

**REDLINE**

Version 2.0 to Version 1.0

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

Redline Version

#### Revision history

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

## Acknowledgements

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

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

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

### ABOUT THE REDLINE VERSION

**This Redline version aims at comparing Version 2.0 to Version 1.0 but may not capture all changes.**

**The Redline version is not a specification document. It is a mark-up copy provided for information only. The user must refer to the official published version.**

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## Introduction

The purpose of this specification is to define a minimum common set of **supplementary** requirements for **the** procurement of high-voltage switchgear and controlgear **assemblies** in accordance with IEC 62271-200, Edition 23.0, 2014, May 2021 for application in the petroleum and natural gas industries.

~~This JIP33 standardized procurement~~ 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 required to use all of these documents be applied in conjunction with each other when applying this specification, the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows:~~

#### IOGP S-620: Supplementary **s**Specification to IEC 62271-200 for **h**High-voltage **s**Switchgear and **e**Controlgear

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to IEC 62271-200, following the IEC 62271-200 clause structure of the parent standard, to assist in cross-referencing the requirements. Where clauses Clauses from the parent standard (IEC 62271-200) are not covered in this specification, there are no supplementary requirements or modifications to the respective clause. The terminology used within amended by this specification follows that of apply as written to the parent standard and otherwise is in accordance with ISO/IEC Directives, Part 2 extent applicable to the scope of supply.

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

#### IOGP S-620D: Procurement Data **s**Sheet **s**—for **h**High-voltage **s**Switchgear and **e**Controlgear Controlgear (IEC)

This document provides project specific requirements where ~~the supplementary specification and its parent standard require the user to define an~~ The procurement data sheet defines application specific requirement. ~~It follows requirements, attributes and options specified by the clause structure purchaser for the supply of equipment to the parent standard and this technical specification.~~ The procurement data sheet may also includes include fields for supplier provided information required by the user for

~~attributes subject to purchaser's~~ technical evaluation. Additional ~~purchaser~~ supplied documents ~~are may~~ also ~~listed be incorporated or referenced~~ in the ~~procurement~~ data sheets, to define scope and technical requirements for enquiry and purchase of the equipment.

**IOGP S-620L: Information ~~R~~Requirements for ~~H~~High-voltage ~~S~~Switchgear and ~~controlgear~~Controlgear (IEC)**

~~This document~~The IRS defines the information requirements, including ~~contents~~, format, timing and purpose, ~~for information~~ to be provided by the ~~manufacturersupplier~~. It ~~may~~ also ~~defines the~~define specific conditions which ~~must be met for conditional~~invoke information requirements ~~to become mandatory~~. The information requirements listed in the IRS have references to the source of the requirement.

**IOGP S-620Q: Quality ~~R~~Requirements for ~~H~~High-voltage ~~S~~Switchgear and ~~controlgear~~Controlgear (IEC)**

~~This document includes a conformity assessment system (CAS) which specifies standardized user interventions against~~The QRS defines quality management ~~system requirements and the proposed extent of purchaser conformity assessment activities at~~for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four ~~different 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 ~~user~~purchaser in the data sheet or in the ~~data sheets~~purchase order.

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

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

~~Unless defined otherwise in the purchase order, the~~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 (~~equipment~~~~procurement~~ data sheets, IRS, QRS);
- d) this specification;
- e) ~~the parent standard~~ IEC 62271-200.

## 1 General

### 1.1 Scope

Replace ~~first sentence~~ ~~fourth list item~~ with

~~This specification amends and supplements IEC 62271-200 Edition 2.0 2011 for the design, materials, fabrication, inspection and testing of AC metal enclosed high-voltage switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.~~

Add to subclause

~~IEC 62271-200 refers to applicable common specification clauses contained within IEC 62271-1. Since the issue of IEC 62271-1 Edition 2.0 2017, there is a mismatch in the clause numbering used in IEC 62271-200 Edition 2.0 2011. For information, the relevant IEC 62271-1:2017 clause numbers are identified in parentheses in the clause headings of these supplementary requirements.~~

~~This specification:~~

~~— addresses both —~~ indoor installation;

Replace second paragraph with

This specification covers:

- ~~— three-phase~~ air-insulated switchgear (AIS) and ~~three-phase~~ gas-insulated switchgear (GIS) ~~for indoor installation with either~~ fixed, removable or withdrawable parts or combinations thereof;
- ~~— minimum requirements for IEC 61850 digital interfaces, establishes minimum default selections from the options given in IEC 62271-3 based on IEC 61850;~~
- ~~— specifies additional —~~ the requirements for generator circuit-breakers ~~to IEC/IEEE 62271-37-013.~~

Add after second paragraph

~~This specification does not cover:~~

- ~~— high-voltage switchgear and controlgear assemblies installed outdoors, other than bus duct and outdoor termination bushings;~~
- ~~— detailed user requirements for electrical control and management systems (ECMSs);~~
- ~~— detailed requirements for optional switchgear condition monitoring systems;~~
- ~~— integrated power semiconductor systems;~~
- ~~— integrated high-voltage variable (adjustable) speed drives~~ to in accordance with IEC 61800-5;
- ~~— ring main units;~~
- ~~— explosion protected “Ex” equipment (incorporating a type of explosion protection covered by in accordance with the IEC 60079 series of standards);~~
- ~~— direct current (— DC) uninterruptible power supply systems for auxiliary power.~~



## 4.2 Normative references

Add to ~~subclause~~ start of clause

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

Add to clause

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

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

IEC 60038, IEC standard voltages

IEC 60051-2—1, Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts

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

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

IEC 60079 (all parts), Explosive atmospheres

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

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

~~IEC 60204-1 – Safety of machinery – 60255 (all parts), Electrical equipment of machines – Part 1: General requirements~~

~~IEC 60255 – Electrical relays – All parts as applicable~~

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

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

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

~~IEC 60364-4-41 Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock~~

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

IEC 60617, Graphical Symbols for Diagrams

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

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

~~IEC TS 60815-1 Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles~~

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

~~IEC 61000-3-6 – 2-4, Electromagnetic compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits 2-4: Environment – Compatibility levels in industrial plants for the connection of distorting installations to MV, HV and EHV power systems low-frequency conducted disturbances~~

~~IEC 61243-5 – Live working – Voltage detectors – Part 5: Voltage detecting systems (VDS)~~

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

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

IEC 61554, ~~Panel Mounted Equipment~~ mounted equipment – ~~Electrical Measuring Instruments~~ measuring instruments – ~~Dimensions for Panel Mounting~~ panel mounting

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

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

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

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

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

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

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

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

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

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

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

~~IEC TR 62061-1 – Guidance on the application of ISO 13849-1 62243-4-2, Security for industrial automation and IEC 62061 in the design of safety-related control systems for machinery – Part 4-2: Technical security requirements for IACS components~~

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

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

~~IEC 62271-200:2011 — 4, High-voltage switchgear and controlgear — Part 200: AC metal-enclosed 4:~~  
~~Handling procedures for sulphur hexafluoride (SF<sub>6</sub>) and its mixtures~~

~~IEC TS 63107, Integration of internal arc-fault mitigation systems in power switchgear and controlgear for~~  
~~rated voltages above 1 kV and up to and including 52 kV assemblies (PSC-assemblies) according to IEC~~  
~~61439-2~~

~~IEC/IEEE 62271-37-013 High-voltage switchgear and controlgear — Part 37-013: Alternating current~~  
~~generator circuit-breakers~~

~~IEC 62271-102 High-voltage switchgear and controlgear — Part 102: High-voltage alternating current~~  
~~disconnectors and earthing switches~~

~~IEC 62271-106 High-voltage switchgear and controlgear — Part 106: Alternating current contactors,~~  
~~contactor-based controllers and motor starters~~

~~IEC 62271-206 High-voltage switchgear and controlgear — Part 206: Voltage presence indicating systems~~  
~~for rated voltages above 1 kV and up to and including 52 kV~~

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

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

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

### **3 Terms, definitions and abbreviated terms**

~~Add new subclause 3.0 before subclause 3.1~~

#### **3.0 Abbreviated terms**

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

~~AIS air-insulated switchgear~~

~~DCS distributed control system~~

~~DMZ demilitarized zone~~

~~ECMS electrical control and management system~~

~~GIS gas-insulated switchgear~~

~~HMI human machine interface~~

~~HSR high-availability seamless redundancy~~

~~ICSS integrated control and safety system~~

~~IED intelligent electronic device~~

~~MCB miniature circuit breaker~~

~~PMS power management system~~

~~PRP parallel redundancy protocol~~

SPS site pollution severity class

VDIS voltage detecting and indicating system

### **3.5 Parts of switchgear and controlgear**

Add new term 3.5.122

#### **3.5.122**

##### **bus coupler**

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

Add new term 3.5.123

#### **3.5.123**

##### **bus section**

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

## **4 Normal and special service conditions (IEC 62271-1 Clause 4)**

Add new subclause heading to clause

### **2.1 Normal service conditions (IEC 62271-1 Subclause 4.1)**

Add new subclause

#### **2.1.2 Indoor switchgear Outdoor portions of bus ducts and controlgear (IEC 62271-1 Subclause 4.1.2)**

The normal service conditions as described in subclause 4.1.2 of IEC 62271-1 bushings shall be applied unless supplementary indoor special service conditions are defined as required by the user in the data sheets. All components shall have the user defined ratings after de-rating factors (if any) for the specified service conditions in accordance with IEC 62271-1, 4.1.3.

Where offshore location is defined by the user in the data sheets, the maximum air temperature shall be 40 °C unless a higher figure of 45 °C is defined by the user in the data sheets.

## **5 Ratings**

### **5.2 Rated voltage ( $U_r$ )**

Add to subclause

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

Add new to subclause

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

Add to subclause

### **2.1.3 — Outdoor switchgear and controlgear (IEC 62271-1 Subclause 4.1.3)**

~~If high-voltage bus duct runs that extend outdoors are required, the normal service conditions, as described in subclause 4.1.3 of IEC 62271-1 shall be applied to the outdoor portion of bus ducts and outdoor bushings, unless supplementary outdoor special service conditions are defined as required by the user in the data sheets.~~

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

Add new to subclause heading

### **2.2 — Special service conditions (IEC 62271-1 Subclause 4.2)**

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

### **5.3 Rated insulation level ( $U_d$ , $U_p$ , $U_s$ )**

Add new to subclause

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

Add to subclause

### **2.2.3 — Exposure to pollution (IEC 62271-1 Subclause 4.2.3)**

~~Unless exposed~~ Insulation covering joints between busbars, branches and fixings shall be removable to facilitate the user in maintenance of the joints.

