DEP SPECIFICATION

HIGH-VOLTAGE SWITCHGEAR AND CONTROL GEAR ASSEMBLIES FOR RATED VOLTAGES BETWEEN 1 kV AND 52 kV (AMENDMENTS/SUPPLEMENTS TO IEC 62271-200)

DEP 33.67.51.31-Gen.

February 2014

DESIGN AND ENGINEERING PRACTICE

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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for high-voltage switchgear and controlgear assemblies for rated voltages between 1 kV and 52 kV in onshore and fixed offshore applications.

Part III of this DEP amends and supplements IEC 62271-200:2003. The additional requirements in this DEP are needed in order to:

a. Make selections from the options given in IEC 62271-200;

b. Specify additional and more stringent requirements, as necessary, for operating and maintaining the gear in continuously operating plants,

c. Specify supplementary provisions required to make the gear suitable for operation in the overall process control design.

NOTE: HV switchgear in the range from 1 to 52 kV is often referred to as Medium Voltage (MV) switchgear.

This is a revision of the DEP of the same number, dated February 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable supply/marketing installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the number of the referenced section or clause number is shown in brackets ( ). Other documents referenced by this DEP are listed in (Part IV).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a minor revision of the DEP of the same number dated February 2012. The following are the main, non-editorial changes.

Section/Clause	Change
5.117	Vacuum switching and <600A the circuit use is irrelevant.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the “Give feedback” link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sww.shell.com/standards. Select “Submit DEP Feedback”, fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com.

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DATA SHEET

Use requisition DEP 33.67.51.93-Gen. with this DEP.

NOTE DEP 33.67.51.80-Gen. (“Schedule for HV switchgear and controlgear assemblies”) is normally attached to the requisition.

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PART II GENERAL

Part III of this DEP is written as amendments and supplements to IEC 62271-200:2003. Wherever reference is made to IEC 62271-200, it shall be understood to mean IEC 62271-200 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of IEC 62271-200 has been used throughout Part III of this DEP.

Clauses in IEC 62271-200, which are not mentioned in this DEP, shall remain valid as written.

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PART III AMENDMENTS/SUPPLEMENTS TO IEC 62271-200:2003

2 NORMAL AND SPECIAL SERVICE CONDITIONS

Add the following clauses:

2.1 NORMAL SERVICE CONDITIONS

2.1.1 Indoor switchgear and controlgear

The atmospheric conditions inside the switch houses shall normally be in accordance with IEC 62271-200.

Where allowance has to be made for the entry of dust, salt and sulphur contaminated air when doors are open, or when cable entrances through the floor are uncovered during maintenance and construction periods, then this shall be identified on the requisition. The Principal shall approve the allowances made to militate against more aggressive atmospheric conditions.

Depending on the area where the switchgear will be installed, condensation inside the switchgear may occur. Proper measures, e.g. by installing sufficiently rated panel heaters, especially for air-insulated switchgear, shall be considered. The quotation shall indicate where allowance has been made for panel heaters.

For offshore applications the switchboard will be installed indoors and shall be suitable for operation in an environment where the relative humidity may reach 98 %.

2.1.2 Outdoor switchgear and controlgear

This DEP is in principle applicable to HV switchgear assemblies installed indoors. The Principal will advise the specific conditions where installation outdoors is specified.

NOTE: The air may be laden with dust, salt or sulphur as encountered in the petrochemical industry or in oil fields. Condensation as a result of high humidity shall also be considered.

2.2 SPECIAL SERVICE CONDITIONS

The requisition will specify any special service condition that the switchgear may be required to withstand in its operational location and that may arise during transport, storage and erection, e.g. pollution, temperature and humidity, shock and vibration.

Unless otherwise specified, the switchboard shall be suitable for installation in a non-hazardous area as defined in IEC 60079-10.

3 TERMS AND DEFINITIONS

Add to this clause:

3.1 GENERAL DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal/Purchaser** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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The **requisition** is DEP 33.67.51.93-Gen., requisition for HV switchgear and controlgear assemblies.

NOTE DEP 33.67.51.80-Gen. ("Schedule for HV switchgear and controlgear assemblies") is normally attached to the requisition.

