1,5 s maximum recovery time.

Add to subclause

For offshore applications, the assembly shall be rated to operate with a system voltage maximum variation not exceeding +/-20 %.

Add to subclause

The assembly shall be rated to operate as a minimum in a class 2 power system supply environment with voltage harmonic content of up to 8 % total harmonic distortion in accordance with IEC 61000-2-4.

5.3 Rated insulation level (U_d, U_p, U_s)

Add to subclause

Main busbars, branches and fixings installed in air-filled compartments shall be fully insulated.

Add to subclause

Insulation covering joints between busbars, branches and fixings shall be removable to facilitate the maintenance of the joints.

5.5 Rated continuous current (I_r)

Add to subclause

Air-insulated switchgear assemblies with a rated continuous current less than or equal to 3 150 A shall not depend on forced ventilation.

Add to subclause

Gas-insulated switchgear assemblies with a rated continuous current less than or equal to 2 500 A shall not depend on forced ventilation.

Add to subclause

Continuous current rating shall be inclusive of derating factors.

Add to subclause

Continuous current rating shall be constant for the entirety of the main busbars.

Add to subclause

Busbars in air-insulated or gas-air mixture filled compartments shall be manufactured from hard drawn, high-conductivity electrolytic copper.

5.6 Rated short-time withstand currents (I_k, I_{ke})

5.6.102 Rated short-time phase-to-earth withstand current (I_{ke})

Replace second sentence with

For systems without a solidly earthed neutral, the value of rated short-time phase to earth withstand current (I_{ke}) shall be at least 87 % of the rated short-time withstand current (I_k) of the main circuit.

Add to subclause

For systems with a solidly earthed neutral, the value of rated short-time phase to earth withstand current (I_{ke}) shall be equal to the rated short-time withstand current (I_k) of the main circuit.

5.7 Rated peak withstand currents (I_p, I_{pe})

5.7.102 Rated peak phase to earth withstand current (I_{pe})

Replace second sentence with

The value of rated peak phase to earth withstand current (I_{pe}) shall be at least 87 % of the rated peak withstand current (I_p) of the main circuit.

5.8 Rated durations of short-circuit (t_k, t_{ke})

5.8.102 Rated duration of phase to earth short-circuit (t_{ke})

Replace second sentence with

The value of rated duration of phase to earth short-circuit (t_{ke}) shall be equal to the rated duration of short-circuit (t_k) of the main circuit.

6 Design and construction

6.1 Requirements for liquids in switchgear and controlgear

Replace subclause with

Liquids shall not be used as a switching or insulating medium.

6.3 Earthing of switchgear and controlgear

6.3.101 Earthing of the high-voltage conductive parts

Add to subclause

Facilities for earthing the high-voltage conductive parts shall be provided on the incoming side of supply generator/transformer circuits and on the outgoing (cable) side of feeder/load circuits in accordance with Figures 1 through 7 to the provided loss of service continuity category.

Add to subclause

A functional unit with a busbar earthing switch or a dedicated busbar earthing compartment shall be provided per bus section.

Add to subclause

Operation of earthing devices shall be manually initiated.

Add to subclause

Switching devices or isolators shall be interlocked to prevent closure when circuit earths are connected.

6.3.102 Earthing of the enclosure(s)

Add to subclause

A hard-drawn high conductivity copper main earth bar shall be installed along the length of the assembly.

Add to subclause

Earth bar ends shall provide bolted connections for an external earth cable or earth bar.

Add new subclause

6.3.105 Earthing for withdrawable type switchgear

6.3.105.1

Insertion of the withdrawable busbar earthing device shall only be possible for incoming supply functional units or dedicated busbar earthing compartments.

6.3.105.2

Application of an earth connection to high-voltage conductive parts shall only be possible when the main circuit switching device is isolated and not in the service position.

6.3.105.3

Earthing connection devices shall be interlocked with other incomers, feeders and bus coupler circuit breakers via a mechanical or electrical interlocking system to prevent connecting an energized circuit to earth.

6.3.105.4

Insertion of a withdrawable main circuit switching device into the service (circuit) position shall not be possible when the earthing provision is connected to the same functional unit.

Add new subclause

6.3.106 Earthing for non-withdrawable (fixed) type switchgear

6.3.106.1

Incoming and outgoing circuit earthing shall be via the functional unit circuit-breaker or by an integrated three-position switch.

6.3.106.2

The bus coupler shall incorporate the busbar earthing system.

6.3.106.3

Application of an earth connection to high-voltage conductive parts shall only be possible when the main circuit switching device in the same functional unit is isolated.

6.3.106.4

De-isolation shall not be possible when the earthing provision within the same functional unit is applied.

