International Association of Oil & Gas Producers

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# Supplementary Specification to IEC 61439-1 & 2 Low-voltage Switchgear and Controlgear Assemblies

Public Review Draft

JIP33
JOINT INDUSTRY PROGRAMME

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## 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).

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# Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of low voltage switchgear and control gear assemblies in accordance with IEC 61439-1, Edition 3, May 2020 and IEC 61439-2, Edition 3.0, July 2020, Corrigendum 1, 2021 for application in the petroleum and natural gas industries.

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




**JIP33 Specification for Procurement Documents**
**Supplementary Technical Specification**

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

**IOGP S-560: Supplementary Specification to IEC 61439-1 & 2 Low-voltage Switchgear and Controlgear**

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

Modifications to IEC 61439-1 or IEC 61439-2 defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

**IOGP S-560D: Procurement Data Sheet for Low-voltage Switchgear and Controlgear**

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

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**IOGP S-560L: Information Requirements for Low-voltage Switchgear and Controlgear**

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

**IOGP S-560Q: Quality Requirements for Low-voltage Switchgear and Controlgear**

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

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS follows that of IEC 61439-1 and IEC 61439-2, and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

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

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

a) regulatory requirements;

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

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

d) this specification;

e) IEC 61439-1 and IEC 61439-2.

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# 1 Scope

*Add to subclause*

This specification does not cover:

a) requirements for integration with the electrical control and management systems (ECMS);

b) requirements for integration of any switchgear condition monitoring systems;

c) explosion protected 'Ex' equipment, (addressed by IEC 60079 series);

d) pillar type or construction site distribution equipment, (addressed by IEC 61439-4 and IEC 61439-5);

e) lighting and small power distribution boards rated less than 250 A.

*Add new subclause*

## 1.1 General

### 1.1.1

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

### 1.1.2

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

### 1.1.3

This specification addresses fully withdrawable switchgear and controlgear of cubicle and multi-cubicle type assemblies for indoor installation. This specification also applies, where specified in the requisition documents to fixed and withdrawable cubicle type assemblies and combinations thereof.

# 2 Normative references

*Add to clause*

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

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

IEC 60051, *Direct acting indicating analogue electrical-measuring instruments and their accessories*

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

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

IEC 60684, *Flexible insulating sleeving*

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

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IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-4-2, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – Semiconductor motor controllers, starters and soft-starters*

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

IEC 60947-7-1, *Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

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

IEC TR 61641, *Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault*

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

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

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62402, *Obsolescence management*

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

# 3 Terms and definitions

## 3.4 Structural parts of assemblies

*Add new term*

**3.4.16**
**bus section**
number of functional units normally connected together in service by a physically continuous main busbar

*Add new term*

**3.2.13**
**bus coupler**
functional unit that contains a mechanical switching device, which electrically connects together two bus sections

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# 5 Interface characteristics

## 5.1 General

*Add to subclause*

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

*Add to subclause*

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

## 5.2 Voltage ratings

### 5.2.1

*Add to subclause*

The assembly shall be rated to operate with a power system supply voltage harmonic content not exceeding 8 % total harmonic distortion (THD) in accordance with IEC 61000-3-2.

## 5.3 Current ratings

#### 5.3.1

*Add to subclause*

The rated current shall be a continuous rating following de-rating for specified service conditions.

## 5.4 Rated diversity factor (RDF)

*Add new subclause*

### 5.4.101

#### 5.4.101.1

A rated diversity factor of 1,0 shall be applied to main (horizontal) busbars.

#### 5.4.101.2

For temperature rise tests or temperature rise calculations, a rated diversity factor of 1,0 shall be applied for sections containing a single functional unit.

#### 5.4.101.3

Spare equipped functional units shall have an assumed loading factor of 0,9.

#### 5.4.101.4

Spare unequipped functional units shall have an assumed loading factor of 0,9 of the maximum potential rated current until the functional unit is equipped.

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# 6 Information

## 6.1 Assembly designation marking

*Add new list item h)*

h) rated peak withstand current;

*Add new list item i)*

i) short-time withstand current;

*Add new list item j)*

j) short-time withstand duration;

*Add new list item k)*

k) degree of protection (IP rating);

*Add new list item l)*

l) form of internal separation;

*Add new list item m)*

m) internal arc resistance rating (current and duration);

*Add new list item n)*

n) arcing class.

