

Supplementary Requirements to IEC 61439-1 & 2 LV Switchgear & Controlgear



Acknowledgements

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Supplementary Requirements to IEC 61439-1 & 2 LV Switchgear & Controlgear

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Foreword

This Specification was prepared by a Joint Industry Project 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF). Seventeen key members from WEF and IOGP membership participated in JIP33 with an effort to leverage and improve industry level standardization. The scope of work has been to harmonize procurement specifications from the seventeen participating Members and develop one agreed and jointly approved Specification building on recognized industry and/or international standards.

Following agreement of the relevant JIP33 sub-team and approval by the JIP33 Steering Committee, the IOGP Management Committee has agreed to the publication of this Specification by IOGP. Where adopted by the individual operating companies, this Specification and associated documentation supersedes existing company documentation for the purpose of industry harmonized practice.

Introduction

This Specification presumes that a compilation of documents will be used for the definition, enquiry and purchase of PSC-Assemblies, which will consist of part, or all of the following:

- S-560, Supplementary Requirements to IEC 61439 - LV Switchgear and Controlgear Assemblies.
- LV PSC-Assembly Requisition (Purchase Order), with required documentation, quality assurance and inspection attachments.
- LV PSC-Assembly Data Sheet(s) for common and individual assembly requirements (supersedes IEC 61439-2 Annex BB (informative), User information template).
- LV PSC-Assembly Circuit Schedule, or data file containing this information (one per Assembly).
- User Diagram(s), such as single line diagrams, schematic diagrams, wiring diagrams, logic diagrams.

Supporting documents requirements will be based on the following:

- IOGP S-560D, Data sheets for IEC 61439 - LV Switchgear and Controlgear Assemblies.
- IOGP S-560L, Supplier Deliverable Requirements List (SDRL) for IEC 61439 - LV Switchgear and Controlgear Assemblies.
- IOGP S-560Q, Purchase Order Quality Requirements (POQR) for IEC 61439 - LV Switchgear and Controlgear Assemblies.

The following requirements are not detailed within this Specification and will be identified in the Requisition, or as an attachment to the Requisition:

- Health, safety and environmental management requirements.
- Packing, preservation, marking and shipping requirements (in addition to the standard requirement in clause 6.2.2).
- Spare parts.

Unless defined otherwise in the Requisition, the order of precedence (highest authority listed first) of the codes and standards shall be:

- a. Local statutory codes and regulations.

- b. International statutory regulations.
- c. Data Sheets.
- d. User documents.
- e. This IOGP Specification.
- f. Referenced international codes.

1 Scope

1.1 General

Additional subclause:

This Specification details requirements for the design, materials, fabrication, inspection and testing of low voltage power switchgear and controlgear assemblies (PSC-Assemblies). This Specification amends and supplements IEC 61439-1 Edition 2.0 : 2011 and IEC 61439-2 Edition 2.0 : 2011, referring sequentially to the same clause numbers.

Clauses of IEC 61439-1 and IEC 61439-2 that are not addressed within this Specification shall remain fully applicable as written. Where there is no direct corresponding IEC 61439 clause, a new reference clause number has been added in this Specification. PSC-Assemblies shall be tested to the extent defined in this Specification and in the Data Sheets to meet the arc containment requirements of the User in accordance with IEC TR 61641.

This Specification addresses fully withdrawable switchgear and controlgear of (multi) cubicle type assemblies for indoor installation, it shall also apply, where specified in the requisition documents to fixed and withdrawable cubicle type assemblies and combinations thereof.

1.2 In scope requirements

Additional subclause:

The requirements detailed in this Specification are intended to:

- a. Establish minimum default selections from the options given in IEC 61439-1 and IEC 61439-2,
- b. Specify additional and functional requirements where IEC 61439-1 and IEC 61439-2 are insufficiently detailed,
- c. Specify provisions or options to encourage indoor installed PSC-Assembly rationalization within the petrochemical, refining, oil and gas industry.

Areas of conflict or inconsistency between these documents shall be brought to the attention of User for resolution. In the event of a conflict between this Specification and a relevant law or regulation, the relevant law or regulation shall be followed. If this Specification creates a higher obligation, it shall be followed as long as this also achieves full compliance with the law or regulation.

NOTE Requirements for Regional Trade Certification (eg CE marking) shall be identified in the Requisition documentation.

1.3 Out of scope requirements

Additional subclause:

This Specification does not cover:

- a. Requirements for integration with the Electrical Control & Management Systems (ECMS),
- b. Requirements for integration of any switchgear condition monitoring systems,
- c. Explosion protected 'Ex' equipment, (addressed by IEC 60079 series),
- d. 'Pillar' type or construction site distribution equipment, (addressed by IEC 61439 parts 4 and 5),
- e. Lighting and small power distribution boards rated less than 250 A.

2 Normative references

This clause of Part 1 and Part 2 is applicable except as follows.

Addition:

The following documents are referenced in this document. For dated references, only the version cited shall be applied. For undated references, the latest version of the referenced document (including any amendments) shall be applied.

ANSI/IEEE C37.2	Standard for Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
BS EN 61439-1	Low-voltage switchgear and controlgear assemblies Part 1: General rules.
BS EN 61439-2	Low-voltage switchgear and controlgear assemblies - Part 2: 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 60112	Method for the determination of the proof and the comparative tracking indices of solid insulating materials.
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 J.
IEC 60684 (All parts)	Flexible insulating sleeving.
IEC 60688	Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals.
IEC 61511-1	Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming requirements
IEC TR 61641	Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault.
IEC 61850 (All parts)	Communication networks and systems in substations.
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 61869-4	Instrument transformers – Part 4: Additional requirements for combined transformers.
IEC 61892-3	Mobile and fixed offshore units – Electrical installations – Part 3: Equipment
IEC 62052-11	Electricity metering equipment (AC) General requirements, tests and test conditions – Part 11: Metering equipment.
IEC 62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
ISO 13489-1	Safety of machinery – Safety-related parts of control systems.

3 Terms and definitions

This clause of Part 1 and Part 2 is applicable except as follows.

3.10 Manufacturer/user

3.10.2 ASSEMBLY manufacturer

Addition:

For the purpose of this Specification, ASSEMBLY manufacturer to be read as Manufacturer.

Additional definitions:

3.2.12 Bus section

A number of sections normally connected together in service by a physically continuous main busbar.

3.2.13 Bus coupler

A functional unit which contains a switching and/or isolating device, which electrically connects together two bus sections.

3.10.4 Circuit Schedule

Developed by User summarising details of specific requirements for each load and designation and its required features and functions.

3.10.5 Data Sheet

Developed by User summarizing the characteristics, performance and constructional requirements for the design and selection of the equipment.

3.10.8 Supplier Deliverable Requirements Listing (SDRL)

Indication of information required, review type, place of review and documents for inclusion as part of requisition.

3.10.9 Technical Authority

Individual or entity responsible for defining the technical requirements of the PSC-Assemblies. The Technical Authority may be the User, or an agent, engineer or consultant authorized to act for, and on behalf of the User. For consistency, the term Technical Authority shall be used.

