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ADDENDUM 1

This addendum (Version 3.01) replaces Edition 3.0 published in December 2022.

NOTE: In addition to the updates listed below, minor editorial/typographical amendments may have been made.

List of updates

Clause/subclause	Update
2	Reference IEC 60255-1 added References IEC 60947-4-1 *, IEC 62262 * and ISO 7010 * deleted
4	Abbreviations IK, IP and ITP added
6.2.2	Third addition to subclause amended New addition to subclause
6.3	First addition to subclause amended Second * addition to subclause deleted New addition to subclause
8.2.1	Subclause replacement deleted
8.4.1	New addition to subclause
8.4.6.1	New sentence deletion in second paragraph
8.5.2.101	Two new sentence replacements
8.5.3.104	Subclause 8.5.3.104.2 * deleted Subclauses 8.5.3.104.3 * and 8.5.3.104.4 * renumbered to 8.5.3.104.2 and 8.5.3.104.3
8.5.3.105	Subclause 8.5.3.105.18 amended New subclauses 8.5.3.105.19 through 8.5.3.105.21
8.5.3.106	Subclause 8.5.3.106.2 * deleted Subclauses 8.5.3.106.3 * through 8.5.3.106.11 * renumbered to 8.5.3.106.2 through 8.5.3.106.10 Subclause 8.5.3.106.9 amended
8.5.3.107.2	Subclause amended
8.5.3.108	New subclauses 8.5.3.108.7, 8.5.3.108.8 including new NOTE, 8.5.3.108.9 and 8.5.3.108.10
8.5.3.109	Subclause 8.5.3.109.10 * deleted Subclause 8.5.3.109.11 * renumbered to 8.5.3.109.10 New subclause 8.5.3.109.11
8.5.5.101.6	Subclause amended
Table 19	Table NOTE amended
8.5.10.1.9	New subclause

List of updates *(continued)*

Clause/subclause	Update
8.6.2	Two new additions to subclause One new addition to subclause including new NOTE
8.6.2.101	Subclauses 8.6.2.101.2 and 8.6.2.101.3 deleted, and subclause heading 8.6.2.101.1 deleted accordingly
8.6.3	Two new additions to subclause
8.6.5	Subclause amended including deletion of NOTE
8.8.101	Subclause 8.8.101.3 * deleted Subclauses 8.8.101.4 * through 8.8.101.14 * renumbered to 8.8.101.3 through 8.8.101.13 New subclauses 8.8.101.14 and 8.8.101.15
8.103.3	Subclause 8.103.3.2 amended Subclause 8.103.3.3 * deleted Subclauses 8.103.3.4 * through 8.103.3.6 * renumbered to 8.103.3.3 through 8.103.3.5
8.105.2.2	Subclause amended
9.3.1	New addition to subclause (after first one)
Bibliography	Reference IEC 60204-1 added
* Clause/subclause number from Edition 3.0.	

Supplementary Specification to IEC 61439-1 and IEC 61439-2 for Low-voltage Switchgear and Controlgear

Revision history

VERSION	DATE	PURPOSE
3.01	September 2025	Addendum 1
3.0	December 2022	Third Edition
2.0	November 2016	Second Edition
1.0	June 2016	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).

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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 third edition cancels and replaces the second edition published in November 2016. Due to technical writing requirements leading to extensive changes, this third edition should be treated as a new document.

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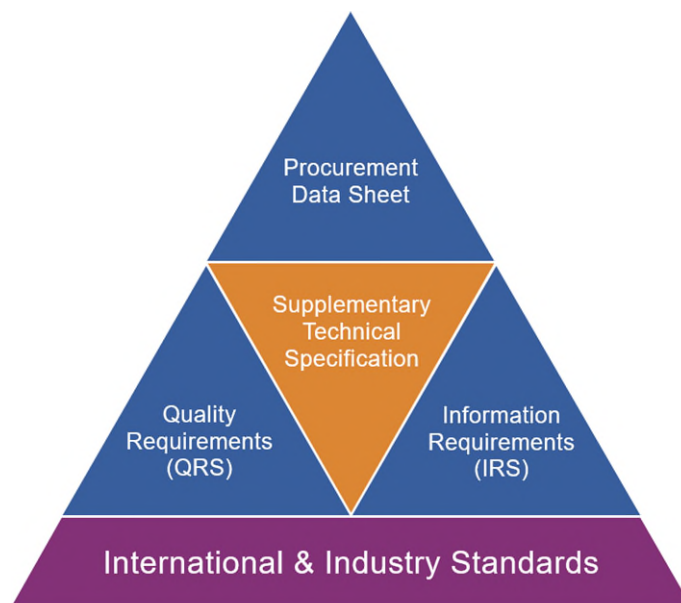
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Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of low voltage switchgear and control gear assemblies in accordance with IEC 61439-1, Edition 3, May 2020 and IEC 61439-2, Edition 3.0, July 2020, Corrigendum 1, 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-560: Supplementary Specification to IEC 61439-1 and IEC 61439-2 for Low-voltage Switchgear and Controlgear

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to IEC 61439-1 and IEC 61439-2, following the IEC 61439-1 and IEC 61439-2 clause structure. Clauses from IEC 61439-1 and IEC 61439-2 not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to IEC 61439-1 or IEC 61439-2 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-560D: Procurement Data Sheet for Low-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-560L: Information Requirements for Low-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-560Q: Quality Requirements for Low-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 61439-1 and IEC 61439-2, 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 61439-1 and IEC 61439-2.

1 Scope

This specification covers fully withdrawable switchgear and controlgear of cubicle and multi-cubicle type assemblies for indoor installation. This specification also applies to fixed and withdrawable cubicle type assemblies and combinations thereof.

Add to subclause

This specification does not cover:

- low-voltage switchgear and controlgear assemblies installed outdoors;
- detailed user requirements for electrical control and management systems;
- explosion protected "Ex" switchgear for use in potentially explosive atmospheres;
- pillar type or construction site distribution equipment (addressed by IEC 61439-4 and IEC 61439-5);
- standalone lighting and small power distribution boards with rated current not exceeding 250 A (addressed by IEC 61439-3).

Add new subclause

1.1

This specification details the requirements for the design, materials, fabrication, inspection and testing of low-voltage power switchgear and controlgear assemblies. This specification amends and supplements IEC 61439-1:2020 and IEC 61439-2:2020, referring sequentially to the same clause numbers.

Add new subclause

1.2

Clauses of IEC 61439-1 and IEC 61439-2 that are not addressed within this specification remain fully applicable as written. Where there is no direct corresponding IEC 61439-1 or IEC 61439-2 clause, a new reference clause number has been added in this specification.

2 Normative references

Add to start of clause

The following publications are referred to in this document, the procurement data sheet (IOGP S-560D) or the IRS (IOGP S-560L) in such a way that some or all of their content constitutes requirements of this specification.