3.2 ADDITIONAL TECHNICAL DEFINITIONS

- **Buscoupler**

A mechanical switching device to connect the two busbar systems of a double busbar arrangement.

- **Panel**

A constructional unit of an assembly between two successive vertical delineations.

- **Restarting relay (RR)**

A relay to initiate the re-closure of a motor circuit under predetermined conditions, after a voltage depression or interruption.

- **Section**

  A constructional unit consisting of a number of panels connected to a continuous busbar system.

- **Sectionalizing switch**

A mechanical switching device to connect the busbar systems of two sections.

- **Trip Circuit Supervision (TCS)**

  A healthy trip indicator provided on all units with electrical tripping. Any loss of trip supply or broken wire in the trip circuit shall operate an alarm relay with contacts wired up for a remote alarm provision.

- **Time delayed restarting relay (TMR)**

  A time delayed relay to initiate a delayed re-closure of a motor circuit, controlled by the process control system, under predetermined conditions, after a voltage depression or interruption.

4 RATINGS

4.1 RATED VOLTAGE (U_r)

Add to this clause:

The nominal voltage will be stated on the requisition including information on the system earthing, e.g. isolated, earthed via neutral earth resistor, or solidly earthed. Based on this, the Manufacturer shall select the applicable rated voltage in accordance with IEC 62271-1.

Maximum variations of both voltage and frequency can occur simultaneously. Temporary voltage depressions down to 80 % rated system voltage shall not affect switchgear and controlgear operations.

Switchboards to be installed offshore shall be suitable for continuous operation from a supply which is subject to voltage waveform distortion caused by thyristor-controlled loads. In the absence of any other data a figure for Total Harmonic Distortion of 8 % shall be used.

4.3 RATED FREQUENCY (f_r)

Add to this clause:

The rated frequency may be 50 Hz or 60 Hz and shall be stated on the requisition. Frequency variations between plus and minus 2 % shall be acceptable.

4.4.1 Rated normal current (I_r)

Add to this clause:

The rated normal current shall be as indicated on the requisition. Ratings shall be quoted on the basis of circuit-breakers and contactors being housed in cubicles under natural

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ventilation conditions. The use of cooling fans within the switchboard enclosure shall not be acceptable where a nominal current capacity less than or equal to 2500A.

The Manufacturer may propose to install assisted cooling in cases where a nominal current capacity greater than 2500A is specified, but this shall require specific approval by the Principal.

The current rating of the incoming feeder, sectionaliser and buscoupler switches shall be the same. The main busbar systems shall be fully current rated over the entire length of the switchgear and shall not be rated lower than the current rating of the incoming feeder, sectionaliser and buscoupler switches.

The rating of switchgear and controlgear assemblies shall take full account of all heat sources within the compartment including their make-and-break duties.

5 DESIGN AND CONSTRUCTION

Add to this clause:

Switchgear and controlgear shall be designed to minimize any risk of short circuits and to ensure personnel and operational safety during all operating conditions, inspections and maintenance.

Air Insulated Switchgear (AIS) shall be designed for continuous operation at full load for at least 7 years without maintenance that would require the circuit or busbar system to be de-energized. Gas Insulated Switchgear (GIS) shall be designed for continuous operation at full load for at least 10 years without maintenance, unless the total number of allowed switching operations is exceeded.

The assemblies shall have a design lifetime of at least 25 years, under the service conditions specified and maintained according to the Manufacturer's recommendation. The anticipated lifetime of electronic components, e.g. protection and control devices, shall also satisfy this requirement. If earlier replacement is to be expected, the Manufacturer shall clearly indicate this in his quotation.

Equipping and commissioning of spare panels and the connecting of main, control and auxiliary cabling shall be possible whilst the switchgear is live and in operation.

AIS and controlgear shall be of the withdrawable type and GIS shall be of the non-withdrawable type both having either a single or double busbar system, and consist of a number of separate panels assembled into one or more sections.

A sectionalising switching device shall electrically interconnect sections for single busbar systems.

Double busbar systems shall have facilities for each section to be electrically coupled by a buscoupler. The busbar systems shall be fully segregated, making it possible to work on and extend one system safely when the other system is energized.

