110 / 220 / 400 kV Gas Insulated Switchgear (GIS) Connected to the Transmission System

XDS-GFS-25-001-R5

April 2025

EirGrid

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	Revision History				
Revision	**Date**	**Description**	**Originator**	**Checker**	**Approver**
R0	31/08/2011	First Issue – This document supersedes XDS-WTS-00-031-R0. This functional spec covers 110 kV, 220 kV and 400 kV. Sections 2, 3, 4.2.2, 4.2.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 6, 7, 8, 9, 10, 12, 16 and 18 updated	Paul Moran	-	Christy Kelleher
R1	01/05/2014	Section 4.2.3 updated	Sandra Howard	-	Paul Moran
R2	25/05/2015	Sections 4.13, 4.2.1, 4.5, 12.1 & 12.2 updated	Kieran French	-	Paul Moran
R3	27/10/2016	Updated as per Due Diligence Tracker	Kieran French	-	Paul Moran
R4	21/01/2019	Detail of changes logged in due diligence tracker. Significant Changes to entire document.	Conor Farrell / Pat Daly	-	Brendan Murray
R5	8th March 2025	Format updated to new EG Format Earthing Section updated including description of Sheath Voltage Limiters for protection against VFTO's/ETV's Changes made due to new EU regulation 2024/573 on Fluorinated Gases Requirement for non SF6 GIS for 110 kV GIS added Updated to take into account ESB Specs -18271 R1 "Specification for SF_6 Quality, Testing and Handling for ESB Assets" -16690 Part 2 Rev 4 "110 kV SF_6 Gas Insulated Switchgear (GIS) – Technical Requirements" (April 2020) Corresponding Technical Schedule update to XDS-GTS-25-001-R5 (400kV added to form single schedule for 110kV, 220kV and 400kV) Substantial updates relating to SF6 gas handling, monitoring; ventilation, gas partitions control to circuit breaker motors changed to DC only. Labelling section removed – now refers to new labelling standard Update to instrument transformers – now refers to XDS-GFS-35-001.	Niall McMahon	Daniele Giustini EirGrid – TPSP EirGrid System Integrity ESB – Due Diligence	Neil Cowap

1 Introduction

This functional specification, together with the accompanying technical schedules, defines requirements for 110 kV, 220 kV and 400 kV Gas Insulated Switchgear for use on and connection to the transmission system[1].

In addition to the requirements of this specification, the equipment shall comply with:

EirGrid Functional Specification XDS-GFS-00-001 "110/220/400 kV Substation General Requirements", and other applicable EirGrid requirements including but not limited to those listed in section 4.2.

Project specific requirements including the project functional specification, project protection specification and single line diagram.

In case of conflict with international or national standards, EirGrid specifications shall take precedence.

For the purposes of this specification the "Customer" is the point of contact to EirGrid for the supply of the equipment, it could be an OEM, ESBN, the contestable project owner or the contestable project design representative.

1.1 Updates Due to EU Directive 2024/573

Fluorinated gases ('F-gases') are man-made greenhouse gases used in various products and appliances (e.g. fridges, air-conditioning units). Their emissions contribute to climate warming. EU Regulations enforces rules to reduce F-gas emissions significantly. Fluorinated greenhouse gases (F-gases) are used in numerous applications and include three types of gases: HFCs, PFCs and SF6. (Fluorinated Gases: Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6) are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes).

The F-gas legislation includes measures to manage and control use of F-gases such as recording and reporting use, volumes imported/exported, containment during handling and recovery/recycling at end of life, training and certification, labelling, leak checks and leakage detection systems, and bans on some uses.

The F-gas Regulation - Article 13 (Item 9): F-gas shall be restricted in the use of switchgear as follows:

Figure 1 EU F-Gas Regulation (2024/573)

[1] All references to Technical Schedules within this document refer to XDS-GTS-25-001 "Technical Schedules for Gas Insulated Switchgear". The Customer shall submit a completed set of Technical Schedules for EirGrid approval.

The GIS offered by the Contractor shall be in accordance with Article 13 of EU Directive 2024/573. In accordance with this article of the regulation, EirGrid shall apply the cascading principle (Table 1 provides a graphical representation of the cascading principles). The GIS offered by the Contractor shall be made applicable for the specific site of installation

Table 1 Insulating Gas requirements per voltage Level

Switchgear Voltage	Requirement
110 kV Switchgear	Unless approved by EirGrid, the insulating medium used shall be SF6 -free
220 and 400 kV Switchgear	This revision of the specification, EirGrid does not stipulate the use of SF6 -free switchgear at 220 kV and above

1.1.1 Putting Into Operation

With regards to GIS containing SF6 which is to be installed before the ban date as specified in the Regulation (EU) 2024/573, please note the following:

The term 'Putting into Operation' is central to a consideration of the relevant dates pursuant to Article 13.9 of the Regulation (EU) 2024/573. EirGrid interprets this term to be the moment of documented handover after the completion of any necessary tests of functionality, performance or other, and any required inspections identified by the OEM or other competent entity, whether completed by OEM, competent entity or EirGrid, prior to overall system integration.

Based on the above, for present purposes "Putting into Operation" of GIS shall be considered to be the

- Delivery
- Assembly
- Gas filling
- Operational and gas quality checks
- On-site HV testing - when required after assembly

The Contractor shall furnish to EirGrid a handover document verifying the above within three weeks of "Putting into operation" and before the relevant ban date.

Should EirGrid need to seek any derogation under Article 13, the Contractor shall furnish the EirGrid with the technical and project specific considerations confirming the need for the derogation, criteria to permit this derogation with reference to relevant section of Regulation (EU) 2024/573 or other supporting legislation.

1.1.2 Building Layout and Associated Drawings

Some EirGrid drawings indicating the layout or other views of GIS substation buildings are based on the use of SF6 switchgear and can only be applied to projects which will meet the deadlines as set out in reg (EU) 2024/573. See relevant drawings for additional information

1.1.3 Training

Special training will be required for ESB operation and maintenance of GIS based on gases other than SF6. Refer to Section 6.7.

2 Abbreviations

Abbreviation	Meaning		
BCU	Bay Control Unit		
CB	Circuit Breaker		
CE	European Conformity		
CIGRE	International Council for Large Electric Systems		
CO_2	Carbon Dioxide		
CT	Current Transformer	VT	Voltage Transformer
DRA	Design Risk Assessment		
EMC	Electromagnetic Compatibility		
EMI	Electromagnetic Interference		
EN	European Normalised Standard		
EPC	Engineer, Procure, Construct – International Federation of Consulting Engineers (FIDIC) definition		
ESBN	ESB Networks		
EU	European Union		
GIS	Gas Insulated Switchgear		
GWP	Global Warming Potential		
HV	High Voltage (above 1 kV per IEC 61936-1)		
ICP	Integrated Control and Protection		
IEC	International Electrotechnical Council		
IPP	Independent Power Producer		
LCC	Local Control Cabinet		
LOTO	Lock Out Tag Out		
MEWP	Mobile Elevated Work Platform		
MTS	Mixed Technology Switchgear		
NCC	National Control Centre		
OEM	Original Equipment Manufacturer		
PAPR	Powered Air Purifying Respirator		
PD	Partial Discharge		
PPE	Personal Protective Equipment		
PPE	Personnel Protective Equipment		
RCC	Regional Control Centre		
REACH	Registration, Evaluation, Authorisation, and Restriction of Chemicals		
RTU	Remote Terminal Unit		
SCS	Station Control System		
SF_6	Sulphur Hexafluoride gas		
SLD	Single Line Diagram		
SVL	Sheath Voltage Limiter		
SWL	Safe Working Load		
TAO	Transmission Asset Owner (ESB)		
TEV	Transient Enclosure Voltage		
UK	United Kingdom		
VFTO	Very Fast Transient Voltage		

3 Network Parameters

The equipment shall be suitable for installation on the Irish Transmission system.

The GIS technical parameters are further detailed in the GIS Technical Schedules XDS-GTS-25-001.

The Customer shall submit fully completed and signed set of technical schedules for EirGrid review in advance of equipment order.

3.1 AC short-circuit breaking current

The design parameters are specified in EirGrid's 110/ General Requirements functional specification XDS-GFS-00-001 and the project specific Single Line Diagram and protection specification.

3.2 DC time constant of the rated short-circuit breaking current

As outlined in IEC 62271-100, there could be instances where standard value DC time constants are inadequate and special case DC time constants may be required.

The standard DC time constants for 110 kV Circuit breakers are

- 45 ms for 40 kA
- 135 ms for 31.5 kA

In certain designated stations on the transmission system (for example Dublin where there is a high X/R ratio), circuit breakers and current transformers shall be designed to accommodate DC time constants in excess of 45 ms.

The Customer shall clarify with the EirGrid project team if a special case DC time constant (X/R ratio) above 45 ms is applicable for the respective project.

The Customer shall provide evidence that the selected circuit breaker and current transformers meet both the AC and DC short circuit current requirements for make and break duty.

4 Legislation, Codes and Standards

4.1 Legislation

Equipment offered shall be compliant with the provisions of the latest applicable versions of all relevant Irish legislation, EU regulations and EU directives.