3.10.10 User Diagrams / Documents

Developed by User, defines the functional requirements for a given type/scheme of circuit, protection, control, metering etc., such as single line diagrams, schematic diagrams, wiring diagrams. Used during the development and design stage of a project.

3.10.11 Functional logic

Control logic embedded in IEDs (eg protection relays) that is developed by the Manufacturer to implement the requirements of the User Diagrams and associated protection relay settings.

3.10.12 Purchase Order Quality Requirements (POQR)

Project based requirements issued by User as part of requisition detailing specific quality requirements / responsibilities by Manufacturer.

4 Symbols and abbreviations

This clause of Part 1 and Part 2 is applicable except as follows.

Additional abbreviations:

ACB : Air circuit breaker

ASD :	Adjustable Speed Drive
ATS :	Automatic Transfer System
CE :	European Conformity
CT :	Current Transformer
ECMS :	Electrical Control and Management System
EU :	European Union
FAT :	Factory Acceptance Test
HMI :	Human Machine Interface
HRC:	High Rupturing Capacity
IED :	Intelligent Electronic Devices
IK :	Code Indication of degree of mechanical impact protection provided by an enclosure against external harmful impacts
I/O :	Input / Output
$I_{p \text{ arc}}$:	Permissible short-circuit current under arcing conditions as defined in IEC TR 61641
$I_{ps \text{ arc}}$:	Permissible short-circuit current under self-extinguishing arcing conditions as defined in IEC TR 61641
IT :	Insulated Terra system earthing
ITP :	Inspection and Test Plan
LED :	Light Emitting Diode
MCB :	Miniature Circuit Breaker
MCCB :	Moulded Case Circuit Breaker
MTS :	Manual Transfer System
POQR :	Purchase Order Quality Requirements
RCBO :	Residual Current Circuit Breaker with Overcurrent Protection
SAT :	Site Acceptance Test
SDRL :	Supplier Deliverable Requirements Listing
SIL :	Safety Integrity Level
THD :	Total Harmonic Distortion (IEC 61000-2-2)
TN :	Terra-Neutral system earthing

5 Interface characteristics

This clause of Part 1 and Part 2 is applicable except as follows.

5.1 General

Addition:

Unless defined otherwise in the Data Sheets, the PSC-Assembly and ancillary components shall be suitable for operation without damaging effect, with power supply system variations of:

- a. AC/DC nominal supply voltage: $\pm 10\%$,
- b. Frequency: $\pm 5\%$,
- c. Temporary over-voltages (transient) in accordance with IEC 61439-2, Annex BB.

5.2 Voltage ratings

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

Addition:

PSC-Assemblies shall be verification tested with coordinated insulation values in accordance with overvoltage category III stated in IEC 61439-1, Annex G unless defined otherwise in the Data Sheets.

5.3 Current ratings

Addition:

Each PSC-Assembly shall have current ratings not less than those defined in the Data Sheets at the specified upper limit ambient air temperature.

5.3.1 Rated current of the ASSEMBLY (I_n)

Addition:

Rated current shall not depend on forced ventilation and shall be continuous ratings after de-rating for the specified service conditions. The main busbars shall be rated for the nominal current over the entire length of the PSC-Assembly and shall not be rated lower than the incoming supply functional units.

5.4 Rated diversity factor (RDF) (IEC 61439-2)

Replacement of text:

A diversity factor of 1,0 shall be applied to main (horizontal) busbars. For temperature rise tests or temperature rise calculations, a diversity factor of 1,0 shall be applied for each section containing only one functional unit. The Circuit Schedule shall identify the assumed loading of the functional units. This shall be used in conjunction with IEC 61439-2, Table 101 to provide RDF for each section, and shall be subject to agreement between User and Manufacturer. The initial RDF to be applied may be defined in the Data Sheets. Spare equipped functional units and unequipped spaces for future functional units shall be considered as being loaded to 90% of their rated current and potentially rated current respectively.

6 Information

This clause of Part 1 and Part 2 is applicable except as follows.

6.1 PSC-ASSEMBLY designation marking (IEC 61439-2)

Addition:

The PSC-Assembly nameplate (designation label) shall be fixed at approximately eye level on the front of the assembly with non-corrodible screws or rivets and shall contain the following additional information:

- e. Rated voltage,
- f. Rated frequency,
- g. Rated current of main busbar system,
- h. Rated peak and short time withstand current and withstand time,
- i. Degree of protection (IP rating),
- j. Form of internal separation,
- k. Internal arc resistance rating (current and duration),
- l. Where applicable, other markings (e.g. CE).

Additionally, on the main nameplate or on an adjacent label:

- m. Assembly identification (tag) number,
- n. User's purchase order number,
- o. Year of manufacture.

6.2 Documentation

6.2.1 Information relating to the ASSEMBLY

Addition:

The Manufacturer shall deliver all the documents as defined in the SDRL, in accordance with the agreed terms, media format requirements, quantities and schedule.

The language used for all provided information shall be English, unless defined otherwise in the requisition or Data Sheets.

All documents (excluding Manufacturer standard catalogues and manuals) shall show the Assembly identification number, User's purchase order number and Manufacturer's reference number. Installation instructions, operations instructions and maintenance instructions can be contained in Manufacturer standard catalogues and manuals, as long as they contain all data and information required in their final form and are relevant to the assemblies supplied and that the materials included in the supply are clearly identifiable within the documents.

6.2.2 Instructions for handling, installation, operation and maintenance

Addition:

Assemblies supplied in multiple transport units shall have these units clearly marked to facilitate reassembly at site.

For PSC-Assemblies having operational removable / withdrawable parts with mass higher than 25 kg (such as circuit breakers), each withdrawable unit that shall be clearly marked. A load certified hoist to facilitate removal of these parts shall be provided or where other methods for manual handling are proposed by the Manufacturer, these shall be subject to agreement with the User.

6.3 Device and / or component identification

Addition:

The language used on all devices, labels, plates and notices shall be English, unless alternative or additional language(s) are defined as required in the Data Sheets. Labels shall have black characters on a white background, warning labels shall have white characters on a red background.

Each functional unit shall have a front of panel circuit designation label and an identical label repeated at the main/auxiliary cable termination locations and shall contain the following information:

- a. Functional unit compartment location (section and tier) number,
- b. Tag number of connected equipment,
- c. Service description of connected equipment,
- d. Circuit rating or motor kW rating.

Circuit designation labels shall be secured with non-corrodible screws or other readily replaceable fixing system. The tag number, service description and rating shall be as defined in the Circuit Schedule.

6.3.101 Synoptic diagram

Additional subclause:

If defined as required in the Data Sheets, a durable mimic one-line (synoptic) diagram shall be provided on the front of the assembly, indicating the busbars, incomers, bus-couplers and main feeders.

7 Service conditions

This clause of Part 1 is applicable except as follows.