Isolating mechanisms and unit withdrawal facilities, where fitted, shall be suitable for operation by a single operator and designed for minimum effort and time of operation.

Facilities for extension of the gear shall be provided at both ends.

The layout of the operational front and the location of the components of the assembly shall be arranged in a logical and systematic sequence and standardized throughout. No operational equipment or metering apparatus shall be located at levels below 200 mm and above 2000 mm. When the latter is not possible due to space constraints, details of the equipment to be installed above 2000 mm shall be given in the quotation together with proposals for any platforms or steps needed to provide adequate access to view or operate the equipment.

Alphanumeric notation, generally in accordance with IEC 60445 shall be used for identification and marking of phases, conductors and terminals.

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For panel arrangements and schematics refer to standard drawings series S 67 as listed in (Part IV).

Korndorfer motor-starter units (incorporating transformer, neutral and transformer shorting circuit-breakers) for offshore applications shall be designed as separate freestanding units, similar in construction to the switchboard. Transformers shall be housed in an enclosure of minimum rating IP 32.

When a switchboard is an assembly of panels from different Manufacturers, the requisition shall clearly state who will be responsible for the complete assembly and for the supply of any required adaptation panel. The adaptation panel shall be constructed so that the requirement for short circuit and internal arc withstand capacity as applicable for the switchgear is satisfied.

5.1 REQUIREMENTS FOR LIQUIDS IN SWITCHGEAR AND CONTROLGEAR

Add to this clause:

Liquids shall only be applied as switching or insulation medium under special circumstances and after approval by the Principal.

5.2 REQUIREMENTS FOR GASES IN SWITCHGEAR AND CONTROLGEAR

Add to this clause:

SF6 gas shall be used as insulation medium. Gas used as insulation medium shall be fully segregated from any gas used for switching medium. Gases other than air may be used as switching medium after approval by the Principal.

The Manufacturer shall confirm in his quotation the criteria for acceptance of the Principal's requirements for environmentally friendly waste disposal of SF6 (polluted) waste throughout and at the end of the life expectancy of the switchgear.

5.3 EARTHING

Add to this clause:

Earthing switches shall have an electrical endurance class E1 according to 4.107 of IEC 62271-102 with respect to their capabilities of making and carrying the prospective short circuit current.

5.3.1 Earthing of the main circuit

Add to this sub-clause:

Clear pictorial instructions, supported by textual explanations, shall be installed showing the procedure for earthing.

The Manufacturer shall state, at the tender stage, the means by which busbars and feeder circuits can be "proved dead" prior to earthing.

A capacitive three-phase voltage indicator system shall be installed, indicating presence of voltage on all outgoing feeders and incomers on the front panel and all sections of the busbar system on the front of the sectionaliser/buscoupler panel(s). Lifetime of a continuously energised indication shall be a minimum of 25 years.

Indicators shall be of type which permits connection of a phasing out instrument to the indicators. Supply of the phasing out instrument suitable for use with the indicators fitted shall be offered as an option in the quotation.

Indicators shall also be fitted such that they can be viewed before attempting opening of enclosures or other actions needed to access outgoing or incoming cable terminations. This may require indicators to be visible from rear or in the cable cellar depending on the specific cabling arrangements. For front access only arrangements no additional indicators are required.

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Add for AIS:

An integrally mounted three phase earthing switch suitable for local manual operation shall be provided on the cable side of all HV switching devices.

Earthing facilities for the earthing of the busbar system of each section shall also be provided. This shall be arranged via the incoming HV switching devices or alternatively by a withdrawable earthing device capable of making and carrying the prospective short circuit current. The Manufacturer shall separately quote for one or more withdrawable earthing devices when applicable. Other type of busbar earthing facilities shall be subject to Principal's approval.

Circuit earthing devices shall be arranged for local manual operation only. Earthing devices for motor starters may be automatically or manually applied when the starter is withdrawn.

When an earthing device has been fitted in a compartment, it shall not be possible to insert a withdrawable switching device into the service position of the compartment concerned.

Add for GIS:

An integrated three-position isolator, with busbar connected/isolated/earthed positions, shall be provided. A circuit or busbar earth shall only be applied via the HV switching device.