These include the following or latest versions/ amendments at time of issue of this specification as appropriate:

SI No. 132	Safety signs regulations 1995
SI No. 291	Safety, Health and Welfare at Work (Construction) Regulations
SI No. 299	Safety, Health and Welfare at Work (General Application) Regulations 2007
SI No. 445	Safety, Health and Welfare at Work (General Application) (Amendment) Reg. 2012
Reg (EC) No 1907/2006	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
Reg (EC) No 1272/2008	Classification, Labelling and Packaging of Substances and Mixtures
Reg (EU) 2015/2068	Format of labels for products and equipment containing fluorinated greenhouse gases
Reg (EU) 2015/2065	Format for notification of the training and certification programmes of the Member States

Reg EU 2015/2066	Minimum requirements and the conditions for mutual recognition for the certification of natural persons carrying out installation, servicing, maintenance, repair or decommissioning of electrical switchgear containing fluorinated greenhouse gases or recovery of fluorinated greenhouse gases from stationary electrical switchgear
Reg (EU) 2024/573	Fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014
Directive 2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS)
Directive 2012/19/EU	Waste electrical and electronic equipment (WEEE)
Directive 2014/30/EU	Harmonisation of the laws of the Member States relating to electromagnetic compatibility
ECE/TRANS/275	Vol. I and II ("ADR 2019") European Agreement Concerning the International Carriage of Dangerous Goods by Road

All equipment and devices shall carry the CE Mark in accordance with Directive 768/2008/EC.

4.2 EirGrid Requirements

4.2.1 Standards

XDS-GFS-00-001	110 /220/ 400 kV Substation General Requirements
XDS-GFS-06-001	110/ 220/ 400 kV Control, Protection and metering
XDS-GFS-07-001	Station Control Protection and Marshalling Kiosks
XDS-GFS-08-001	Station Auxiliary Power Supplies
XDS-GFS-12-001	Earthing and Lightning Protection
XDS-GFS-13-001	Substation Civil and Building Works
XDS-GFS-14-001	Station Electrical & Mechanical Services for Transmission System Control Buildings and Compound
XDS-HFS-03-001 XDS-FFS-03-001 XDS-EFS-03-001	Instrument Transformers 110kV Instrument Transformers XDS-HFS-03-001-R2 220kV Instrument Transformers XDS-FFS-03-001-R0 400kV Instrument Transformers XDS-EFS-03-001-R0

4.2.2 Drawings

XDN-LAB-STND-001	Station Signage
XDS-DGA-00-001	Earthing Practice

4.2.3 Other

XDS-GGD-00-001	Derogation Process
XDS-SDM-00-001	Safe by Design

4.3 National, International and Other Applicable Standards

ET103	National rules for electrical installations – Power installations exceeding 1 kV AC
IS 10101[2]	National Wiring rules for electrical installations

[2] IS10101 does not apply to internal wiring of equipment. Final low voltage installations of which GIS equipment are a part shall meet IS10101 for protection of persons from risk of injury and damage to equipment from normal operation, faults, overloads, voltage disturbances and electromagnetic disturbances.

EN 50110-1	Operation of electrical installations. General requirements
EN 50052	Specification for high-voltage switchgear and controlgear for Industrial use. Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear
EN 50064	Specification for wrought aluminium and aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear
EN 50068	Specification for wrought steel enclosures for gas-filled high-voltage switchgear and controlgear
EN 50069	Specification for welded composite enclosures of cast and wrought aluminium alloys for gas-filled high-voltage switchgear and controlgear
EN 50089	Specification for cast resin partitions for metal-enclosed gas filled high-voltage switchgear and controlgear
EN 50089	Cast resin partitions for metal enclosed gas-filled high-voltage switchgear and control gear.
EN 50110-1	Operation of electrical installations – General requirements
IEC 60034	Rotating electrical machines
IEC 60060	High Voltage Test Techniques
IEC 60068	Environmental testing
IEC 60099-4	Surge Arrestors – Part 4: Metal-oxide surge arresters without gaps for AC systems
IEC 60137	Insulated bushings for alternating voltages above 1000 V
IEC 60255-5	Insulation Tests for electrical Relays
IEC 60265	High-voltage switches
IEC 60270	High-voltage Test Techniques, - partial discharge measurements
IEC 60376	Specification of SF_6 for use in electrical equipment
IEC 60480	Guide to checking of SF_6 taken from electrical equipment
IEC 60507	Artificial pollution tests on high-voltage insulators to be used on a.c. systems
IEC 60529	Degrees of protection provided by enclosures, control gear standards
IEC 60694	Common specifications for high-voltage switchgear and controlgear standards
IEC 60859	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages of 72.5 kV and above
IEC 61462	Composite Hollow Insulators
IEC 61869-1	Instrument Transformers, Part 1 general requirements
IEC 61869-2	Instrument Transformers, additional requirements for current transformers
IEC 61869-3	Instrument Transformers, additional requirements for inductive voltage transformers
IEC 61869-5	Additional requirements for capacitor voltage transformers
IEC 61869-7	Additional requirements for electronic voltage transformers
IEC 61869-11	Additional requirements for low power voltage transformers
IEC 62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV - Test methods and requirements
IEC 62271	High voltage switchgear and control gear; - parts 1 to 310 all relevant parts and clauses, including but not limited to the following:
IEC 62271-1	High-voltage switchgear and control gear – Part 1: Common Specifications
IEC 62271-4	High-voltage switchgear and control gear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixtures
IEC 62271-100	High voltage switchgear and controlgear;-High-voltage alternating current circuit breakers.
IEC 62271-102	Alternating current disconnectors and earthing switches
IEC 62271-110	Inductive load switching
IEC 62271-203	Gas – insulated metal enclosed switchgear for rated voltages above 52 kV
IEC 62271-301	Dimensional standardisation of terminals.

IEC 62271-306	Direct connection between power transformer and gas insulated metal-enclosed switchgear for rated voltages of 72.5 kV and above.
IEC 62474	Material declaration for products of and for the electrotechnical industry
IEC 63359	Fluids for electrotechnical application: Specifications for the re-use of mixtures of gases alternative to SF6
IEC 63360	Fluids for electrotechnical application - Specification of gases alternative to SF6 to be used in electrical power equipment

4.4 Other References

CIGRE Brochure 234	SF_6 Recycling Guide. Re-use of SF_6 gas in electrical power equipment and final disposal (Revision 2003) - 2003
CIGRE Brochure 276	Guide for the Preparation of Customised "Practical SF_6 Handling Instructions" – 2005
CIGRE Brochure 430	SF_6 Tightness Guide – 2010
CIGRE Brochure 567	SF_6 Analysis for AIS, GIS and MTS - 2014

5 Service Conditions

The GIS shall be installed indoors on a concrete floor, positioned over a cable room/basement in a substation building and all equipment provided shall be capable of operating satisfactorily as specified in EirGrid General Requirements specification XDS-GFS-00-001 and EirGrid Substation Civil and Building Works XDS-GFS-13-001.Corrosion Protection

Corrosion of both ferrous metals and of aluminium and aluminium alloys is a particular problem in Ireland. Experience has shown that extreme precautions are necessary, because of the high humidity, to prevent the aggressive ingress of moisture between flange plates, around gaskets and O-rings, at insulator / flange interfaces, etc.

All externally exposed ferrous parts shall be hot-dip galvanised to comply with EirGrid Specification XDS-GFS-17-001. Nuts, bolts and washers shall be stainless steel of suitable grade for the outdoor conditions as stated.

Corrosion protection of all external switchgear components and fittings, e.g. transformer bus ducting to outdoor AIS bushings shall be designed to achieve a High Durability (above 20 years) coating to Category CX (ISO 12944-2) suited to environments with high condensation, pollution and salinity. Evidence of compliance to CX standard according to ISO or IEC test methods (e.g. Accelerated ageing and humidity) shall be provided.

To assist in the exclusion of moisture between flange plates, around gaskets and O-rings, at insulator / flange interfaces, etc. all flanges shall have silicon grease applied during assembly in the factory or at the site of installation. Flanges shall be designed to allow the injection of grease during assembly and topping up during regular maintenance works.

All externally assembled flanges shall be treated following installation to C5-M standard to eliminate moisture ingress.

6 General Requirements

6.1 General

The GIS switchgear shall be designed for safety, reliability, maintainability and ease of operations as the primary considerations, with due consideration for the environment.

Gas Insulated Switchgear shall have an anticipated asset life of not less than 40 years.

All equipment and materials shall be new and of the highest quality, and shall be capable of withstanding the electrical and atmospheric environmental conditions on site over the anticipated GIS switchgear life.

The Customer shall have available reliability statistics for the GIS on offer in terms of total bay-years in service experience, mean time between failure (MTBF) statistic and failure rate (1 /100 years) as defined in CIGRE 3rd Survey WG A3.06, 10 / 2012; Calculations based on CIGRE 513; Table 5-52.

6.2 Service Experience

The Customer shall comply with each of (1), (2a), (2b), (4), (5), (6), (7) and (8) below. Note point (3) may be considered by the Employer as alternative to (2a) and / or (2b).

The Customer shall have:

1. Ongoing experience for at least the past 10 years from the date of this tender enquiry in the production gas-insulated switchgear (SF6 and/or SF6-free) in the relevant voltage range (110 kV) or higher as specified.
2. Satisfactory[3] Service experience of the gas-insulated switchgear, in the voltage range from 110 kV and higher:
    a. across a minimum of three Utilities in either EU, UK, USA, Canada, Norway, Switzerland, Japan, Australia, New Zealand or South Korea, with proof of service experience in writing from these Utilities and acceptance of these by the Employer.