7.1 Normal service conditions

Addition:

PSC-Assemblies shall be suitable for installation in an indoor location unless defined otherwise in the Data Sheets.

7.1.1.1 Ambient air temperature for indoor installations

Addition:

Ambient air temperatures as described in IEC 61439-1 shall be applied unless defined otherwise in the Data Sheets. All components shall have the User specified ratings after de-rating factors (if any) for the specified service conditions.

7.1.3 Pollution degree

Addition:

Unless defined otherwise in the Data Sheets, PSC-Assemblies shall be suitable for use in a pollution degree 3 environment.

7.2 Special service conditions

Addition:

Requirements for special service conditions shall be as defined the Data Sheets.

Replacement of text:

- l) Excessive voltage harmonics in the system greater than THD = 8%.

7.3 Conditions during transport, storage and installation

Replacement of text:

Any special conditions that arise, e.g. extended storage periods, shock and vibration and / or extreme temperatures, will be stated in the Requisition. Transport packing arrangements will be provided by the Manufacturer to meet User packing and storage requirements as defined in the Requisition; this shall include weights, lifting requirements and dimensions.

Requirements for external heater supply connection during storage and transit shall be defined in the Data Sheets.

8 Constructional requirements

This clause of Part 1 and Part 2 is applicable except as follows.

Additional subclauses:

8.0.101 General

PSC-Assemblies shall be fully enclosed and shall consist of multi-cubicle sections joined together to form a rigid freestanding assembly suitable for floor mounting, unless defined otherwise in the Data Sheets.

The floor shall not be considered as being part of the enclosure. PSC-Assemblies shall be suitable for securing to longitudinal runs of channels flush with the floor surface, unless defined otherwise in the Data Sheets.

PSC-Assemblies shall comprise one or more bus sections to which incoming units and outgoing units are connected. Bus sections shall be linked through bus coupler units. All functional units in PSC-Assemblies shall be withdrawable, unless defined otherwise in the Data Sheets. The required quantity and type of functional units are defined in the Circuit Schedule.

As far as practical, higher power capacity functional units shall be accommodated in the bottom portion of the sections for ease of handling the withdrawable components.

When marine class is identified as a requirement in the Data Sheets, PSC Assemblies shall additionally be in accordance with stated requirements for low voltage switchgear and controlgear assemblies as defined in IEC 61892-3.

Removable covers intended to be removed for maintenance shall have retainable fastening means when undone (e.g. captive bolts and nuts).

8.0.102 Provision for future development

Unless defined otherwise in the Data Sheets, PSC-Assemblies shall have the following provisions for future development:

- a. 10% fully equipped spare (unassigned) functional outgoing units as defined and designated in the Circuit Schedule,
- b. 10% free unequipped space provision for future functional units for outgoing circuits.

8.0.103 Technology readiness and obsolescence

The PSC-Assemblies shall have a design and post FAT supported lifetime of at least 20 years under service conditions. Manufacturer shall have an obsolescence management plan in accordance with a recognised system for all PSC-Assembly components by example to IEC 62402 as defined in the Data Sheets.

All provided equipment shall have

- a. A production unit or full scale prototype built and installed; with full interface and function test program performed in the intended (or closely simulated) environment and operated for less than 3 years; the equipment might require additional support for the first 12 to 18 months of operation.

Or

- b. Equipment that is field proven, installed and operating for more than three years with acceptable reliability, demonstrating low risk of early life failures in the field.

8.1 Strength of materials and parts

8.5.9 General

Addition:

The PSC-Assemblies shall be designed for continuous operation at full load for at least 90 000 hours (10 years) without maintenance which would require the main busbars and the distribution busbars (dropper system) to be de energized. When operating under the specified service conditions, the main and distribution busbars including their connections shall not require planned maintenance during the lifetime of the assembly.

Functional units shall be designed for continuous operation at full load for at least 35 000 hours (4 years) without maintenance. Depending on User's operating environment, Manufacturer shall identify components that are not suitable for 4 years continuous operation.

8.5.10 Protection against corrosion

Addition:

Unless defined otherwise in the Data Sheets, the Manufacturer's standard painting and corrosion system can be used.

Manufacturers may offer their external standard surface finish colour unless defined otherwise in the Data Sheets.

8.2 Degree of Protection provided by an ASSEMBLY enclosure

8.2.1 Protection against mechanical impact (IEC 61439-2)

Replacement of text:

PSC-Assemblies shall have external mechanical impact strength (IK) of minimum IK 08 as defined in IEC 62262 unless defined otherwise in the Data Sheets.

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water

Addition (after last paragraph):

PSC-Assemblies shall be provided with space heaters for anti-condensation prevention in each section, where specified in the Data Sheets.

Space heaters shall:

- a. Be designed for operation at the voltage defined in the Data Sheets,
- b. Have a minimum degree of protection of IP 2X,
- c. Include an additional mechanical guard where the heater surface temperature exceeds 60°C,
- d. Be replaceable without a requirement to isolate main circuits within the section.

The heating system of each bus section of the PSC-Assembly shall be separately supplied from a remote source unless defined otherwise in the Data Sheets and User Diagrams. The following provisions for each bus section heater supplies shall be made:

- a. Be protected by a MCB and 30 mA RCD or RCBO with ‘loss of supply’ volt free contact wired to terminals for remote supervision,
- b. Have a front of panel indicating LED lamp with a label engraved “Heater Supply On”,
- c. Be controlled by a thermostat/hygrostat, as defined in the Data Sheets,
- d. If defined in User Diagrams, be fitted with a manual switch to bypass the thermostat/hygrostat control.

8.2.3 ASSEMBLY with removable parts

Addition to second paragraph:

After the removal of a removal part, minimum degree of protection of IP 2X shall be provided.

Addition to third paragraph:

Shutters will not be dependent on gravity and shall automatically open/cover the main circuit contact apertures. Where the apertures inherently provide the degree of protection IP 2X, then shutters can be omitted.

Addition:

Any revealed accessible shutters that prevent access to normally live parts shall be marked with warning triangle signs stating voltage as follows: “DANGER VOLTS”. Each set of accessible shutters for main circuit compartments (typically ACBs and larger MCCBs) shall be capable of being individually operated and the shutters shall be padlockable in the closed position. Accessible shutters shall be labelled in conformance with the following:

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

8.2.101 PSC-ASSEMBLY with withdrawable parts (IEC 61439-2)

Addition to first paragraph:

Unless defined otherwise in the Data Sheets, the minimum degree of ingress protection for the external enclosure of a PSC-Assembly shall be IP 31 for indoor use.

NOTE PSC-Assembly ventilation requirements may incorporate lower levels of IP protection subject to agreement between User and Manufacturer.

8.4 Protection against electric shock

8.4.1 General

Addition:

HRC fuses and associated fuse carriers shall only be accessible when they are fully isolated or when they offer a degree of protection to live parts of at least IP 2X when the fuses are inserted, have been withdrawn or are being withdrawn.