*Add to subclause*

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

## 6.2 Documentation

### 6.2.1 Information relating to the assembly

*Add to subclause*

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

### 6.2.2 Instructions for handling, installation, operation and maintenance

*Add to subclause*

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

*Add to subclause*

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

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### 6.3 Device and/or component identification

*Add to subclause*

Informative labels shall have black characters on a white background.

*Add to subclause*

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

*Add to subclause*

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

*Add to subclause*

The functional unit shall contain the following information:

a) functional unit compartment number;

b) tag number of connected equipment;

c) service description of connected equipment;

d) circuit kW or kVA rating.

*Add to subclause*

Identification and label plates shall be attached to non-removable parts of the PSC-assembly with stainless steel 316 fixings.

## 7 Service conditions

### 7.2 Special service conditions

*Replace list item l) with*

l) voltage harmonics in the system with a THD greater than 8 % with frequencies up to 40$^{th}$;

## 8 Constructional requirements

### 8.1 Strength of materials and parts

#### 8.1.1 General

*Add new subclause*

#### 8.1.1.101 General

**8.1.1.101.1**

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

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**8.1.1.101.2**

The floor shall not be considered as being part of the enclosure.

**8.1.1.101.3**

PSC-assemblies shall have one or more bus sections to which incoming units and outgoing units are connected.

**8.1.1.101.4**

Bus sections shall be linked through bus coupler units.

**8.1.1.101.5**

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

**8.1.1.101.6**

PSC-assemblies specified for marine installation shall be in accordance with IEC 60092-101.

**8.1.1.101.7**

PSC-assemblies specified for offshore installation shall be in accordance with IEC 61892-3.

## 8.2 Degree of protection provided by an assembly enclosure

### 8.2.1 Protection against mechanical impact

*Replace subclause with*

PSC-assemblies shall have a degree of protection against mechanical impacts of at least IK08 in accordance with IEC 62262.

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

*Add to first paragraph*

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

*Add new subclause*

**8.2.2.100 Space heaters**

**8.2.2.100.1**

Space heaters internal to PSC-assemblies shall have a degree of protection of at least IP2X in accordance with IEC 60529.

**8.2.2.100.2**

Space heaters internal to PSC-assemblies shall incorporate a mechanical guard where heater surface temperature exceeds 60 °C.

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**8.2.2.100.3**

PSC-assembly space heaters and motor space heaters shall be individually powered from external discrete sources.

**8.2.2.100.4**

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

**8.2.2.100.5**

The bus section heater supply shall have a front of panel indicating LED lamp with a label engraved "Heater supply on".

### 8.2.3 Assembly with removable parts

*Add to second paragraph*

When a removable part has been removed, the minimum degree of protection shall be IP2X.

*Add to third paragraph*

Shutters shall automatically open/cover the main circuit contact apertures and not be dependent on gravity.

*Add to third paragraph*

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

*Add to subclause*

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

*Add to subclause*

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

*Add to subclause*

Shutters shall be lockable in the closed position.

*Add to subclause*

Accessible shutters shall be labelled in conformance with Table 16.

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*Add new Table 16*

**Table 16 – Accessible shutters labelling**

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

## 8.4 Protection against electric shock

### 8.4.6 Operating and servicing conditions

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

*Delete second sentence of second paragraph*

#### 8.4.6.2 Requirements related to accessibility in service by authorized persons

*Add to first paragraph*

Functional unit auxiliary and control supplies from external sources shall be protected by a dedicated lockable 2-pole MCB per functional unit.

##### 8.4.6.2.2 Requirements related to accessibility for inspection and similar operations

*Add new list item*

– auxiliary and control terminals shall have a degree of protection of at least IP2X in accordance with IEC 60529.

##### 8.4.6.2.4 Requirements related to accessibility for extension when energized

*Add to subclause*

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

## 8.5 Incorporation of switching devices and components

### 8.5.2 Removable parts

#### 8.5.2.101 Withdrawable parts

*Add to subclause*

Removable hardware shall be labelled to facilitate identification of its functional unit.

*Add to subclause*

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

*Add to subclause*

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

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*Add to subclause*

Withdrawable functional units shall have the following positions:

a) service (main circuit and auxiliary circuit contacts connected);

b) test (auxiliary circuits connected but main circuit contacts disconnected);

c) isolated (main and auxiliary circuits disconnected);

d) removed.