Add to clause

BS EN 61439-2, *Low-voltage switchgear and controlgear assemblies Power switchgear and controlgear assemblies*

IEC 60034-11, *Rotating electrical machines – Part 11: Thermal protection*

IEC 60051 (all parts), *Direct acting indicating analogue electrical-measuring instruments and their accessories*

- IEC 60079-14:2013, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*
- IEC 60092-101:2018, *Electrical installations in ships – Part 101: Definitions and general requirements*
- IEC 60255-1, *Measuring relays and protection equipment – Part 1: Common 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 60664-1, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*
- IEC 60684, *Flexible insulating sleeving*
- IEC 60688, *Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals*
- IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*
- IEC 60947-4-2, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – Semiconductor motor controllers, starters and soft-starters*
- IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*
- IEC 60947-5-5, *Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function*
- IEC 60947-7-1, *Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors*
- IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances.*
- IEC 61511-1, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*
- IEC 61869-2:2012, *Instrument transformers – Part 2: Additional requirements for current transformers.*
- IEC 61869-3, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers.*
- IEC 61892-3:2019, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*
- IEC 62052-11, *Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment*
- IEC 62402, *Obsolescence management*
- IEC TR 61641:2014, *Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault.*
- IEC TS 63107, *Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC-assemblies) according to IEC 61439-2*

3 Terms and definitions

3.1 General terms

Add new term 3.1.16

3.1.16

bus coupler

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

Add new term 3.1.17

3.1.17

bus section

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

Add new term 3.1.18

3.1.18

insulatum terra

IT

(latin) electrical system earthing method with no connection or high impedance connection to earth

Add new term 3.1.19

3.1.19

secondary selective

substation configuration where two (or more) switchboard bus sections are connected together via a bus coupler(s) and when loss of supply on an incoming circuit occurs, service to the switchboard is maintained where the bus coupler(s) is normally closed and if the bus coupler(s) is normally open, service is restored through manual or automatic closure of the bus coupler device

4 Symbols and abbreviations

Add to clause

AC	alternating current
ACB	air circuit breaker
ASD	adjustable speed drive
DC	direct current
DMZ	demilitarized zone
ECMS	electrical control and management system
FAT	factory acceptance test
HMI	human machine interface
HRC	high rupturing capacity
IED	intelligent electronic device

IK	code indication of degrees of protection provided by enclosures against external mechanical impacts
IP	ingress protection (rating code)
I/O	input/output
IT	insulatum terra
ITP	inspection and test plan
LED	light emitting diode
MCB	miniature circuit breaker
MCCB	moulded case circuit breaker
PMS	power management system
PSC	power switchgear and controlgear
PSS	power semiconductor system
RCBO	residual current circuit breaker with overcurrent protection
RCD	residual current device
SIL	safety instrumented level
THD	total harmonic distortion

5 Interface characteristics

5.2 Voltage ratings

5.2.1 Rated voltage (U_n) (of the assembly)

Add to subclause

The PSC-assembly and ancillary components shall be rated for nominal supply voltage variations of $\pm 10\%$.

Add to subclause

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

5.2.4 Rated impulse withstand voltage (U_{imp}) (of the assembly)

Add to subclause

PSC-assemblies shall be type tested in accordance with IEC 60664-1 to provide a minimum coordinated insulation values in accordance with overvoltage category III as stated in Table G.1.

5.3 Current ratings

5.3.1 Rated current of an assembly (I_{nA})

Add to subclause

The rated current of a PSC-assembly main busbars and main circuits shall not depend on forced ventilation.

NOTE This does not preclude the use of forced cooling on individual outgoing circuits with high thermal influence such as functional units containing integral adjustable (variable) speed drive modules.

Add to subclause

Busbar connections within bus coupler sections and the bus coupler switching device shall have a rated current not less than that of the main busbars.

5.3.3 Group rated current of a main circuit (I_{ng})

Replace second paragraph with

Where the group rated current (I_{ng}) of a main circuit is less than the rated current (I_{nc}) of this circuit, the group rated current of the functional unit in its designated compartment position shall be marked on the functional unit.

Replace NOTE 2 with

NOTE 2 For a functional unit with a given I_{ng} , the specific arrangement of assembly or section of an assembly can also be stated in terms of power at the given I_{ng} .

5.4 Rated diversity factor (RDF)

Add new subclause

5.4.101 Values of assumed loading

5.4.101.1

For temperature rise tests and temperature rise calculations, an assumed loading factor of 1,0 shall be applied for sections containing a single functional unit.

5.4.101.2

Spare equipped functional units shall have an assumed loading factor in accordance with Table 101.

5.4.101.3

Unequipped spaces shall have an assumed loading factor in accordance with Table 101 for representative circuits that occupy the space.

5.5 Rated frequency (f_n)

Replace second sentence of second paragraph with

The PSC-assembly and ancillary components shall be rated for nominal supply frequency variations of $\pm 5\%$.

6 Information

6.1 Assembly designation marking

Add new list item h)

h) rated peak withstand current;

Add new list item i)

i) short-time withstand current;

Add new list item j)

j) short-time withstand duration;

Add new list item k)

k) degree of protection (IP rating);

Add new list item l)

l) form of internal separation;

Add new list item m)

m) internal arc fault rating (permissible current and duration);

Add new list item n)

n) arcing class.

Add to subclause

The main nameplate or an adjacent label shall include the assembly identification (tag) number, purchase order number and year of assembly manufacture.

6.2 Documentation

6.2.1 Information relating to the assembly

Add to subclause

All documents excluding manufacturers catalogues and manuals shall state the assembly identification number, user's purchase order number and manufacturer's reference number.

6.2.2 Instructions for handling, installation, operation and maintenance

Add to subclause

When a secondary selective electrical interlock or mechanical interlock system is fitted, nameplates containing operational instructions shall be fixed on the front of the PSC-assembly near the point of operation.

Add to subclause

Assemblies supplied in multiple transport units shall be identified to facilitate reassembly at site.

Add to subclause

Operational removable or withdrawable parts weighing more than 25 kg shall be provided with a label confirming that they weigh more than 25 kg.

Add to subclause

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

6.3 Device and/or component identification

Add to subclause

Danger, caution and warning labels shall be in accordance with local and national regulatory requirements.

Add to subclause

The functional unit shall have circuit designation labels at the front of panel and main/auxiliary cable terminations.

Add to subclause

The functional unit shall contain the following information:

- a) functional unit compartment number;
- b) tag number of connected equipment;
- c) service description of connected equipment;
- d) motor kW or feeder current rating.

Add to subclause

Nameplates and identification tags shall be attached to the PSC-assembly with stainless steel 316 threaded fasteners.

Add to subclause

PSC assemblies that are accessible from the rear shall have identification provided for the front and rear covers.

7 Service conditions

7.2 Special service conditions

Replace list item l) with

- l) voltage harmonics in the system with a total harmonic distortion exceeding 8 %;

8 Constructional requirements

8.2 Degree of protection provided by an assembly enclosure

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code)

Replace first sentence of second paragraph with

After installation in accordance with the assembly manufacturer's instructions, the degree of protection of an enclosed assembly shall be at least IP3X.

8.2.3 Assembly with removable parts

Add to third paragraph

Shutters shall automatically open/cover main circuit contact apertures by the movement of the withdrawable unit.