8.4.6 Operating and servicing conditions

8.4.6.2 Requirements related to accessibility in service by authorized persons

8.4.6.2.1 General

Addition:

Where control and/or bus wired auxiliary supplies to sections and / or functional units are provided from external sources, isolation points shall be provided for each individual functional unit or for the sections as detailed on the User Diagrams.

8.4.6.2.4 Requirements related to accessibility for extension under voltage

Replacement of last paragraph:

The PSC-Assembly is not required to be extended when operating under voltage.

Addition:

Busbars shall have pre-drilled extremities for possible future expansion.

8.4.6.2.6 Locking arrangements

Additional subclause:

Manufacturer's standard locking provision facilities shall be provided unless defined otherwise in the Data Sheets.

8.5 Incorporation of switching devices and components

8.5.2.101 Withdrawable parts (IEC 61439-2)

Addition:

Withdrawable functional units shall be marked to identify where the units shall be replaced in the PSC-Assembly.

In the 'stab in' connections between the fixed and withdrawable parts, conducting contact surfaces of fixed parts shall be protected against oxidation.

Where defined in the Data Sheets, facilities for remote testing of withdrawable units shall be provided. This may include extension umbilicals or specific test modules. Functionality / interface of module shall be agreed between User and Manufacturer.

8.5.2.102 Interlocking and padlocking of removable and withdrawable parts (IEC 61439-2)

Addition:

Withdrawable functional units which are physically identical but electrically have a different function shall be non-interchangeable. Obstacles shall be employed to prevent insertion of a motor starter unit into a space for a contactor or plain feeder unit of the same physical size. Circuit breakers and functional units of the same rating and function shall be interchangeable.

Mandatory interlocks shall be of a mechanical type and shall not rely on gravity. Electrical interlocks shall “fail safe” to a de-energized state.

8.5.3 Selection of switching devices and components

Addition:

The main incomers, bus couplers, and outgoing power feeder units rated 800 amps and above shall be provided with withdrawable ACBs or non-withdrawable load switches unless defined otherwise in the Data Sheets. Outgoing power feeders rated 630 amps and below shall be controlled by fuse switch units or MCCBs. The motor starter functional units shall be comprised of a combination of fuse-switch units or MCCBs, contactors and protection relays, configured in accordance with the User Diagrams. Lighting and small power feeders shall be with fuse-switch units or MCCBs. When defined as required in the Circuit Schedule, outgoing functional units shall be provided with contactors for the automatic control of outdoor lighting circuits, or for ignition source control, or for load shedding schemes.

Where specified in the Data Sheets, electrical protection relays (IEDs) shall have communications protocols in compliance with IEC 61850. The User Diagrams shall define the required interconnectivity between the functional units and the external environment.

Addition to second paragraph:

Switching devices shall switch all phases or poles (i.e. 4 pole type for 3 phase + neutral systems).

Addition to fourth paragraph:

Unless defined otherwise on the Circuit Schedule, circuit breakers shall have selectivity category A or B depending on the duty as follows:

- a. Category A for outgoing units not requiring selective protection.
- b. Category B for all other units requiring selective protection.

By default, auxiliary control circuits shall be category A.

Where utilised, load switches shall be fault make, load break and comply with and be verification tested to IEC 60947-3 and have a utilization category AC 22.

Replacement of note text:

NOTE Guidance is given in IEC TR 61912-1 and IEC TR 61912-2, specifically Table 1. Selectivity Category B should be provided on circuit breakers above 100 amps where defined on the Circuit Schedule.

8.5.3.101 Incoming and bus coupler units

Additional subclause:

Incoming and bus coupler units shall be fitted with protection, control, indication, metering, interlocking, inter tripping and auto transfer (if any) facilities as defined in the User Diagrams. Key interlock systems between upstream, incoming and bus coupler units shall be provided only when defined in the User Diagrams.

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

The metering supply to volt and watt-hour meters etc. shall be protected with HRC type fuses of the fully insulated pattern fixed directly to the busbar system with provision to allow safe change-out as required. Secondary isolation for the metering supply shall be provided.

8.5.3.102 Isolating switching devices (disconnectors)

Additional subclause:

Isolating switching devices shall consist of either a switch (mechanical), a disconnector fuse, or a fuse disconnector and:

- a. Switches, disconnectors, switch-disconnectors and fuse combination units shall comply with and be verification tested to IEC 60947-3 and have a utilization category AC 22 when switching mixed resistive and inductive loads and AC 23 when switching motor loads or other highly inductive loads, number of operating cycles shall be to category A of IEC 60947-3 Table 4 unless defined otherwise in the Circuit Schedule,
- b. Disconnector fuse and fuse disconnectors shall comply with and be verification tested to IEC 60947-3 for uninterrupted duty, utilization category AC 23B,
- c. Shall have a rated (conditional) short-circuit making capacity in conformity with the prospective short-circuit currents, as specified for the busbar system,
- d. Switching mechanisms shall be of the independent manual operating, air-break type with quick snap action make and break features,
- e. Shall be easily accessible and operable from the front of the assembly without opening a cover and the 'I' (on) and 'O' (off) positions of the switches shall be clearly identified at front of CB.

Switching of the neutral pole for motor circuits (where the neutral is used for only for the control circuit) may be implemented using suitably rated auxiliary contacts with a 3 pole switch provided such contacts meet the requirements for an isolating contact.

Auxiliary circuits that derive their power supply from an external source shall be connected via auxiliary switch contacts that de-energize the circuits if the switching device is isolated.

8.5.3.103 Circuit breakers

8.5.3.103.1 Air circuit breakers

Additional subclause:

Air circuit breakers (ACBs) shall be of the electric motor wound, spring stored energy closing type, provided with means for manually charging the closing mechanism.

ACB operating mechanisms shall have:

- a. A shunt trip coil release of energized to trip type,
- b. A closing release coil with an interlock to inhibit closing if a trip condition exists,

- c. An anti-pumping device,
- d. A spring charging motor operating at phase to neutral or line-to-line voltage supply as defined in the Data Sheets,
- e. Spring charged / discharged indicator, and manual spring charge facility.
- f. An operations counter, only when defined in the User Diagrams.
- g. A manual mechanical trip facility with a transparent cover guard and clearly labelled when defined in the Data Sheets.

A control power supply for tripping, closing, protection and indication functions, shall be defined in the Data Sheets. Individual auxiliary circuits shall be provided with separate double pole MCB protection.

Control functionality and trip circuit supervision of ACBs shall be defined in the User Diagrams.

ACBs shall have at least the following volt free contacts wired as spares contacts to terminals in the outgoing terminal block:

- a. Two normally open (52a) auxiliary contacts,
- b. Two normally closed (52b) auxiliary contacts,
- c. One 'in service' position contact.

8.5.3.103.2 Moulded case circuit breakers

Additional subclause:

MCCB outgoing feeder functional units (not in combination with a contactor) shall:

- a. Be provided with shunt trip, where remote tripping is defined in the Circuit Schedule,
- b. Be manually actuated from the front of the panel without opening the door,
- c. Have clear indication of the 'O' (off), 'Trip' and 'I' (on) positions,
- d. Where defined in the Data Sheets, MCCBs shall be provided with a minimum of one set of auxiliary volt free contacts for trip and status indication.