Add new subclause

6.3.107 Voltage detecting and indicating systems

6.3.107.1

When specified, integrated voltage detecting and indicating systems shall be of the capacitive three-phase voltage type in accordance with IEC 62271-213.

6.3.107.2

When specified, a separable voltage detecting and indicating system shall be of the capacitive three-phase voltage type in accordance with IEC 62271-213 and IEC 62271-215.

6.3.107.3

When a voltage detecting and indicating system is specified, indicators shall be installed next to the connection (cable) compartment on incoming circuits, outgoing feeders and the front of bus coupler panels.

6.4 Auxiliary and control equipment and circuits

6.4.1 General

Add to subclause

An alarm shall be initiated on the loss of incoming auxiliary or control power supplies.

Add to subclause

Functional unit auxiliary and control supplies shall be protected by dedicated miniature circuit breakers (MCBs).

Add to subclause

Auxiliary and control supply MCBs shall incorporate an auxiliary contact to initiate a trip remote alarm.

Add to subclause

Failure of the functional unit tripping circuit supply shall inhibit main circuit-breaker/contactor closure and initiate local and remote alarms.

6.4.2 Protection against electric shock

Add new subclause

6.4.2.3 Precautions for auxiliary and control circuits

Equipment and terminals powered from an external source shall be labelled accordingly.

Circuits operating above safety extra low voltage shall incorporate isolation facilities.

6.4.3 Components installed in enclosures

6.4.3.4 Requirements for auxiliary and control circuit components

6.4.3.4.1 General

Add to subclause

Low-voltage fuses shall be in accordance with IEC 602691 and IEC 602692.

Add to subclause

IEDs shall be provided with the ability for multifunction control including protection, indication, metering, supervisory input/output and communication functions.

Add to subclause

Plug-in type auxiliary components shall be provided with retaining clips.

6.4.3.4.2 Cables and wiring

Add to subclause

Self-aligning contacts or a multi-conductor cable with plug and socket shall be used for withdrawable device auxiliary circuit connections.

Add to subclause

Interposing relay contacts shall be terminated in the low-voltage control compartment.

6.4.3.4.4 Auxiliary switches

Add to subclause

High-voltage switching device volt-free auxiliary contacts shall be directly activated by the main operating mechanism.

Add to subclause

High-voltage switching device volt-free auxiliary contacts shall be a minimum of Class 2 in accordance with IEC 62271-1, Table 8.

6.4.3.4.5 Auxiliary and control contacts

Add to subclause

Control and auxiliary device utilization categories shall be in accordance with IEC 60947-5-1.

Add to subclause

AC switching elements shall be utilization category AC-15.

Add to subclause

DC switching elements shall be at least utilization category DC-13.

Add to subclause

Rated operational currents (I_e) shall be at least 5 A at 230 V AC rated operational voltage and 1 A at 110 V DC rated operational voltage.

6.4.3.4.6 Heating elements

Add to subclause

Assembly space heaters shall have a degree of protection of at least IP2X in accordance with IEC 60529.

Add to subclause

Assembly space heaters shall incorporate a guard when the heater surface temperature exceeds 60 °C.

Add to subclause

Assembly space heaters and motor space heaters shall be individually powered from external sources.

Add to subclause

Assembly and motor space heaters shall be protected by a 30 mA residual current device with volt-free contacts wired to terminals.

Add to subclause

Motor space heater auxiliary circuits shall be energized when the main circuit switching device is open while in the service position or test position.

Add to subclause

Assembly space heater supplies shall have a front of panel indicating LED lamp with a label engraved "Heater supply on".

Add new subclause

6.4.4 Actuators and indication

6.4.4.1

When colour defines function, actuators shall be green for start/on and red for stop/off.

6.4.4.2

Status colour coding of indicator components and colour human machine interface (HMI) screens shall be in accordance with Table 105.

NOTE Colour coding of status indicator does not apply to intelligent electronic devices (IEDs) or protection relays with a suite of status light emitting diodes (LEDs) which are all the same colour.

Add new Table 105

Table 105 – Colour coding of status indicator

Colour	Meaning	High-voltage – Assembly application	
	Safety of persons or environment	Circuit-breaker	Motor starter / contactor feeder
Red	Danger	Closed (On)	Running (On)
Yellow	Warning/caution	Tripped	Tripped
Green	Safe	Open (Off)	Stopped (Off)
Blue	Mandatory significance	Trip circuit healthy (or unhealthy)	Not applicable
White	No specific meaning assigned	Voltage indication (Heater On)	Motor heater on
NOTE The colours detailed in this table are in accordance with IEC 60073.			

6.4.4.3

Indication lamps shall be light emitting diodes.