AND

    b. with a minimum of 100 bays SF6-GIS in total in these Utilities EACH of which shall have a minimum of five years satisfactory2 service experience at date of this enquiry issue. Relevant service experience in Irish and other Utility experience not referenced in tender submission may be used by the Employer in the evaluation of this criterion at their discretion.

AND

    c. with a minimum of 25 bays alternative GIS (i.e. SF6 free) in total in these Utilities EACH of which shall have a minimum of three years satisfactory2 service experience at date of this enquiry issue. Relevant service experience in Irish and other Utility experience not referenced in tender submission may be used by the Employer in the evaluation of this criterion at their discretion.

AND

    d. Minimum of 250 bay-years GIS in service experience in total.

GIS references for 2 (a), 2 (b), 2 (c) and 2 (d) shall have busbar rating above and short circuit rating at or in excess of requirements of this specification.

3. The GIS on offer in compliance with this specification shall be manufactured in the same plants which produced the GIS cited as meeting the service experience requirements outlined in 2(a), 2(b), 2(c) and 2(d).

[3] Satisfactory service experience defined whereby there has been no major failures requiring an unscheduled outage of the gas-insulated switchgear to occur throughout the defined five-year period.

4. At least 5 years production in the particular manufacturing plant proposed is required, although if the particular plant proposed is a relocated existing plant using substantially the same workforce the combined time of both plants would be considered.
5. Acceptance by the Employer of any factory listed during the Tendering Process shall be subject to a detailed Factory Quality and Production Audit by the Employer and /or its representative.

6.3 Health and Safety

It shall be the sole responsibility of the Designer appointed by the Customer to produce a suitable & sufficient design risk assessment of the GIS design in association with the GIS equipment layout.

The risk assessment Shall ensure that the design is safe and without risk to health when properly used by a person at a place of work, taking into account the initial installation, time based inspection, time based maintenance requirements, operation activities, decommissioning and future extension of the switchgear.

Any additional control measures deemed applicable shall be mutually agreed with EirGrid, prior to station handover.

There shall be compliance with the provisions of all relevant Directives of the European Communities relating to work equipment, i.e. regarding safety of personnel who operate and maintain the equipment.

A design risk assessment template can be found in Appendix 2 of the Safe by Design Methodology XDS-SDM-00-001-R0.

Particular safety hazards to be noted include:

- SF_6 is heavier than air and can present a hazard due to asphyxiation where it displaces oxygen, in particular in cable basements and other low lying parts of GIS installations.
- Other gases used for insulating or interrupting medium may also have associated health and safety hazards, which shall be addressed in the design. In addition, tenderer shall demonstrate REACH compliance for any chemicals/gases used in the offered switchgear.
- In addition, gases including methane, radon and CO_2 may accumulate in basements and other confined spaces.

Refer also to section 1.1 for further information.

6.4 Warranty

Warranty requirements shall be as outlined in EirGrid 110 / General Requirement's functional specification XDS-GFS-00-001.

6.5 Quality Assurance

Quality Assurance requirements shall be as outlined in EirGrid 110 / General Requirement's functional specification XDS-GFS-00-001.

The Customer shall ensure the switchgear is manufactured in accordance with the requirements of this specification.

Any deviations to the Functional Specifications shall be outlined in the TECHNICAL SCHEDULES for EirGrid review prior to equipment ordering.

Where deviations are proposed in the design the Customer shall submit a formal Derogation Request outlining an explanation of why the non-compliance is expected and any additional information to support the request for EirGrid to consider. Further information is outlined in EirGrid's Derogation Process XDS-GGD-00-001.

Documents and all details necessary to complete the detailed design and construction of the installation shall show switchgear / cable arrangements, clearances, mounting of structures on the foundations, structure details and loadings to demonstrate to how the switchgear / cables will fit in the switchgear building.

The drawings shall include all necessary horizontal and vertical clearances to walls and roof and to the hook of the travelling crane which will be used for erection and subsequent maintenance of the switchgear.

6.6 Design Documentation to be provided

Please see below a non-exhaustive list of the documents to be supplied by the Customer for EirGrid review and required for installation, operation and maintenance:

1. Single line diagrams of switchgear and gas compartments.
2. Outline dimension drawings of complete equipment, section and plan view drawings of the equipment within the GIS room. Dimensional drawings shall be provided in CAD and PDF format. 3D views provided in these or as additional .stp files
3. Outline dimension drawings of complete equipment.
4. Outline dimension drawings weights of transport modules of plant.
5. Dimensions of the necessary door opening to admit the largest module.
6. Weight and dimensions of largest component to be lifted by travelling crane.
7. Position and dimensions of openings for the exit bushing ducting.
8. Weight of largest unit to be lifted inside the building.
9. Weight of largest unit to be lifted outside the building.
10. Crane lifting capacity required for positioning of complete transport unit into building.
11. The value and position of all static and dynamic floor loadings of the complete installation.
12. Dimensional details of all support steelwork and floor fixings.
13. Civil works tolerances, particularly in the elevation of positions of installation of the GIS.
14. Location of power cable floor ducts.
15. Details of the power cable floor penetrations and of the GIS manufacturers' side of the GIS / cable interface design.
16. Location of control cable floor ducts.
17. Method of off-loading and positioning of switchgear.
18. Ventilation requirements.
19. Schematic diagrams showing the individual operation, control, monitoring, alarm and CT and VT circuits complete with terminal numbers.
20. Overpressure calculation for the switchroom to determine the requirements, if any, for pressure relief vents to reduce internal room pressure to safe levels.
21. Layout and detailed design drawing of the earthing system and connection points to the GIS. Details of transient earthing and any special measures required to mitigate EMI and VFTOs.
22. LCC layout, wiring diagrams, secondary wiring diagrams, secondary wiring termination locations and terminal layouts.
23. Interlocking conditions.
24. Gas compartment layouts, CB and disconnector control schematics and wiring diagrams.
25. Timing diagrams showing relation between main contacts and auxiliary switches (including trip coil contacts) for closing, tripping and auto-reclosing cycles.
26. All remaining drawings pertaining to the plant, including final details of all aspects of the plant including gas-handling plant.

27. Detailed Schedule of Tests.

6.7 Training

The Customer shall provide training to ESBN and EirGrid staff as specified in EirGrid's 110 / General Requirements functional specification XDS-GFS-00-001.

The training shall be held on the substation site and shall consist of two separate sessions to be held on two consecutive days each attended by the necessary staff.

The training on the equipment is required prior to handover at a time to be mutually agreed and is generally an item for discussion at the Operational Instruction kick off meeting.

Special training shall be provided for the operation and maintenance of GIS using gases other than SF6. This shall include health and safety, recommended practices and precautions, gas handing operations, recommended operating pressures etc.

6.8 Layout and access to the GIS

The layout of the GIS shall be designed for the ultimate development of the station, taking into account the physical constraints of the site to ensure future works can take place with minimum disruption to the initial development. Refer to Service Continuity requirements in section 6.11 and access requirements in section 0.

The design shall ensure maximum safety of personnel during operation and maintenance.

All parts of main circuits to which access is required shall be capable of being earthed.

To ensure safety of personnel during maintenance, the GIS and switch room shall be arranged to facilitate safe and direct personnel access to all locations as follows;

1. Electrical and mechanical points of control of the GIS (disconnectors, earthing switches and circuit breaker mechanical trip mechanism)
2. Mechanical position indication of circuit breakers
3. Mechanical position indicators of disconnectors and earth switches
4. Inspection windows to verify position of disconnectors and earth switches (if provided)
5. Gas density monitors, pressure transducers and filling points
6. Circuit breaker spring status mechanical indication
7. Current transformer secondary connection terminal boxes
8. Voltage transformer secondary connection terminal boxes

The Customer's design risk assessment shall identify the location of all components listed above.

Where the layout consists of two or more bays coupled to each other via the busbar, the busbar shall incorporate an additional buffer or spacer compartment to allow movement of personnel in between the bays to access any components located to the side of bays to carry out the activities 1 to 8 as listed above. An illustration of this requirement is shown in Figure 2 below.

Figure 2 Access for inspection and maintenance to side mounted components

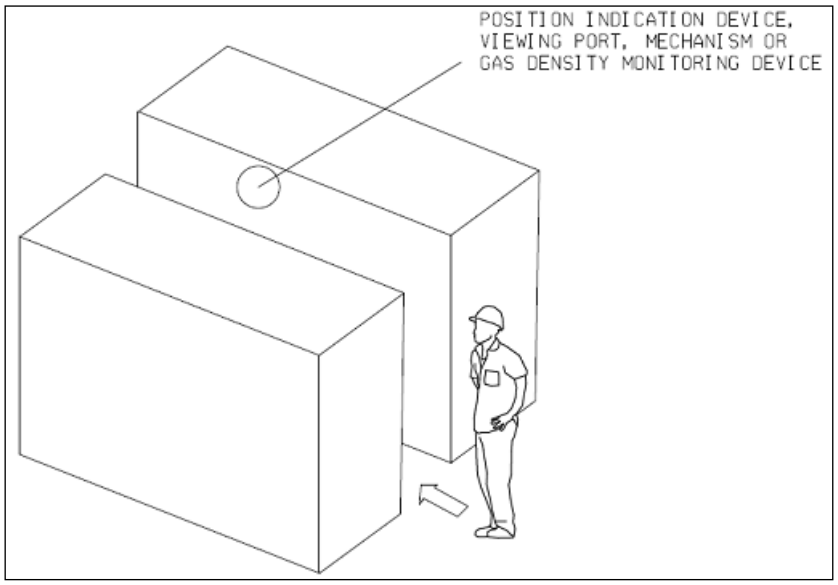


Figure 3 Access for inspection and Maintenance to Side mounted Components

The additional buffer compartment shall be provided where the proposed equipment does not provide an access route between the bays. The buffer or spacer compartment shall be suitably sized such that spacing is provided between bays to allow access and movement of persons carrying out operations, regular inspection and maintenance tasks.