*Add to subclause*

Withdrawable functional units which are physically identical but electrically have a different function shall be non-interchangeable.

*Add to subclause*

Withdrawable functional units that have an identical duty and rating shall be interchangeable.

*Add to subclause*

Mandatory interlocks shall be of mechanical type.

*Add to subclause*

Electrical interlocks shall "fail safe" to a de-energized state.

### 8.5.3 Selection of switching devices and components

*Add to subclause*

Circuit breakers above 100 A shall be selectivity category B in accordance with IEC 60947-2.

*Add to subclause*

Main incomers, bus couplers and outgoing power feeders rated 800 A and above shall be provided with withdrawable ACBs or non-withdrawable load switches.

*Add to subclause*

Outgoing power feeders rated 630 A and below shall be provided with fuse switch units or MCCBs.

*Add to subclause*

Motor starters shall be provided with a combination of fuse-switch units or MCCBs, contactors and protection relays.

*Add to subclause*

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

*Add to subclause*

Switching devices shall switch all phases and neutrals where present.

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*Add to subclause*

Outgoing circuit breakers that do not require selective protection shall be selectivity category A in accordance with IEC 60947-2.

*Add to subclause*

Outgoing circuit breakers that require selective protection shall be selectivity category B in accordance with IEC 60947-2.

*Add to subclause*

Auxiliary control circuit breakers shall be selectivity category A in accordance with IEC 60947-2.

*Add to subclause*

Load switches shall be of the "fault make, load break" type.

*Add to subclause*

Load switches shall be utilization category AC-22 in accordance with IEC 60947-3

*Add new subclause*

**8.5.3.101 Incoming and bus coupler units**

**8.5.3.101.1**

Metering supplies shall be protected by fully insulated pattern HRC type fuses fixed directly to the busbar system with provision for safe change-out.

**8.5.3.101.2**

For metering supplies, a secondary means of isolation shall be provided.

**8.5.3.101.3**

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

*Add new subclause*

**8.5.3.102 Isolating switching devices (disconnectors)**

**8.5.3.102.1**

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

**8.5.3.102.2**

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

**8.5.3.102.3**

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

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**8.5.3.102.4**

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

**8.5.3.102.5**

The number of operating cycles shall be in accordance with category A of IEC 60947-3, Table 4.

**8.5.3.102.6**

Disconnector fuse and fuse disconnectors shall be utilization category AC 23B for uninterrupted duty.

**8.5.3.102.7**

Disconnector fuse and fuse disconnector rated short-circuit making capacity shall be at least equal to the busbar prospective short-circuit current.

**8.5.3.102.8**

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

**8.5.3.102.9**

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

**8.5.3.102.10**

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

### 8.5.3.103 Circuit breakers

*Add new subclause*

#### 8.5.3.103.1 Air circuit breakers

**8.5.3.103.1.1**

Circuit-breaker operating mechanisms shall have spring stored energy.

**8.5.3.103.1.2**

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

**8.5.3.103.1.3**

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

**8.5.3.103.1.4**

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

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**8.5.3.103.1.5**

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

**8.5.3.103.1.6**

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

**8.5.3.103.1.7**

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

**8.5.3.103.1.8**

Circuit-breaker operating mechanisms shall have an operations counter.

**8.5.3.103.1.9**

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

**8.5.3.103.1.10**

Circuit-breakers shall have at least two normally open (52a) auxiliary contacts wired to terminals in the outgoing terminal block.

**8.5.3.103.1.11**

Circuit-breakers shall have at least two normally closed (52b) auxiliary contacts wired to terminals in the outgoing terminal block.

**8.5.3.103.1.12**

Withdrawable circuit-breakers shall have an "in service" position auxiliary contact wired to terminals in the outgoing terminal block.

### 8.5.3.103.2 Moulded case circuit breakers

**8.5.3.103.2.1**

MCCB outgoing feeder functional units that are not in combination with a contactor shall have a shunt trip facility when remote tripping is provided.

**8.5.3.103.2.2**

MCCB outgoing feeder functional units that are not in combination with a contactor shall be manually actuated from the front of the panel without opening the door.