Unless otherwise specified in the requisition the busbar earthing system shall be integrated with the sectionaliser HV switching device.

Circuit and busbar earthing devices shall be normally arranged for local manual operation only. Suitable interlocks shall be fitted to prevent accidental earthing of a live busbar, refer to [5.11].

5.3.2 Earthing of the enclosure

Add to this sub-clause:

For direct connection to the station-earthing grid, earthing bolts of at least M12 shall be provided at both ends of the main earth bar.

5.4 AUXILIARY AND CONTROL EQUIPMENT

Add new sub-clauses:

5.4.100 Secondary wiring and terminals

Secondary wiring shall not be mounted direct to metal.

The wiring support methods used shall prevent damage to the wiring and shall allow changes to be made to the wiring in the future without excessive difficulty.

The approved method is to accommodate and support the wiring using covered plastic channels, insulated tubes or plastic strips. The filling factor for channels and tubes shall not exceed 70 %.

Alternative wiring support methods may be used but they shall be subject to specific approval by the Principal.

Internal wiring between panels shall be adequately protected against mechanical damage by e.g. rubber grommets. Wiring passing through HV compartments shall be installed in conduit or trunking to facilitate the replacement of the wiring without the need to de-energise the HV compartment.

The minimum cross section for wiring of current transformer secondary circuits shall be 2.5 mm^2.

For bus wiring and outgoing control circuits, individual terminals shall be provided for each external conductor. These terminals shall be of the non-loosening, wedge or cage type construction, obviating the use of cable lugs and constructed in such a way that direct contact between screw, bolt or nut and conductor is avoided.

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NOTE For the termination of internal secondary wiring, push-on connections with insulation support of the compression type may be used.

Wiring of equipment on doors shall be arranged so that the wiring cannot be trapped by door movement.

Control circuits deriving power from bus-wiring through the switchboard shall have a dedicated overcurrent protection per functional unit (located in the functional unit concerned).

Circuits and terminals operating at different voltages and/or performing different functions shall be adequately segregated, or barriers fitted.

All secondary wiring between the isolated and withdrawn switching device truck and the enclosure shall consist of an umbilical cord with plug and socket connector.

Wiring and terminals shall be identified in accordance with the related wiring diagrams.

For spare panel philosophy reference is made to (5.111)

5.4.101 Arrangement of power supply for protection relays

As the integrity of the power supply to protective relays is of paramount importance to plant safety, the design of any protective scheme shall ensure that the risk of damage to the power supply cabling or of power system failure shall be minimised.

The power supply from the DC (preferred 110V) distribution board shall be routed to protection relays and trip coils via bus wiring between each associated relay and control panel. The protection relay supply buses shall end at the terminals of the DC supply supervision relay. This arrangement ensures 100 % coverage of auxiliary supply wiring for supervision.

The auxiliary power supply wiring inside the relay and control panel shall be made by connecting all the equipment supply terminals in parallel, thus forming positive and negative supply rails with as many connection points as required by the number of circuits. No looping of the power supply shall be made from one relay to another nor shall supply to output relays contacts be looped from relay auxiliary supply (a dedicated feed from the supply distribution rail within the panel shall be provided).

Where two breaker trip coils are fitted then they shall be wired to two supplies drawn from two separate DC buses. The associated main and back-up protection equipment shall also be supplied from the same two DC buses. Each DC supply bus shall be independently supervised by a supply supervision relay.

External wiring systems for numerical relays that exit the substation building shall be designed so that electromagnetic interference does not adversely affect the operation of the protection devices. This is principally a concern where route length exceeds 50m.

This shall be achieved by:

Either

Utilising a secure auxiliary DC supply via interposing relays to provide digital inputs to these sensitive devices ensuring that the independent DC bus voltage does not exit the substation. In addition the operating time of the protective device shall take account of the additional time required for the operation of these interposing relays (20 ms).

Or

Using shielded twisted pair cables located in trenches, or routed above ground on tray or ladder work, which are separated from HV power cables or secondary side LV transformer cables by minimum of 1 m.