Free standing LCC's shall be positioned over a cable opening or floor opening to accept the low voltage control cabling.

The local control cabinets shall be swing frame EMC shielded type with door opening outwards to the left hand side. All points of control shall be located on the front of the cabinet to allow operation and inspection without stepping inside the cabinet.

The interior of the cabinet shall be equipped with a light. Removable gland plates shall be labelled with permanent stickers identifying the Safe Working Load (SWL) that the plate may bear.

Adequate safety screens shall be provided for all moving parts.

Provision shall be made for carrying out primary injection tests on all current and voltage transformers without requiring internal access to any gas compartment.

The HV cable screen termination box in the HV cable room should be accessible from ground level.

6.8.1 Provision of 3D model for Access

The Contractor shall provide an accurate 3D model for review / comment by the OEM before approval.

The installation of access platforms and associated support steelwork shall be included and they shall not impede upon any of the items mentioned above. The 3D model shall include any proposed access platforms to confirm accessible locations are not hindered.

6.9 Access Platforms

Fixed platforms or walkways shall be provided to facilitate operation, inspection and maintenance of the 220 kV and above GIS as referenced in Table 1 "Operation, Inspection and Maintenance Activities". Platforms shall be sourced from an approved supplier (subject to EirGrid review and approval) and installed before commencement of final commissioning.

Platforms shall be designed to take account of additional necessary requirements when working at height as per SI 299 Part 4.

Handrails shall be provided on the platforms where necessary to achieve safe access to LCCs, CB mechanism boxes, VT's and all other relevant equipment on the GIS switchgear.

The use of handrails and/ or catenary harness system shall be considered to ensure the safety of personnel for all activities while on the platform.

A platform/ catwalk serving two or more operating positions shall have two stairways to the operating floor. Any external gas pipework shall be mechanically protected and arranged so that it cannot be damaged by operating staff in the course of their duties. The general layout of the plant shall be such as to permit replacement of any faulty component while maintaining the service continuity of the bays not directly affected.

Lifting eyes shall be provided on all GIS components or removable catwalk sections which cannot be lifted safely by other means.

Access platform design shall be incorporated into the overall switch room design by the Customer. The design shall be coordinated with the location of emergency exits and shall allow for future extension to cater for the ultimate development of the station.

The Contractor shall ensure that the positioning of fixed platforms shall not inhibit the access of points of operation / viewing ports or position indication.

Mobile platforms are required for 110 kV GIS.

6.10 Operation, Inspection and Maintenance Requirements

The GIS installed shall be subject to regular local operation, inspection and time-based maintenance intervals in accordance with EirGrid maintenance policies.

An outline of these is given in Table 2 as an example only. Additional maintenance requirements may apply according to the type and nature of the GIS offered.

The Customer shall be cognisant of these requirements when designing the GIS equipment and when completing the required Design Risk Assessments (DRA's).

The frequency of the tasks below shall be accounted for in DRA to be developed by the Customer for the installation.

Table 2 Operation, Inspection, Maintenance and Repair Activities

Activity	Frequency	Tasks to be performed
GIS Operation	May occur daily	- Electrical operation of disconnectors / earth switches at LCC. - Visual confirmation of CB, disconnector and earth switch. - Attachment of lock and notice (LOTO system as outlined in specification XDS-GFS-00-001) on mechanisms of disconnectors and earth switches. - Confirmation of voltage / currents locally at LCC
Inspection	Monthly	- Record pressures of all Gas density monitors - Visually inspect CB drive mechanism - Visually confirm position of all MCB's and fuses, including those within VT secondary boxes - Confirm heaters operating in all drive and marshalling boxes - Record CB operation counters
Maintenance	Annually	- Electrical operation and functional tests of switching devices - PD & thermography - Gas leak detection – all flanges and insulators

Activity	Frequency	Tasks to be performed
	Every 4 or 5 years	- Mechanical Operation and functional test of all mechanisms - Inspect and lubricate drives and mechanisms
	Every 6 years	- Calibration of Gas density monitors
	Every 8 or 10 years	- CB timing and contact resistance tests - Gas sampling and testing - CT and VT injection tests - Disconnector contact resistance tests
	Every 20 years	- Change Gas desiccant / moisture absorbers
Fault Finding	Ad Hoc	- Circuit tracing, mechanism / relay checks and tests

Platforms shall be provided to safely perform the operation and inspection tasks as outlined in section 6.8.

Mobile Elevated Work Platforms (MEWP's) may be proposed to fulfil requirements outlined above subject to satisfactory risk assessment provided by the customer and reviewed by EirGrid.

6.10.1 Lock-out, Tag-out Permit to Work System

The switchgear shall be operated in accordance with Lock-Out, Tag-Out (LOTO) permit to work system as outlined in EirGrid specification XDS-GFS-06-001 and as detailed in EN 50110-1:2013 section 6.2 (the "five safety rules").

6.10.1.1 Three position switches for disconnect and maintenance earthing functions

Particular attention shall be given where the GIS manufacturer proposes the use of three position switches to perform disconnection and maintenance earthing functions.

Separate independent electrical or manual operation is required of the disconnector function and the earthing function.

Operators are required to lock-off the disconnector mechanism and isolate the electrical control supply to the disconnector drive while retaining electrical or manual control of the maintenance earthing function.

The following procedure as sequenced below facilitates this:

1. Open the disconnector;
2. Lock-off the disconnector mechanism;
3. Isolate the electrical supply to the disconnector drive;
4. Close the maintenance earth switch;

Where the switchgear cannot operate in accordance with this sequence, to fulfil the service continuity requirements additional earthing switches with isolation facilities shall be included within designated bays, in particular busbar coupling bays.

6.10.2 Special Tools & Equipment

The Customer shall submit details of all tools and spares required for correct operation and maintenance for a 40 year expected lifetime of the switchgear.

Special equipment shall include all hoists, jigs, special tools, templates and gauges required for the erection and subsequent maintenance of the switchgear. These shall be included in the supply and shall not be returnable.

Any special tools required for maintenance of the equipment shall be listed in the TECHNICAL SCHEDULES. A complete set shall be provided per substation.

6.10.3 Spare Parts

The Customer shall guarantee the continuing availability of the complete range of spare parts for at least 25 years for the equipment offered.

The OEM shall identify those spare parts which they recommend should be held. The spare parts recommended shall be clearly identified on the drawings and maintenance instructions provided by the supplier. These spare parts will be supplied with the switchgear for storage by the asset owner.

6.10.4 Heaters

To prevent condensation, heaters, suitably protected shall be fitted where necessary. The live parts of the heaters shall be enclosed with degree of protection IP2X.

The supply voltage for heaters shall be 230 V AC.

6.10.5 Gas Deterioration

Details shall be given of the degree of gas deterioration, which can be tolerated before treatment, or replacement of the gas is necessary for both a leak (affecting percentage insulation and moisture) and for normal switching and internal arcing event (affecting percentage insulation, moisture and by-products). Details of necessary treatment shall be given with supporting material.

6.11 Service continuity

For double busbar GIS installations, outages shall be limited to one bay and/or one section of busbar (e.g. A1, B1 etc. ('This may be considered as a minimum to be MRE11 as defined by IEC 62271-203:2022. Note that in the case of couplers on double busbars this requires one of the busbar sections connected to the coupler to remain in service.)) during the following activities:

(a) Time-based maintenance tasks as referenced in this specification.

(b) Any extension to the original installation[4],

(c) Fault replacement of circuit breakers (incl. interrupter housing), busbar disconnectors/ earth switch replacement, CTs and VTs.

Additional gas compartments shall be provided as required to ensure that the above availability is achieved allowing for the following constraints:

a) It shall be possible to earth all internal components and completely depressurise any compartment to gain access for maintenance.

b) Adjacent compartments shall have their pressure reduced (see also section 9.1).

c) Disconnects in reduced pressure compartments may not be used to provide isolation from live parts – i.e. isolation from live parts shall be provided by a disconnect in a fully pressurised compartment.

The Customer can propose any additional features to achieve the service continuity requirements.

The Customer shall submit the details of the methodology utilised to achieve the required service continuity level, and the approach used shall in accordance with Annex F of IEC 62271-203 of 2011.

6.11.1 High Voltage Withstand Testing

It is a requirement that every new piece of HV equipment added or replaced is to be subjected to a high voltage withstand test after installation on site as quality assurance verification and additional reassurance

[4] The location of possible future extensions should be identified in the SLD.

for the manufacturing warranty. Note that on-site HV tests shall be performed at 100 % of factory test values.

The Customer shall detail the service continuity achieved during HV testing of replacement components.

The Customer shall also provide a risk assessment and method statement demonstrating how this work (i.e. HV testing of a replacement circuit breaker, CT and busbar disconnector) shall be carried out in a safe manner.