### **5.5 Rated continuous current ( $I_r$ )**

Add to subclause

~~data sheets, high-voltage~~ Air-insulated switchgear and controlgear assemblies shall be suitable for use in an indoor environment with a "very light" site pollution severity rated continuous current less than or equal to 3 150 A shall not depend on forced ventilation.

Add to subclause

Add new subclause

### **2.2.7 — Other parameters (IEC 62271-1 Subclause 4.2.7)**

~~High-voltage switchgear and controlgear shall operate under other parameters of special service conditions if defined by the user in the data sheets.~~

~~NOTE — IOGP S-620D line items 2.2.7 a) to l) within section "Special service conditions — other parameters" align with the IEC 61439-1 special service conditions requirements for low-voltage switchgear and controlgear assemblies.~~

## **3 — Terms and definitions (IEC 62271-1 Clause 3)**

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

Add to subclause**3.10.136**

Continuous current rating shall be inclusive of derating factors.

**~~bus coupler~~**

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

**3.10.137****~~bus section~~**

~~a number of functional units normally connected together in service by a physically continuous main busbar~~

**3.10.138****~~circuit schedule~~**

~~developed by the user and defining the required mechanical switching device, duty, load details, and other individual circuit functions~~

**3.10.139****~~data sheets~~**

~~developed by the user summarizing the characteristics, performance and constructional requirements for the design and selection of the equipment~~

**3.10.140****~~factory acceptance test (FAT)~~**

~~performance of routine tests and any user agreed additional functional tests on the assembled high-voltage switchgear and controlgear and associated equipment, with user agreed acceptance of the test results to permit release of the equipment from the factory~~

**3.10.141****~~functional logic~~**

~~control logic embedded in intelligent electronic devices (IED) or protection relays, that is developed by the manufacturer to implement the requirements of the user diagrams and associated protection relay settings~~

**3.10.142****~~manufacturer~~**

~~organization taking the responsibility for the completed high-voltage switchgear and controlgear assemblies and equipment with associated interconnections, accessories, enclosures and supporting structures~~

~~NOTE — The assembly manufacturer may be a different organization to the original equipment manufacturer organization that has carried out the original design and the associated verification of an assembly or main circuit components within an assembly.~~

**3.10.143****~~user diagrams~~**

~~developed by the user, defines the functional requirements for a given type or scheme of circuit, protection, control, metering etc. such as switchgear single line diagrams, and circuit and wiring diagrams. Used during the development and design stage of a project~~

## **4 — Ratings (IEC 62271-1 Clause 5)**

### **4.1 — Rated voltage ( $U_r$ ) (IEC 62271-1 Subclause 5.2)**

#### Add to subclause

Unless defined otherwise by the user in the data sheets, the high-voltage switchgear and controlgear assembly shall be suitable for operation with power system supply voltage harmonic content not exceeding 6,5 % total harmonic distortion (THD), without damaging effect.

NOTE — The THD values of 6,5 % is in accordance with IEC TR 61000-3-6:2008, Table 2 planning levels.

### **4.2 — Rated Insulation level (IEC 62271-1 Subclause 5.3)**

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

#### Add to subclause

The rated insulation level of the high-voltage switchgear and controlgear shall be as defined by the user in the data sheets, selected from the Range I values given in Table 1 and Table 2 of IEC 62271-1.

Main busbars in air-filled compartments and their branches to switching devices and voltage transformers, shall be insulation-covered.

### **4.4 — Rated normal current and temperature rise**

#### **4.4.1 — Rated normal current ( $I_r$ ) (IEC 62271-1 Subclause 5.5)**

##### Add to subclause

Rated normal currents of 3150 A and below for AIS assemblies, and 2500 A and below for GIS assemblies, 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 normal current throughout the entire length of the high-voltage switchgear and controlgear assembly. The use of forced cooling is subject to agreement between the user and the manufacturer.

Busbars in air-insulated or gas-air mixture filled compartments shall be manufactured from hard drawn, high-conductivity electrolytic copper unless aluminium is defined as required by the user in the data sheets.

#### **4.4.2 — Temperature rise (covered in IEC 62271-1 Subclauses 4.1.2 and 4.2.4)**

##### Add to subclause

The high-voltage switchgear and controlgear assembly shall comply with temperature rise limitations for the maximum design air temperature defined by the user in the data sheets.



#### **4.5.6 Rated short-time withstand currents ( $I_k$ ) (IEC 62271-1 Subclause 5.6, $I_{ke}$ )**

##### **4.5.6.102 Rated short-time phase-to-earth withstand current ( $I_{ke}$ )**

Replace second sentence with

Replace second sentence with

~~The~~For systems without a solidly earthed neutral, the value of rated short-time phase to earth withstand current ( $I_{ke}$ ) shall be at least 87 % of the rated short-time withstand current ( $I_k$ ) of the main circuit, ~~unless defined otherwise by the user in the data sheets.~~

Add to subclause

4.6For systems with a solidly earthed neutral, the value of rated short-time phase to earth withstand current ( $I_{ke}$ ) shall be equal to the rated short-time withstand current ( $I_k$ ) of the main circuit.

#### **5.7 Rated peak withstand currents ( $I_p$ ) (IEC 62271-1 Subclause 5.7, $I_{pe}$ )**

##### **4.65.7.102 Rated peak phase to earth withstand current ( $I_{pe}$ )**

Replace second sentence with

Replace second sentence with

The value of rated peak phase to earth withstand current ( $I_{pe}$ ) shall be at least 87 % of the rated peak withstand current ( $I_p$ ) of the main circuit, ~~unless defined otherwise by the user in the data sheets.~~

#### **4.75.8 Rated durations of short-circuit ( $t_k$ ) (IEC 62271-1 Subclause 5.8, $t_{ke}$ )**

##### **4.75.8.102 Rated duration of phase to earth short-circuit ( $t_{ke}$ )**

Replace second sentence with

Replace second sentence with

The value of rated ~~short-time~~duration of phase to earth ~~withstand current ( $I_{ke}$ )~~short-circuit ( $t_{ke}$ ) shall be equal to the rated duration of short-circuit ( $t_k$ ) of the main circuit, ~~unless defined otherwise by the user in the data sheets.~~

#### **4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits ( $U_a$ ) (IEC 62271-1 Subclause 5.9)**

Add to subclause

~~The rated supply voltage of auxiliary and control circuits shall be as defined by the user in the data sheets, selected from the values given in Table 6 and from line items 1 to 5 in Table 7 of IEC 62271-1.~~



#### ~~4.101 Ratings of the internal arc classification (IAC)~~

##### ~~4.101.2 Types of accessibility~~

~~Add to subclause~~

~~Accessibility shall be Accessibility Type A unless defined otherwise by the user in the data sheets.~~

~~Add to subclause~~

~~All equipment shall be accessible from the front, except for cable termination chambers. Requirements for front or rear access to cable termination chambers shall be as defined by the user in the data sheets. All components in back-to-wall mounted high-voltage switchgear and controlgear assemblies shall be accessible from the front only.~~

## **5.6 Design and construction**

### ~~(IEC 62271-1 Clause 6)~~

~~Add new subclause~~

#### **5.0.101 General**

~~High-voltage switchgear and controlgear assemblies shall be suitable for securing to longitudinal runs of channels flush with the floor surface, unless defined otherwise by the user in the data sheets.~~

~~When marine class or offshore installation is identified by the user as a requirement in the data sheets, the equipment shall conform with the stated requirements for high-voltage switchgear and controlgear assemblies as defined in IEC 60092-101 and IEC 61892-3 respectively.~~

~~Add new subclause~~

#### **5.0.102 Technology readiness and obsolescence**

~~The high-voltage switchgear and controlgear assemblies, excluding electronic components, shall have a design and post factory acceptance test (FAT) supported lifetime of at least 20 years under the defined service conditions.~~

~~The manufacturer shall have an obsolescence management plan in accordance with a recognized system for all high-voltage switchgear and controlgear assembly components, as defined by the user in the data sheets.~~

~~NOTE IEC 62402 is an example of an obsolescence management guide; refer to [17] of Bibliography.~~

~~The use of switchgear and controlgear assemblies and sub-components with less than 3 years proven operational service shall be subject to agreement between the user and the manufacturer.~~

~~Add new subclause~~

#### **5.0.103 Dependability of materials and parts**

~~Unless longer service periods are defined as required by the user in the data sheets, high-voltage switchgear and controlgear assemblies and functional units shall be designed for continuous operation at full load under the normal service conditions for at least 45 000 hours (5 years). During this period, the main busbars and the distribution busbars (dropper system) shall not need to be de-energized for maintenance or inspection.~~

~~The manufacturer shall identify components within the installation, operation and maintenance manual that are not suitable for 5 years continuous operation without inspection or replacement under the service conditions as defined in the data sheets.~~

## **5.1 Requirements for liquids in switchgear and controlgear ~~(IEC 62271-1 Subclause 6.1)~~**

~~Add to~~Replace subclause with

Liquids shall not be used as a switching or ~~as an~~ insulating medium ~~unless agreed between the user and the manufacturer for use in specialist items.~~

## **5.3 Earthing of switchgear and controlgear**

~~(IEC 62271-1 Subclause 6.3)~~

### **5.3.101 Earthing of the high-voltage conductive parts**

Add to subclause

Facilities for earthing the high-voltage conductive parts shall be provided on the incoming side of ~~each~~ supply (generator/transformer) circuits and on the outgoing (cable) side of ~~each~~ feeder/load ~~circuit as shown~~circuits in accordance with Figures ~~101 to 106 appropriate~~ 1 through 7 to the provided loss of service continuity ~~(LSC)~~ category.

~~Facilities for earthing the high-voltage conductive parts of each bus section shall be provided via the incoming supply functional units.~~Add to subclause

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

Add to subclause

~~Switches for~~Operation of earthing of high-voltage conductive parts shall have a minimum classification for short-circuit making of Class E1, as specified in subclause 5.102 of IEC 62271-102:2003 unless defined otherwise by the user in the data sheets.