Add to third paragraph

The actuation of shutters shall not be dependent on gravity.

Add new NOTE to third paragraph

NOTE Where the apertures inherently provide the degree of protection IP2X, shutters may be omitted.

Add to subclause

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

Add to subclause

Accessible shutters for main circuit compartments (e.g. air circuit breakers (ACBs) and larger moulded case circuit breakers (MCCBs)) shall be individually operated.

Add to subclause

Accessible busbar shutters and accessible incoming circuit shutters shall be padlockable in the closed position or located within a compartment with a padlockable compartment access door.

Add to subclause

For withdrawable parts, accessible shutters shall be identified in accordance with Table 16.

Add new Table 16

Table 16 – Accessible shutters labelling

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

8.4 Protection against electric shock

8.4.1 General

Add to subclause

Protection against electric shock shall be in accordance with IEC 60364-4-41.

Add to subclause

Where the PSC assemblies are installed on a marine or offshore floating unit, non-conductive handrails shall be installed on the front and accessible rear side of each assembly enclosure.

8.4.2 Basic protection

8.4.2.3 Barriers or enclosures

Add after fourth paragraph

Air-insulated live parts inside enclosures or on the inside face of compartment doors that are accessible with the compartment door open shall be protected against electric shock with a degree of protection of at least IPXXB.

NOTE IPXXB is stipulated in accordance with IEC 60529 as distinct to the use of designation IP2X as the door is opened and the danger is now access to hazardous parts within. IPXXB provides finger "touch-safe" protection against contact to live parts equivalent to IP2X.

8.4.6 Operating and servicing conditions

8.4.6.1 Devices to be operated or components to be replaced by ordinary persons

Delete second sentence of second paragraph

8.4.6.2 Requirements related to accessibility in service by authorized persons

8.4.6.2.1 General

Add to first paragraph

Auxiliary and control supplies fed from power sources external to the PSC-assembly shall each be provided with a padlockable isolation facility.

Add to subclause

Live parts within enclosures and live parts mounted on the internal face of compartment doors that are accessible with the compartment door open shall be protected against electric shock with a degree of protection of at least IPXXB.

Add to subclause

Fuse-links and associated fuse carriers shall only be accessible when they are isolated or when protected against electric shock with a degree of protection of at least IPXXB during the replacement of fuse-links.

8.5 Incorporation of switching devices and components

8.5.2 Removable parts

Add to subclause

Heavier withdrawable functional units shall be located in the lower half of the assembly sections with the lighter units located in the upper half.

8.5.2.101 Withdrawable parts

Replace first sentence of first paragraph with

Withdrawable parts of PSC assemblies shall have a test position or a test situation, and an isolated position.

Replace first sentence of second paragraph with

To prevent unauthorized operation, removeable and withdrawable parts (i.e. units) or their associated assembly location shall be capable of being secured with a padlock in both the disconnected and test positions.

Add to subclause

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

Add to subclause

Stab-in connection fixed contact surfaces shall be protected against oxidation.

Add to subclause

If 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 functional units shall have the following positions:

- a) connected – main circuit electrically connected, auxiliary circuits electrically connected;
- b) test – main circuit electrically disconnected, auxiliary circuits electrically connected;
- c) isolated – main circuit electrically disconnected, auxiliary circuits electrically disconnected;
- d) removed – functional unit physically removed from the PSC-assembly.

NOTE When fitted, auxiliary circuits can also include any copper or fibre optic communication cables to the withdrawable functional unit.

Add to subclause

For withdrawable functional units fitted with intelligent electronic devices (IEDs) that have remote control interface, it shall be possible to test the input/output (I/O) available via the IED remote control interface while the functional unit is in the test position.

8.5.2.102 Interlocking and padlocking of removable and withdrawable parts

Add to first paragraph

The main circuit disconnect device of withdrawable functional units shall be mechanically interlocked to prevent opening and closing on to the distribution busbars with the door open.

Add to subclause

Physically identical withdrawable functional units shall be non-interchangeable with other units that have a different duty, circuit rating or control function.

Add to subclause

Withdrawable functional units of the same compartment dimensions that have an identical duty, circuit rating and control function shall be interchangeable.

Add to subclause

Electrical interlocks to external auxiliary circuits shall revert to a "fail safe" condition when a withdrawable function unit is withdrawn.

8.5.3 Selection of switching devices and components

Add to subclause

Outgoing circuits with rated current above 630 A shall be provided with withdrawable ACBs.

Add to subclause

Outgoing circuits with rated currents up to and including 630 A shall be protected with fuses or with circuit breakers.

Add to subclause

Lighting and small power feeders shall be provided with fuse-switch units or MCCBs.

Add to subclause

Switching devices shall simultaneously switch all phases and when present, simultaneously switch the neutral.

Add new subclause

8.5.3.101 Incoming and bus coupler units

8.5.3.101.1

Incoming main circuit and bus coupler functional units shall be located in separate vertical sections.

NOTE This does not preclude metering, auxiliary equipment or an outgoing functional unit being in the same vertical section as an incomer or bus coupler.

8.5.3.101.2

Main incoming circuit units and bus coupler units shall be provided with withdrawable ACBs or, if specified, switch-disconnectors.

8.5.3.101.3

Incoming main circuit and bus coupler functional unit switch-disconnectors shall have, as a minimum, utilization category AC-22 in accordance with IEC 60947-3.

8.5.3.101.4

Incoming main circuit and bus coupler functional unit switch-disconnectors shall have a short-time withstand current capacity at least equal to the main busbar rated short-time withstand current (I_{cw}) and duration.

8.5.3.101.5

For three-phase and neutral functional units, the neutral pole current rating shall be not less than that for the PSC-assembly neutral busbars.

Add new subclause

8.5.3.102 Isolating switching devices (disconnectors)

8.5.3.102.1

An isolating switching device shall be a mechanical switch, a disconnector fuse or a fuse disconnector.

8.5.3.102.2

Switches, disconnectors, switch-disconnectors and fuse combination units shall be in accordance with IEC 60947-3.

8.5.3.102.3

Switches, disconnectors, switch-disconnectors and fuse combination units used for switching mixed resistive and inductive loads shall have a utilization category AC-22.

8.5.3.102.4

Switches, disconnectors, switch-disconnectors and fuse combination units used for switching motor loads or highly inductive loads shall have a utilization category AC-23.

8.5.3.102.5

Switches, disconnectors, switch-disconnectors and fuse combination units shall be designated for frequent operation, utilization category suffix A of IEC 60947-3.

8.5.3.102.6

Disconnector-fuses and fuse-disconnectors shall have as a minimum utilization category AC-23B for uninterrupted duty.

8.5.3.102.7

Disconnector-fuse and fuse-disconnector rated short-circuit making capacity (I_{cm}) shall be at least equal to the busbar rated short-time withstand current (I_{pk}).

8.5.3.102.8

Switching mechanisms shall be of independent manual operating, air-break type with quick-snap action "make and break" features.