**8.5.3.103.2.3**

MCCB outgoing feeder functional units that are not in combination with a contactor shall have clear indication of the "O" (off), "Trip" and "I" (on) positions on the front of the device.

**8.5.3.103.2.4**

MCCBs shall be provided with auxiliary volt free contacts for trip and status indication.

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*Add new subclause*

### 8.5.3.104 Main circuit fuses

**8.5.3.104.1**

Fuses used for main circuit protection shall be in accordance with IEC 60269-2.

**8.5.3.104.2**

Fuses shall be high rupture capacity (HRC) type general purpose fuse links, utilization category gG for feeders and aM / gM for motor circuits to provide type 2 co-ordination.

**8.5.3.104.3**

DIN D type fuses shall only be offered with ratings up to 63 A and be provided with short-circuit limiting devices up to 400 A.

**8.5.3.104.4**

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

*Add new subclause*

### 8.5.3.105 Motor starters and contactor feeders

**8.5.3.105.1**

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

**8.5.3.105.2**

Emergency stop pushbuttons shall be red, mushroom head, stay-put with a manual reset.

**8.5.3.105.3**

Front of panel actuators shall be shrouded and operable only with the functional unit in the test position.

**8.5.3.105.4**

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

**8.5.3.105.5**

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

**8.5.3.105.6**

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

**8.5.3.105.7**

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

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**8.5.3.105.8**

Labels shall be provided adjacent to fuses, confirming fuse ratings in accordance with circuit design.

**8.5.3.105.9**

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

**8.5.3.105.10**

For three-phase, four wire (TN) systems, contactors shall have a control voltage derived from the phase and neutral on the circuit (load) side of the isolating device.

**8.5.3.105.11**

Control circuit supplies shall be provided with fuse or MCB protection within each functional unit.

**8.5.3.105.12**

For three-phase, three-wire (IT) systems, contactors shall have an operating control voltage of 230Vac, supplied via a control transformer.

**8.5.3.105.13**

Primary windings of control transformers shall be fuse or MCB protected.

**8.5.3.105.14**

The secondary star point shall be earthed at a single point via an accessible removable link.

**8.5.3.105.15**

Control circuit supplies shall be protected by fuse or MCB, located external to the functional units.

**8.5.3.105.16**

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

**8.5.3.105.17**

The motor heater supply shall be automatically isolated when the main circuit is isolated.

**8.5.3.105.18**

The motor space heater power supply shall be distributed from dedicated motor heater auxiliary bus wiring within each bus section of the PSC-assembly.

**8.5.3.105.19**

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

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*Add new subclause*

### 8.5.3.106 Motor protection

**8.5.3.106.1**

Motor protection functionality shall be in accordance with ANSI/IEEE C37.2.

**8.5.3.106.2**

Three-phase thermal overload protection shall be in accordance with ANSI 49.

**8.5.3.106.3**

Motor protection functionality shall be three-phase instantaneous or definite-time short circuit protection ANSI 50/51.

**8.5.3.106.4**

Motor protection functionality shall be provided by relays supplied by current transformers within the withdrawable part of the functional unit.

**8.5.3.106.5**

Protection relay settings shall be configurable by a single-phase test supply.

**8.5.3.106.6**

Earth fault protection shall be provided for motors rated equal to or greater than 30 kW.

**8.5.3.106.7**

Earth fault protection sensitivity shall be less than 10 % of the rated nominal motor current or 5 A.

**8.5.3.106.8**

Circuits supplying motors with type of protection "e" shall be in accordance with IEC 60079-14.

**8.5.3.106.9**

Motors located in a hazardous area and have a power rating exceeding 1,0 kW shall be individually protected against overload.

**8.5.3.106.10**

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

**8.5.3.106.11**

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

**8.5.3.106.12**

Where IEDs are specified, the additional requirements listed in Table 17 shall be provided.