8.5.3.104 Main circuit fuses

Additional subclause:

Where fuses are used for main circuit protection, they shall conform to IEC 60269-1 and IEC 60269-2 and system type shall be as defined in the Data Sheets. Fuses shall be high rupture capacity (HRC) type general purpose fuse links, utilization category gG for feeders and aM / gM for motor circuits to provide type 2 co-ordination, unless defined otherwise in the Data Sheets.

'DIN' fuses of the D type shall only be applied up to maximum 63 amps and shall be backed up by short-circuit current limiting devices of maximum 400 amps rating. Fuseholders shall provide a minimum degree of protection of at least IP 2X.

If specified, fuse-failure indication shall be provided as defined in User Diagrams.

8.5.3.105 Motor starters and contactor feeders

Additional subclause:

Motor starters and contactor feeders shall be comprised of either fuse or MCCB protected electromagnetic contactors as defined in the Data Sheets, with configuration as detailed in the Circuit Schedule. Functionality shall be as defined in the User Diagrams.

Front of panel components shall be defined in the User Diagrams. Emergency stop pushbuttons shall be red, mushroom head, stay-put, manually reset type and shall operate irrespective of the status of any other controls or selector switches.

When defined in the User Diagrams, front of panel start pushbuttons shall be green, shrouded type and shall only be operative with the functional unit in the test position.

Motor starters, reversing starters and contactor feeders shall conform to IEC 60947-4-1.

Contactors shall be suitable for both uninterrupted duty and class 12 intermittent duty (12 operating cycles per hour), with minimum utilization category AC 3 unless defined otherwise in the Circuit Schedule. A suitable current rating and utilization category combination shall be selected by the Manufacturer and agreed by the User.

NOTE Reference should be made to IEC 60947-1, Annex A for further guidance.

Contactors shall be selected to ensure that the motor start up current does not exceed the overload current withstand capability of contactors. Co-ordination between starters or contactor feeders and the associated short circuit protection devices shall conform to IEC 60947-4-1, type '2'. Where type '2' co-ordination is achieved by use of a fuse link rated less than the maximum capacity of the fuse holder, a label shall be provided adjacent to fuse position with the following legend: "Maximum fuse rating _____ A to maintain IEC 60947-4-1 type '2' co-ordination" as indicated in the Circuit Schedule.

Mechanical endurance for contactors shall not be less than one million no load operating cycles.

For PSC-Assemblies for use on 3 phase, 4 wire (TN) systems, contactors shall have an operating control voltage derived from the phase and neutral on the circuit (load) side of the isolating device within each functional unit, unless defined otherwise in the Data Sheets. The control circuit supply shall be provided with fuse or MCB protection within each functional unit.

For PSC-Assemblies for use on 3 phase, 3 wire (IT) systems, contactors shall have an operating control voltage of 230Vac unless defined otherwise in the Data Sheets, derived from a control transformer, one in each section to serve all functional units in that section, unless defined otherwise in the Data Sheets. The primary windings of control transformers shall be fuse or MCB protected. One pole of the secondary winding shall be provided with fuse or MCB protection and the other pole shall be earthed through a link. The control circuit supply shall be provided with fuse or MCB protection external to each functional unit as defined in the User Diagram.

If defined as required in the Data Sheets, motor starter functional units shall have provisions for motor space heater supply. Motor space heater circuits shall be energized whenever the main circuit switching device is open when either in the service or the test position. The motor heater supply shall be automatically simultaneously isolated when the main circuit is isolated. The motor heater supply voltage shall be as defined in the Data Sheets and shall be distributed from dedicated motor heater auxiliary bus wiring within each bus section of the PSC-Assembly.

When defined as required in the Data Sheets, earth fault protection function shall be manually reset from the front of compartment (resettable without opening the functional unit). Earth fault protection trip signal shall not be reset on loss of control power.

I/O requirements for intelligent type or hard-wired type signals (or combinations of both) shall be as defined in the User Diagrams.

8.5.3.106 Motor protection

Additional subclause:

Motor protection functionality shall conform to ANSI /IEEE C37.2 and the following requirements:

- a. Three-phase thermal overload protection ANSI 49,
- b. Three-phase instantaneous or definite-time short circuit protection ANSI 50/51,
- c. Protection relay supplied by current transformers within the withdrawable part of the functional unit,
- d. Setting(s) of protection relays shall be possible with a single-phase test supply,
- e. Requirements for earth fault protection shall be as defined in User Diagrams. The sensitivity of the protection shall not exceed 10 % of the rated nominal motor current or 5 A, whichever is greater,
- f. Overload relays protecting Ex e electric motors shall have a current/time characteristic below the maximum locked rotor time (te) as indicated on the Circuit Schedule and shall be certified,
- g. Motors located in a hazardous area having a power rating exceeding 1,0 kW shall be individually protected against overload,
- h. Over temperature protection using PTC thermistor / RTD shall be provided as required in the Circuit Schedule. Thermistor thermal protection control units shall conform to the performance requirements within IEC 60034-11.

Where IEDs are specified, the following additional requirements shall be provided as listed below:

	ANSI device code	IEC Nomenclature	Motors < 110 kW	Motors ≥ 110 kW	Motors ≥ 185 kW
Locked rotor protection	51LR			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 supervision based on thermal stress calculation	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			X	X
Front-of-panel protection reset			O	O	O

NOTE 1. For IED motor protection relays, protection reset shall be via the IED HMI which can be located other than at the front of panel,

NOTE 2 X = User required, O = Fit only if defined as required in User Diagrams.

8.5.3.107 Motor restarting facilities

Additional subclause:

If defined as required in the Data Sheets, an automatic restart facility shall be provided to restart the motor after voltage dips.

8.5.3.108 Integrated adjustable speed drives (ASD) and power semiconductor systems

Additional subclause:

Technical performance requirements for these systems are not detailed in this specification. Adjustable speed drives and power semiconductor systems shall conform to IEC 60947-4-2.

Where these form an integral part of the PSC-Assembly they shall meet the following minimum requirements unless defined otherwise in the User Diagrams:

- a. Selected and rated for continuous duty at kW rating as defined in the Circuit Schedule,
- b. Have front panel HMI for control and interrogation,
- c. Auxiliary power supplies control and functionality including protection requirements shall be as defined in the User Diagrams,
- d. Compartments upstream of protective devices shall have arc containment ratings in accordance with the IEC TR 61641 requirements defined for the PSC-Assembly.

8.5.3.109 Current transformers

Additional subclause:

Current Transformers (CTs) used for differential current protection and restricted earth fault schemes (IEC 61869-2) shall be of accuracy class as defined in the User Diagrams.

Unless defined otherwise in the User Diagrams, CT accuracy class shall be as a minimum:

- a. Class 1 – Measuring incoming units,
- b. Class 3 – Measuring outgoing units,
- c. Class 5P – Protection.