8.5.3.102.9

Switching mechanisms shall be accessible and operable from the front of the PSC-assembly without opening a cover.

8.5.3.102.10

Switching mechanisms shall have the "on" (I) and "off" (O) positions of the switches identified at the front of the switching device.

8.5.3.102.11

All switches used for isolating a circuit shall be padlockable in the "off" position.

Add new subclause

8.5.3.103 Circuit breakers

8.5.3.103.1 General

Circuit breakers that are used in a main incomer or bus coupler or in feeders to sub-distribution switchboards shall have selectivity category B in accordance with IEC 60947-2.

8.5.3.103.2 Air circuit breakers

8.5.3.103.2.1

Air circuit breaker operating mechanisms shall have a shunt trip coil release of energized-to-trip type.

8.5.3.103.2.2

Air circuit-breaker operating mechanisms shall have a closing release coil with an interlock to inhibit closing when a trip condition exists.

8.5.3.103.2.3

Air circuit-breaker operating mechanisms shall have an anti-pumping device.

8.5.3.103.2.4

Air circuit-breaker operating mechanisms shall have spring stored energy.

8.5.3.103.2.5

Air circuit-breaker operating mechanisms shall have a spring charging motor.

8.5.3.103.2.6

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

8.5.3.103.2.7

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

8.5.3.103.2.8

Air circuit-breaker operating mechanisms shall have an operations counter.

8.5.3.103.2.9

Air circuit breakers shall be provided with a manual mechanical trip facility with a transparent cover guard.

8.5.3.103.2.10

In addition to contacts required for design of control logic and indication, each air circuit breaker shall be provided with the specified number of normally open and normally closed auxiliary contacts wired to terminal blocks.

8.5.3.103.2.11

If specified, test blocks shall be installed on the air circuit breaker or associated instrument compartment door.

8.5.3.102.2.12

Test blocks shall allow for isolation of power monitoring and protective relay equipment inputs and outputs.

8.5.3.103.2.13

Test blocks shall be wired to provide three-phase (and neutral) bus voltage and three-phase (and neutral) currents.

8.5.3.103.3 Moulded case circuit breakers

8.5.3.103.3.1

When remote tripping is specified, MCCB equipped outgoing feeder functional units that are not in combination with a contactor shall have a shunt trip facility.

8.5.3.103.3.2

MCCBs that are the main circuit switching and isolation device for outgoing functional units shall be operable while the compartment door or drawer is in the closed position.

8.5.3.103.3.3

MCCBs that are the main circuit isolation device for outgoing functional units shall be padlockable in the "off" position.

8.5.3.103.3.4

MCCB rated short-circuit making capacity (I_{cm}) shall be at least equal to the busbar rated peak withstand current (I_{pk}).

Add new subclause

8.5.3.104 Main circuit fuses

8.5.3.104.1

Fuses used for main circuit protection shall be high rupturing capacity (HRC) type, general purpose fuse links in accordance with IEC 60269-2.

8.5.3.104.2

Fuse holders shall have a degree of protection of at least IP2X.

8.5.3.104.3

Labels shall be located adjacent to main and auxiliary circuit fuses, confirming fuse ratings in accordance with circuit design.

Add new subclause

8.5.3.105 Motor starters and contactor feeders

8.5.3.105.1

Motor starters and contactor feeders shall be provided with fuse or MCCB protected electromagnetic contactors.

8.5.3.105.2

The short-circuit protection device for motor starters and contactor feeders shall provide Type 2 co-ordination.

8.5.3.105.3

Unlatched contactors shall be of under-voltage release type.

8.5.3.105.4

Latched contactor feeders shall have a manual mechanical trip facility with a guarded manual release.

8.5.3.105.5

Contactors, motor starters and associated protective devices shall be in accordance with IEC 60947-4-1.

8.5.3.105.6

Contactors shall be rated for uninterrupted duty with at least class 12 intermittent duty, with a utilization category of at least AC-3 in accordance with IEC 60947-1.

8.5.3.105.7

Contactors feeding motors in plugging or inching service shall have a utilization category of AC-4.

8.5.3.105.8

Contactor no-load operating mechanical endurance shall not be less than 1 million cycles.

8.5.3.105.9

Emergency stop pushbuttons shall comply with IEC 60947-5-5.

8.5.3.105.10

Emergency stop pushbuttons shall be provided with a protective guard or shroud to prevent unintended operation.

8.5.3.105.11

The colour and marking of actuators shall be in accordance with IEC 60204-1.

8.5.3.105.12

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

8.5.3.105.13

The control power supply shall be connected to the outgoing side of the main circuit isolating device for contactors that have their control circuit source derived internally within each functional unit.

8.5.3.105.14

If a contactor control circuit source derived internally from within each bus section is specified, a control power transformer shall be provided for each busbar section with the supplies wired in parallel to the functional units.

8.5.3.105.15

If a contactor control power source external to the PSC-assembly is specified, a control power circuit shall be provided in each vertical section with the functional unit supplies wired in parallel.

8.5.3.105.16

Contactor functional units with control power transformers shall be provided with primary and secondary overcurrent protection.

8.5.3.105.17

Contactor control circuits shall be provided with fuse or miniature circuit breaker (MCB) protection within each functional unit.

8.5.3.105.18

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

8.5.3.105.19

The separation distance between the cable entry location and the associated terminals shall provide for the minimum bending radii for the required cable cores.

8.5.3.105.20

The secondary winding of the control power transformer shall have the neutral earthed.

8.5.3.105.21

External control power supplies and their distribution circuits to individual assembly shall be protected by fuses or MCB.

Add new subclause

8.5.3.106 Motor protection

8.5.3.106.1

Motor starter functional units shall be provided with thermal overload protection (ANSI 49) for each phase of the main circuit.

8.5.3.106.2

Solid-state overload relays and microprocessor based digital multifunction motor protection relays shall be provided with adjustable overload characteristic over the range of IEC 60947-4-1 trip classes from 10 to 30.

8.5.3.106.3

Motor starter functional units shall be provided with instantaneous overcurrent protection (ANSI 50) and/or definite-time overcurrent protection (ANSI 51) for each phase of the main circuit.

8.5.3.106.4

On solidly earthed systems, motor starter functional units feeding motors rated equal to or greater than 30 kW shall be fitted with core balance current transformer actuated earth fault protection.

8.5.3.106.5

When earth fault protection is specified, it shall be manual reset only.

8.5.3.106.6

The protection devices in functional units supplying motors with type of protection "eb" shall be in accordance with IEC 60079-14:2013, 11.3.

8.5.3.106.7

Motor thermal protection units shall be in accordance with IEC 60034-11.

8.5.3.106.8

Contactors shall be selected in accordance with the associated HRC fuse earth fault breaking current.

8.5.3.106.9

If IEDs are provided, the additional minimal functional requirements listed in Table 17 shall be fulfilled.