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*Add new Table 17*

**Table 17 – IED requirements**

| | ANSI device code | IEC nomenclature | Motors < 110 kW | Motors ≥ 110 kW | Motors ≥ 185 kW |
|---|---|---|---|---|---|
| Locked rotor protection | 51LR | | | X | X |
| Definite-time undercurrent protection | 37 | I< | O | O | O |
| Inverse-time unbalance protection based on negative phase-sequence current | 46 | I2> | O | O | O |
| Motor start-up supervision based on thermal stress calculation | 48 | Is ts 2 | | X | X |
| Cumulative start-up time counter and restart disable function | 66 | Σtsi | | X | X |
| Lockout relay | 86 | | | X | X |
| Front-of-panel protection reset | | | O | O | O |
| **Key**<br>X = user required<br>O = fit only if defined as required in user diagrams | | | | | |
| NOTE For IED motor protection relays, protection reset should be via the IED HMI. | | | | | |

*Add new subclause*

### 8.5.3.107 Integrated adjustable speed drives and power semiconductor systems

**8.5.3.107.1**

Adjustable speed drives (ASD) and power semiconductor systems (PSS) shall be in accordance with IEC 60947-4-2.

**8.5.3.107.2**

ASDs and PSSs forming an integral part of the PSC-assembly shall be selected and rated for continuous duty at kW rating.

**8.5.3.107.3**

Compartments upstream of protective devices shall have arc containment ratings in accordance with the IEC TR 61641 requirements specified.

*Add new subclause*

### 8.5.3.108 Current transformers

**8.5.3.108.1**

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

**8.5.3.108.2**

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

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**8.5.3.108.3**

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

**8.5.3.108.4**

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

**8.5.3.108.5**

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

**8.5.3.108.6**

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

*Add new subclause*

**8.5.3.109 Voltage transformers**

**8.5.3.109.1**

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

**8.5.3.109.2**

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

**8.5.3.109.3**

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

**8.5.3.109.4**

Voltage transformers shall be protected by MCBs on secondary windings.

**8.5.3.109.5**

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

**8.5.3.109.6**

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

**8.5.3.109.7**

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

**8.5.3.109.8**

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

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**8.5.3.109.9**

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

**8.5.3.109.10**

Secondary circuits shall be equipped with terminals with measuring bushings.

**8.5.3.109.11**

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

*Add new subclause*

**8.5.3.110 Unearthed electrical supplies (IT)**

**8.5.3.110.1**

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

**8.5.3.110.2**

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

**8.5.3.110.3**

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

**8.5.3.110.4**

Insulation monitoring and earth fault detection shall have a data interface for transmission of insulation resistance values and alarms to switchgear data management units.

**8.5.3.110.5**

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

**8.5.3.110.6**

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

**8.5.3.110.7**

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

**8.5.3.110.8**

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

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*Add new subclause*

### 8.5.3.111 Transfer systems

**8.5.3.111.1**

Automatic transfer systems (ATS) or manual transfer systems (MTS) shall be rated for switchgear operating at normal conditions with the bus section circuit breaker open.

**8.5.3.111.2**

The principle for operation shall be that ATS operates as non-synchronous transfer and MTS operates as synchronous transfer.

**8.5.3.111.3**

Instantaneous overcurrent (ANSI 50) and earth fault (ANSI 50N) relays shall be provided in the incomer to inhibit the auto-transfer facility on detection of a bus section fault.

## 8.5.5 Accessibility

*Add new subclause*

**8.5.5.101**

**8.5.5.101.1**

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

**8.5.5.101.2**

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

**8.5.5.101.3**

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

**8.5.5.101.4**

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

a) when placed on floating offshore installations;

b) when located outdoors (exposed to wind);

c) when door is equipped with electrical components.

**8.5.5.101.5**

Hinged doors shall not require the use of tools to open.

**8.5.5.101.6**

Doors or covers that are required to be locked when equipment is in operation shall facilitate padlocking.

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**8.5.5.101.7**

Key operated fixed door locking devices shall not be provided.

**8.5.5.101.8**

The PSC-assembly height shall be a maximum of 2,5 m.

### 8.5.6 Barriers

**8.5.6.1**

*Add to subclause*

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

*Add new Table 18*

**Table 18 – Minimum degrees of protection**

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

**8.5.8**

*Replace subclause with*

Discrete indication lamps shall be light emitting diode (LED) types.

*Add to subclause*

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

*Add to subclause*

Indicator light colour coding shall be in accordance with IEC 60073 and Table 19.