6.4.4.4

Discrete indication lamps shall operate at the same voltage except those directly connected to heater supply circuits.

Add new subclause

6.4.5 Security for industrial automation and control systems

6.4.5.1

When specified, industrial automation and control system components shall be in accordance with IEC 62443-4-2.

6.10 Pressure/level indication

Add to subclause

Local indication and alarms with remote interfaces shall be provided.

6.12 Locking devices

Add to subclause

High-voltage compartment doors shall be padlockable in the closed position.

Add to subclause

Disconnectors and circuit-breakers shall be padlockable in the open position.

Add to subclause

When withdrawable functional units are removed, safety shutters shall be padlockable in the closed position.

Add to subclause

Earth switches shall be padlockable.

Add to subclause

Switching device local/remote selectors shall be lockable in the "local" and "remote" positions.

6.16 Gas and vacuum tightness

Add to subclause

The relative leakage rate F_{rel} for SF_6 and SF_6 mixtures shall not be greater than 0,1 % per year.

6.101 General requirements for assemblies

Add to subclause

Assemblies specified for marine installations shall be in accordance with IEC 60092-101.

Add to subclause

Assemblies specified for offshore installations shall be in accordance with IEC 61892-3.

Add to subclause

Assemblies shall be rated for continuous operation at rated load under normal service conditions for at least 36 000 h (4 years).

Add to subclause

During a continuous operation period of 45 000 h (5 years), the main busbars and the distribution busbars (dropper system) shall not require de-energizing for maintenance or inspection.

Add to subclause

Equipment shall be accessible from the front of the assembly, except for cable termination chambers which can be accessible from the front or rear.

Add to subclause

Components in back-to-wall mounted assemblies shall be accessible from the front.

Add to subclause

Pre-drilled holes shall be provided at free ends of bus bars for future on-site extension.

Add to subclause

Where withdrawable main circuit feeders are provided with a contactor and fuses, the fuses shall be part of the withdrawable assembly.

6.102 Metal enclosure

6.102.1 General

Replace first sentence of third paragraph with

The enclosure shall have a degree of protection of at least IP3X in accordance with IEC 60529.

6.102.2 Covers and doors

In first sentence of second bullet, replace "with provision for locking" with

with provision for padlocking

Add to subclause

Doors or covers with mounted electrical components shall have supplementary equipotential bonding.

Add to subclause

On floating offshore, mobile offshore and marine installations, doors shall be securable in the open position.

6.103 High-voltage compartments

6.103.1 General

Add to first paragraph after list

For gas-insulated switchgear assemblies, the minimum LSC category shall be LSC2.

Add to first paragraph after list

For air-insulated switchgear circuit-breaker functional units, the minimum LSC category shall be LSC2B.

Add to first paragraph after list

For air-insulated switchgear contactor feeder functional units, the minimum LSC category shall be LSC2A.

Add to fourth paragraph

Busbar compartments shall contain no more than one busbar section.

Add to fourth paragraph

Busbar risers on different sides of a bus coupler switching device shall be in separate compartments.

6.103.2 Fluid-filled compartments (gas or liquid)

6.103.2.4 Pressure relief of fluid-filled compartments

Add to subclause

Fluid filled compartments shall be provided with a pressure-relief device.

6.103.3 Partitions and shutters

6.103.3.2 Metal partitions and shutters

Add to subclause

Accessible shutters preventing access to live parts, shall be marked in accordance with ISO 7010:2019, Graphical Symbol W012 "Warning; Electricity".

Add to subclause

Three-phase shutters for main conductors shall have a manually operated facility, securable in the open position.

Add to subclause

For withdrawable parts, accessible shutters shall be identified in accordance with Table 106.

Add new Table 106

Table 106 – Identification of accessible shutters

Equipment	Text
Busbars	BUSBAR
Incoming unit supply circuit	SUPPLY
Outgoing unit feeder cables	CIRCUIT

6.104 Removable parts

Add to subclause

When specified, facilities for remote testing of withdrawable main circuit units shall be provided by means of extension umbilicals or specific test modules.

Add to subclause

Withdrawable main circuit units shall only be interchangeable between positions of same electrical function and rating.

6.106 Internal arc fault

Add to subclause

The internal arc classification (IAC) of the assembly shall be all sided protection FLR.

Add to subclause

Internal arc tests shall be for a rated three-phase arc fault current (I_A) value at least that of the specified short-time withstand current (I_k) for a minimum arc fault duration of 1 s.

Add new subclause

6.107 Labelling and identification

6.107.1 General

6.107.1.1

Graphical symbols, safety colours and safety signs shall be in accordance with ISO 7010.

6.107.1.2

Text-only warning labels shall have white characters on a red background.