Add new Table 17

Table 17 – Intelligent electronic device (IED) requirements

	ANSI device code	IEC nomenclature	Motors < 110 kW	Motors ≥ 110 kW	Motors ≥ 185 kW
Locked rotor protection	51LR		O	X	X
Definite-time undercurrent protection	37	$I_{<}$	O	O	O
Inverse-time unbalance protection based on negative phase-sequence current	46	$I_{2>}$	O	O	O
Motor start-up time supervision	48	$I_{S^2} t_S$		X	X
Cumulative start-up time counter and restart disable function	66	Σt_{Si}		X	X
Lockout relay	86		O	X	X
Front-of-panel protection reset			O	O	O
Key X = required O = optional, fit when user specified					
NOTE For IED motor protection relays, protection reset should be via the local IED HMI, accessible with the front compartment door closed.					

8.5.3.106.10

Microprocessor based digital multifunction motor protection relays shall be provided with undervoltage ride-through and/or auto-restart functionality.

Add new subclause

8.5.3.107 Integrated adjustable speed drives and power semiconductor systems

8.5.3.107.1

ASDs and PSSs shall be in accordance with IEC 60947-4-2.

8.5.3.107.2

Devices requiring human interface (e.g. ASDs and IEDs) shall be provided with a programmer or operator interface that is accessible with the front compartment door closed.

8.5.3.107.3

For applications that require a reduced voltage starter, solid-state soft starter type unit shall be provided.

8.5.3.107.4

Adjustable speed drives and soft starter units shall include facilities for isolation and bypass if indicated on the project drawings.

Add new subclause

8.5.3.108 Current transformers

8.5.3.108.1

Current transformers shall be in accordance with IEC 61869-2.

8.5.3.108.2

Current transformer accuracy class shall be class 1 for measuring incoming devices.

8.5.3.108.3

Current transformer accuracy class shall be class 3 for measuring outgoing devices.

8.5.3.108.4

Current transformer accuracy class shall be class 5P for protective devices.

8.5.3.108.5

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

8.5.3.108.6

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

8.5.3.108.7

For external connections of current transformer circuits, terminals shall be suitable for terminating ring type lugs.

8.5.3.108.8

Control wiring shall be terminated using insulated compression lugs on screw type terminals.

NOTE Spade, fork, ring and bootlace lugs are typical lug types used for terminals and connectors on components.

8.5.3.108.9

Control wiring terminated on IEDs (e.g. microprocessor-based multifunction protective relays and meters) that do not have screw type terminals shall be terminated with crimp type ferrules or pin lugs.

8.5.3.108.10

Current transformers shall have a short-circuit current withstand rating for a minimum of 1 s in accordance with IEC 61869-2:2012, 5.204.

Add new subclause

8.5.3.109 Voltage transformers

8.5.3.109.1

Voltage transformers shall be in accordance with IEC 61869-3.

8.5.3.109.2

Voltage transformers shall be of dry insulation type with an earthed screen between the primary and secondary winding.

8.5.3.109.3

Voltage transformers shall be protected by MCBs or fuses on the primary side.

8.5.3.109.4

Voltage transformers shall be protected by MCBs on secondary windings.

8.5.3.109.5

Voltage transformer accuracy class shall be class 1,0 for measuring devices.

8.5.3.109.6

Voltage transformer accuracy class shall be class 3P for protective devices.

8.5.3.109.7

With the exception of unearthed (IT) systems with insulation monitoring, three-phase voltage transformers shall be provided with star connection and neutral earthed at one point on the secondary.

8.5.3.109.8

For unearthed (IT) systems with insulation monitoring, the voltage transformer on the primary side shall be connected line to line.

8.5.3.109.9

Voltage transformer secondary connections shall be wired to terminals for external wiring when remote metering is required.

8.5.3.109.10

When the voltage transformer secondary voltage is used for control or interlock, a MCB with signal contacts for trip indication shall be provided.

8.5.3.109.11

The primary protection for voltage transformers in bus bars and main circuits shall be physically accessible solely when the switchgear is in a de-energized state.

Add new subclause

8.5.3.110 Unearthed electrical supplies (IT)

8.5.3.110.1

Insulation monitoring and earth fault detection shall be provided for PSC-assemblies with unearthed (IT) electrical supplies.

8.5.3.110.2

Insulation monitoring and earth fault detection shall have continuous monitoring of insulation resistance of each bus section.

8.5.3.110.3

Insulation monitoring and earth fault detection shall have provision for audible and electronic alarm indication of low insulation resistance.

8.5.3.110.4

Insulation monitoring and earth fault detection shall have a communication interface for transmission of insulation resistance values and alarms to a remote supervisory system.

8.5.3.110.5

Insulation monitoring and earth fault detection systems shall provide automatic location of earth faults by the use of current transformers fitted in motor starters or feeders.

8.5.3.110.6

Insulation monitoring and earth fault detection shall have selectable insulation impedance ranges.

8.5.3.110.7

Insulation monitoring and earth fault detection shall have local display of system insulation resistance value at each PSC-assembly.

8.5.3.110.8

Insulation monitoring and earth fault detection systems shall be compatible with adjustable speed drive and power semiconductor systems.

Add new subclause

8.5.3.111 Automatic or manual transfer schemes

8.5.3.111.1

The transfer scheme shall be disabled if one or more transfer breakers are in the test, isolated or removed position.

8.5.3.111.2

Manual transfer schemes having no electrical interlocks, sync checks or controls shall have a key type interlock to achieve mechanical interlocking between circuit breaker operations.

8.5.3.111.3

The transfer scheme shall operate as indicated in the supplemental descriptions provided with the project drawings.

8.5.3.111.4

Transfer scheme logic shall be hardwired and/or software configured within devices integral to the PSC-assembly.

8.5.5 Accessibility

Add to subclause

The PSC-assembly height shall not exceed 2,5 m.

Add new subclause

8.5.5.101 Component accessibility

8.5.5.101.1

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

8.5.5.101.2

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

8.5.5.101.3

Removable covers shall be provided on main busbar compartments for access to busbar joint construction and maintenance activities.

8.5.5.101.4

Hinged doors shall open at least 95° on the vertical axis and not be obstructed by adjacent equipment or doors.

8.5.5.101.5

Door restraints shall be provided for securing hinged doors in the open position in the following cases:

- a) when placed on floating offshore installations;
- b) when located outdoors (exposed to wind);
- c) when door is equipped with electrical components.

8.5.5.101.6

Doors and covers required to be opened during normal operation shall have latches that are operated either by hand, captive screws using a flat-head screwdriver or similar means.

8.5.5.101.7

Hinged cable compartment doors shall be padlockable.

8.5.6 Barriers

8.5.6.1

Add to subclause

PSC-assemblies shall provide the following minimum degrees of protection in accordance with IEC 60529 and Table 18.

Add new Table 18

Table 18 – Minimum degrees of protection

Location	Minimum degree of protection
Between horizontal busbar compartments and any other compartment	IP 2X
Between incoming and bus-coupler sections	IP 2X
Between main busbar systems of two separate sections	IP 2X
Between panels	IP 2X
Between compartment of each functional unit and other compartments	IP XXB

8.5.8 Indicator lights and push-buttons

Add to subclause

Status colour coding of indicator components and colour human machine interface (HMI) screens shall be in accordance with Table 19.