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*Add new Table 19*

**Table 19 – Colour coding of status indicator**

| Colour | Meaning | PSC-assembly application | |
|---|---|---|---|
| | Safety of persons or environment | ACB | Motor starter / contactor feeder |
| Red | Danger | Closed (On) | Running (On) |
| Yellow | Warning/caution | Tripped | Tripped |
| Green | Safe | Open (Off) | Stopped (Off) |
| Blue | Mandatory significance | Trip circuit healthy (or unhealthy) | |
| White | No specific meaning assigned | Voltage indication (Heater On) | Motor heater on |

*Add new subclause*

### 8.5.10 Auxiliary components

#### 8.5.10.1 General

**8.5.10.1.1**

Control and indication devices mounted on the front of the panel shall be in a consistent, logical, ergonomic and symmetrical arrangement.

**8.5.10.1.2**

Where specified, facilities for calibration and injection testing protection relays from the front of the functional unit and without disconnection of secondary wiring shall be provided.

**8.5.10.1.3**

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

**8.5.10.1.4**

Control and auxiliary devices shall be mechanical duration class 1.

**8.5.10.1.5**

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

**8.5.10.1.6**

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

**8.5.10.1.7**

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

**8.5.10.1.8**

AC switching elements shall be utilization category AC-15.

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**8.5.10.1.9**

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

**8.5.10.1.10**

Where required, emergency shutdown interface relays shall be SIL rated in accordance with IEC 61511-1.

### 8.5.10.2 Indicating and measuring devices

#### 8.5.10.2.1 General

Indicating instruments shall be digital or analogue and have minimum accuracy class of 2.5.

#### 8.5.10.2.2 Analogue instruments

Analogue instruments shall be flush mounted and conform to relevant parts of IEC 60051.

#### 8.5.10.2.3 Digital instruments

**8.5.10.2.3.1**

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

**8.5.10.2.3.2**

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

**8.5.10.2.3.2**

Multi-functional digital measuring devices displays shall be visible without ambient lighting.

**8.5.10.2.3.1**

When specified, static energy meters shall be rated for three-phase unbalanced loads in accordance with IEC 62052-11.

**8.5.10.2.3.2**

Energy meters and maximum demand meters shall be suitable for three-phase unbalanced load.

**8.5.10.2.3.3**

Watt-hour integrating meters shall be fitted with a pulse transmitter.

**8.5.10.2.3.4**

Where required, test terminal blocks shall be provided on the panel front for kWh meter testing.

**8.5.10.2.3.5**

Where specified, maximum current demand indicators with a period of 30 min shall be provided for incomers and outgoing feeders in accordance with IEC 62052-11.

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#### 8.5.10.2.4 Transducers

**8.5.10.2.4.1**

Transducer outputs shall be in accordance with IEC 60688 and wired to terminals in the outgoing terminal block.

**8.5.10.2.4.2**

The output signal of the transducer shall not exceed 20 mA, even when the input value is more than 100 % of the defined output range (e.g. during motor starting).

### 8.5.10.3 Analogue instruments

**8.5.10.3.1**

Analogue devices shall display black print on a white background identifying actual primary circuit values.

**8.5.10.3.2**

External zero adjustment shall be provided.

**8.5.10.3.3**

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

**8.5.10.3.4**

Analogue meters shall conform to IEC 60051-2.

**8.5.10.3.5**

Analogue meters shall have a selector switch and an off position.

**8.5.10.3.6**

Voltmeters shall be operated from the VT secondary windings.

**8.5.10.3.7**

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

**8.5.10.3.8**

Analogue ammeters shall have a maximum demand indicator where used for incomers and ACB outgoing feeders.

**8.5.10.3.9**

Analogue motor ammeters shall monitor single phase only.

**8.5.10.3.10**

Analogue motor ammeters shall be rated for motor starting currents.

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**8.5.10.3.11**

Analogue watt-meters and VAr meters shall be rated for three-phase unbalanced load in accordance with IEC 60051-3.

### 8.5.101 Description of the types of electrical connections of functional units

*Add to subclause*

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

*Add to subclause*

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

*Add new subclause*

### 8.5.102 Operation

**8.5.102.1**

The PSC-assemblies shall be rated for continuous operation at rated load for at least 90 000 h (10 years) without maintenance that requires de-energization of the busbars.

**8.5.102.2**

Functional units shall be designed for continuous operation at full load for at least 35 000 h (4 years) without maintenance.