Details of additional gas partitioning compartments or isolation devices proposed for this purpose shall also be provided by the Customer.

If required, test bushings and adequate clearance around the location of the test bushing for testing shall be provided while maintaining the required service continuity of adjacent equipment.

6.11.2 Additional Requirements for Circuit Breaker Replacements

Cable connected feeder bays shall be designed so that the interrupter or circuit breaker pole may be removed and replaced on site during the lifetime of the GIS without disconnection or removal of the Customer's HV cables.

In the case of three or single phase encapsulated GIS the design shall incorporate a disconnection facility between the circuit breaker and HV cable box compartment to facilitate this. De-gassing of the cable box when replacing a circuit breaker is permissible during these works however disconnection or removal of the cables shall be avoided.

6.11.3 Barrier and Support Insulators

Gas zone partitions shall be capable of withstanding the following pressure differentials in both directions according to European regulations CENELEC EN 50089- 1992 / A1:1994:

- Rated filling density on one side and vacuum on the other
- Maximum pressure rise resulting from an internal arc on one side and atmospheric air on the other side

In line with service continuity requirements it shall be possible to open any compartment without impacting on the availability of adjacent bays and only one busbar section at a time shall be affected.

The manufacturer shall describe any design features of the insulator, gas sealing system and 'O' ring positioning that may impact on this requirement and identify additional necessary measures to eliminate such impacts (i.e. additional buffer compartments, gas valves or density monitors).

The location and design of spacers / barriers shall be such as to minimize the possibility of particle collection.

The Customer shall provide physical designs of the switchgear showing locations and orientation of insulators in relation to switching devices.

Suitable measures shall be taken to ensure enclosures and compartments are potentially bonded where separated by insulating spacers to prevent external or internal flashovers due to very fast transient voltages (VFTO's) being induced on the enclosure during switching.

Any specific requirements and procedures relating to earthing of the GIS shall be provided by the Customer.

7 GIS - Primary Plant

7.1 Introduction

The GIS primary plant shall include all items of equipment and support structures, configured and assembled together in accordance with the project specific single line diagram.

The nominal and short time withstand current of HV primary plant (instrument transformers, circuit breakers, disconnectors) and busbar ratings shall be as shown in the single line diagrams (SLDs) and in the Customer's TECHNICAL SCHEDULES.

The GIS shall include the control and marshalling cabinets complete with interconnecting cables, support structures and necessary provision for future extensions.

The building, control room and switchgear shall be designed and suitably sized to facilitate the ultimate development of the station including all future and spare bays as illustrated in the project specific SLD.

7.2 Equipment Layout

7.2.1 GIS based on SF6

The GIS building layout shall be designed in accordance with EirGrid's latest GIS standard layout drawings. The Customer shall submit their GIS station layout design for EirGrid review to incorporate technical feedback in advance of finalising planning submission.

Optimisation of the standard building to accommodate smaller switchgear us is acceptable, but subject to the derogation process.

7.2.2 GIS based on gases other than SF6

Switchgear using zero GWP gas, or alternative non-zero GWP gas have the potential to be physically larger than existing SF6 based switchgear.

The full impact on building design of GIS equipment using gases other than SF6 is not fully known at this time.

The Customer will be required to propose design drawings following existing design principles and requirements, (including clearances to other equipment, space for testing, access, maintainability etc) while also allowing for the increased dimensions of the switchgear. It is expected that depending on the switchgear bought the buildings may have to be optimised.

7.3 Auxiliary Supplies

The following are the auxiliary supplies available. Operating coils and other auxiliary equipment shall be designed accordingly:-

Table 3 Auxiliary Supplies

Voltage	Application
220 V DC	All tripping and closing circuits, direct drive motors Circuit Breakers, Disconnectors, earth switches etc.)
220 V, 48 V or 24 V DC	Signal and alarm circuits
230/ 400 V AC, 50 Hz	Circuit breaker compressor or spring winding motors, heaters, etc.

Refer to XDS-GFS-08-001 “Station Auxiliary Power Supplies” for further details of station auxiliary power supplies.

7.4 Labelling and Nameplates

Each individual piece of switchgear shall be provided with a nameplate bearing information as specified by the relevant IEC Publication.

Individual equipment nameplates shall contain the actual type tested current / voltage ratings of the equipment.

The switchgear shall be labelled to show (but not limited to);

1. The insulating gas being used
2. Insulating gas quantity (kg)
3. Global Warming Potential
4. CO_2 equivalent
5. The text “Contains fluorinated greenhouse gases covered by the Kyoto Protocol” (where SF_6 or any F-Gas is used)
6. Where applicable the text “hermetically sealed”, a reference that the switchgear has a tested leakage rate of less than 0.1%.

The following is a non-exhaustive list of the required labels:

1. Each GIS bay and its LCC shall be identified according to the bay designation on the SLD.
2. Each HV switching device, including earth switches, shall be clearly labelled to indicate its function and bay.
3. Each phase of the GIS bays and busbar shall be identified with appropriate phase reference at each point where it may be accessed.
4. Each partition between gas volumes shall be identified.
5. Each gas density / pressure monitor shall be identified with a label containing a reference to the gas volume being supervised.
6. Each valve shall be labelled identifying its function.

Refer to XDN-LAB-STND-001 “Station Labels” for further details and requirements.

The Customer shall ensure that any label affixed to a removable or opening element is replicated and positioned in a prominent and easily visible manner on the corresponding internal or fixed section of the device.

A labelling schedule shall be submitted by the Customer at detailed design stage for EirGrid’s review.

The labelling schedule shall include:

- The label text, text size, material and mounting location for each item of equipment. The label text shall incorporate bay codes and names from the single line diagram.
- A statement of compliance with XDN-LAB-STND-001, with any deviations or additions noted.

7.4.1 Gas Labelling

Colour coding shall be applied to the fitting/fitting cap to distinguish the gas used between specific gases and gas mixtures - SF6, NOG (natural origin gas), F-gas mixtures.

In addition, the gas/gas mixture used shall be easily identifiable using labels/notices/integrated branding on switchgear main body with text outlining composition of gas and not to be filled with SF6 gas or other

gases such as “CONTAINS XYZ GAS (80% A, 10% B, 10% C), DO NOT FILL WITH SF6”. Awareness of gas/gas mixtures is critical for long term operation and maintenance, and safety of staff to prevent incorrect handling and in case of internal fault.

7.5 Partial Discharge and Radio Interference Voltage Measurement

Each item of switchgear shall meet the requirements specified in the appropriate IEC Publication for partial discharge (PD) and / or radio interference voltage (RIV) for that item.

7.6 Circuit Breakers

7.6.1 Ratings and Switching Requirements

Circuit Breakers shall comply with IEC 62271-100 and the following:

- First pole to clear factor: 1.5
- Rated Operating Sequence (for rapid auto-reclosing): O-0.3s-CO-3min-CO

  From the Open position (with the springs wound /with the operating mechanism charged) the circuit breakers should be capable of carrying out the following cycle:

  - Close, Trip immediately (e.g. in 2 cycles - 40 ms), be available to Close again after 300 ms (to achieve a dead time[5] of ~ 500 to 600 ms) and Trip Immediately.
  - The circuit breaker shall be capable of carrying out a further close and immediate trip after a period of 3 minutes.

At 110 kV, circuit breakers shall be triple pole operated unless otherwise specified.

At 220 kV and 400 kV, circuit breakers shall be single pole (independently) operated where required for single pole line protection schemes used at these voltage levels.

Capacitor bank or reactor switching at all voltage levels also require single pole operated circuit breakers.

Single pole operated circuit breakers shall have mechanical endurance class M2. Details of type test certification shall be available. Details of type test certification for M2, C2 and CC2 testing shall be made available.

7.6.2 Point On Wave Switching

As outlined above single pole operation circuit breakers are required to switch capacitor banks, shunt reactor banks and other reactive compensation devices. This ensures the circuit breaker is synchronised (soft) closed and / or opened by means of control switching relays.

The control relay for synchronised operation shall be included in the project specific protection specification. The Customer shall supply the necessary relay integrated in the LCC and licenced copies of any software required to configure the timing settings.

Capacitive switching currents may compromise part or all of the operating duty of a circuit breaker. When guaranteeing compliance in the TECHNICAL SCHEDULES the rating of the circuit breaker for capacitive current switching shall include:

1. rated line-charging breaking current
2. rated cable-charging breaking current
3. rated single capacitor bank breaking current

[5] Time from Trip to Closed position.

4. rated back-to-back capacitor bank breaking current
5. rated single capacitor bank inrush making current
6. rated back-to back capacitor bank inrush making current.

Values of rated capacitive switching currents shall be as given in IEC62271-100.

When guaranteeing compliance in the TECHNICAL SCHEDULES, the associated maximum switching overvoltage shall be stated.

The circuit breakers shall be class C2 very low probability of restrike when breaking the full range of capacitive switching currents up to and including the rated values.

7.6.3 Transient Recovery Voltage and Rate of Rise of Recovery Voltage

The Transient Recovery Voltage (TRV) shall be in accordance with IEC 62271-100, with first-pole-to-clear factor of 1.5 for all test duties.

The details of any device incorporated in the circuit breaker to limit or control the Rate of Rise of Recovery Voltage (RRRV) across the circuit breaker contacts or to divide the voltage across multiple series breaking contacts shall be made available.