NOTE Colour coding of status indicator does not apply to IEDs or protection relays with a suite of status LEDs which are all the same colour.

Add new Table 19

Table 19 – Colour coding of status indicator

Colour	Meaning	PSC-assembly application	
	Safety of persons or environment	ACB	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	Not applicable
White	No specific meaning assigned	Voltage indication (Heater On)	Motor heater on
NOTE Colours detailed in this table are in accordance with IEC 60204-1.			

Add to subclause

Discrete indication lamps shall be LED types.

Add to subclause

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

Add new subclause

8.5.10 Auxiliary components

8.5.10.1 General

8.5.10.1.1

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

8.5.10.1.2

Control and auxiliary devices shall be mechanical duration class 1.

8.5.10.1.3

Control and auxiliary devices shall be rated for 120 cycles per hour (each relay).

8.5.10.1.4

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.

8.5.10.1.5

AC switching elements shall be utilization category AC-15.

8.5.10.1.6

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

8.5.10.1.7

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

8.5.10.1.8

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

8.5.10.1.9

Measuring relays and protection equipment shall be in accordance with IEC 60255-1.

8.5.10.2 Indicating and measuring devices

8.5.10.2.1 Analogue instruments

8.5.10.2.1.1

Analogue instruments shall be in accordance with relevant the parts of IEC 60051.

8.5.10.2.1.2

Analogue indicating instruments shall have a minimum accuracy class of 2,5.

8.5.10.2.1.3

Analogue instruments shall be flush mounted on the front of the PSC-assembly.

8.5.10.2.1.4

Analogue instruments shall display black characters on a white background identifying actual primary circuit values.

8.5.10.2.1.5

Analogue instruments shall be provided with pointer external zero adjustment facility.

8.5.10.2.1.6

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

8.5.10.2.1.7

Analogue ammeters and voltmeters shall have a deviation at the rated value of about 80 % of the full scale range.

8.5.10.2.1.8

Current transformer connected ammeter selector switches shall be "make before break" type.

8.5.10.2.1.9

Analogue voltmeters shall have a voltage selector switch equipped with an "off" position.

8.5.10.2.1.10

Voltmeters shall be operated from the voltage transformer secondary windings.

8.5.10.2.1.11

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

8.5.10.2.2 Digital instruments

8.5.10.2.2.1

Multi-functional digital measuring devices shall have a minimum accuracy class of 1,0.

8.5.10.2.2.2

Multi-functional digital measuring devices shall display current, voltage and power factor per phase together with instantaneous and a running total of kilowatt-hours.

8.5.10.2.3 Energy meters

8.5.10.2.3.1

If specified, energy meters shall be solid state meter type in accordance with IEC 62052-11.

8.5.10.2.3.2

Energy meters shall be rated for three-phase unbalanced load measurement.

8.5.10.2.3.3

If specified, energy meter test terminal blocks shall be provided on the panel front adjacent to the respective energy meter.

8.5.10.2.4 Transducers

Transducers shall be in accordance with IEC 60688.

8.5.101 Description of the types of electrical connections of functional units (IEC 61439-2)

Add to subclause

For withdrawable type functional units, the electrical connections shall be type W.W.W.

Add to subclause

For disconnectable type functional units, the electrical connections shall be type D.D.F.

Add new subclause

8.5.102 Operation

8.5.102.1

PSC-assemblies shall be rated for continuous operation at rated load under normal service conditions for at least 45 000 h (5 years) without planned maintenance that requires de-energization of the busbars.

8.5.102.2

Functional units shall be designed for continuous operation at full load under normal service conditions for at least 45 000 h (5 years) without planned maintenance.

8.6 Internal electrical circuits and connections

8.6.1 Main circuits

Add to first paragraph

Partitions shall be incorporated to prevent an internal arc occurrence in a bus section propagating to adjacent bus sections.

Add to subclause

Busbars shall be manufactured from hard drawn, high conductivity electrolytic copper.

Add to subclause

The main busbars shall be of the same cross sectional area throughout the entire length of the PSC-assembly to achieve the defined rated current.

Add to subclause

If specified, busbar insulating materials and busbar joint shrouds shall be of a flame retardant type in accordance with the relevant part of IEC 60684, non-hygroscopic and non-tracking.

Add to subclause

Where busbars are insulated, the insulation of the main busbar joints and interconnecting busbar joints shall be removable and replaceable for joint inspection.

Add to subclause

For PSC-assemblies incorporating a neutral busbar, if specified, each incoming stepdown transformer circuit shall be provided with an accessible removable link between the neutral busbar and the protective earth.

Add to subclause

Main circuit neutral/protective earthing links shall be removable without exposure to other live parts.

8.6.2 Auxiliary circuits

Add to subclause

Earthed poles shall be connected via a removable link.

Add to subclause

Auxiliary circuits powered from an external source shall be via auxiliary main switch contacts in accordance with the status of the main switching device.

Add to subclause

Individual busbar sections of the switchgear assembly shall have a dedicated auxiliary and control power supply.

Add to subclause

Where devices are mounted on hinged doors, wiring connections shall be made with flexible conductors protected in a flexible conduit or sleeve.

Add to subclause

Cable trunking shall have 20 % spare space for future additions.

NOTE Cable trunking is also known as wiring duct, cable duct, cable channel, etc.

Add new subclause

8.6.2.101 Interface with supervisory systems

Incoming auxiliary supplies shall be monitored with an alarm for loss of availability.

8.6.3 Bare and insulated conductors

Add to subclause

A maximum of two conductors shall be terminated on a single terminal.

Add to subclause

Internal wiring shall be soft or annealed copper multi-stranded wire with 600 V insulation.

8.6.5 Identification of the conductors of main and auxiliary circuits

Add to subclause

Internal wiring shall be identified at both ends within 3 cm of the termination in accordance with the circuit and wiring diagrams, using one of the following:

- a) machine printed 360° slip-on wire markers;
- b) heat-shrink wire markers;
- c) permanent stencilling per wire with a unique tag or wire number.

Add new Table 20

Table 20 – Identification of conductors and terminals

Designated conductor	Mandatory marking
AC conductors	
Phase 1	L1
Phase 2	L2
Phase 3	L3
Neutral	N
DC conductors	
Positive pole	(+)
Negative pole	(–)
NOTE Alphanumeric notations and symbols are in accordance with IEC 60445.	

Add new subclause

8.6.8 Earth bar

8.6.8.1

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

8.6.8.2

Dedicated termination points for all functional unit earthing and external earthing requirements shall be provided.

8.6.8.3

Earth bars shall incorporate spare M10 connection points at the bottom of outgoing cable compartments and incoming panels to facilitate external earth connections.

8.7 Cooling

Add to subclause

The PSC-assembly shall be naturally ventilated.

8.8 Terminals for external cables

Add to subclause

In the absence of user defined field cable information, guidance shall be taken from Table A.1 using the maximum cross-section values.

Add to subclause

Cable supports and bracing points spanning the entire height at intervals not exceeding 450 mm shall be incorporated in cable compartments.