6.107.1.3

Informative labels shall have black characters on a white background.

6.107.1.4

Assemblies shall be provided with a front-mounted label that includes the equipment tag number.

6.107.1.5

Withdrawable parts shall be labelled with their designated functional unit compartment number.

6.107.2 Circuit labels

6.107.2.1

Functional units shall have a front-of-panel circuit designation label.

6.107.2.2

Assemblies with rear access shall have additional circuit designation labels at the rear.

6.107.2.3

Circuit designation labels shall include the following information:

a) functional unit compartment number;

b) tag number of connected equipment;

c) service description of connected equipment;

d) circuit kW or kVA rating.

6.107.3 Identification of main and auxiliary circuit conductors

Conductor identification of main and auxiliary circuits shall be in accordance with Table 107.

Add new Table 107

Table 107 – Identification of conductors

Conductor	Main circuit marking	Auxiliary circuit marking	Supplementary colour marking (when used)
AC circuits			
Phase 1	L1	L1	As specified
Phase 2	L2	L2	As specified
Phase 3	L3	L3	As specified
Neutral		N	As specified
Protective earth	PE and/or earth symbol	PE and/or earth symbol	Yellow/Green
DC circuits			
Positive pole		(+)	Red
Negative pole		(-)	White

Add new subclause

6.108 Main circuit switching devices

6.108.1 Isolating switching devices (disconnectors)

6.108.1.1

Disconnectors and earthing switches shall be in accordance with IEC 62271-102.

6.108.1.2

Switches shall be in accordance with IEC 62271-103.

6.108.2 Circuit-breakers

6.108.2.1

Circuit-breakers shall be at least class S1 in accordance with IEC-62271-100.

6.108.2.2

Circuit-breaker operating mechanisms shall have spring-stored energy.

6.108.2.3

Circuit-breaker operating mechanisms shall have a spring-charging motor.

6.108.2.4

Circuit-breaker operating mechanisms shall have a closing release coil with an interlock to inhibit closing if a trip condition exists.

6.108.2.5

Circuit-breaker operating mechanisms shall have a spring-charged/discharged indicator.

6.108.2.6

Circuit-breaker operating mechanisms shall have a manual spring charge facility.

6.108.2.7

Circuit-breaker operating mechanisms shall have an anti-pumping device.

6.108.2.8

Circuit-breaker operating mechanisms shall have a shunt trip coil release of energize-to-trip type.

6.108.2.9

Circuit-breaker operating mechanisms shall have a mechanically operated position indicating device showing the position of the main circuit contacts in accordance with IEC 60417.

6.108.2.10

Circuit-breaker operating mechanisms shall have an operations counter.

6.108.2.11

Withdrawable circuit-breakers with identical rating and duty shall be physically interchangeable between receiving compartments of matching rating and duty.

6.108.2.12

Circuit-breakers shall have at least two spare normally open auxiliary contacts wired to terminals in the outgoing terminal block.

6.108.2.13

Circuit-breakers shall have at least two spare normally closed auxiliary contacts wired to terminals in the outgoing terminal block.

6.108.2.14

Withdrawable circuit-breakers shall have two spare "in service" position auxiliary contacts wired to terminals in the outgoing terminal block.

6.108.2.15

Withdrawable circuit-breakers shall have two spare "out of service" position auxiliary contacts wired to terminals in the outgoing terminal block.

6.108.3 Generator circuit-breakers

Generator circuit-breakers shall be in accordance with IEC/IEEE 62271-37-013.

6.108.4 Motor starters and contactor feeders

6.108.4.1

Contactors shall be in accordance with IEC 62271-106.

6.108.4.2

The no-load operating cycle mechanical endurance shall be at least 0,1 for latched contactors in accordance with IEC 62271-106:2021, 5.105.

6.108.4.3

The no-load operating cycle mechanical endurance shall be at least 0,3 for unlatched contactors in accordance with IEC 62271-106:2021, 5.105.

6.108.4.4

Classification of acceptable damage shall be type c in accordance with IEC 62271-106:2021, 5.107.3.4 for the largest fuse size rated for the fuse holder.

6.108.4.5

Motor starter contactors shall be rated for continuous and intermittent duty of at least class 12 in accordance with IEC 62271-106:2021, 5.102.2.

6.108.4.6

Contactor feeders shall be mechanically latched with an electrical trip coil and guarded manual release.

Add new subclause

6.109 Voltage transformers

6.109.1

Voltage transformers shall be in accordance with IEC 61869-1.

6.109.2

Inductive voltage transformers shall be in accordance with IEC 61869-1 and IEC 61869-3.