Using two wires per switching circuit to avoid creation of unbalanced pairs

Applying a time delay filter of a minimum of 20 ms to all digital inputs

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Add new sub-clause:

5.4.200 Auxiliary contacts

Auxiliary and control circuit connections on withdrawable switching devices shall be made either with self-aligning plug and socket contacts or with a multi-conductor cable with plug and socket arrangement.

In order to allow connections to remote alarm and indicating devices, each HV switching device (8) shall at least be provided with 2 sets of potential-free, free auxiliary contacts of class 2 according IEC 62271-1, directly operated by the operating mechanism. One set shall be normally open and one set normally closed.

The contacts shall be wired up to the terminal blocks in the LV control compartment.

5.10 NAME PLATES

Add to this clause:

Name, identification, instruction and warning plates and their fixing materials shall be of durable, corrosion resistant material. They shall be provided with indelible inscriptions in the language as specified on the requisition. Plates mounted on the outside of the equipment shall be fixed by means of durable self-threading screws or pop rivets or alternatively affixed by a high performance adhesive, type 3M 7872 and 3M 7871, or equivalent.

Add new following rows on Table 1 – Nameplate information

	Abbreviation	Unit	**	Condition: Marking only required if
Principal's purchase order number			X	
Principal's switchboard title and TAG number	SWB TAG No.		X	
Rated voltage of auxiliary circuits		V	X	
Degree of protection	IP		X	

(**) X = the marking of these values is mandatory.

All withdrawable units shall be fitted with a rating plate providing the following information:

a. Manufacturer's name and/or trade mark;

b. Type designation and serial number;

c. Rated nominal current;

d. Rated voltage;

e. Year of manufacture;

f. Number of relevant standard(s).

All equipment which can be removed for maintenance or replacement shall have identification labels on the equipment itself and on the mounting plate surface.

5.11 INTERLOCKING DEVICES

Add to this clause:

Interlocks shall be provided to prevent applying busbar earthing with any incoming feeder in the service position; back feeding via cable and/or transformer feeders or voltage transformers shall also be taken into account.

For a double busbar system "busbar transfer without current interruption" is required. It is acceptable for such a transfer to require the bus coupler to be closed first / opened last.

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Where this requirement results in two circuit breakers per feeder, the requirement for busbar transfer without current interruption may be waived by specific approval from Principal.

Add to sub-clause

a) Metal-enclosed switchgear and controlgear with removable parts:

The operation of the earthing switch shall be mechanically interlocked, allowing closure of the earthing switch only when the HV switching device is not in the service position.

Padlocking facilities, suitable for padlocks with 8 mm hasp diameter minimum, shall be provided for locking the earthing device in the open and closed position.

Add to sub-clause

b) Metal-enclosed switchgear and controlgear provided with disconnectors:

The three-position isolator switch shall be interlocked to prevent operation when the HV switching device is in the closed position.

Padlocking facilities, suitable for padlocks with 8 mm hasp diameter minimum, shall be provided for locking the three-position isolator in the isolated or earthed position.

Padlocking facilities, suitable for padlocks with 8 mm hasp diameter minimum, shall be provided for locking the HV switching device electrically and mechanically in the closed position when the three-position isolator is in the earthed position.

Padlocking facilities, suitable for padlocks of 8 mm hasp diameter minimum, shall be provided on all circuit-breakers in the “OFF” position.

5.12 POSITION INDICATION

Add to this clause:

On the front of each functional unit a clearly visible positive indication of all switching devices shall be provided representing their actual contact position.

Earthing devices shall be equipped with a mechanically operated positive indication, which shall also be clearly visible without removal or opening of panel doors or covers.

In both cases an indication of the isolated or closed position shall only occur when the specified position has been attained in each pole of the switch or circuit breaker.

5.13 DEGREE OF PROTECTION BY ENCLOSURES

Add to this clause:

For switchgear in normal service conditions the degree of protection of the enclosure shall be at least IP 3XD as specified in IEC 60529. The floor of the switch house shall not be considered to be part of the enclosure.