Add to subclause

Terminals for the connection of external auxiliary control cables shall be provided with a minimum of 10 % spare unwired terminals without reducing the size of the field wiring allocated space.

Add to subclause

Power cable terminals shall be provided with phase separation screens.

Add to subclause

The largest functional unit compartments shall be located at the bottom of the PSC section with provision for direct entry and termination.

Add to subclause

Where single core cables enter the PSC-assembly, the associated gland plates or transit frames shall be fabricated using a non-magnetic metal.

Add to subclause

Gland plates and multi-cable transit frames shall be connected directly to the main protective earth.

Add new subclause

8.8.101 Terminals for control and auxiliaries

8.8.101.1

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

8.8.101.2

Terminals shall be of modular design in accordance with IEC 60947-7-1.

8.8.101.3

Parallel connections shall be made using cross connection links approved by the terminal manufacturer.

8.8.101.4

Terminal blocks shall be grouped by function and operating voltage.

8.8.101.5

Terminal blocks shall be separated from other groups using barrier plates or earthed terminals.

8.8.101.6

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

8.8.101.7

Terminals associated with external sources of supply shall display a warning label.

8.8.101.8

Space for a minimum of 10 % spare terminals to be installed, shall be provided for future use.

8.8.101.9

Spare I/O contacts of protection/auxiliary relays shall be wired to terminal blocks and numbered.

8.8.101.10

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

8.8.101.11

Earthing links for control supplies and current transformers shall be removable.

8.8.101.12

Instrument circuits requiring dedicated earthing shall have separate instrument earth bars isolated from main earth bars.

8.8.101.13

When external cable conductors are terminated directly onto flat bar with cable lugs, the termination points shall have pre-drilled holes to the user defined diameters.

8.8.101.14

Interconnecting wires between shipping sections shall be terminated on terminal blocks and permanently marked in accordance with the wiring diagram.

8.8.101.15

Terminals for external cables sized 10 mm² and above shall accept hexagonal compression type crimp lugs.

8.101 Internal separation of PSC-assemblies (IEC 61439-2)

Add to subclause

Internal separation shall be a minimum of Form 4a for ACB functional units and a minimum of Form 3b for all other functional units.

Add new subclause

8.102 PSC-assembly physical configuration

8.102.1

PSC-assemblies shall be fully enclosed and consist of multi-cubicle sections joined to form a rigid freestanding assembly for floor mounting.

8.102.2

Functional units with the greatest mass shall be in the lowest cubicles of the tier.

8.102.3

PSC-assemblies specified for marine installation shall be in accordance with IEC 60092-101:2018, Clause 4.

8.102.4

PSC-assemblies specified for offshore electrical installations shall be in accordance with IEC 61892-3:2019, 7.1 to 7.4.

Add new subclause

8.103 Enclosure space heaters

8.103.1 Space heaters

8.103.1.1

If specified, PSC-assembly enclosure space heaters shall maintain the enclosure internal air temperature at least 5 K above the specified minimum ambient air temperature.

8.103.1.2

PSC-assembly enclosure space heaters shall incorporate a mechanical guard where the heater surface temperature exceeds 60 °C.

8.103.1.3

PSC-assembly enclosure space heaters shall have a degree of ingress protection of at least IP2X in accordance with IEC 60529.

8.103.1.4

Each vertical section space heater circuit shall be protected by a MCB with a 30 mA residual current device (RCD) or by a residual current circuit breaker with overcurrent protection (RCBO).

8.103.1.5

PSC-assembly enclosure space heaters shall be wired to an accessible terminal block for connection to an external power source.

8.103.2 Space heater supply monitoring

8.103.2.1

If space heater supply monitoring is specified, each bus section heater supply shall have a front of panel indicating LED lamp and labelled "Heater supply on".

8.103.2.2

If space heater supply monitoring is specified, each bus section heater supply shall have a loss of supply actuated volt-free signal wired to an accessible terminal block.

8.103.3 Space heater current monitoring

If space heater load current monitoring is specified, a control unit shall be provided.

8.103.3.1

The space heater control unit supply disconnect shall be a circuit breaker which is padlockable in the "off" position.

8.103.3.2

If a space heater control unit is specified, the space heater circuit shall include a momentary controller bypass push button.

8.103.3.3

The space heater control unit shall be provided with an ammeter.

8.103.3.4

The space heater control unit ammeter shall have an appropriately sized scale such that the failure of a single space heater element results in a visible change in ammeter reading.

8.103.3.5

The normal operating ampacity of a space heater circuit shall be inscribed on the ammeter nameplate.

Add new subclause

8.104 Provision for future development

8.104.1

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

8.104.2

Unequipped spaces shall be fitted with the internal components to enable the subsequent installation of a functional unit in that space while the PSC-assembly busbars are energized.

8.104.3

The PSC-assemblies shall have a design and post factory acceptance test (FAT) supported lifetime of at least 20 years under service conditions.

8.104.4

The manufacturer shall have an obsolescence management plan in accordance with a recognized system for all PSC-assembly components by example to IEC 62402.

8.104.5

Provided equipment shall be field proven for at least three years.

Add new subclause

8.105 Condition based monitoring

8.105.1 General

8.105.1.1

Condition based monitoring systems shall provide real-time continuous monitoring.

8.105.1.2

Real time monitored condition parameters shall be displayed on a front of panel mounted HMI.

8.105.1.3

Continuous monitoring systems shall include communications interface(s) capable of conveying temperature data, status and alarming for each monitored point.

8.105.2 Thermal monitoring

8.105.2.1

If specified, PSC-assemblies shall be equipped with factory-integrated continuous thermal monitoring technology.

8.105.2.2

Thermal monitoring shall include hotspot detection sensors for main incoming sections, e.g. main circuit breaker, lugs and shipping splits.

9 Performance requirements

9.3 Short-circuit protection and short-circuit withstand strength

9.3.1 General

Add to subclause

PSC-assemblies shall be designed, constructed and verification tested in accordance with IEC TR 61641 to provide personnel protection under arcing condition for restricted access authorized persons.

Add to subclause

PSC-assemblies specified with an arcing class shall have third-party verified type test certification stating conformance to IEC TR 61641.

Add to subclause

The permissible short-circuit current under arcing conditions ($I_{p\text{ arc}}$) value shall be at least equal to the specified rated short-time withstand current (I_{cw}) for a minimum arc fault duration of 0,3 s.

Add to subclause

PSC-assemblies with arcing class B or arcing class C classification, an arc fault within a functional unit shall be confined to that functional unit compartment.

Add to subclause

PSC-assemblies with arcing class B or arcing class C classification, an arc fault on a distribution busbar shall confine the arc to that section without propagating to the main busbars.

Add to subclause

Pressure-relief device or pressure-relief ducting, if required, shall be fully rated to withstand the forces associated with an arc fault within the PSC-assembly.

Add to subclause

If pressure-relief ducting with an outdoor exhaust vent is required, the exhaust ducting shall be provided with a wall penetration kit and exterior exhaust outlet equipped with environmental seals.