~~Switches for earthing of high-voltage conductive parts shall have a minimum mechanical endurance Class M0, as specified in subclause 5.106 of IEC 62271-102:2003 unless defined otherwise by the user in the data sheets.~~

~~Earthing devices shall be arranged for manually initiated operation only, from operator locations as defined by the user in the data sheets.~~

Add to subclause

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

### **6.3.102 Earthing of the enclosure(s)**

Add to subclause

~~NOTE — Contactor feeder functional units serving circuits without back-feed may have outgoing circuit earthing automatically applied following a manually initiated isolation action or functional unit withdrawal.~~

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

Add to subclause

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

Add new subclause**56.3.101.4105 Earthing for withdrawable type switchgear**

~~Facilities for incoming and outgoing circuit earthing shall be via the functional unit circuit-breaker or by an integrally mounted three-phase earthing switch.~~

~~Facilities for busbar earthing shall be:~~

- ~~— via the functional unit circuit-breaker of each supply (generator/transformer) circuit on the busbar side;~~
- ~~— by an integrally mounted three-phase earthing switch; or~~
- ~~— by a withdrawable truck mounted busbar earthing switch.~~

~~For busbar earthing via a withdrawable truck mounted earthing switch, the manufacturer shall provide one earthing truck for each high-voltage switchboard assembly. It shall not be possible to insert 6.3.105.1~~

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

~~Earthing devices shall include the following safety and locking and functions:~~

a) ~~It shall 6.3.105.2~~

Application of an earth connection to high-voltage conductive parts shall only be possible to apply an earth connection to high-voltage conductive parts when when the main circuit switching device within the same functional unit, is isolated and not in the service (circuit) position.

b) ~~6.3.105.3~~

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

6.3.105.4

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

Add new subclause**6.3.106 Earthing for non-withdrawable (fixed) type switchgear**6.3.106.1

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

**6.3.106.2**

The bus coupler shall incorporate the busbar earthing system.

**6.3.106.3**

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

**6.3.106.4**

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

Add new subclause

Add new subclause

**5.3.101.2 Earthing for non-withdrawable (fixed) type switchgear**

~~Facilities for incoming and outgoing circuit earthing shall be via the functional unit circuit breaker, or by an integrated three-position switch.~~

~~The bus coupler functional unit shall incorporate the busbar earthing system and shall provide integrated facilities for earthing each bus section.~~

~~Earthing switches shall include the following safety and locking functions:~~

- ~~a) It shall only be possible to apply an earth to high-voltage conductive parts when the main circuit switching device within the same functional unit is isolated; and~~
- ~~b) De-isolation and closing of the main circuit switching device shall not be possible when the earthing provision within the same functional unit is applied.~~

**5.3.102 Earthing of the enclosure**

Add to subclause

~~A hard-drawn high conductivity copper earth bar shall be provided along the full length of each high-voltage switchgear and controlgear assembly sized in accordance with subclause 5.3.105 of IEC 62271-200, with provision for bolted connection of an external earth cable connection at each end. This earth bar shall be extended with the same cross section to each high-voltage external circuit termination compartment.~~

Add new subclause

**5.3.106<sup>107</sup> Voltage detecting and indicating systems**

**Where defined as required by 6.3.107.1**

When specified, integrated voltage detecting and indicating systems shall be of the user in the data sheets, a capacitive three-phase voltage detecting system to confirm both the presence and absence of main circuit voltage type in accordance with IEC-61243-5 shall be provided. The 62271-213.

### 6.3.107.2

When specified, a separable voltage detectors on each functional unit detecting and indicating system shall be installed adjacent to the connection (cable) compartment on all incoming circuits and outgoing feeders, and on the front of the bus coupler panels for each bus section.

Where defined as required by the user in the data sheets, a capacitive three-phase voltage presence indicating system to confirm the presence of main circuit voltage type in accordance with IEC 62271-206 shall be provided. The voltage 213 and IEC 62271-215.

### 6.3.107.3

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

Voltage indicating/detection systems shall be fitted with measuring test points which permit connection of an external phase comparator (phasing-out) instrument.

## 6.4 Auxiliary and control equipment (IEC 62271-1 Subclause 6.4 and circuits

### 6.4)

Add new subclause

#### 5.4.1 General (IEC 62271-1 Subclause 6.4.1)

Each Add to subclause

An alarm shall be initiated on the loss of incoming auxiliary and/or control power supply shall be monitored and initiate an alarm on loss of availability supplies.

Within each functional unit, the auxiliary Add to subclause

Functional unit auxiliary and control supplies shall be distributed into separate circuits. Each separate circuit shall be protected by dedicated miniature circuit breakers (MCBs), fitted with an auxiliary.

Add to subclause

Auxiliary and control supply MCBs shall incorporate an auxiliary contact to initiate an MCBa trip remote alarm. Means shall be provided to lock the MCB operating mechanism in the open position.

NOTE – IEC 60898-1 locking provision may be by the insertion of proprietary third party pad lockable devices; refer to [15] of Bibliography.

Functional unit control circuits are to be arranged such that operation or failure of the Add to subclause

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

Low voltage fuses shall conform to IEC 60269-1 and 2.

## **Functional unit** 6.4.2 Protection against electric shock

Add new subclause

### 6.4.2.3 Precautions for auxiliary and control circuits ~~that derive their power supply~~

Equipment and terminals powered from an external source shall be ~~clearly identified and for circuits~~ labelled accordingly.

Circuits operating ~~at~~ above safety extra low voltage, ~~be connected via removable links or isolation~~ shall incorporate isolation facilities.

### 6.4.3 Components installed in enclosures

6.4.3.4 Requirements for auxiliary and control circuit ~~Add new subclause~~

#### ~~5.4.1.1~~ **Auxiliary components**

##### ~~Unless shown otherwise on~~ 6.4.3.4.1 General

Add to subclause

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

Add to subclause

IEDs shall be provided with the ~~user diagrams, ability for multifunction control including protection, control, indication, metering, supervisory~~ Input/Output (I/O) input/output and communication functions ~~shall be provided by multifunction IEDs. Any user required front of panel discrete components shall be proved as shown on the user diagrams. IED human machine interface (HMI) and discrete items of the same function shall be arranged in a consistent physical position across functional units.~~

Add to subclause

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

##### 6.4.3.4.2 Cables and wiring

Add ~~new~~to subclause

#### ~~5.4.1.2~~ **Actuators and indication**

~~The colour~~ Self-aligning contacts or a multi-conductor cable with plug and marking of actuators (push buttons) ~~socket shall be used for withdrawable device auxiliary circuit connections.~~

Add to subclause

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

##### 6.4.3.4.4 Auxiliary switches

Add to subclause

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

Add to subclause

High-voltage switching device volt-free auxiliary contacts shall be a minimum of Class 2 in accordance with ~~IEC 60204~~ IEC 62271-1, Table 8.

#### **6.4.3.4.5 Auxiliary and control contacts**

Add to subclause

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

Add to subclause

AC switching elements shall be utilization category AC-15.

Add to subclause

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

Add to subclause

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

#### **6.4.3.4.6 Heating elements**

Add to subclause

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

Add to subclause

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

Add to subclause

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

Add to subclause

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

Add to subclause

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

Add to subclause

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

Add new subclause: ~~Where~~

#### 6.4.4 Actuators and indication

##### 6.4.4.1

When colour ~~is used to define~~ defines function, ~~start/on~~ actuators shall be green for start/on and red ~~for stop/off actuators, red.~~

##### On discrete indication components or on colour HMI screens, 6.4.4.2

Status colour coding of ~~status indication~~ indicator components and colour human machine interface (HMI) screens shall be in accordance with Table 105, ~~unless defined otherwise by the user in the data sheets.~~

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

Add new Table 105 — Status indicator colour coding

Table 105 – Colour coding of status indicator

Colour	Meaning	High-voltage – Assembly Application	
	Safety of persons or environment	Circuit-breaker	Motor starter / contactor feeder
Red	Danger	Closed (On)	Running (On)
Yellow	Warning/caution	Tripped	Tripped
Green	Safe	Open (Off)	Stopped (Off)
Blue	Mandatory significance	Trip circuit healthy (or unhealthy)	Not applicable
White	No specific meaning assigned	Voltage indication (Heater On)	Motor heater on

NOTE ~~Colours~~ The colours detailed in ~~the table~~ this table are in accordance with IEC 60073; ~~refer to [11] of the Bibliography.~~

NOTE ~~This requirement does not apply to IEDs or protection relays with a suite of status LEDs which are all the same colour.~~

##### 6.4.4.3

Indication lamps shall be light emitting diodes.

##### 6.4.4.4

Discrete indication lamps shall ~~be long-life light emitting diode (LED) type and shall~~ operate at the same voltage ~~for interchangeability purposes, exceptions being indicating lights~~ except those directly connected into heater supply circuits.



Add new subclause**6.4.5.4.1.3 Auxiliary contacts**

**Auxiliary** Security for industrial automation and control circuit connections on withdrawable devices shall be fitted with either self-aligning plug and socket contacts, or a multi-conductor cable with plug and socket arrangement.systems

Every high-voltage switching device shall have sets of volt free auxiliary contacts, of quantity as defined on the user diagrams, for remote alarm and indication, directly activated by the main operating mechanism, Class 2 in accordance with Table 8 of IEC 62271-1.

Where slave relays are used to obtain the required quantity of auxiliary contacts, one set being normally open and the other set normally closed, these contacts shall be terminated at the low-voltage control compartment.

**5.4.3 Components installed in enclosures (IEC 62271-1 Subclause 6.4.3)****5.4.3.4 Requirements for auxiliary and control circuit components (IEC 62271-1 Subclause 6.4.3.4)****5.4.3.4.1 General (IEC 62271-1 Subclause 6.4.3.4.1)****6.4.5.1**

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

Add to subclause

Control and auxiliary devices shall conform to IEC 60947-5-1 with thermal/breaking capacities of contacts rated for their application and conforming to Table 4 and Annex A of IEC 60947-5-1:2016. 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 230V AC; 1A 110V DC;
- d) service cycles: 120 cycles/hour (each relay);
- e) mechanical duration class: 1 (in millions of operation cycles).

**5.4.3.4.6 Heating elements (IEC 62271-1 Subclause 6.4.3.4.6)**Add to subclause

If defined as required by the user in the data sheets, low-voltage auxiliary and control component compartments and air insulated high-voltage connection (cable) compartments shall be provided with space heaters for anti-condensation prevention.

Space heaters internal to the high-voltage switchgear and controlgear assemblies shall:

- be designed for operation at the voltage as defined by the user in the data sheets;
- have a minimum degree of protection of IP2X;
- include an additional mechanical guard where the heater surface temperature exceeds 60 °C.