7.6.4 Inductive and Capacitive Current Switching

The over-voltage associated cable charging current shall be in accordance with IEC 62771-100.

The Customer shall also ensure that all circuit breakers are suitably rated for capacitive charging breaking currents as outlined in the associated EirGrid TECHNICAL SCHEDULES.

Note that EirGrid also request maximum cable capacitance per phase and max charging current per phase in the EirGrid 110 /220 /400 kV Cable TECHNICAL SCHEDULES. EirGrid do not have a default required value for Max Phase Capacitance (μF/km) and Max Charging current per phase (A/km) as part of these Cable TECHNICAL SCHEDULES as the value required is bespoke, i.e. it depends on the breaker rating and the length of the cable and capacitive contributions from other sources. Therefore the Customer shall consult with EirGrid on a project specific basis prior to order of Circuit Breakers to ensure that Cable and Circuit Breaker requirements are aligned and that there are no impacts on existing Circuit Breaker installations i.e. existing circuit breaker ratings are not exceeded for new long cable lengths installed.

7.6.5 Switching small inductive currents

The over-voltage associated with small inductive current switching shall be in accordance with IEC 62771-100.

The Customer shall calculate the amplitude of overvoltages generated by switching inrush currents associated with transformers of the ratings illustrated on single line or equipment diagrams. The purpose of this exercise is to advise on the necessity or otherwise of fitting surge arresters on cable / transformer connections.

7.6.6 Circuit Breaker Operating Mechanism Type

Circuit breakers shall be suitable for triple-pole or single-pole rapid auto-reclosing.

The operating mechanism shall be of the stored energy motor spring wound type. Other types may be acceptable with the exception of compressed air mechanisms.

The mechanism shall be trip-free in any position and shall include an anti-pumping facility.

Circuit breakers having individual drives per pole shall be provided with automatic tripping on pole discrepancy.

The operating mechanisms of circuit breakers designated for use on capacitor bank and reactor switching shall be mechanical endurance class M2.

The mechanism shall be equipped with an emergency mechanical trip mechanism to allow operation of the trip coil in event of auxiliary supply failure or blackout restart procedures of islanded systems.

7.6.7 Control

The circuit breaker spring shall be operated from a single or three phase 400/ 230 V AC or a 220 V DC motor-driven energy accumulator.

A +10%/ -15% tolerance applies to DC supplies. A full description of the drive mechanism shall be provided as part of the TECHNICAL SCHEDULES submission. All motors shall be protected by an MCB located in the Local Control Cubicle (LCC). The MCB shall be equipped with auxiliary contacts for signalling and alarm purposes.

Two electrically independent[6] tripping coils and one closing coil shall be provided, all suitable for 220 V DC operation. Both positive and negative poles of the closing coil shall be switched by all operating devices supplied in the switchgear.

A separate and independent control switch shall be provided at the bay LCC to isolate both the positive and negative supply to the close coils.

Circuit breakers having individual drives per pole shall have two independent trip coils and one close coil per pole, otherwise the quantities apply per triple-pole unit.

An automatically controlled anti-condensation heater (230 V AC) shall be provided in mechanism box(es).

7.6.8 Pole Discrepancy

Circuit breakers having individual drives per pole shall be provided with automatic tripping on pole discrepancy. The tripping device shall have a time delay, which is adjustable from zero to one second. The discrepancy trip devices shall operate a trip coil.

7.6.9 Shielding of Moving Parts

The operating mechanism shall be arranged so that no moving parts are accessible when locally mechanically operating the circuit breaker in emergencies.

The height of mechanical operating facilities should be suited to the level of effort required. Where possible operating facilities which require significant effort should be located at a height of approximately 1 m from operator standing height.

Where controls and mechanisms accessed during operation of the switchgear are located in the same box containing moving parts there shall be shields fitted internally to guard against accidental contact. Allowance shall be made in the shield design to ensure that emergency mechanical trip mechanism (both coils) are accessible to the operator in a safe manor. An operator shall be able to insert the manual winding handle without exposure to moving parts. Note that heaters and MCB's located within the mechanism boxes require regular inspection as they are susceptible to failure.

7.6.10 Auxiliary Contacts

A minimum of eight normally-open and eight normally-closed auxiliary switches shall be provided and shall be wired to individual terminals in the bay LCC. These shall be in addition to those used for the internal circuits.

[6] The circuit breaker shall operate correctly when either trip coil operates. Each trip coil is supplied from a separate 220 V DC supply.

7.6.11 Mechanical Position Indication

A mechanical position indicator of the main contact of the circuit breaker shall be provided and must be visible to a person electrically operating the bay at the LCC.

It shall be marked as follows:

- The word 'ON' in white letters on a red background shall be used to indicate the breaker is in the closed position
- The word 'OFF' in white letters on a green background shall be used to indicate the breaker is in the open position

An operations counter shall also be included and be clearly visible from the operating floor.

7.6.12 Spring Mechanism Position Indication

A status indicator for the stored energy spring shall be provided at the circuit breaker mechanism box. It shall be possible to verify the status of the spring (charged or discharged) without opening any doors or removing mechanism covers. A suitable external indicator or viewing window on the mechanism box shall be provided on all mechanisms. The indications shall be clearly marked 'CHARGED' and 'DISCHARGED' to indicate the status of the spring.

7.7 Disconnectors

7.7.1 Ratings

The disconnectors shall comply, in general, with IEC Publication 62271-102.

The nominal and short circuit ratings of disconnectors shall be as specified in the project specific SLD.

The disconnectors, in addition to their continuous current rating shall be capable of switching the busbar capacitive currents, of withstanding the induced very fast transient switching over-voltages and of withstanding the DC trapped charge which may remain on the busbars.

Particle generation by disconnector operation shall not reduce the dielectric strength of the installation.

Disconnectors shall be rated to make and break capacitive and inductive charging currents in accordance with the rated voltage and rated current of the installation, in accordance with IEC 62271-102.

Disconnects shall have a minimum bus-transfer voltage rating as stated in Table 4.

Table 4 Min Rated Bus-Transfer Voltage

	110 kV	220 kV	400 kV
Standard Disconnects	10 V	20 V	30 V
Disconnects to AIS busbars	100 V	200 V	300 V

The rated bus-transfer current shall be marked on the nameplates of the relevant disconnectors.

All busbar and sectionaliser disconnectors shall have a rated bus-charging current of 0.1 A as per IEC 62271-102. The rated bus-transfer current shall be marked on the nameplates of the relevant disconnectors.

7.7.2 Control

Each disconnector shall be equipped with a dedicated 220 V DC motor driven mechanism which will normally be operated electrically from a remote control position and from the bay LCC.

All drives shall be provided with hold-on arrangements to extend the open and close electrical command impulses until operation is completed.

Electrical operation shall require a double-pole command i.e. both the positive and negative sides of the electrical command impulse shall be switched.

Disconnectors shall be capable of being operated manually for maintenance and adjustment operations. Automatic lock-out of the power drive when the manual lever is engaged shall be provided.

Where access to the manual operation of disconnectors / earthing switches is via shutters controlled by blocking coils, these coils shall form part of the station interlocking and require review / comment by the Employer.

The drive mechanism shall also have the facility to attach a 'Hold Off' notice as per the LOTO permit to work system herein.

7.7.3 Position Indication

It shall be possible to obtain positive confirmation (clear indication) of the position of all disconnectors either through easily accessible inspection windows, an approved kinematic chain, The proposed method should be certified, type tested and is subject to EirGrid approval. The Contractor shall provide a portable colour viewing camera with an integrated light source to visually confirm the position of the disconnector contact. One camera is sufficient per installation.

The Mechanical Position Indication shall be marked as follows:

- The word 'ON' in white letters on a red background shall be used to indicate the disconnector is in the closed position
- The word 'OFF' in white letters on a green background shall be used to indicate the disconnector is in the open position

An operation counter shall also be included and be clearly visible from the operating floor. The position indication text shall also be clearly visible from ground level.

7.7.4 Locking Arrangements

Locking arrangement in both the ON and OFF position by means of padlocks is required.

The locking arrangement shall be capable of accepting a padlock with a shackle bend radius of 30 mm, shackle length of 23 mm and cross-section of 6.3 mm.

The locking arrangement shall prevent both electrical and mechanical operation of the disconnect.

A dimensioned drawing of the locking arrangement shall be provided by the customer.

7.7.5 Auxiliary Contacts

Eight normally open and eight normally closed auxiliary switches shall be provided and wired to individual terminals in the bay control / marshalling cabinet for use by the Purchaser.