NOTE The wall penetration kit and exterior exhaust outlet can also require additional features to maintain the integrity of the wall or bulkhead being penetrated, such as fire rating or blast overpressure certification.

Add to subclause

Minimum room dimension requirements and other guidelines (e.g. pressure-relief flaps, arc ducts, exhaust vents) required to ensure the PSC-assembly arc fault protection for personnel safety and building integrity shall be provided.

Add to subclause

If specified, internal arc fault mitigation system shall be provided and integrated into the PSC-assembly in accordance with IEC TS 63107.

9.3.4 Co-ordination of protective devices

In third paragraph, replace "(e.g. by a warning label in the assembly or in the operating instructions, see 6.2)" with

by a warning label within the relevant functional unit compartments

10 Design verification

10.10 Temperature-rise

10.10.1 General

Add to subclause

For PSC-assemblies incorporating additional supervisory devices, the verification of temperature-rise shall include the in-service heat contribution from these additional components.

11 Routine verification

11.8 Mechanical operation (IEC 61439-2)

Replace second sentence of first paragraph with

Verification shall include the checking of interlocking and locking arrangements associated with removable and withdrawable parts, including the insertion interlocks of mechanically identical withdrawable functional units.

11.10 Wiring, operational performance and function

Add new subclause

11.10.1 Functional testing

Functional testing of the completed PSC-assembly shall include the following:

- a) operation of all circuit breakers and switching devices, including any auto-transfer schemes;
- b) electrical and mechanical interlocks;
- c) control devices that are either hard wired or communicating over a network and, if applicable, local HMI;
- d) current and voltage transformers or sensors;

NOTE Primary injection for current transformers is not required to comply with this requirement.

- e) circuit breaker trip units, protective relays and metering devices;
- f) indicator lights;
- g) circuit breaker drawout and mechanical insertions, including operation of the shutter mechanism;
- h) vertical section space heaters and thermostat/hygrostat if applicable;
- i) continuous thermal monitoring system if applicable;
- j) auxiliary equipment provided as part of the system design (e.g. interposing relay panel, mimic panel, remote racking equipment, and absence of voltage tester device);
- k) high resistance earthing system, if applicable;

Add new subclause

11.101 Electrical control and management system (ECMS) simulation test

11.101.1

If specified, a simulation test shall be carried out between the remote HMI and electrical control devices on the PSC-assemblies and the specific functions.

11.101.2

The simulation test shall check and validate the ECMS and interfaces with interconnected electrical assemblies.

11.101.3

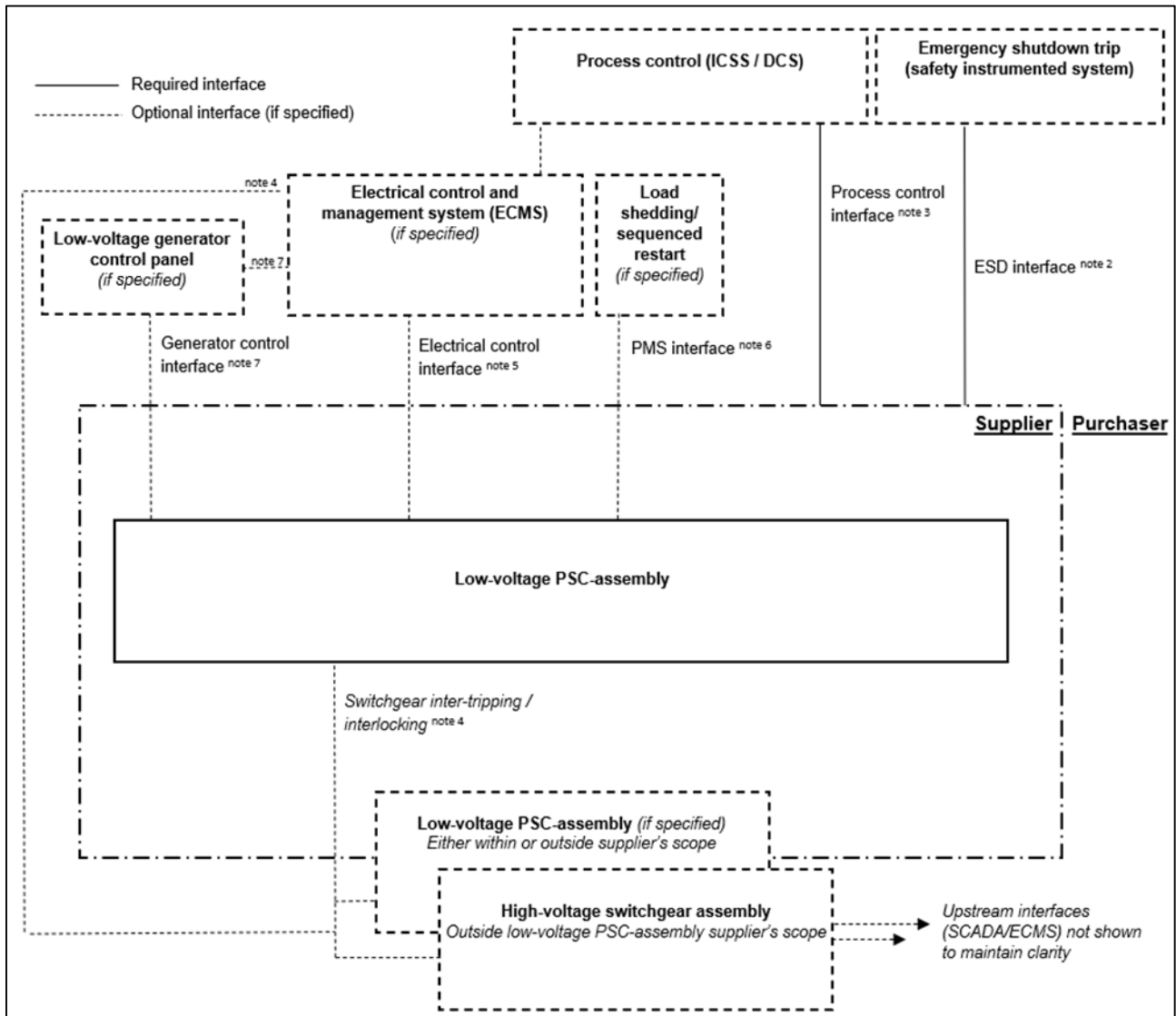
The ECMS simulation tests shall be carried out in accordance with the procedures, documentation and tools proposed by the ECMS provider.

Add new Annex HH

Annex HH (informative)

Integration with external systems

Add new Figure HH.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 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 ECMS.

Note 4 Incoming circuit breaker intertripping/interlocking to either upstream high-voltage switchboards or interconnectors to adjacent low-voltage PSC-assemblies. The assumed default is hardwired from PSC-assembly to upstream or 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 PSC-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 PSC-assembly circuits, (e.g. hardwired discrete trips, load start inhibits and status monitoring).

Note 7 It is typically for emergency/essential switchboards, PSC-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 HH.1 – Communications interface block diagram

Bibliography

Add to Bibliography

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

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