~~The heating system of each bus section of the high-voltage switchgear and controlgear assembly shall:~~

- ~~— be separately supplied from a remote source;~~
- ~~— be provided with a MCB and 30 mA residual current device (RCD) or residual current circuit-breaker with overcurrent protection (RCBO), with “loss of supply” volt free contact wired to terminals for remote supervision;~~
- ~~— be controlled by a thermostat or hygrostat, as defined by the user in the data sheets;~~
- ~~— be fitted with a manual switch to bypass the thermostat/hygrostat control, if defined in the user diagrams.~~

~~If defined as required by the user in the data sheets, motor starter functional units shall be fitted with auxiliary circuits to supply remote space heaters within the high-voltage motors.~~

~~Auxiliary circuits for remote motor space heaters shall:~~

- ~~— supply the motor space heaters at the voltage as defined by the user in the data sheets;~~
- ~~— be energized whenever the motor starter functional unit main circuit switching device is open, when either in the service or the test position;~~

~~Additional requirements for isolation of the remote motor space heater supplies and by-pass of the heater controls when the main circuit switching device is isolated shall be as defined on the user diagrams.~~

~~The remote motor space heater auxiliary supply of each bus section of the high-voltage switchgear and controlgear assembly shall:~~

- ~~— be separately supplied from a remote source;~~
- ~~— be distributed from dedicated motor space heater auxiliary bus wiring;~~
- ~~— be provided with a MCB and 30 mA residual current device (RCD) or residual current circuit-breaker with overcurrent protection (RCBO), with “loss of supply” volt free contact wired to terminals for remote supervision.~~

## ~~5.9 Low and high pressure interlocking and monitoring devices (IEC 62271-1 Subclause 6.10.1)~~

~~Add to subclause~~

~~For GIS assemblies, local and remote Pressure/level indication and alarm capability shall be provided. The method of local pressure indication shall be as defined by the user in the data sheets.~~

## ~~5.10 Nameplates (IEC 62271-1 Subclause 6.11)~~

~~Add to subclause~~

~~The high-voltage switchgear~~Add to subclause

Local indication and controlgear assembly nameplate shall contain other legally required regional markings, where applicable.

## 5.11 ~~Interlocking devices (including IEC 62271-1 Subclause 6.12)~~

### Add to subclause

Where interlocks between main circuit switching devices and associated earthing switches and “upstream” or “downstream” switchgear assemblies are required, they shall be either mechanical or electrical type to fulfil the interlocking function as defined in the user diagrams.

Busbar section earthing switches shall be mechanically or electrically interlocked to prevent closure, until all incomers, interconnectors or possible back-feed circuits are secured in an out-of-service position.

Facilities for padlocking alarms with remote interfaces shall be provided for the following as a minimum:

## 6.12 Locking devices

### Add to subclause

a) ~~high~~ High-voltage compartment doors shall be padlockable in the closed ~~position~~.

b) ~~disconnectors (isolators) open or~~ Add to subclause

Disconnectors and circuit-breakers shall be padlockable in the ~~isolated~~ open position;

c) ~~\_\_\_\_\_~~ Add to subclause

When withdrawable functional units are removed, safety shutters closed (withdrawable items only with separate facility for busbar and circuit shutters); shall be padlockable in the closed position.

### Add to subclause

d) ~~earth~~ Earth switches closed or circuit-breakers in the earthed position;

e) ~~earth switches open or circuit-breakers blocked from being in the earthed position;~~

f) ~~access to isolation and earth switch operating mechanisms;~~

g) ~~each withdrawable main circuit device compartment shall be provided with a padlockable mechanical interlock to prevent reinsertion of a main circuit device.~~

~~Padlocking or key locking shall be provided for switching device control circuit~~ Add to subclause

Switching device local/remote ~~selector switches in all~~ selectors shall be lockable in the “local” and “remote” positions.

## 5.15 6.16 Gas and vacuum tightness ~~(IEC 62271-1 Subclause 6.16)~~

### Add new subclause

### 5.15.1 ~~General (IEC 62271-1 Subclause 6.16.1)~~

For AIS assemblies, other than for earth switches and isolators, air shall not be used as a switching medium unless defined otherwise by the user in the data sheets.

~~For GIS assemblies, compartments where SF<sub>6</sub> is used as the switching medium, gas barriers shall be included to prevent the migration of arc degradation products beyond the switching compartment, and to uphold the functional unit LSC category during switching compartment inspection or replenishment of the SF<sub>6</sub>.~~

Add new to subclause

#### **5.15.2 — Controlled pressure systems for gas (IEC 62271-1 Subclause 6.16.2)**

~~For GIS assemblies, controlled pressure systems shall not be used unless defined otherwise by the user in the data sheets. The relative leakage rate  $F_{rel}$  for~~

Add new subclause

#### **5.15.3 — Closed pressure systems for gas (IEC 62271-1 Subclause 6.16.3)**

Replace first list item with

~~— for SF<sub>6</sub> and SF<sub>6</sub> mixtures, shall not be greater than 0,1 % per year.~~

#### **5.17 — Fire hazard (flammability) (IEC 62271-1 Subclause 6.18)**

6. Add to subclause

~~Where defined as required by the user in the data sheets, auxiliary and control circuit insulation shall be low smoke, zero halogen content.~~

~~The manufacturer shall state the fire resistant and self-extinguishing properties of the materials used.~~

~~NOTE Properties can be demonstrated by testing to internationally recognized standards such as IEC 60695-1-10 and 12; refer to [13] and [14] of Bibliography.~~

#### **5.18 — Electromagnetic compatibility (EMC) (IEC 62271-1 Subclauses 6.19 and 7.9)**

Add to subclause

**The EMC101 General requirements specified in IEC 62271-1 for assemblies**

Add to subclause 7.9.1.2 onwards and Annex J.5

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

#### **5.20 — Corrosion (IEC 62271-1 Subclause 6.21)**

Add to subclause

Add to subclause

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

Add to subclause

~~Unless defined otherwise by the user in the data sheets, the manufacturer's standard painting and corrosion protection system for the service conditions defined in the data sheets shall be used.~~

~~Unless defined otherwise by the user in the data sheets, the manufacturer's standard colour finish shall be used.~~

## 5.101 Internal arc fault

### ~~Add to subclause~~

~~The internal arc classification (IAC) of the switchgear shall be FLR unless defined otherwise by the user in the data sheets.~~

~~The internal arc type test for the high-voltage switchgear shall be for a rated three-phase arc fault current ( $I_A$ ) value not less than the defined for continuous operation at rated short-time withstand current ( $I_k$ ) for a minimum arc fault duration of 0,5 s, unless defined for a longer duration by the user in the data sheets. The switchgear shall be provided with means to safely direct and exhaust gases resulting from an internal arc flash, load under normal service conditions for at least 36 000 h (4 years).~~

### ~~Add to subclause~~

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

### ~~Add to subclause~~

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

### ~~Add to subclause~~

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

### ~~Add to subclause~~ **Partitions**

~~Pre-drilled holes shall be provided at bus coupler boundaries to prevent an internal arc in one bus section propagating to other bus sections.~~

~~Where defined as required in the user diagrams, an internal arc fault detection and active protection system to reduce incident energy levels, shall be provided and integrated into the high-voltage switchgear and controlgear assembly.~~

## 5.102 Enclosure

### 5.102.1 General

~~Replace second sentence~~ **free ends of first paragraph with**

~~The floor surface below the installed high-voltage switchgear and controlgear shall not be considered as being part of the enclosure unless defined otherwise by the user in the data sheets.~~

~~Replace first sentence of fourth paragraph with~~

~~When the metal enclosed high-voltage switchgear and controlgear is installed, the enclosure shall provide at least the degree of protection IP3XW. The supplementary "W" weather conditions shall be taken as water dripping from above the assembly.~~

~~NOTE The supplementary "W" requirement is not subject to verification by testing.~~

## 5.102.2 ~~Covers and doors~~

Add to subclause after second paragraph

~~Hinged doors which can open at least 95° around their vertical axis shall not be obstructed by adjacent equipment or doors~~bus bars for future ~~on the high-voltage switchgear and controlgear assembly.~~

~~Extraneous conductive parts such as doors or covers which have mounted electrical components (lamps, push buttons, etc.) shall be provided with supplemental equipotential bonding, in accordance with IEC 60364-4-41.~~

~~Door restraints shall be provided for securing doors in the open position:~~

~~—— when placed on floating offshore, mobile offshore or marine installations; and~~

~~—— when defined as required by the user in the data sheets, on low-voltage compartment doors~~site extension.

Add to subclause after fourth paragraph

~~Covers or doors that give access to compartments which do not contain any high-voltage parts (e.g. low-voltage control compartments, or mechanism compartments), shall have tool-based or procedure-based accessibility, as defined by the user in the data sheets.~~

~~NOTE — Compartments secured by tumbler lock common keys or panel keys (e.g. 7 mm square, 8 mm triangle or similar) are regarded as procedure-based access.~~

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

## 6.102 Metal enclosure

### 6.102.1 General

Replace the first sentence for the procedure-based accessible compartments subclause of third paragraph with

~~These compartments shall be provided~~The enclosure shall have a degree of protection of at least IP3X in accordance with IEC 60529.

### 6.102.2 Covers and doors

In first sentence of second bullet, replace “with provision for locking by padlocks.” with

Add to the end of subclause

~~Covers or doors that give access to high-voltage compartments shall have accessibility as defined by the user in the data sheets.~~

## 5.103 High voltage compartments

### 5.103.1 General

with provision for padlocking

Add to subclause ~~after first paragraph~~

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

Add to subclause

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

## **6.103 High-voltage compartments**

### **6.103.1 General**

Add to first paragraph after list

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

~~For AIS assemblies, the LSC category shall be:~~

~~\_\_\_\_\_ for~~ Add to first paragraph after list

For air-insulated switchgear circuit-breaker functional units, the minimum LSC category shall be LSC2B<sub>1</sub>.

~~\_\_\_\_\_ for~~ Add to first paragraph after list

For air-insulated switchgear contactor feeder functional units ~~serving circuits without back-feed, a, the~~ minimum of LSC category shall be LSC2A.

~~Add to subclause after~~ Add to fourth paragraph

Busbar compartments shall ~~not~~ contain no more than one busbar section.

Add to fourth paragraph

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

### **5.103.2 Fluid-filled compartments (gas or liquid)**

#### **5.103.2.3 Tightness**

~~6~~ Add to subclause after third paragraph

~~For GIS assemblies, indication when the pressure has fallen below the minimum functional level shall be provided locally, and with provision made for remote indication of the alarm state.~~

#### **5.103.2.4 Pressure relief of fluid-filled compartments**

Add to subclause

~~For GIS assemblies, each fluid~~ Fluid filled compartments shall be ~~equipped~~ provided with a pressure-relief device.