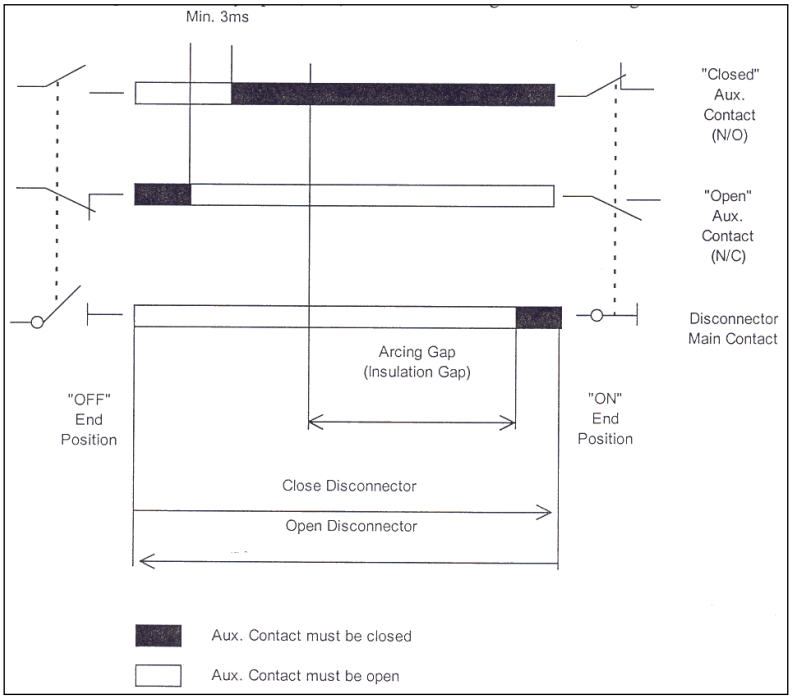
The number of auxiliary contacts proposed shall exclude those supplied and incorporated in circuits for the safe operation and position indication of the disconnectors.

The Supplier shall state the number of auxiliary contacts operated directly by the disconnector mechanism. The minimum requirement is two normally open and two normally closed 'direct acting' contacts.

Where designated as 'direct acting', the auxiliary switches shall be positively driven in both directions by the main drive mechanism. The Supplier shall state if contacts are not direct acting, e.g. if reproduced by latching relays.

One of each normally open and normally closed auxiliary contacts referred to above are to switch according to the following sketch in Figure 2:

Figure 4 Operating sequence of normally open and normally closed contacts



7.7.5.1 *During closing*

- The N/C contact must open at least 3 ms before the closing of the N/O contact.
- The N/O contact must close before the main contact reaches the insulation breakdown gap.

7.7.5.2 *During opening*

- The N/O contact ("Closed" signal) must not open before the main contact has passed the contact gap at which re-ignition can occur.
- During the closing operation the N/O contact must close before the main contact reaches the insulation breakdown gap.

These special contacts shall be directly driven from the disconnector mechanism and are not required on earthing switches. These contacts shall be reserved for use by the busbar protection system.

The quantities apply per pole for disconnectors and having individual drives per pole; otherwise the quantities apply per triple-pole unit.

7.7.6 Disconnectors As Three Position Switches

To fulfil ESB Networks Safety Rules it shall be possible to lock-off disconnector mechanisms and isolate the electrical control supply to disconnector drives while retaining electrical or manual control of the maintenance earthing function.

This is to allow maintenance testing of the circuit breaker while maintaining service continuity requirements.

The Operator of the switchgear shall open the disconnector, lock-off the disconnector mechanism, isolate the electrical supply to the disconnector drive and then close the maintenance earth switch, either electrically or manually.

Where manufacturer's switchgear cannot operate in accordance with this procedure, to fulfil the service continuity requirements as outlined herein, additional earthing switches with isolation facilities must be included within designated bays, in particular busbar coupling bays.

7.8 Fault Making Earthing Switches

7.8.1 Ratings

All busbar earth switches and HV Line / Cable and Transformer bay earth switches must be insulated high speed fault-making earthing switches and shall comply in general with IEC Publications 62271-102.

They shall be capable of making the peak withstand current (fault-making) and carrying the short time-current for 1 second and shall also be capable of interrupting induced (inductive and capacitive) currents

The induced-current switching class shall be Class B as specified in the project requirements, and as defined by IEC 62271-102. Class B is required for circuits having relatively long sections of line or high coupling to adjacent circuits.

Particle generation by fault making earth-switch operation shall not reduce the dielectric strength of the installation.

The full energy required for a high-speed closing operation must not be stored when the earthing switch is Off (open), but shall be accumulated after the On (close) command is given and before the On operation takes place.

Short circuit making capability shall be class E1 type.

7.8.2 Control

Each earthing switch shall be equipped with a dedicated 220 V DC motor driven mechanism which will normally be operable electrically from a remote control position and also from the bay LCC.

Drives shall be fitted with external hold on circuitry such that the command to open or close motorised disconnects from the Bay Control Unit will proceed to completion even in the event that the Bay Control Unit fails after giving the initial command.

Electrical operation shall require a double-pole command i.e. both the positive and negative sides of the electrical command impulse shall be switched.

The earthing switches shall be capable of being operated manually for maintenance and adjustment operations. Automatic lock-out of the power drive when the manual lever is engaged shall be provided.

Where access to the manual operation of disconnectors / earthing switches is via shutters controlled by blocking coils, these coils shall form part of the station interlocking and require review / comment by the Employer.

The drive mechanism control shall ensure that each disconnector reaches the fully open and fully closed positions at all times in accordance with the interlocking requirements in the EirGrid functional specification XDS-GFS-06-001.

Where control mechanisms, accessed during operation of the switchgear, are located within boxes containing moving parts, shields shall be fitted to guard against accidental contact.

An operator shall be able to insert the manual operating handle without exposure to moving parts and have the facility to attached a “Hold Off” notice as per LOTO permit to work system.

7.8.3 Position Indication

The requirements as outlined in section 7.7.3 for disconnector position indication shall also apply for Earthing Switches.

7.8.4 Locking Arrangements

The requirements as outlined in section 7.7.4 for disconnectors shall also apply for Fault Making Earthing Switches.

7.8.5 Auxiliary Contacts

Eight normally open and eight normally closed auxiliary switches shall be provided and wired to individual terminals in the LCC.

The number of auxiliary contacts proposed shall exclude those supplied and incorporated in circuits for the safe operation and position indication of the earthing switches.

The customer shall state the number of auxiliary contacts operated directly by the switch mechanism. The minimum requirement is two normally open and two normally closed 'direct acting' contacts.

Where designated as 'direct acting', the auxiliary switches shall be positively driven in both directions by the main drive mechanism.

The customer shall state if contacts are not direct acting, e.g. if reproduced by latching relays.

7.8.6 Test Facilities

To facilitate tests on individual phases of equipment and outgoing cables, the maintenance earthing switches shall have the earth connection brought out through insulated bushings (minimum of 10 kV withstand) and the three phases connected together and earthed externally with removable connection. Where necessary, should any bolts, used as part of the insulated device, require torquing, the Contractor shall provide torquing details on a label either close to the insulated device or on a drawing displayed on the wall of the GIS room.

The relevant insulation level (AC and DC) of the earthing connection (when removed) shall be stated.

7.9 Maintenance Earthing Switches

7.9.1 Ratings

All the maintenance earthing switches shall comply in general with IEC Publication 62271-102. They shall be capable of carrying the short-time current for 1 sec. and should also be capable of interrupting induced (inductive and capacitive) currents. The switching capabilities of proposed devices shall be provided by the Customer to EirGrid. [7]

Particle generation by maintenance earth switch operation shall not reduce the dielectric strength of the installation.

7.9.2 Control

Each maintenance earthing switch shall be equipped with a dedicated 220 V DC motor driven mechanism which will normally be operated electrically from the bay control/ marshalling cabinet.

All drives shall be provided with hold-on arrangements to extend the open and close electrical command impulses until operation is completed.

Electrical operation shall require a double-pole command i.e. both the positive and negative sides of the electrical command impulse shall be switched.

The earthing switches shall be capable of being operated manually for maintenance and adjustment operations. Automatic lock-out of the power drive when the manual lever is engaged shall be provided.

Where access to the manual operation of disconnectors / earthing switches is via shutters controlled by blocking coils, these coils shall form part of the station interlocking and require review / comment by the Employer.

The drive mechanism control shall ensure that each disconnector reaches the fully open and fully closed positions at all times in accordance with the interlocking requirements in the EirGrid functional specification, XDS-GFS-06-001.

Where control mechanisms, accessed during operation of the switchgear, are located within boxes containing moving parts, shields shall be fitted to guard against accidental contact.

An operator shall be able to insert the manual operating handle without exposure to moving parts and have the facility to attached a "Hold Off" notice as per LOTO permit to work system.

7.9.3 Position Indication

The requirements as outlined in section 7.7.3 for Disconnectors shall also apply for Earthing Switches.

7.9.4 Locking Arrangements

The requirements as outlined in section 7.7.4 for Disconnectors shall also apply for Maintenance Earthing Switches.

7.9.5 Auxiliary Contacts

The requirements as outlined in section 7.8.5 for Fault Making Earthing Switches shall also apply for Maintenance Earthing Switches.

7.9.6 Test Facilities

The maintenance and service continuity requirements found in this section shall apply to all installations.

It may be necessary for maintenance earth switches to be equipped with insulated bushings for test purposes.

The customer shall provide isolatable maintenance earths where required. The relevant insulation level (AC and DC) of the earthing connection (when removed) shall be available. Where insulated bushings are provided, details as Section 8.6.6 shall apply.

7.10 Instrument Transformers

This section should be read in conjunction with XDS-GFS-35-001, which provides ratings and general requirements for instrument transformers.

This specification provides additional requirements for the construction and interfacing of instrument transformers with gas-insulated switchgear.

7.10.1 Terminal Boxes

Secondary windings shall be wired and connected to the terminal boxes and from there to the marshalling cabinet/ LCC.

Terminal boxes of instrument transformers shall be located outside the high voltage enclosure.

Means for short circuiting and earthing shall be provided in the LCC. The terminals and their arrangement shall be submitted to EirGrid for approval.