6.109.3

Capacitive voltage transformers shall be in accordance IEC 61869-1 and IEC 61869-5.

6.109.4

Low-power voltage transformers shall be in accordance with IEC 61869-1 and IEC 61869-6.

6.109.5

Low-power passive voltage transformers shall be in accordance with IEC 61869-1 and IEC 61869-11.

6.109.6

Voltage transformer accuracy class shall be at least class 1,0 for measuring applications and class 3P for protection applications in accordance with IEC 61869-3.

6.109.7

For tariff metering applications, voltage transformer accuracy class shall be at least class 0,2 s in accordance with IEC 61869-3.

6.109.9

Withdrawable voltage transformers shall be protected by HRC fuses or have a current self-limiting protective feature.

6.109.10

Where withdrawable voltage transformers are protected by HRC fuses on the primary side, the fuses shall be accessible on withdrawal of the voltage transformer.

6.109.11

Voltage transformers shall be protected by MCBs with an auxiliary contact for trip indication on the secondary windings.

6.109.12

Withdrawable voltage transformers shall have automatic shutters operated by the racking mechanism.

6.109.13

Withdrawable voltage transformer automatic shutters shall be padlockable in the withdrawn position.

6.109.14

Disconnectable voltage transformers shall be padlockable in the disconnected position.

6.109.15

Three-phase voltage transformers shall incorporate star-connected windings with the secondary star-point earthed at a single point via an accessible removable link.

Add new subclause

6.110 Current transformers

6.110.1

Current transformers shall be in accordance with IEC 61869-1.

6.110.2

Inductive current transformers shall be in accordance with IEC 61869-1 and IEC 61869-2.

6.110.3

Low-power current transformers shall be in accordance with IEC 61869-1 and IEC 61869-6.

6.110.4

Low-power passive current transformers shall be in accordance with IEC 61869-1 and IEC 61869-10.

6.110.5

Current transformer accuracy class shall be at least class 1,0 for measuring incoming applications, class 3,0 for measuring outgoing applications and class 5P for protection applications in accordance with IEC 61869-2.

6.110.6

Current transformers connected to external circuits shall have shorting links located at the outgoing terminals.

6.110.7

Current transformer secondary windings shall be connected to earth via a single disconnecting link.

Add new subclause

6.111 Surge arresters

When specified, metal oxide surge arresters in accordance with IEC 60099-4 shall be installed on the circuit side of the main circuit switching device within an enclosure compartment.

Add new subclause

6.112 Indication and measuring devices

6.112.1 General

6.112.1.1

Discrete indicating and measuring device dimensions shall be in accordance with IEC 61554.

6.112.1.2

Discrete indicating and measuring devices shall be flush mounted with a non-reflective display.

6.112.1.3

Indicating devices shall have an accuracy class of at least 2,5 for analogue instruments in accordance with IEC 60051-1.

6.112.2 Analogue instruments

6.112.2.1

Analogue devices shall have black characters on a white background displaying actual primary circuit values.

6.112.2.2

An external zero adjustment shall be provided.

6.112.2.3

Analogue voltmeters and ammeters shall be in accordance with IEC 60051-2.

6.112.2.4

Analogue ammeters and voltmeters shall be provided with a selector switch equipped with an "off" position.

6.112.2.5

Ammeter selector switches shall be "make-before-break" type.

6.112.2.6

A maximum demand facility with a period of 30 min shall be provided for incomers and outgoing feeders in accordance with IEC 62052-11.

6.112.2.7

The lower scale reading for analogue ammeters on non-motor circuits shall not be less than 20 % of rated load.

6.112.2.8

Analogue wattmeters and varmeters shall be in accordance with IEC 60051-3 for three-phase unbalanced loads.

6.112.3 Energy metering

Static energy meters shall be rated for three-phase unbalanced loads in accordance with IEC 62052-11.

6.112.4 Transducer outputs

6.112.4.1

Transducer outputs shall be in accordance with IEC 60688.

6.112.4.2

Transducer outputs shall be wired to terminals in the outgoing terminal block.

Add new subclause

6.113 Protection devices

6.113.1

Protection relays shall be multi-function intelligent electronic devices (IEDs) in accordance with the IEC 60255 series.

6.113.2

HMIs and front of panel mounted relays shall be flush mounted.

6.113.3

The part of the protection device providing the protection function shall be demountable without disconnection of I/O wiring.

6.113.4

Protection relays shall have facilities for calibration and injection testing at the front of the functional unit without disconnection of secondary wiring.

6.113.5

Fuses for main circuit feeder protection shall be in accordance with IEC 60282-1.

6.113.6

Fuses for motor circuit protection shall be in accordance with IEC 60644.