~~NOTE "Compartment" in the context used above could be more than one compartment, connected together in one pressure system.~~

### 56.103.3 Partitions and shutters

#### 5.103.3.1 General

Replace first paragraph with

~~Partitions and shutters shall provide at least the degree of protection IP2X according to Table 7 of IEC 62271-1, unless defined otherwise by the user in the data sheets.~~

#### 56.103.3.2 Metallic partitions and shutters

Add to subclause

~~For withdrawable parts, any revealed accessible~~ Accessible shutters ~~that prevent~~ preventing access to normally live parts, shall be marked in accordance with ISO 7010:2019, Graphical Symbol W012 electrical hazard warning triangle signs with supplemental text stating the numerical value of the circuit voltage: "Warning: Electricity".

~~For withdrawable parts, each three~~ Add to subclause

Three-phase set of accessible shutters for main circuit conductors shall be capable of being individually have a manually opened for inspection or testing purposes operated facility, securable in the open position.

Add to subclause

For withdrawable parts, accessible shutters shall be identified in accordance with Table 106, ~~unless alternative or additional languages are defined as required in 5.106 for labelling and identification.~~

Add new Table 106

**Table 106 – Identification of accessible shutters**

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

### 56.104 Removable parts

Add to subclause

~~Where defined as required by the user in the data sheets~~ When specified, facilities for remote testing of withdrawable main circuit units shall be provided by means of extension umbilicals or specific test modules.

Add to subclause

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



Add new subclause

## **5.106 Internal arc fault**

Add to subclause

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

Add to subclause

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

Add new subclause

## **6.107 Labelling and identification**

~~The language used on all devices, labels, plates and notices shall be English, unless alternative or additional languages are defined as required by the user in the data sheets.~~ 6.107.1

### **General**

#### **6.107.1.1**

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

#### **6.107.1.2**

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

#### **6.107.1.3**

Informative labels shall have black characters on a white background.

#### **Each high-voltage switchgear and controlgear assembly 6.107.1.4**

Assemblies shall be provided with ~~an identification number~~ a front-mounted label, ~~fixed on that includes~~ the front of the assembly which shall contain the user defined switchgear equipment tag number.

#### **Any main circuit hardware or equipment that is withdrawable 6.107.1.5**

Withdrawable parts shall be ~~fitted~~ labelled with ~~a panel number locator label to facilitate re-insertion to the correct~~ their designated functional unit compartment number.

Add new subclause

## **5.106-1 6.107.2 Circuit labels**

### **Each functional unit 6.107.2.1**

Functional units shall have a front-of-panel circuit designation label ~~and for assemblies.~~

**6.107.2.2**

Assemblies with rear access, ~~an identical label repeated at the~~ shall have additional circuit designation labels at the rear. ~~The label~~

**6.107.2.3**

Circuit designation labels shall ~~contain~~ include the following information ~~as defined in the circuit schedule:~~

- a) functional unit compartment ~~location (number);~~;
- b) tag number of connected equipment;
- c) service description of connected equipment; ~~and~~
- d) circuit kW or kVA rating ~~or motor kW rating.~~

~~Circuit designation labels shall be secured with non-corrodible screws or other demountable fixing system.~~

Add new subclause

**5.106.2** **6.107.3** **Identification of the conductors of main and auxiliary circuits** circuit conductors

~~The~~ Conductor identification of ~~the conductors in~~ main and auxiliary circuits shall be in accordance with Table 107, ~~unless defined otherwise by the user in the data sheets.~~

~~It is not a mandatory requirement to colour wiring insulation or main circuit conductors, but where colour is used as an identifier, these colours shall be applied.~~

~~In regions where national standards mandate other identification colour schemes, these shall be applied.~~

Add new Table 107

**Table 107 – Identification of conductors**

Conductor	Main circuit marking	Auxiliary circuit marking	Supplementary colour marking <del>(when used)</del>
<b>AC <del>C</del>ircuits</b>			
Phase 1	L1	L1	<del>Brown</del> <u>As specified</u>
Phase 2	L2	L2	<del>Black</del> <u>As specified</u>
Phase 3	L3	L3	<del>Grey</del> <u>As specified</u>
Neutral		N	<del>Blue</del> <u>As specified</u>
Protective earth	PE and/or earth symbol	PE and/or earth symbol	Yellow/Green
<b>DC <del>C</del>ircuits</b>			
Positive pole		(+)	Red
Negative pole		(-)	White

Add new subclause

NOTE — Colouring and marking above is in accordance with Annex A of IEC 60445; refer to [12] of Bibliography.

Add new subclause**5.106.3 Mimic diagrams**

If defined as required by the user in the data sheets, a durable mimic one-line (synoptic) diagram shall be provided on the front of the assembly, displaying the single line arrangement of busbars and the main circuit switching devices of incomers, bus couplers, feeders and starters.

Add new subclause**5.107 Provisions for future development**

High-voltage switchgear and controlgear assemblies shall have the following provisions incorporated for future development:

- a) fully equipped “spare” panels, including a main circuit switching device, of quantity, rating and function as designated in the circuit schedule;
- b) partially equipped “skeleton” panels shall be fitted at a minimum with busbars and main circuit isolators/shutters. The quantity and rating shall be as designated in the circuit schedule.

The switchgear assembly shall be constructed such that it is extendable at the free end of bus sections and that extension panels can be erected in situ, without de-energization of the assembly. Busbar ends shall be pre-drilled for future extension.

Add new subclause heading**56.108 Main circuit switching devices**Add new subclause**56.108.1 Isolating switching devices (disconnectors)****6.108.1.1**

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

**6.108.1.2**

Switches shall comply be in accordance with IEC 62271-103. ~~Electrical and mechanical endurance class shall be as defined by the user in the data sheets.~~

Add new subclause**56.108.2 Circuit-breakers****6.108.2.1**

Circuit-breakers shall ~~have a minimum of Class~~ be at least class S1 ~~intended for use in accordance with cable system circuits, unless defined otherwise by the user in the circuit schedule for line system circuits~~ IEC-62271-100.

6.108.2.2

Circuit-breaker operating mechanisms shall have :

a) ~~spring-stored energy;~~

b) ~~a~~ 6.108.2.3

Circuit-breaker operating mechanisms shall have a spring-charging motor ~~operating at the voltage supply as defined by the user in the data sheets;~~

c) ~~6.108.2.4~~

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

d) ~~6.108.2.5~~

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

6.108.2.6

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

e) ~~6.108.2.7~~

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

f) ~~a~~ 6.108.2.8

Circuit-breaker operating mechanisms shall have a shunt trip coil release of energized ~~to-trip~~ type;

g) ~~dual shunt trip coils when defined as required in the user diagrams;~~

h) ~~under voltage release when defined as required in the user diagrams;~~

i) ~~a manual mechanical trip facility with a transparent cover guard;~~

j) ~~6.108.2.9~~

Circuit-breaker operating mechanisms shall have a mechanically operated position indicating device ~~that shows~~ showing the position of the main circuit contacts, ~~marked "OPEN" and "CLOSED"; in accordance with IEC 60417.~~

k) ~~padlocking provisions for locking the circuit~~ 6.108.2.10

Circuit-breaker operating ~~mechanism in the open position;~~

l) ~~mechanisms shall have~~ an operations counter.

6.108.2.11

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

~~Unless defined otherwise by the user in the data sheets,~~ 6.108.2.12

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

#### 6.108.2.13

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

#### 6.108.2.14

Withdrawable circuit-breakers shall have, ~~as a minimum, the following spare volt free~~ two spare "in service" position auxiliary contacts wired to terminals in the outgoing terminal block.

#### 6.108.2.15

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

- ~~— two normally open (52a) auxiliary contacts;~~
- ~~— two normally closed (52b) auxiliary contacts; and~~
- ~~— For withdrawable circuit-breakers, two "in service" position contacts.~~

~~Add new subclause~~

### **5.108.3 Generator circuit-breakers**

Generator circuit-breakers shall ~~conform to~~ be in accordance with IEC/IEEE 62271-37-013 ~~for operation with circuit parameters as defined by the user in the circuit schedule.~~

~~NOTE A generator circuit breaker is defined as a circuit breaker typically installed between the generator and its associated step up generator transformer and having enhanced transient recovery voltage and rate of rise of recovery voltage (RRRV) capability.~~

~~Add new subclause~~

### **5.108.4 Motor starters and contactor feeders**

#### 6.108.4.1

Contactors shall ~~conform to~~ be in accordance with IEC 62271-106.

#### 6.108.4.2

The ~~minimum~~ no-load operating cycle mechanical endurance shall be ~~in excess of 100 000~~ at least 0,1 for latched contactors ~~and 300 000~~ in accordance with IEC 62271-106:2021, 5.105.

#### 6.108.4.3

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

#### 6.108.4.4

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

#### 6.108.4.5

Motor starter contactors shall ~~have a utilization category of AC-3 and be rated for both continuous duty and a minimum intermittent duty of Class 12. The manufacturer shall document the number of on-load operating cycles which can be made without any repair or replacement for the corresponding AC-3 service conditions of IEC 62271-106:2011 Table 10~~ at least class 12 in accordance with IEC 62271-106:2021, 5.102.2.

#### 6.108.4.6

Contactor ~~(transformer)~~ feeders shall be mechanically latched ~~and have~~ with an electrical trip coil and ~~a~~ guarded manual release. ~~The release shall be guarded to prevent inadvertent operation.~~

Add new subclause

### **5.109 Voltage transformers**

~~Voltage transformers (VTs) shall conform to IEC 61869-1 and additionally conform to IEC 61869-3 for inductive VTs and IEC 61869-5 for capacitive VTs. Low power VTs shall additionally conform to IEC 61869-6 and IEC 61869-11 for low power passive VTs.~~

~~Unless defined otherwise in the user diagrams, VT accuracy class shall as a minimum be:~~

~~— Class 1,0 — measuring;~~

~~— Class 3P — protection.~~

~~VTs shall:~~

~~a) — have a secondary voltage of 110 V, unless defined otherwise by the user in the data sheets;~~

~~b) — be of dry insulation type with an earthed screen between the primary and secondary winding;~~

~~c) — (withdrawable VTs) be protected by HRC fuses on the primary side which are accessible once the VT has been withdrawn, or have a current self-limiting protective feature subject to agreement between the user and the manufacturer;~~

~~d) — be protected by MCBs on the secondary windings whereby MCBs have an auxiliary contact for trip indication;~~

~~e) — (withdrawable VTs) have automatic shutters, operated by the racking of the VT, and be padlockable in the withdrawn position;~~

~~f) — (disconnectable VTs) be padlockable in the disconnected position;~~

~~g) — (three-phase VTs) be provided with star connected windings with the secondary star point earthed at one point via an accessible removable link.~~

~~The use of low power VTs with alternative configurations to items a) to g) above, shall be subject to agreement between the user and the manufacturer.~~