The top of the switchgear shall be sealed to such an extent that the ingress of small quantities of vertically dripping water is prevented. It is recognised this requirement may be in conflict with design features to vent gasses in event of an internal arc fault. The Manufacturer shall make clear in his quotation the implications of complying with this requirement for the design of switchgear offered e.g. requirement to fit a duct to route internal arc fault gasses to outside the substation.

The degree of protection for the shutters and the partitions between compartments shall be at least IP 3X as specified in IEC 60529, which shall be maintained under all operational conditions. A reduction to degree of protection IP2X is permitted if shutters are mounted such that access close to shutters is not required during normal operation of the switchgear. Normal operation shall include padlocking of the shutters.

The degree of protection between panels shall be at least IP 3X as specified in IEC 60529, which shall be maintained under all operational conditions.

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For switchgear where more adverse service conditions are specified (see [2.1.1]) a higher degree of protection (IP4X) may be specified on the requisition.

Through wiring solely between the LV compartment of different panels shall have a degree of protection of at least IP 3X as specified in IEC 60529.

LV compartments shall be easily accessible and, when opened, shall offer a degree of protection of at least IP 2X as specified in IEC 60529 towards any live part inside the compartment and on the door.

If anti-condensation heating is required inside the assembly, it shall be supplied from a separate LV source connected between system phase and neutral. The heating system of each section shall be separately protected and switched for isolation purposes by means of a miniature circuit breaker in combination with an earth leakage protecting device of 30 mA, which shall have a separate contact wired up to terminals to provide a remote alarm. When the heating system is live, this shall be indicated by means of a prominently situated red LED.

NOTES: 1 Adaptor panels shall be taken into account when defining anti condensation heating requirements.

2 Busbar compartments of a section do not need to have partitions between the individual panels.

Add for AIS:

Busbar compartments of different sections of the switchboard as well as the different sides of the sectionaliser shall have partitions with a degree of protection of at least IP 3XD as specified in IEC 60529

In addition for GIS:

Reference is made to [5.102.2]

5.15 GAS AND VACUUM TIGHTNESS

Add to this clause:

The relative leakage rate F_{rel} , as specified in IEC 62271-1 shall be less than 1 % per year. The time between replenishments (T) as specified in IEC 62271-1 shall be at least 10 years.

Type test reports as specified in IEC 62271-1 regarding tightness of gas filled compartments shall be available in the quotation stage.

For gas-filled compartments where the minimum functional level exceeds 100 kPa (relative pressure), a pressure indication gauge with clearly visible pointer and a low-pressure alarm contact shall be provided. The low-pressure alarm contact shall be set halfway between normal operating pressure and the minimum functional level (refer to [3.120]).

5.18 ELECTRO MAGNETIC COMPATIBILITY (EMC)

5.18.1 Installation requirements for protection relays

In general, the rules for design and installation in accordance with IEC TR 61000-5-1 and IEC TR 61000-5-2 shall be followed in order to achieve an Industrial level EM environment (as described in IEC TR 61000-2-5 – see also IEC 61000-6-2) inside low voltage compartments where protective relays or other instruments are located.

More specifically, the following installation requirements apply:

- Protection relays shall be installed in metallic, shielded cabinets or cubicles. Equipment enclosure shall be bonded to the conductive surface of the cabinet or cubicle. In case of separate relays and door displays/terminals, wiring between these elements shall be shielded. For relays with non-conductive cases, the external earth connection for grounding of the relays's internal metal work shall be connected to the conductive surface of the cabinet or cubicle.
- All cables to equipment inside HV switchgear cubicles shall be shielded. The shield shall have low transfer impedance properties and be bonded at both ends at the HV

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cubicle and the secondary cubicle or cabinet, using short, low impedance connections such as cable clamps or cable glands.

- Differential mode circuits shall be kept compact by installing lead wires and their return wires in the same cable loom or cable trunking.
- All solenoids of relays, contactors or circuit breakers shall have adequate de-coupling devices to suppress high frequency interference to electronic protection relays.
- The cable armouring and conductive sheathing of HV cables shall be continued to and be terminated at the HV cubicle in accordance with the Manufacturer/Supplier's installation instructions. Additional bonding to the substation earth bar/ring may be applied to reduce the impedance for power frequency return currents in the event of an earth fault.
- The armouring and/or shielding of external secondary cables shall be continued and terminated at the secondary cubicles or cabinets, using low impedance connections such as cable clamps or cable glands.