Add new subclause

6.114 Cable terminations

6.114.1 Terminals for external conductors

6.114.1.1

Separate termination compartments for high-voltage and low-voltage connections shall be provided.

6.114.1.2

Where high-voltage terminations utilize cable lugs, high-voltage cable termination (bar) conductors shall be pre-drilled.

6.114.1.3

Where high-voltage terminations utilize cable glands, undrilled gland plates shall be provided.

6.114.1.4

Where single core line conductors have been specified, gland plates shall be fabricated using a non-magnetic material.

6.114.1.5

High-voltage terminations utilizing proprietary separable insulated connector systems shall be deadbreak connectors.

6.114.2 Terminals for control and auxiliary circuits

6.114.2.1

Wiring for external connections shall be brought out to individual terminals on a terminal block.

6.114.2.2

Terminal blocks shall be grouped by function and operating voltage.

6.114.2.3

Terminal block groups shall be separated using barrier plates or earthed terminals.

6.114.2.4

Functional groups, voltage levels and discrete terminals shall be identified by labels.

6.114.2.5

Terminals that remain live following a functional unit isolation shall display a warning label.

6.114.2.6

Terminals powered from external supplies shall display a warning label.

6.114.2.7

When specified, spare I/O contacts of protection/auxiliary relays shall be wired to terminal blocks and numbered.

6.114.2.8

Terminals associated with inductive current transformer circuits shall be provided with shorting links.

6.114.2.9

Instrument circuits requiring dedicated earthing shall be in accordance with IEC TR 61000-5-2.

Add new subclause

6.115 Interfaces

6.115.1 Interface with external equipment packages and control systems

Emergency shutdown interface relays shall be safety integrity level (SIL) rated in accordance with IEC 61511-1.

6.115.2 Application of communication protocols to protective functions

6.115.2.1

Digital interfaces shall be in accordance with IEC 62271-3.

6.115.2.2

Signals and values for protective functions exchanged by IEDs on the same IEC 61850 station bus network shall function independently of servers, firewalls and additional communications infrastructure.

Add new subclause

6.116 Condition monitoring

6.116.1 General

When specified, condition monitoring systems shall be in accordance with the requirements in 6.116.1.1 through 6.116.1.6

6.116.1.1

The system shall be integral to the assembly.

6.116.1.2

The system shall provide real-time continuous monitoring.

6.116.1.3

Sensors shall be maintenance free for at least 45 000 h (5 years).

6.116.1.4

Data shall be displayed on an HMI.

6.116.1.5

Data from monitored equipment shall be accessible by the site supervisory system.

6.116.1.6

The condition monitoring system shall not impact performance or continued service of the assembly.

6.116.2 Thermal monitoring

Busbar joints, circuit breaker to busbar connections and cable terminations shall, as a minimum, be monitored.

6.116.3 Partial discharge

Partial discharge condition monitoring shall be in accordance with IEC 60270.

6.116.4 Circuit breaker monitoring

Circuit breaker monitoring shall, as a minimum, include opening and closing times, spring charging data, failed spring charging attempts and number of operations.

8 Routine tests

8.6 Design and visual checks

Add new subclause

8.6.1

Visual inspection shall the validate the assembly layout in accordance with the manufacturer's drawings.

Add new subclause

8.6.2

Visual inspection shall validate the functional unit and assembly labelling.

Add new subclause

8.6.3

Visual inspection shall validate the integrity of internal wiring connections and earthing.

Add new subclause

8.6.4

Visual inspection shall validate wiring in accordance with final wiring diagrams.

8.102 Mechanical operation tests

In third paragraph, add new list item

– padlocking facilities, interlocks, mechanisms and limit switches function correctly.

11 Transport, storage, installation, operation and maintenance

Add new subclause

11.6 Special tools

11.6.1

Special tools for installation, operation and maintenance including circuit breaker operating handles, earthing switch operating handles and software interrogation cables, shall be shipped with the assembly.

11.6.2

Operational removable or withdrawable parts weighing more than 25 kg shall be provided with labels confirming the actual weight.

11.6.3

Where a separable voltage detecting and indicating system (VDIS) is specified, the external phase comparator instrument shall be provided.

13 Influence of the product on the environment

Add to clause

Handling of SF6 during manufacture, transport, installation and commissioning shall be in accordance with IEC 62271-4.

Add new Annex E

Annex E
(normative)

Additional requirements for fault current limiter assembly

E.1 General

This annex specifies requirements additional to the main body of this specification for fault current limiters incorporated within an assembly or forming a free-standing fault current limiter assembly.

E.2 Ratings – rated normal current and temperature rise

E.2.1 Rated normal current (I_r)

The rated continuous current (I_r) of the fault current limiter shall not be less than the rated continuous current of the associated incoming circuit, bus sections or bus coupler.