Add new subclause

### **5.110 Current transformers**

~~Current transformers (CTs) shall conform to IEC 61869-1 and additionally conform to IEC 61869-2 for inductive CTs. Low power CTs shall additionally conform to IEC 61869-6 and IEC 61869-10 for low power passive CTs.~~

~~Unless defined otherwise in the user diagrams, CT accuracy class shall as a minimum be:~~

- ~~a) Class 1 measuring incoming units;~~
- ~~b) Class 3 measuring outgoing units;~~
- ~~e) Class 5P protection.~~

~~CTs used for differential current protection and restricted earth fault schemes shall be of accuracy class as defined in the user diagrams. Magnetization curves shall be provided by the manufacturer for Class PX CTs. Core balance CTs shall be installed in locations as shown in the user diagrams.~~

~~Requirements for free issue CTs to be installed remotely to the assembly shall be as defined in the user diagrams, in quantities as defined in the high-voltage switchgear and controlgear scope.~~

~~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.~~

Add new subclause

### **5.111 Surge arrestors**

~~Metal oxide surge arrestors to IEC 60099-4, as required by the user in the data sheets, shall be installed on the circuit (cable) side of the main circuit switching device within a switchgear enclosure compartment.~~

Add new subclause heading

### **5.112 Indication and measuring devices**

Add new subclause

#### **5.112.1 General**

~~Where indication and measuring functions are not incorporated into the multifunction IED, discrete analogue instruments shall comply with 5.112.2 and multifunction digital instruments shall comply with 5.112.3.~~

~~Discrete indicating and measuring devices shall be of flush mounting type, equipped with non-glare, non-reflecting windows and shall have standardized dimensions in accordance with IEC 61554 and installed in the associated functional unit.~~

~~Indicating functions shall have a minimum accuracy class of 2,5 S for digital instruments.~~

Add new subclause

#### **5.112.2 Analogue instruments**

~~Analogue indicating instruments shall be of square bezel type, minimum size in accordance with IEC 61554. Analogue device fascias shall be white with black pointers and the scale shall be marked with primary circuit 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;~~
- ~~—— have a voltage selector switch; and~~
- ~~—— have an off position.~~

~~Analogue ammeters shall:~~

- ~~—— conform to IEC 60051-2;~~
- ~~—— have a selector switch; and~~
- ~~—— have an off position.~~

~~Ammeter selector switches shall be “make before break” type and are to include a maximum demand indicator where used for incomers and 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;~~
- ~~—— have reduced full scale; and~~
- ~~—— be rated for motor starting currents.~~

~~Analogue wattmeters and varmeters shall conform to IEC 60051-3 and shall be suitable for three-phase unbalanced load.~~

Add new subclause

### **5.112.3 Digital instruments**

~~Multi-function digital measuring devices shall have an accuracy class of 1,0 S unless defined otherwise by the user in the data sheets.~~

Add new subclause

### **5.112.4 Energy metering**

~~Static energy meters and maximum demand meters shall conform to IEC 62052-11 with a default minimum accuracy class as defined by the user in the data sheets, or higher accuracy for specific schemes as defined in the user diagrams. They shall be suitable for three-phase unbalanced load.~~

~~Where shown in the user diagrams, test terminal blocks shall be provided on the panel front for testing the kilowatt hour meters. Where shown in the user diagrams, meters shall be provided with maximum demand indicators of 30 minute period.~~



Add new subclause

**5.112.5 Transducer outputs**

**Transducer outputs** 6.109 Voltage transformers

6.109.1

Voltage transformers shall comply be in accordance with IEC 60688 61869-1.

6.109.2

Inductive voltage transformers shall be in accordance with IEC 61869-1 and be wired to a separate terminal block IEC 61869-3.

6.109.3

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

6.109.4

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

6.109.5

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

6.109.6

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

6.109.7

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

6.109.9

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

6.109.10

Where withdrawable voltage transformers are protected by HRC fuses on the user in primary side, the data sheets, the transducer outputs fuses shall be 4-20 mA. The output signal accessible on withdrawal of the transducer shall not exceed 20 mA, even when voltage transformer.

6.109.11

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

#### 6.109.12

Withdrawable voltage transformers shall have automatic shutters operated by the ~~input value is more than 100 % of racking mechanism.~~

#### 6.109.13

Withdrawable voltage transformer automatic shutters shall be padlockable in the ~~defined output range (e.g. during motor starting)-withdrawn position.~~

#### 6.109.14

Disconnectable voltage transformers shall be padlockable in the disconnected position.

#### 6.109.15

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

Add new subclause

### **5.113—Protection devices**

#### **Protection relays** 6.110 **Current transformers**

##### 6.110.1

Current transformers shall be ~~of multi-function IED type unless defined otherwise by the user in the data sheets.~~

~~Protection relays shall conform to accordance with IEC 60255. HMI and front of panel mounted relays shall be flush mounted. The portion of the device providing the protection function shall be demountable without the need to disconnect secondary wiring. Inductive CT connections shall be automatically shorted if the device is removed 61869-1.~~

##### 6.110.2

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

##### 6.110.3

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

##### 6.110.4

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

##### 6.110.5

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

##### 6.110.6

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

### 6.110.7

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

#### Add new subclause

Each protection relay shall have facilities for calibration and injection testing by personnel standing at the front of the functional unit and without disconnection of secondary wiring. Accessible test terminals shall be provided for calibration and testing and inductive CT secondary circuits provided with shorting link terminals.

Power supply for the protection relays shall be derived from the AC or DC tripping supply as defined by the user in the data sheets. A main circuit trip shall not be initiated in the event of loss of this supply to the relay. Protection relays shall maintain their accuracy and functionality for continuous operation at any point over the full range of AC and DC auxiliary voltage variations, defined by the user in the data sheets.

Where shown as required on the user diagrams, duplicate trip systems shall be provided.

Where fuses are used for main circuit protection, they shall conform to IEC 60282-1 or IEC 60644 for motor circuits.

#### Add new subclause heading

### **5.114 Cable terminations**

#### **6.111 Surge arresters**

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

#### Add new subclause

#### **5.114.1 Terminals for external conductors**

The default method of high voltage cable termination for incoming and outgoing circuits shall be as defined by the user in the data sheets, or if required differently for individual circuits, as defined in the circuit schedule.

The high voltage and low voltage terminals and termination compartments shall be sized to accommodate the type, size and number of cables as defined in the circuit schedule. Separate termination compartments for high voltage and low voltage connections shall be provided.

The default direction of entry for main circuit and auxiliary and control cables shall be from below unless defined otherwise by the user in the data sheets, or if required differently for individual circuits, as defined in the circuit schedule.

Where high voltage terminations employ palm cable lugs, high voltage cable termination (bar) conductors shall be pre-drilled by the manufacturer to accommodate the type, size and number of cable conductor cores as defined in the circuit schedule.

Where high voltage terminations employ cable glands, undrilled gland plates shall be provided, sized to accommodate the type, size and number of cables as defined in the circuit schedule. Gland plates for single core cable terminations shall be non-ferrous and any requirements for gland plates to be insulated from the enclosure, are to be identified in the circuit schedule.

Where high voltage terminations employ proprietary separable insulated connector systems, they shall be of deadbreak type.

## **6.112 Indication and measuring devices**

### **6.112.1 General**

#### **6.112.1.1**

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

#### **6.112.1.2**

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

#### **6.112.1.3**

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

### **6.112.2 Analogue instruments**

#### **6.112.2.1**

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

#### **6.112.2.2**

An external zero adjustment shall be provided.

#### **6.112.2.3**

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

#### **6.112.2.4**

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

#### **6.112.2.5**

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

#### **6.112.2.6**

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

#### **6.112.2.7**

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

#### **6.112.2.8**

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

### 6.112.3 Energy metering

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

### 6.112.4 Transducer outputs

#### 6.112.4.1

Transducer outputs shall be in accordance with IEC 60688.

#### 6.112.4.2

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

Add new subclause

### 5.1146.113 Protection devices

#### 6.113.1

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

#### 6.113.2 Terminals for control

HMI and auxiliaries front of panel mounted relays shall be flush mounted.

~~All wiring for external connections shall be brought out to individual terminals on a terminal block. The terminal blocks shall be grouped by function and operating voltage, separated from other groups using barrier plates or earthed terminals. Functional grouping, voltage levels and discrete terminals shall be 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.~~

~~All spare I/O contacts of protection/auxiliary relays shall be wired to terminal blocks and numbered as per manufacturer documentation. If required by the user, space for or provision of, unused spare terminals for future use shall be provided as defined by the user in the data sheets. Terminals associated with inductive CT circuits shall be provided with shorting links mounted in accessible low voltage compartments. Links used for earthing of control supplies and CTs shall be mounted in accessible low voltage compartments.~~

~~Equipment containing instrument or instrument circuits requiring special earthing, shall be equipped with a separate instrument earth bar isolated from the enclosure.~~

#### 6.113.3

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

#### 6.113.4

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

#### 6.113.5

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

#### 6.113.6

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

Add new subclause

### ~~56.114.3~~ Gas to air bushings Cable terminations

~~Where 6.114.1 Terminals for external, open terminal~~ conductors

#### 6.114.1.1

~~Separate termination compartments for high-voltage and low-voltage connections are defined as required in the circuit schedule, gas to air bushings shall be provided for connections between the GIS assemblies, overhead transmission lines and open terminal transformers.~~

~~Unless defined otherwise by the user in the data sheets, outdoor bushings shall be suitable for use in an outdoor environment with site pollution severity class "medium" and selection to Approach 3 according to IEC TS 60815-1.~~

~~Bushing electrical connection hole configuration shall be as defined in the circuit schedule, or in the absence of user requirements, the manufacturer's standard hole configuration.~~

#### 6.114.1.2

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

#### 6.114.1.3

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

#### 6.114.1.4

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

#### 6.114.1.5

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

### 6.114.2 Terminals for control and auxiliary circuits

#### 6.114.2.1

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

#### 6.114.2.2

Terminal blocks shall be grouped by function and operating voltage.

#### 6.114.2.3

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

#### 6.114.2.4

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

#### 6.114.2.5

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

#### 6.114.2.6

Terminals powered from external supplies shall display a warning label.