All metallic cases for relays, instruments and meters shall be connected to an earth bar by means of cable of not less than 2.5 mm^2 cross-section. Reliance shall not be placed solely on the physical contact of the case to the panel.

5.101 INTERNAL FAULT

Add to this clause:

The switchgear shall be qualified as classification IAC according to IEC 62271-200 with regard to its mechanical strength in the event of an internal arc. The test performance shall be in conformity with accessibility type AFLR.

The test shall be executed for all separate compartments within the functional unit containing HV equipment, i.e. busbar compartment, circuit breaker/contactor compartment and cable compartment.

Type test reports regarding internal arc withstand performance shall be available in the quotation stage.

Add for AIS and GIS:

All assemblies shall be type-tested at their rated short circuit current, preferably with an arc withstand duration of 1s.

Where internal arc test withstand time is less than the short circuit withstand time of the busbars then manufacturer's proposal must clearly state that the protection responding to internal arcs must be arranged to operate before the tested internal arc withstand time is exceeded.

Manufacturer shall offer as an option, his proposals to meet this condition if the original enquiry does not incorporate protection capable of meeting this requirement without compromising discrimination with incoming or outgoing circuits.

Where the manufacturer's proposal includes detection of an arc and provision of a trip signal to the upstream or supplying circuit breaker then additional trip signal cable requirement shall be clearly stated in manufacturer's offer.

5.102 ENCLOSURES

5.102.1 General

Add to this sub-clause:

Enclosures shall be free standing and self-supporting. If a base frame is required this shall be indicated on the requisition. The floor shall not be considered as being part of the enclosure.

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All components requiring periodic maintenance shall be easily accessible.

Cable installation work on functional units (replacements or new installations) and equipping of spare panels shall be safely possible without adjacent units having to be de-energised.

The Loss of Service Continuity category (LSC) of AIS switchgear shall be LSC2B according to IEC 62271-200.

All structures, sheeting and other metal parts shall be adequately protected against corrosion. Frame and partitions may be of galvanised steel without further paint coating. Those parts/covers requiring painting shall be properly pre-treated before the final coat(s) of oil resistant finishing paint is applied. Manufacturer's standard colour is acceptable. If a Manufacturer does not have a standard colour, light grey is preferred for external surfaces.

5.102.2 Covers and doors

Add to this sub-clause:

The following categories of covers or doors shall be fitted according to the type of accessible compartments they provide access to:

For AIS:

Busbar compartment : Tool-based accessible compartment.

Main Device Compartment	: Interlock-controlled accessible compartment.
Cable Compartment	: Tool-based accessible compartment.
Current Transformer Compartment	: Tool-based accessible compartment.
Voltage Transformer Compartment	: Tool-based accessible compartment.
Cable/Current Transformer Compartment	: Tool-based accessible compartment.
Low Voltage / Control Compartment	: Procedure-based accessible compartment.
Other Compartments	: To be categorised in the requisition.

Busbar compartments of different sections of the switchboard as well as the different sides of the sectionaliser shall have separate doors or covers.

For GIS:

Busbar compartment	: Tool-based accessible compartment*.
Main Device Compartment	: Tool-based accessible compartment*.
Cable Compartment	: Tool-based accessible compartment.
Current Transformer Compartment	: Tool-based accessible compartment*.
Voltage Transformer Compartment	: Tool-based accessible compartment*.
Cable/Current Transformer Compartment	: Tool-based accessible compartment.
Low Voltage / Control Compartment	: Procedure-based accessible compartment.
Other Compartments	: To be categorised in the requisition.

* = For bolted configuration only. Alternatively, a non-accessible compartment (e.g. completely welded GIS tank) can be applied.

Busbars of different sections of the switchboard as well as the different sides of the sectionaliser/buscoupler shall be located in different compartments having separate doors or covers.

5.103 COMPARTMENTS

5.103.2.2 Design

Add to this sub-clause:

Pressure relief that relies on allowing the arc to burn through the enclosure at designated points shall not be used.

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