Requirements for free-issue CTs shall be as defined in the User Diagrams. CT wiring connected to external circuits shall have shorting links located at the outgoing terminals. CT circuits shall have their secondary windings connected to earth via one disconnecting link.

The Manufacturer shall provide details on ratio, output, class and accuracy for all manufacturer provided CTs in accordance with IEC 61869-2. Magnetization curves shall be provided for Class PX CTs.

8.5.3.110 Voltage transformers

Additional subclause:

Voltage transformers (VTs) shall:

- a. Be of dry insulation type with an earthed screen between the primary and secondary winding,
- b. Have a secondary voltage of 110 V, unless defined otherwise in the Data Sheets,
- c. Be suitably protected by MCBs/fuses on the primary side and by MCBs on the secondary windings.

VT accuracy class shall be as a minimum:

- a. Class 1,0 – Measuring,
- b. Class 3P – Protection.

Three-phase VTs shall be provided with star connection and neutral earthed at one point on the secondary. An exception shall be on IT-systems with insulating monitoring system, where the VT on primary side shall be connected line to line.

VT secondary connections shall be wired to terminals for external wiring when remote metering is required. The secondary circuits shall be equipped with terminals with measuring bushings.

If the VT secondary voltage is used for control or interlock, MCB with signal contact for trip indication shall be provided.

The Manufacturer shall provide details on ratio, output, class and accuracy for all manufacturer provided VTs in accordance with IEC 61869-3.

8.5.3.111 Unearthed electrical supplies (IT)

Additional subclause:

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

The design and provision of such systems shall include:

- a. Continuous monitoring of insulation resistance of each bus section,
- b. Provision for audible and electronic alarm indication of low insulation resistance with data interface for transmission of insulation resistance values and alarms to switchgear data management units,
- c. Provision for automatic location of earth faults to either individual or grouped circuits and incoming or outgoing circuit level by the use of CTs fitted in motor starters or feeders as defined in the Data Sheets,
- d. Selectable insulation impedance ranges,
- e. Local display of system insulation resistance value at each PSC-Assembly,
- f. Detection system compatible with variable frequency drives and heater electronic burst firing control system.

Where stated in the Data Sheets, provision of a portable insulation fault location system shall be provided.

8.5.3.112 Automatic transfer system

Additional subclause:

Where defined in the User Diagrams, an Automatic Transfer System (ATS) and a Manual Transfer System (MTS) shall be provided for switchgear that operates under normal conditions with bus section circuit breaker open. The principle for operation shall be as follows:

- a. ATS operates as non-synchronous transfer,
- b. MTS operates as synchronous transfer.

An instantaneous overcurrent (ANSI 50) and earth fault (ANSI 50N) relays shall be provided in the incomer to block the auto-transfer if failed bus section has a fault.

8.5.5 Accessibility

Addition:

All equipment shall be accessible from the front, except for cable termination chambers, which shall be accessed from the rear or front, as defined in the Data Sheets. All components in back-to-back mounted PSC-Assemblies shall be accessible from the front only. All assembly components requiring maintenance shall be easily accessible.

Panels and cabinets where access is required for routine maintenance or inspection should have hinged doors which shall open at least 95 degrees. Hinged doors should open around their vertical axis and shall not be obstructed by adjacent equipment or doors on the PSC-Assembly. Door restraints shall be provided for securing 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.

Opening of hinged doors should be possible without using tools. Doors or covers that are required to be locked when equipment is in operation shall facilitate padlocking. Other fixed door locking devices with key shall not be used. Doors or covers which have components mounted (lamps, push buttons, etc.) shall be bonded to main assembly cabinet or earth bar.

Replacement of note text:

NOTE In some countries, national codes or regulations may further limit the minimum and maximum height. Unless defined otherwise in the Data Sheets, PSC-Assembly height will be a maximum of 2,5m.

8.5.6 Barriers

Addition:

PSC-Assemblies shall be built with metallic or non-metallic internal barriers to achieve the required form of segregation and shall provide the following minimum degrees of protection unless defined otherwise in the Data Sheets:

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

Replacement of text:

Where defined as required in the User Diagrams, discrete indication lamps shall be long life LED type and shall operate at the same voltage for interchangeability purposes, exceptions being indicating lights directly connected in heater supply circuits.

Indicator light colour coding shall be in accordance with IEC 60073 and the illustrative table below unless defined otherwise in the Data Sheets:

Colour	Meaning	PSC-Assembly Application	
		Safety of persons or environment	ACB
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)	
White	No specific meaning assigned	Voltage indication (Heater On)	Motor heater on

Addition:

8.5.9 Auxiliary components

8.5.9.1 General

Front of panel control switches, meters, meter switches, position indicating lights, protection relays, etc. that are to be mounted on front of PSC-Assembly panels shall be ergonomically arranged in a logical, symmetrical manner.

Where defined in the Data Sheets, test blocks for protection relay secondary injection testing shall be provided to allow relay testing and calibration from the front of the panel without disconnecting wiring.

Control and auxiliary devices shall conform to IEC 60947-5-1 with thermal/breaking capacities of contacts rated for their application and conforming to IEC 60947-5-1 Table 1 and Annex A. The utilization categories and minimum characteristics shall be:

- a. AC-15 for AC applications,
- b. DC-13 for DC applications,
- c. Rated operational currents (I_e): 5A 230 V a.c. ; 1A 110 V d.c.,
- d. Service cycles: 120 cycles / hour (each relay),
- e. Mechanical duration class: 1 (in millions of operation cycles).

Plug-in type relays shall be provided with retaining clips. Where defined in the Circuit Schedule, emergency shutdown interface relays shall be SIL rated.

NOTE Reliability data shall be provided at proposal for SIL loop connected components in accordance with IEC 61511-1.

8.5.9.2 Indicating and measuring devices

8.5.9.2.1 General

Indicating instruments shall be digital or analogue type as defined in the Data Sheets and shall have minimum accuracy class of 2.5. Analogue instruments shall be flush mounted and conform to relevant parts of IEC 60051.

8.5.9.2.2 Analogue instruments

Analogue indicating meters shall be of the square pattern type. Analogue device fascia's shall be white, with black pointers and the scale shall be in actual values. External zero adjustment shall be

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

Analogue voltmeters shall conform to IEC 60051-2 and shall have a voltage selector switch and shall have an off position. Voltmeters shall be operated from voltage transformers secondaries unless defined otherwise in the User Diagrams.

Analogue ammeters shall conform to IEC 60051-2 and shall have a selector switch and shall have an off position. Ammeter selector switches shall be "make before break" type. Analogue ammeters shall include a maximum demand indicator where used for incomers and ACB outgoing feeders or where defined on the User Diagrams.

The minimum scale reading for analogue ammeters on non-motor circuits shall not be less than 20% of the normal or full load reading. Analogue motor ammeters shall monitor single phase only and shall have reduced full-scale and shall be rated for motor starting currents.