#### 6.114.2.7

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

#### 6.114.2.8

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

#### 6.114.2.9

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

Add new subclause

### **56.115 Interfaces**

Add new subclause

#### **56.115.1 Interface with supervisory systems**

~~Communication interfaces with process control systems, ECMSs or other non-safety function systems shall be as defined by the user in the data sheets.~~

~~Any user requirements for discrete analogue and digital I/O interfaces with a remote supervisory system or substation annunciator panel shall be as identified on the user diagrams or as defined in a user functional specification.~~

Add new subclause

#### **5.115.2 Interface with external equipment packages and control systems**

~~The user requirements for interfaces with external packages and machinery control systems and emergency shutdown systems shall be as identified on the user diagrams or as defined in a user functional specification.~~

~~If a functional unit is defined on the circuit schedule as forming part of a machinery package, the interface components shall conform to IEC TR 62061-1 for safety of machinery and control systems, and requirements for related documents.~~

~~Emergency shutdown interface relays shall be safety integrity level (SIL) rated in accordance with IEC 61511-1 to the SIL level defined in the circuit schedule.~~

## **6.115.2 Application of communication protocols to protective functions**

### **6.115.2.1**

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

### **6.115.2.2**

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

Add new subclause

## **Manufacturer 6.116 Condition monitoring**

### **6.116.1 General**

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

#### **6.116.1.1**

The system shall be integral to the assembly.

#### **6.116.1.2**

The system shall provide ~~probability of failure on demand reliability~~ real-time continuous monitoring.

#### **6.116.1.3**

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

#### **6.116.1.4**

Data shall be displayed on an HMI.

#### **6.116.1.5**

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

#### **6.116.1.6**

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

### **6.116.2 Thermal monitoring**

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

### **6.116.3 Partial discharge**

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



#### 6.116.4 Circuit breaker monitoring

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

### 8 Routine tests

#### 8.6 Design and visual checks

Add new subclause

##### ~~for SIL loop connected components~~ 8.6.1

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

Add new subclause

##### ~~5.115.3 Device configuration and set-point responsibilities~~

~~The manufacturer shall be responsible for protection relay, IED generic configuration and IED functional logic files. The user will be responsible for provision of the protection relay settings specific to the load or the electrical system network. The manufacturer shall submit functional logic diagrams and configuration settings files to the user.~~

~~A responsibility matrix or flow chart shall be developed between both parties and used as an interface control document.~~

#### 8.6.2

Visual inspection shall validate the functional unit and assembly labelling.

Add new subclause

##### ~~5.115.4 Application of communication protocols to protective functions~~

##### ~~Digital interfaces based on IEC 61850 (refer to [16] of Bibliography)~~ 8.6.3

Visual inspection shall conform to IEC 62271-3.

~~Use of IEC 61850 for transfer of protection signals or measured values used for protective functions between IEDs shall be subject to agreement between the user and the manufacturer.~~

~~Use of IEC 61850 process bus shall be subject to agreement between the user and the manufacturer.~~

~~For interlocking, blocking, protection signals or measured values used for protective function transferred between IEDs on the same IEC 61850 Station Bus network, the following applies:~~

- ~~—— they shall be fully functional independently of the associated wide area communications infrastructure (servers and firewalls);~~
- ~~—— the FAT shall demonstrate that this is achieved.~~

## ~~6 — Type tests (IEC 62271-1 Clause 7)~~

### ~~6.1 — General (IEC 62271-1 Subclause 7.1)~~

#### Add to subclause

~~For each high-voltage switchgear and controlgear assembly type and rating offered, the manufacturer shall provide type test certificates for all applicable type tests.~~

~~Type test certificates shall as a minimum, provide a summary of type tests, including the specific year and edition of the IEC used to perform the type tests.~~

~~Optional type tests shall be performed if defined as required by the user in the data sheets.~~

~~Type test specimens shall not be offered for use in service.~~

### ~~6.2 — Dielectric tests~~

#### ~~6.2.8 — Artificial pollution tests for outdoor insulators~~

#### Add to subclause

~~Additional tests for condensation and pollution shall be performed if defined as required by the user in the data sheets.~~

## ~~7 — Routine tests (IEC 62271-1 Clause 8)~~

#### Add to clause

~~Equipment shall be subject to user inspection and user routine test representation as defined in IOGP S-620Q for the required conformity assessment system (CAS) level.~~

~~The CAS level shall be as defined by the user in the data sheets.~~

### ~~7.5 — Design and visual checks (IEC 62271-1 Subclause 8.6)~~

#### Add to subclause

~~Visual inspection to verify conformance of the switchgear shall be based on the current version of approved documentation and all other relevant information in accordance with IOGP S-620L, to validate the following as a minimum:~~

- ~~a) — assembly layout in accordance with the drawings;~~
- ~~b) — functional units and overall assembly are correctly labelled;~~
- ~~c) — interchangeability of removable parts in accordance with 5.104;~~
- ~~d) — operation, padlocking facility and effectiveness of safety shutters;~~
- ~~e) — effectiveness of padlocking facilities, interlocks, operating mechanisms and limit switches;~~
- ~~f) — integrity of internal wiring connections and earthing;~~

~~g) — correctness of~~ Add new subclause

#### 8.6.4

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

~~h) — component layout and mounting.~~

#### ~~7.101 — Partial discharge measurement~~

Add to subclause

~~The partial discharge test shall be performed if defined as required by the user in the data sheets.~~

#### 8.102 Mechanical operation tests

In third paragraph, add new list ~~Add new subclause~~

#### ~~7.107 — ECMS simulation test~~

~~Where defined by the user in the data sheets, a simulation test to validate the ECMS interfaces shall be carried out between the remote HMI and IEDs on the high-voltage switchgear and controlgear assemblies and the specific functions (remote control, restarting, automatic transfer, load shedding, etc.). The scope, timing and location of the ECMS simulation test shall be agreed between the user and the manufacturer.~~

### ~~9 — Information to be given with enquiries, tenders and orders~~

Add to subclause

~~The manufacturer shall provide the information as defined by the user in the information requirements specification.~~

~~The language used for all provided information shall be English, unless defined otherwise by the user in the data sheets.~~

~~All order unique information (i.e. excluding the manufacturer standard catalogues and manuals) shall show the assembly identification number, the user's purchase order number and the manufacturer's reference number.~~

~~NOTE — Installation, operations and maintenance instructions can be contained within the manufacturer's standard catalogues and manuals, provided 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.~~

Replace clause heading with

#### ~~9.2 — Information with tenders and orders~~

Replace item 2) with

~~2) — Certificates:~~

~~a) — type test certificates;~~

~~b) — certificate of conformity.~~

Add to item 3)

~~m) — general arrangement details;~~

- ~~n) — weight data sheet;~~
- ~~o) — heat dissipation calculation;~~
- ~~p) — bill of materials.~~

Add to item 4)

- ~~d) — functional design specification;~~

~~NOTE — Functional design specification to include motor starter and contactor feeder number of on load operating cycles~~

- ~~e) — switchgear single line diagram;~~
- ~~f) — circuit and wiring diagram;~~
- ~~g) — inter panel diagram;~~
- ~~h) — CT sizing calculations;~~
- ~~i) — CT characteristics;~~
- ~~j) — high-voltage protective devices characteristics and ratings.~~

Replace item 5) with

~~5) — Parts management:~~

- ~~a) — recommended spare parts list;~~
- ~~b) — list of components not suitable for 5 years continuous operation without inspection or replacement.~~

~~NOTE — Identified as supplementary sheet to the Installation, Operation and Maintenance Manual.~~

Add to subclause

~~6) — Contract management:~~

- ~~a) — supplier master information register/index;~~
- ~~b) — obsolescence management plan.~~

~~10 — padlocking facilities, interlocks, mechanisms and limit switches function correctly.~~

## **11 Transport, storage, installation, operation and maintenance (IEC 62271-1 Clause 11)**

### **~~10.1 — Conditions during transport, storage and installation (IEC 62271-1 Subclause 11.2)~~**

Add new subclause

#### **~~10.1.1 — Packing provisions~~**

~~Preparation for shipment shall be in accordance with the manufacturer's standard packing provision to meet project location and storage requirements, as defined by the user in the data sheets and purchase order.~~

~~Where the equipment integration site differs from the end usage site, associated transport/logistic options and conditions at the integration site shall be subject to agreement between the user and the manufacturer.~~

Add new subclause

## **10.1.211.6 Special tools**

### **11.6.1**

Special tools ~~and equipment required~~ for installation, operation, and maintenance ~~of the switchgear~~ including circuit breaker operating handles, earthing switch operating handles and software interrogation cables, shall be identified by the manufacturer as priced options with their bid package, for the user consideration. Items selected for purchase by the user, and detailed in the purchase order, shall be packed separately and shipped ~~together~~ with the assembly.

### **For high-voltage switchgear assemblies which have operational11.6.2**

Operational removable or withdrawable parts ~~with a weight greater~~ weighing more than 25 kg ~~requiring lifting,~~ shall be marked with their weight. 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~~ with labels confirming the actual weight.

### **11.6.3**

Where a ~~capacitive three-phase voltage indicating or~~ separable voltage detecting ~~and indicating~~ system (VDIS) is fitted, ~~a compatible~~ specified, the external phase comparator ~~(phasing-out)~~ instrument shall be ~~offered as a special tool option by the manufacturer~~ provided.

~~The required quantity of load certified hoists shall be defined by the user in the purchase order.~~

## **11— Safety (IEC 62271-1 Clause 12)**

### **11.101 Procedures**

Add to subclause

~~Warning plates or caution notices shall be installed, identifying possible danger points. The labels shall be strategically located to ensure visibility prior to access to the respective parts of the assembly.~~

## **1213 Influence of the product on the environment ~~(IEC 62271-1 Clause 13)~~**

Add to clause

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

Add new annex

Annex-DD (new) E

## Annex E (normative)

### Additional requirements for fault current limiter assembly

#### DDE.1 General

This annex specifies additional requirements, additional to the main body of this specification, for fault current limiters, ~~either integrated~~ incorporated within ~~a high-voltage switchgear and controlgear~~ an assembly, or forming a free-standing fault current limiter assembly.

~~The clause numbering of this annex follows that of the main body of this specification, preceded with "DD."~~  
~~The additional text in this annex should be read alongside the relevant clauses.~~

~~Fault current limiters with superconducting elements shall only be used if subject to agreement between the user and the manufacturer.~~

#### DD.4E.2 Ratings

#### DD.4.4 Rated – rated normal current and temperature rise

##### DD.4.4E.2.1 Rated normal current ( $I_r$ )

Add to subclause

The rated ~~normal~~ continuous current ( $I_r$ ) of the fault current limiter shall not be less than the rated ~~normal~~ continuous current of the associated incoming circuit, bus sections or bus coupler ~~with which it is associated.~~

##### DD.4.5E.2.2 Rated short-time withstand currents ( $I_k$ )

Add to subclause

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

##### DD.4.6E.2.3 Rated peak withstand current ( $I_p$ )

Add to subclause

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

## **DD.2.4.7 Rated durations of short-circuit ( $t_k$ )**

### Add to subclause

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

## **DD.5.3 Design and construction**

### **DD.5.0.101 — General**

#### Add to subclause

The fault current limiter shall recognize and limit a short circuit current within the first quarter cycle of the fault current rise.