## 8.6 Internal electrical circuits and connections

### 8.6.1 Main circuits

*Add to first paragraph*

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

*Add to subclause*

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

*Add to subclause*

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

*Add to subclause*

Where busbars are insulated, insulating materials shall be of a flame retardant type in accordance with the relevant part of IEC 60684, and non-hygroscopic and non-tracking.

*Add to subclause*

The insulation of the main busbar joints and to interconnecting busbar joints shall be removable and replaceable for inspection.

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### 8.6.2 Auxiliary circuits

*Add to subclause*

Earthed poles shall be connected via a removable link.

*Add to subclause*

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

*Add new subclause*

#### 8.6.2.101 Interface with supervisory systems

**8.6.2.101.1**

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

**8.6.2.101.2**

A healthy circuit condition shall be indicated by a closed circuit signal.

**8.6.2.101.3**

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

a) tripped on fault for each ACB;

b) protection / control supply failure for each bus section;

c) common trip alarm for each bus section of busbar, with all individual motor starter fault controls wired together;

d) trip circuit healthy alarm;

e) relay watchdog alarm.

### 8.6.5 Identification of the conductors of main and auxiliary circuits

*Add to subclause*

The identification of the conductors of main and auxiliary circuits shall be as per Table 20.

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*Add new Table 20*

**Table 20 – Identification of conductors**

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

*Add new subclause*

### 8.6.8 Neutral

**8.6.8.1**

For a TN-S system, each incoming circuit (downstream of the transformer) shall be provided with a removable link between the neutral and the PE bar at the PSC-assembly.

**8.6.8.2**

The removable link shall be removable without exposure to live parts.

*Add new subclause*

### 8.6.9 Earth bar

**8.6.9.1**

A hard-drawn high conductivity copper earth bar shall be incorporated.

**8.6.9.2**

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

**8.6.9.3**

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

**8.6.9.4**

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

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**8.7.1**

*Replace subclause with*

The PSC-assembly shall be naturally ventilated.

## 8.8 Terminals for external cables

*Replace fifth paragraph with*

Internal cable compartment width shall be in accordance with specified cable quantity and sizes and at least 400 mm.

*Add to fifth paragraph*

Space shall be provided in outgoing cable compartments for the use of a clip-on ampere meter.

*Add to fifth paragraph*

At least 300 mm free space shall be provided between the gland plate and internal equipment to facilitate cable installation and connection.

*Add to subclause*

In the absence of user defined field cable information, guidance shall be taken from IEC 61439-1, Table A.1 using the maximum cross-section values.

*Add to subclause*

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

*Add to subclause*

Terminals shall be provided for all spare cable cores.

*Add to subclause*

Power cable terminals shall be provided with phase separation screens.

*Add to subclause*

The largest incomers/feeders shall be located at the bottom of the PSC section with provision for direct entry and termination.

*Add to subclause*

Removable, undrilled gland plates shall be provided in each panel for glanding of power and control cables.

*Add to subclause*

When single core line conductors are specified, associated gland plates shall be of non-magnetic material.

*Add to subclause*

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

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*Add new subclause*

### 8.8.101 Terminals for control and auxiliaries

**8.8.101.1**

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

**8.8.101.2**

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

**8.8.101.3**

Not more than one wire shall be inserted into a single terminal.

**8.8.101.4**

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

**8.8.101.5**

Terminal blocks shall be grouped by function and operating voltage.

**8.8.101.6**

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

**8.8.101.7**

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

**8.8.101.8**

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

**8.8.101.9**

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

**8.8.101.10**

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

**8.8.101.11**

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

**8.8.101.12**

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

**8.8.101.13**

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

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### 8.101 Internal separation of PSC-assemblies

*Add to subclause*

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

*Add new subclause*

### 8.102 Provision for future development

#### 8.102.1

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

#### 8.102.2

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

#### 8.102.3

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

## 9 Performance requirements

### 9.3 Short-circuit protection and short-circuit withstand strength

#### 9.3.1 General

*Add to subclause*

When required, internal arc fault mitigation system (IAMS) shall be provided and integrated into the PSC-assembly in accordance with IEC/TS 63107.

*Add to subclause*

Internal arc tests shall be for a rated three-phase arc fault current (IA) value at least that of the specified short-time withstand current (Ik) for at least an arc fault duration of 0,5 s.