E.2.2 Rated short-time withstand currents (I_k)

The rated short-time withstand current (I_k) and the rated short-time phase to earth withstand current (I_{ke}) of the fault current limiter shall not be less than the rated short-time withstand currents of the associated incoming circuit, bus sections or bus coupler.

E.2.3 Rated peak withstand current (I_p)

The rated peak withstand current (I_p) and the rated peak phase-to-earth withstand current (I_{pe}) of the fault current limiter shall not be less than the rated peak withstand currents of the associated incoming circuit, bus sections or bus coupler.

E.2.4 Rated durations of short-circuit (t_k)

The rated duration of short-circuit current (t_k) and the rated duration of phase-to-earth short-circuit current (t_{ke}) of the fault current limiter shall not be less than the rated durations of short-circuit currents of the associated incoming circuit, bus sections or bus coupler.

E.3 Design and construction

E.3.1 Auxiliary and control equipment

E.3.1.1

Fault current limiter protective function circuits shall prevent common mode failures between phases including sensors, signal treatment and triggering system.

E.3.1.2

Fault current limiter protective function circuits shall provide an external function where operation is disabled when a system fault level is within an acceptable range.

E.3.1.3

Operation selector switches shall be lockable.

E.3.1.4

Operation selector switches shall be located front of panel.

E.3.1.5

A watchdog module shall be provided to continuously monitor triggering unit functions.

E.3.1.6

Triggering systems shall be powered by individually protected auxiliary circuits.

E.3.1.7

Triggering units shall operate independently of each other.

E.3.1.8

Front of panel operation selector switches shall provide "on", "inhibited" and "off" positions with auxiliary contacts for remote status indication.

E.3.2 Isolating switching devices (disconnectors)

The fault current limiter assembly shall provide isolation points on the incoming and outgoing sides of main circuit conductors.

E.3.3 Interlocking devices

E.3.3.1

Circuit-breakers installed in series with the fault current limiter shall be opened automatically when the fault current limiter is triggered.

E.3.3.2

Circuit-breakers installed in series with the fault current limiter shall be interlocked to prevent closure when interrupting elements are activated and the fault current limiter triggering unit is not reset.

E.3.3.3

Access to the fault current limiter compartment shall be prevented unless in-series circuit-breakers are open.

E.3.3.4

Access to the fault current limiter compartment shall be prevented unless the in-series connected switching devices or isolators are in the open position.

E.3.3.5

Access to the fault current limiter compartment shall be prevented unless incoming and outgoing sides of the main circuit conductor are earthed.

E.3.3.6

Series switching devices or isolators shall be interlocked to prevent closure when fault current limiter earths are connected.

E.3.4 Design and visual checks

In addition to switchgear assembly inspections, fault current limiters shall have functional checks of the measuring unit, the triggering and indication unit, excluding final elements.

E.4 Transport, storage, installation, operation and maintenance

E.4.1 Special tools

E.4.1.1

Special tools for fault current limiter installation, operation and maintenance shall be shipped together with the assembly.

E.4.1.2

A test unit with leads shall be provided for commissioning and function testing.

E.4.1.3

Three-phase copper bars shall be provided.

E.4.1.4

The three-phase copper bars shall be attachable at the active elements point of connection.

E.4.1.5

The three-phase copper bars shall be of a current rating equal to the assembly busbars.