In a switchboard with more than one fault current limiter installed, additional tripping criteria shall be subject to agreement between the user and the manufacturer.

### **DD.5.0.103 — Dependability of materials and parts**

#### Add to subclause

With the exception of the replacement of interrupting elements, the manufacturer shall advise of any components requiring maintenance or inspection within the service periods defined, as required for the high-voltage switchgear by the user in the data sheets, that would require de-energizing of the main circuit of the fault current limiter assembly.

## **DD.5.3 Earthing of switchgear and controlgear**

### **DD.5.3.101 — Earthing of the high-voltage conductive parts**

The fault current limiter assembly shall be configured with the switchgear and controlgear assembly, such that it is provided with earthing facilities on both sides of the main circuit conductors, for the purpose of maintenance and testing.

## **DD.5.4 Auxiliary and control equipment**

### **DD.5.4.3.1 — General.1**

#### Add to subclause

Fault current limiter protective function circuits shall ~~be designed to~~ prevent common mode failures between ~~each phase~~ phases including sensors, signal treatment and triggering system. ~~The three triggering units shall work independently of each other. The auxiliary power supplies for each treatment and triggering system shall be powered by separately protected auxiliary circuits. A watchdog module shall be provided to continuously monitor the most important functions of the three triggering units.~~

### **E.3.1.2**

Fault current limiter protective function circuits shall ~~be designed to accept the option of~~ provide an external blocking function ~~such that the fault limiter where~~ operation is ~~blocked whenever the operating condition~~ (disabled when a system fault levels are level is within an acceptable range) ~~allows~~.

~~If defined in the user diagrams, a front of panel, lockable, three-position~~ E.3.1.3

~~Operation selector switch ("On", "Inhibited" and "Off"), shall be provided for the purpose of isolation of the protective function circuits. The switches shall be lockable.~~

E.3.1.4

~~Operation selector switches~~ shall be ~~fitted~~ located front of panel.

E.3.1.5

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

E.3.1.6

Triggering systems shall be powered by individually protected auxiliary circuits.

E.3.1.7

Triggering units shall operate independently of each other.

E.3.1.8

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

~~DD.5.108 Main circuit switching devices~~

~~DD.5.108.1~~ E.3.2 **Isolating switching devices (disconnectors)**

Add to subclause

The fault current limiter assembly shall ~~be configured with the switchgear and controlgear assembly, such that it is provided with~~ provide isolation points on ~~both the incoming and outgoing~~ sides of ~~the~~ main circuit conductors, ~~for the purpose of maintenance and testing.~~

~~DD.5.11~~ E.3.3 **Interlocking devices**

Add to subclause

~~Any circuit~~ E.3.3.1

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

~~\_\_\_\_\_ receive the triggering signal directly from the triggering unit of~~ E.3.3.2

Circuit-breakers installed in series with the fault current limiter; ~~and~~

~~\_\_\_\_\_ shall~~ be interlocked to prevent ~~circuit-breaker~~ closure ~~until the~~ when interrupting elements are ~~replaced~~ activated and the fault current limiter triggering unit is not reset.

E.3.3.3

Access ~~within to~~ the fault current limiter ~~enclosure~~ compartment shall be prevented unless ~~all of the following~~ apply:



~~the in-series circuit-breakers are open; and~~

~~the other series downstream~~ E.3.3.4

Access to the fault current limiter compartment shall be prevented unless the in-series connected switching devices or isolators ~~(where present)~~ are in the open position; ~~and~~

~~both~~ E.3.3.5

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

~~The series circuit-breaker and where relevant, the other series~~ E.3.3.6

Series switching devices or isolators shall be interlocked to prevent closure, ~~until all~~ when fault current limiter earths are ~~removed~~ connected.

## ~~DD.7.5~~ E.3.4 Design and visual checks

~~Add to subclause~~

In addition to ~~the inspection defined to verify conformance of high voltage switchgear and controlgear assemblies, the fault current limiter assembly~~ inspections, fault current limiters shall have functional checks shall include:

~~functioning~~ of the measuring unit;

~~functioning of~~ the triggering ~~(firing)~~ and indication unit, excluding final elements.

## ~~DD.9~~ Information to be given with enquiries, tenders and orders

### ~~DD.9.2~~ Information with tenders

~~Add to item 3)~~

m) ~~fault current limiter details:~~

~~interrupting current capability (kA rms);~~

~~weight of each fault current limiter replaceable element (kg).~~

## ~~DD.10~~ E.4 Transport, storage, installation, operation and maintenance

### ~~DD.10~~ E.4.1.3 Special tools

~~Add to subclause~~

#### E.4.1.1

Special tools ~~and equipment required~~ for fault current limiter installation, operation, and maintenance ~~of the fault current limiter shall form part of the order and be packed separately and~~ shall be shipped together with the ~~fault current limiter~~ assembly.

~~The special tool set shall include:~~

a) ~~Test~~ E.4.1.2

A test unit ~~and with~~ leads shall be provided for commissioning and ~~periodic-function test of the fault current limiter; testing.~~

b) ~~One three~~ E.4.1.3

Three-phase ~~set of~~ copper bars ~~which can be fixed in the position normally occupied by~~ shall be provided.

E.4.1.4

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

E.4.1.5

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

~~DD.10~~ E.4.2.9 **Basic input data by the manufacturer**

Add to subclause

~~The manufacturer shall be responsible for setting the~~ The triggering value of the fault current limiter ~~based on shall be set according to the specified~~ minimum and maximum short-circuit fault level ~~contribution figures provided by the user.~~

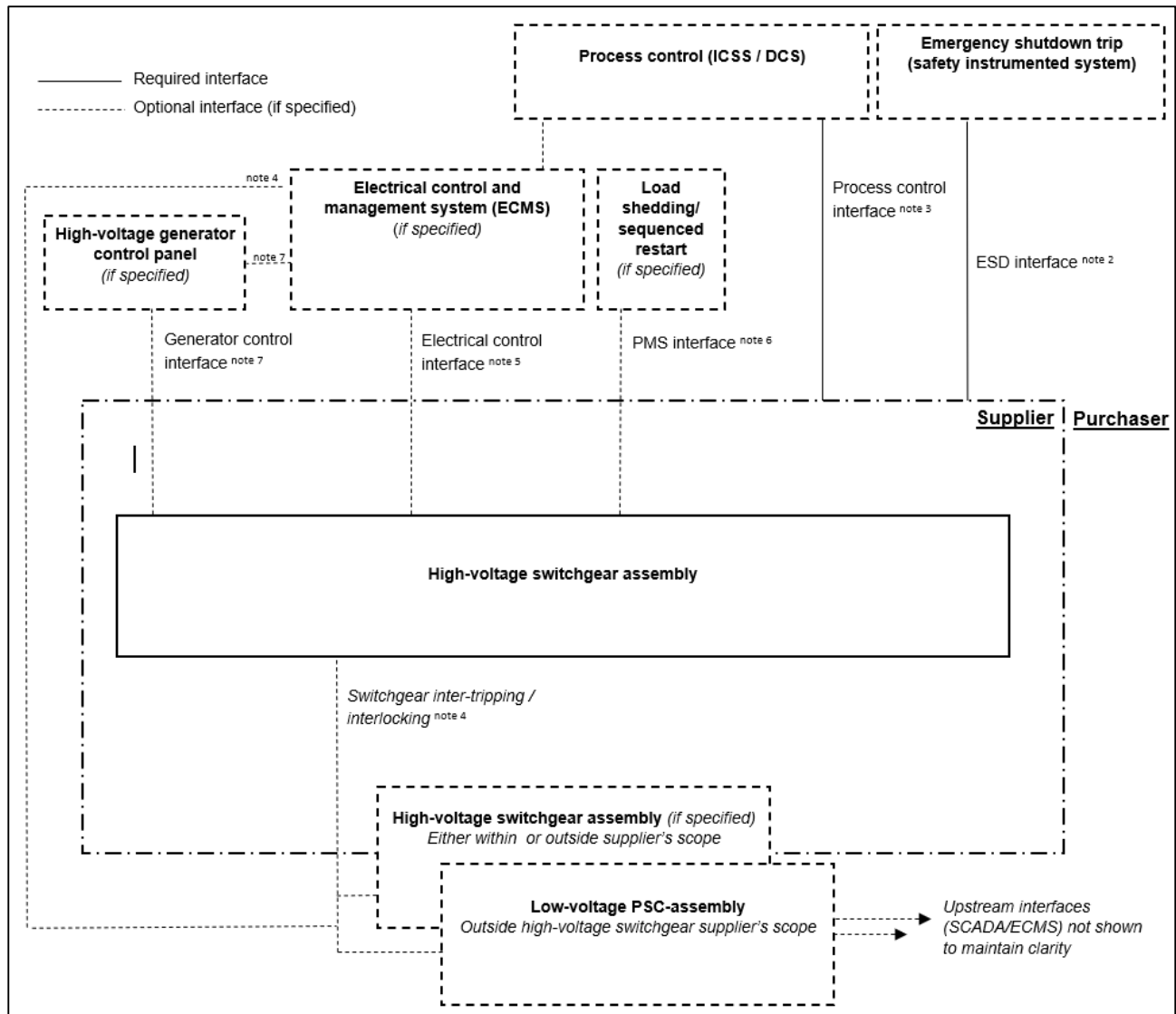
**Bibliography**

Add new Annex F

## Annex F (informative)

### Integration with external systems

Add new Figure F.1



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

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

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

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

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

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

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

**Figure F.1 – Communications interface block diagram**

Redline Version

## Bibliography

### ~~[11] Add to Bibliography~~

- ~~[12] IEC 60445:2017, Basic and safety principles for man-machine interface, marking and identification — Identification of equipment terminals, conductor terminations and conductors~~
- ~~[13] IEC 60695-1-10, Fire hazard testing — Part 1-10: Guidance for assessing the fire hazard of electrotechnical products — General guidelines~~
- ~~[14] IEC 60695-1-12, Fire hazard testing — Part 1-12: Guidance for assessing the fire hazard of electrotechnical products — Fire safety engineering~~
- ~~[15] IEC 60898-1, Electrical accessories — Circuit breakers for overcurrent protection for household and similar installations — Part 1: Circuit breakers for a.c. operation~~
- ~~[16] IEC 61850, Communication networks and systems for power utility automation — All parts as applicable~~
- ~~[17] IEC 62402, Obsolescence management — Application guide~~

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