#### 9.3.4 Co-ordination of protective devices

*Replace third paragraph with*

Series rated (combination rated) switching devices shall not be used.

## 11 Routine verification

*Add new subclause*

### 11.101 ECMS simulation test

#### 11.101.1

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

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**11.101.2**

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

**11.101.3**

The tests shall be carried out in accordance with the tools and support proposed by the ECMS provider.

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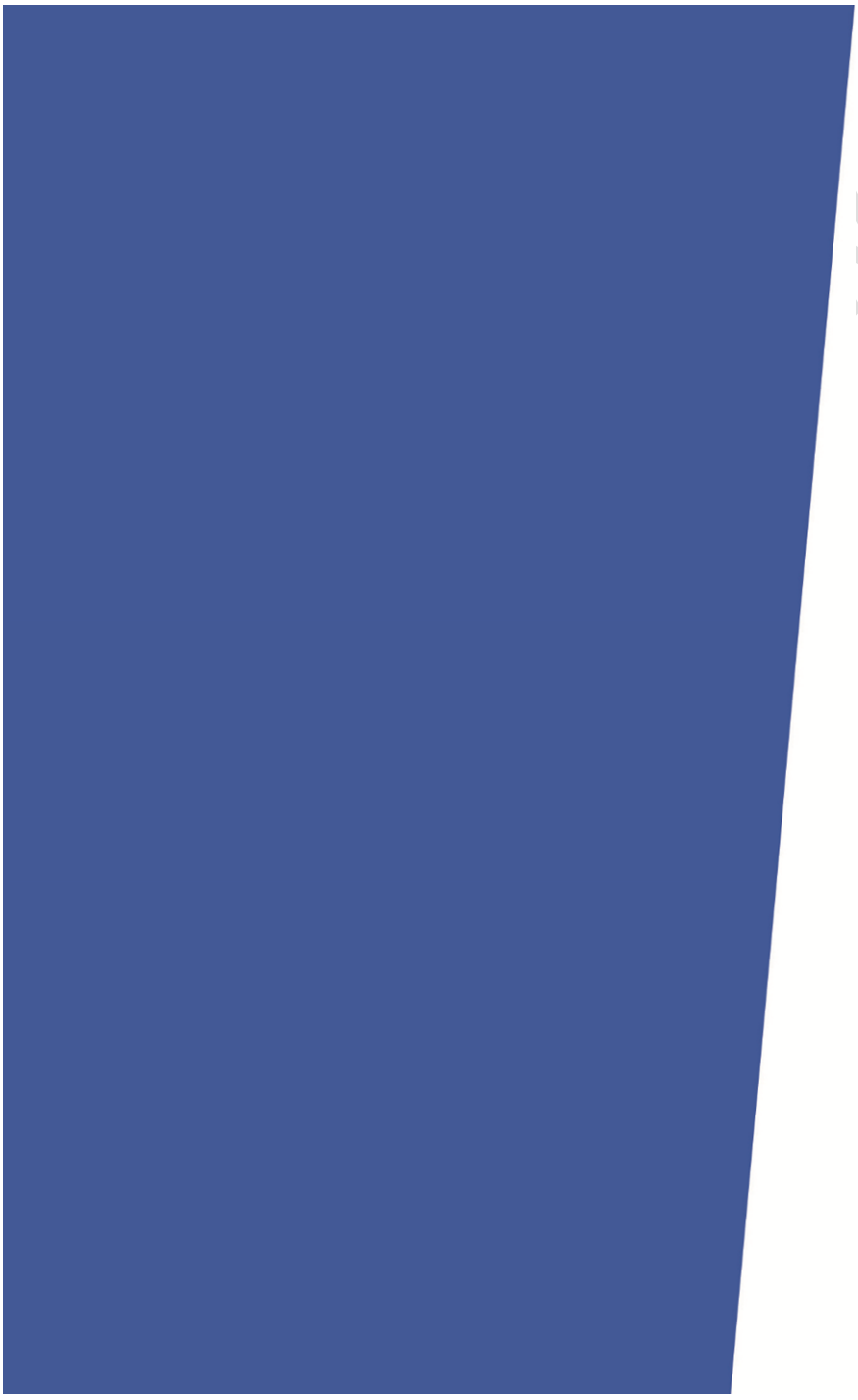
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