E.4.2 Basic input data by the manufacturer

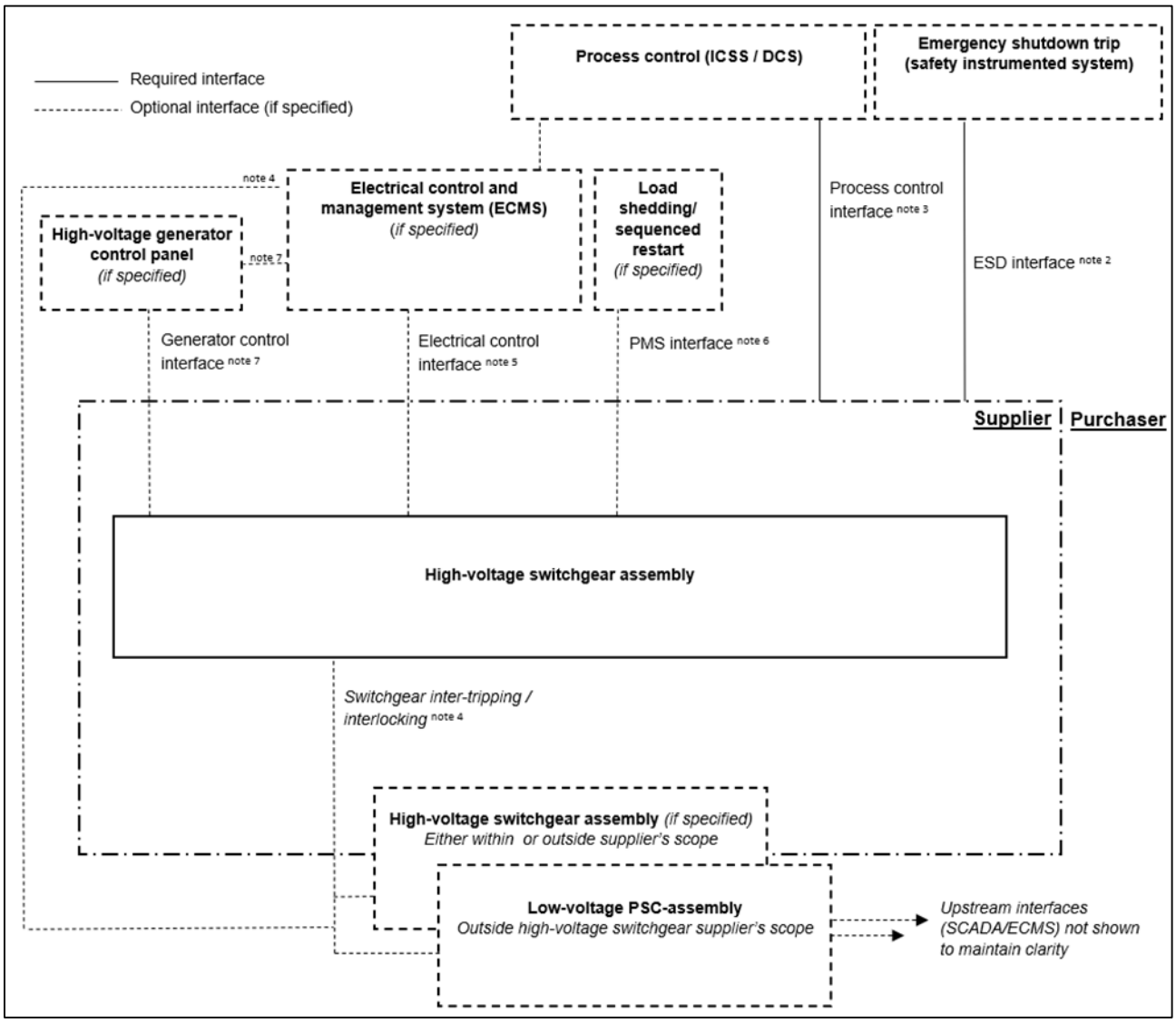
The triggering value of the fault current limiter shall be set according to the specified minimum and maximum short-circuit fault level.

Add new Annex F

Annex F
(informative)

Integration with external systems

Add new Figure F.1



Note 1 This figure is for illustrative purposes only as control system integration topologies are user/project specific. This figure is not intended to assign any IEC 62264-1 (ISA-95) hierarchy levels 0 to 4 or imply any demilitarized zone (DMZ) perimeter boundaries.

Note 2 High integrity emergency shutdown – highest priority interface. Assumed default is hardwired fail-safe. The alternate use of SIL rated digital protocol control is subject to user agreement.

Note 3 Interface between the automated process control system and process related load circuits. It is either discrete hardwired I/O or via digital protocol, or multiple interfaces (mainly via digital protocol but with hardwired motor stop/starts as defined by the user). The process control interface should be segregated/firewalled from the electrical control and management system (ECMS).

Note 4 Incoming circuit breaker intertripping/interlocking to either downstream (low-voltage) switchboards or interconnectors to adjacent high-voltage switchgear assemblies. The assumed default is hardwired from switchgear assembly to downstream switchboards, but it may also be IED-to-IED communication or via the ECMS.

Note 5 Non-process control/supervisory interface to an ECMS. It may also enable network connectivity to the process control system, other high-voltage switchgear assemblies and generator control panels(s). The ECMS may enable authorized user interface for IED remote configuration / remote access.

Note 6 Interface to power management system (PMS) for load shedding and/or sequenced restart. The PMS may be integral to the ECMS with communication via the electrical control interface or a standalone load shedding system acting directly on the switchgear assembly circuits, (e.g. hardwired discrete trips, load start inhibits and status monitoring).

Note 7 It is typically for on-site generation, switchgear assembly to generator control interface for the generator incomer circuit breaker control. The interface may be hardwired, IED-to-IED communication or via the ECMS.

Figure F.1 – Communications interface block diagram

Bibliography

Add to Bibliography

[15] IEC 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

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