Analogue watt-meters and VAr meters shall conform to IEC 60051 -3 and shall be suitable for 3 phase unbalanced load.

8.5.9.2.3 Digital instruments

Multi-functional digital measuring devices shall have an accuracy class of 1,0 unless defined otherwise in the Data Sheets and shall as a minimum be able to display current, voltage and power factor per phase together with instantaneous and a running total of kWhrs.

Multi-functional digital measuring devices shall be equipped with back lights.

8.5.9.2.4 Energy meters

Energy meters and maximum demand meters shall be in accordance with IEC 62052-11 with a default minimum accuracy class as defined in the Data Sheets or higher accuracy for specific schemes as defined in the User Diagrams and shall be suitable for 3 phase unbalanced load. All watt-hour integrating meters shall be fitted with a pulse transmitter for input to a remote supervisory system or a metering summation scheme.

Where specified in the User diagrams, test terminal blocks shall be provided on the panel front for testing the kWh meters and kWh meters. Meters shall be provided with maximum demand indicators of 30 minutes period.

8.5.9.2.5 Transducers

Transducers shall be provided as indicated on the User Diagrams. Transducers shall comply with IEC 60688 and be wired to a separate terminal block for external connections. Unless defined otherwise in the Data Sheets, the transducer outputs shall be 4–20 mA. The output signal of the transducer shall not exceed 20 mA, even when the input value is more than 100% of the defined output range (e.g. during motor starting).

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

Addition:

For withdrawable type functional units, the electrical connections shall be type (W.W.W) in accordance with IEC 61439-2. When used, for disconnectable type functional units the electrical connections shall be type (D.D.F) minimum.

8.6 Internal electrical circuits and connections

8.6.1 Main circuits

Addition:

Busbar compartments shall be designed to prevent arc propagation and the spread of fire to adjacent compartments and across bus coupler panels.

The main (horizontal) and interconnecting (vertical) busbars shall be manufactured from hard drawn, high conductivity electrolytic copper. 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.

The main and interconnecting busbars, phase and neutral, and joints shall be bare (uninsulated) unless defined otherwise in the Data Sheets.

Where busbars are insulated, insulating materials shall be of a flame retardant type in accordance with the relevant part of IEC 60684, and non-hygroscopic and non-tracking. The insulation of the main busbar joints and to interconnecting busbar joints shall be removable and easily replaceable for inspection. The comparative tracking index (CTI as defined in IEC 60112) of the insulating material used for the supports and insulation of the busbar and dropper systems shall be at least 300. The CTI for the insulation materials used for the components protected by the short-circuit protective devices in the outgoing functional units shall be at least 175.

8.6.1.1 Neutral

Additional subclause:

Unless otherwise specified in the Data Sheets, the PSC-Assembly shall be arranged for a TN-S power system with separate neutral (NE) and protective (PE) bars throughout the PSC-Assembly. Unless defined otherwise in the Data Sheets, for a TN-S system, each incoming circuit (downstream of the transformer) shall be provided with a removable link between the neutral and the PE bar at the PSC-Assembly. The link shall be located in such a position that its removal can take place without exposure to other live parts.

8.6.1.2 Earth bar

Additional subclause:

A hard drawn high conductivity copper earth bar shall be provided along the full length of each PSC-Assembly with provision for external earth cable connection at each end sized in accordance with IEC 61439-1, Annex B.

The earth bar shall be extended to all cable termination compartments and shall be easily accessible. Connection points for all functional shall be provided for terminating the cable earth leads and the external earth connections. For the termination of external earth connections the earth bar shall be provided with a M10 bolt at the bottom of each outgoing cable compartment and at the incoming panels. All metallic non-current carrying parts of the PSC-Assembly including gland plates and hinged doors shall be bonded together and connected to the earth bar.

Internal bonding of different parts of the assembly enclosures can be achieved directly via bolted or welded steel to steel faces. Extraneous conductive parts including doors shall be bonded to the assembly structure. This may include flexible copper connections as defined in the Data Sheets and if provided, these shall be arranged such that they cannot be trapped when the door is opened or closed.

8.6.2 Auxiliary Circuits

Addition:

Main / Auxiliary circuits within the PSC-Assembly shall be low smoke, zero halogen content unless otherwise defined in the Data Sheets.

Earthed poles shall be connected via a removable link.

Functional unit auxiliary circuits that derive their power supply from an external source shall be connected via auxiliary switch contacts that de-energize the auxiliary circuits if the main circuit switching device is isolated unless defined otherwise in the User Diagrams.

8.6.2.1 Interface with supervisory systems

Additional subclause:

Each incoming auxiliary supply shall be monitored with an alarm for loss of availability. A healthy circuit shall be a closed circuit signal.

The PSC-Assembly shall be provided with potential free contacts wired to a terminal strip for sending the following alarm signals to a remote supervisory system or substation annunciator panel:

- a. Tripped on fault for each ACB,
- b. Protection / control supply failure for each bus section,
- c. Common trip alarm for each bus section of busbar, with all individual motor starter fault controls wired together,
- d. Trip circuit healthy alarm,
- e. Relay watchdog alarm.

8.6.2.2 Interface with external equipment packages and control systems

Additional subclause:

The User requirement for interfaces with external packages and control systems shall be as identified on Circuit Schedule.

Where the communications protocol for individual functional units are different to those defined in section 8.5.3, these shall be identified in the Circuit Schedules for interface between the functional units and the control system.

For the purpose of this specification, there are three levels of interface (Circuit Schedule):

- a. Level A System Interface - Hard Wired

Fundamental level of interface with direct acting hardwired connections to external packages or panels, in which remote devices are rated for the contactor operating voltage or any required LV/SELV interposing relays are located external to the PSC-Assembly.

- b. Level B System Interface - Serial & Hard Wired

Serial interface to external systems with additional hard-wired interface as Level A.

- c. Level C System Interface - Serial interface to external systems.

Full serial interface only.

If a functional unit is defined on the Circuit Schedule as forming part of a machinery package, the components shall conform to ISO 13489-1 and IEC 62061 for safety of machinery and control systems.

8.6.2.3 Device configuration and set-point responsibilities

Additional subclause:

The User and Manufacturer shall have joint responsibility for the creation and control of protection relay setting files. Manufacturer shall be responsible for functional logic files and User will be responsible for provision of the final protection relay settings. Manufacturer shall submit functional logic and protection settings files to User for review.

A responsibility matrix / flow chart shall be developed between both parties and used as an interface control document during all stages of the order.

8.6.5 Identification of the conductors of main and auxiliary circuits

Additional subclause:

The identification of the conductors of main and auxiliary circuits shall be as follows unless defined otherwise in the Data Sheets:

Conductor	Mandatory marking	Supplementary colour when used
AC Circuits		
Phase 1	L1	Brown
Phase 2	L2	Black
Phase 3	L3	Grey
Neutral	N	(Light) Blue
Protective earth	PE and/or earth symbol	Yellow/Green
DC Circuits		
Positive pole	(+)	Red
Negative pole	(-)	Black

8.7 Cooling

Replacement of text:

The PSC-Assembly shall be naturally ventilated type and comply with temperature rise limitations for the maximum design air temperature defined in the Data Sheets.

8.8 Terminals for external conductors

Addition:

All power (supply & load), and auxiliary cables shall enter from below unless defined otherwise for a PSC-Assembly in the Data Sheets, or defined otherwise for individual circuits in the Circuit Schedule.

Terminals, both main and auxiliary, cable entries, support facilities for cable clamping, and earthing facilities shall be provided, suitable for the type, size and number of cables as defined in the Circuit Schedule. In the absence of User defined field cable information, guidance shall be taken from IEC 61439-1, Annex A Table A.1, using the maximum cross-section values.

Replacement of fifth paragraph:

The internal width dimension of cable compartments shall be suitable for the specified cable type (quantity, conductor size and bending radii) to enable the cable connections to be performed easily and safely, but shall be of minimum internal width 400 mm. Space shall be provided in outgoing cable compartments for the use of a clip on ampere meter (ammeter).

Addition after last paragraph:

Cable supports shall be provided for the full height of the PSC-Assembly cable compartments at intervals not exceeding 450 mm with adequate bracing and support for the cables to avoid unrestrained movement under short circuit conditions.

Terminals shall be provided for the termination of spare cores of all auxiliary control cables as defined on the Circuit Schedule or User Diagrams and in addition, not less than 10% spare terminals shall be provided for future use.

For incomers and large power feeders, insulating phase separation screens shall be provided at the incomer cable connections and terminals for more than one power cable core per phase shall have termination facilities arranged to avoid crossing of phase cores.

Unless defined otherwise in the Data Sheets, removable, undrilled gland plates shall be provided in each vertical panel for glanding of power and control cables. Gland plate material shall be defined in the Data Sheets. In the case of single core cables with armour and/or lead sheathing, any requirement for special glands which allow for insulation between the armour/lead sheath and gland plate shall be defined in the Data Sheets.

At least 300 mm clearance shall be allowed between the gland plate and any internal equipment to permit easy cable installation and connection. For incomers and large power feeders, distance between base plate and cable connection plates shall be at least 400 mm.

Where defined in the Data Sheets, large incomers/feeders shall be located at bottom of the PSC section and have provision for direct entry and termination.

8.8.1 Terminals for control and auxiliaries

Additional subclause:

All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block. Terminals shall be of modular design in conformance to IEC 60947-7-1. No more than one wire shall be inserted into any one terminal and parallel connections shall be made using purpose designed cross connection links.

Terminal blocks shall be logically grouped by function and operating voltage, separated from other groups using barrier plates or earthed terminals and shall be indelibly marked and voltage levels shall be clearly identified by labels. Terminals remaining live when a functional unit is isolated shall be provided with a warning label. Terminals associated with external sources of supply shall be provided with a warning label.

Unless specified otherwise in the Data Sheets, space for not less than 10% spare terminals shall be provided for future use. All spare I/O contacts of protection/auxiliary relays shall be wired up to the terminal block and numbered as per Manufacturer drawing. Terminals associated with current transformer circuits shall be provided with readily movable shorting links. Links used for earthing of control supplies and current transformers shall be readily movable for test purposes.

Equipment containing instrument or instrument circuits/cables requiring special earthing shall be equipped with separate IE earth bar. IE bars shall be isolated from the enclosure.

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

Addition:

Unless defined otherwise in the Data Sheets, form of internal separation shall be a minimum of Form 4a for ACBs and a minimum of Form 3b for all other functional units.

NOTE 3 Options for internal separation can include those detailed in BS EN 61439-1 and BS EN 61439-2 and defined in the Data Sheets.

9 Performance requirements

This clause of Part 1 is applicable except as follows.

9.3 Short-circuit protection and short-circuit withstand strength

9.3.1 General

Addition:

The PSC-Assembly shall be designed, constructed and verification tested (as a special test) for “Internal Arc Containment” in accordance with the requirements of IEC TR 61641. The minimum requirement is for Arcing Class A. Where Arcing Class B and Arcing Class C assemblies are defined, the PSC-Assembly shall withstand internal arcing for 0,3 s. $I_{p\ arc}$ and $I_{ps\ arc}$ shall be defined in the Data Sheets.

Where defined as required in the Data Sheets, an internal arc fault detection system shall be provided and integrated into the PSC-Assembly.

9.4 Electromagnetic compatibility (EMC)

Addition:

Default EMC environment shall be Environment A unless otherwise defined in the Data Sheets.

10 Design verification

This clause of Part 1 and Part 2 is applicable except as follows.

10.1 General

Addition:

Design verification over and above the requirements of IEC 61439-1 and IEC 61439-2 shall be carried out in accordance with the requirements defined in this Specification and Data Sheets.

For each PSC-Assembly type and rating offered, evidence of certified verification test certificates shall be included with proposals.

11 Routine verification

This clause of Part 1 and Part 2 is applicable except as follows.

11.1 General

Replacement of first paragraph:

The POQR will define the User requirements for routine verification.

All equipment covered by this specification shall be subject to inspection and testing by User at the Manufacturer works during manufacture. In certain cases, these activities can extend to Manufacturer's sub-suppliers works.

Prior to dispatch, the Manufacturer shall carry out the full routine tests in accordance with IEC 61439-1 and IEC 61439-2 on the total assembly, or parts thereof if delivered separately, and the results shall be recorded in a test report.

A witnessed final factory routine verification, Factory Acceptance Test (FAT) shall be carried out on the complete assembled PSC-Assembly to demonstrate the proper functioning of the complete assembly including Intelligent Devices / Relays, etc. Transport units can be wired together instead of being joined at the busbars.

11.101 ECMS simulation test

Additional subclause:

The purpose of the simulation test is to check and validate the ECMS and interfaces with interconnected electrical assemblies. Where specified in the Data Sheets, a simulation test shall be carried out between the remote HMI and electrical control devices on the PSC-Assemblies and the specific functions (remote control, restarting, automatic transfer, load-shedding, etc.). The timing and location of the ECMS simulation test shall be agreed between the User and the Manufacturer.

The tests shall be carried out in accordance with the tools and support (meeting, procedure and documentation) proposed by the ECMS provider.

Bibliography

Additional references:

DNV–RP-A203	Qualification of New Technology
IEC 62402	Obsolescence management – Application guide.
IOGP S-560D	Data sheets for IEC 61439 - LV Switchgear and Controlgear Assemblies.
IOGP S-560L	Supplier Deliverable Requirements List (SDRL) for IEC 61439 - LV Switchgear and Controlgear Assemblies.
IOGP S-560Q	Purchase Order Quality Requirements (POQR) for IEC 61439 - LV Switchgear and Controlgear Assemblies.
RAL	RAL German Institute for Quality Assurance and Certification. http://www.ral-farben.de/en/PRODUCTS-SHOP/

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