The terminals in the LCC shall be as outlined in EirGrid specification XDS-GFS-07-001.

Where billing and check metering CT/ VTs are installed in the switchgear, the secondary terminals shall be located in separate, sealable and accessible terminal boxes.

The Customer shall ensure that the star point wiring is implemented at the base of the CT terminals in the Metering marshalling kiosk enclosure for Metering Circuits.

7.10.2 Current Transformers

Current transformers shall meet the general requirements of IEC 61869-1 and IEC 61869-2 and the requirements of XDS-GFS-35-001.

Suitable measures shall be taken to prevent induced current in the enclosure interfering with the performance of the current transformers. The method shall be described by the supplier.

Direct connection of gas insulated switchgear to power transformers is not a preferred solution. If it is installed then provision shall be made for a CT in the bus duct section between the bay earth switch (DE) and the transformer bushing for busbar protection purposes (in line with EirGrid protection requirements).

7.10.3 Ring Type Current Transformers

A separate protection ring type current transformer shall be mounted around the outgoing cable or cables together with a copper earth return or bonding lead. Solid ring core type is preferable, split core CTs are acceptable.

Supports, when incorporated onto cable termination support steelwork shall be designed to avoid circulating currents.

The manufacturer shall confirm the window diameters of the current transformers offered. Minimum inner window diameters are indicated in XDS-GFS-35-001.

Where ring CT's are used for billing and check metering applications, the secondary terminals shall be installed in Metering Marshalling Kiosks in the Cable Basement room as illustrated in Photo 1.

Photo 1 Ring CTs and Metering marshalling Boxes

7.10.4 Voltage Transformers

7.10.4.1 General Requirements for Voltage Transformers

Voltage transformers shall meet the requirements of IEC 61869-1 IEC 61869-3 and the EirGrid instrument transformer specification see 4.2.1

VTs shall be mounted directly on the high voltage enclosure with plug-in contacts that allow easy removal.

Revenue metering VT secondary terminals shall be located in separate, sealable and accessible terminal boxes.

Measures designed to prevent ferro-resonance in VTs, where necessary, shall be proposed and described in the tender.

Voltage transformers shall be capable of discharging safely the connected cable capacitance.

7.10.4.2 Protection Of Secondary Windings

. The MCB for downstream protection of VT circuits shall be located in the LCC. Refer also to the EirGrid instrument transformer specification see 4.2.1

7.10.4.3 Open-delta / residual voltage secondary windings

The single pole MCB for downstream protection of the open-delta circuit shall be in the LCC on the 'a' side only. Refer also to the EirGrid instrument transformer specification see 4.2.1

7.10.5 HV Cable Test Requirements for GIS

HV cables are generally connected directly to the GIS switchgear without open air terminations.

HV cable withstand tests shall be performed in accordance with IEC 62067 at varying frequencies between 20 Hz and 300 Hz.

It shall be possible to perform routine high voltage commissioning tests on the connecting underground cables utilising a connection point on the GIS without having to remove the cable termination.

The line disconnector between the circuit breaker and cable shall be opened during this test. The Customer shall be in a position to confirm the suitability of the cable connection compartment for the application of the varying frequency voltage.

During the test the voltage transformers at each station shall be isolated to facilitate the application of a varying frequency voltage in the range of 20 Hz to 300 Hz onto the HV cable while connected to the GIS.

It shall be possible to disconnect the inductive voltage transformers from the HV bay by removal or disconnection of an internal link within the gas compartment.

Each feeder shall facilitate removal of the voltage transformer to allow connection and testing of HV cable.

(During a HV cable test at the remote station end, assuming it is also a GIS station the voltage transformer shall be disconnected by removal of an internal link within the gas compartment.)

When removing and inserting the link, the voltage transformer may be de-gassed but not the rest of the bay. The voltage shall be applied onto the cable utilising the connection flange for the voltage transformer.

The Customer shall provide one AIS test bushing and GIS adaptor per installation to connect onto the flange in place of the voltage transformer for application of the voltage in accordance with rated voltage.

Details and drawings of the adaptor proposed shall be available.

As part of the switchgear assembly works the Customer shall facilitate training in connection requirements for HV cable testing for removal/ disconnecting voltage transformers and connecting HV cable test kits.

7.10.6 Power Voltage Transformers

Customer shall provide the optional feature for supply of a power voltage transformer which may be used to perform dielectric testing (power frequency withstand tests) on the GIS installation without additional equipment in the future.

The power VT's shall be fitted to a nominated bay(s) in place of the conventional VT and suitable for performing the withstand test on any busbar section and a bay connected to the busbar.

The customer shall state the capacitive limitations of a single VT in accordance with the project specific SLD and advise the minimum number of power VT's required.

7.10.7 HV Cable / Capacitor Bank Discharge Capability

Some voltage transformers may be required to discharge long lengths of high voltage cables or high voltage capacitor banks. The cable or capacitor discharge capability at different voltages shall be outlined in the TECHNICAL SCHEDULES.

Typical requirements (to cover maximum cable lengths) on the networks covered by this specification are as follows:

Table 5 Voltage Transformer Discharge Capacitance

Rated Primary Voltage kV	Discharge Capacitance µF		
	XLPE Cable	Oil-Insulated Cable	Capacitor Bank
110/ √3	6.0	6.0	13.0

7.10.8 Busbar Voltage Sensors – Low Power Instrument Transformers

Capacitive or field probe voltage sensors shall be installed for the purpose of measuring power flow indication across the busbar.

These non-conventional instrument transformers or low power instrument transformers as defined by IEC 61869 shall be incorporated into a suitable gas compartment of the relevant bay(s) and calibrated on-site by the customer.

The customer may offer dedicated window or probe type sensors contained within gas compartments other than the circuit breaker compartment.

Alternatively it will be acceptable to utilise a sensor on the switchgear, intended for the purpose of periodic partial discharge measurement, as the voltage sensor during normal service.

Any necessary converter electronics for the sensor shall be housed within the LCC of the bay supplied with the switchgear.

The manufacturer may supply a passive voltage sensor for direct connection to the Integrated Control and Protection (ICP) relay, or a complete system compromising of the sensor and converter electronics.

The system supplied shall include all necessary shielded cabling of fixed lengths to interconnect the sensor to the integrated or standalone LCC included in the GIS scope of supply.

The system (sensor + converter) shall be capable of providing the required voltage output to the customer's ICP relay located within the bay LCC.

Fixed external capacitors for the system shall be connected via industry standard BNC connections directly at the switchgear. They shall be housed within robust sealed packages easily removable for test, calibration and replacement purposes. The package shall be clearly marked with the value of capacitance and rated voltage. An insulated earth lead of minimum 6 mm^2, coloured yellow and green shall directly bond the capacitor to the frame of the bay.

One spare external capacitor shall be supplied with each installation. Where different values of capacitance are used on coupler and sectionaliser bays one of each shall be supplied.

The sensor or system shall provide an output signal in accordance with one of the following options:

1) The sensor or system shall provide a secondary voltage of 0 to 100 V/√3 to the Customer's ICP relay for the rated operating voltage.
    - Secondary output voltage 0 – 100 V/√3
    - Overvoltage capability 1.9 x UN for 30 seconds.
    - Input burden of the relay 0.06 VA at UN = 100 V/√3
    - Class accuracy of the system CL 2 or better

The sensor shall be calibrated so that accuracy is maintained at switch room ambient temperatures of -5 °C to + 25 °C.

Where the specified secondary voltage output of the system is not possible, the manufacturer may, subject to approval by the Purchaser, alternatively offer the following secondary output(s);

- -20 to +20 mA input burden of relay 121Ω
- + 4 to 20 mA as above
- -10 to + 10 V input impedance 11.3 kΩ @ ±10 V

Where a system is proposed to fulfil the requirement of this specification the auxiliary voltage supply for the converter shall be 220 V DC (+10 / -15 %).

2) An EN 61850-8-1 databus serial communications port to connect to the Employer's bay control device.
3) An EN 103 slave protocol serial communications port to connect to the Employer's bay control device.

7.11 Surge Arresters

Surge arresters may be required in some installations.

The Customer shall indicate how GIS Surge Arresters can be installed at cable sealing ends and Gas / Air bushing interfaces.

The arrestors shall be in separate gas compartments to the busduct and bushings.

Surge Arresters fitted to GIS shall comply with requirements of IEC Publication 60099-4 and shall be gapless metal oxide.

- 110 kV surge arresters shall have a reference voltage of 114 kV
  - LIPL (max) of 295 kV
  - nominal discharge current 10 kA and
  - IEC Discharge Class 3
- 220 kV surge arresters shall have a reference voltage of 228 kV
  - LIPL (max) of 592 kV
  - nominal discharge current 10 kA and
  - IEC Discharge Class 2 as a minimum.
- 400 kV surge arrestors shall have a reference voltage of 396 kV
  - LIPL (max) of 1029 kV
  - Nominal discharge current 20 kA and
  - IEC Discharge Class 5 as a minimum

7.12 Access and Layout Requirements

LCCs are required for local plant operation during commissioning, testing and maintenance for both RTU and SCS applications.

In all GIS transmission substations, the switchgear in each bay shall be locally controlled at the GIS switchgear by its own individual bay local control cabinet (LCC) located in close proximity to the switchgear either integrated within the GIS switchgear as shown in Figure 5 or free standing.

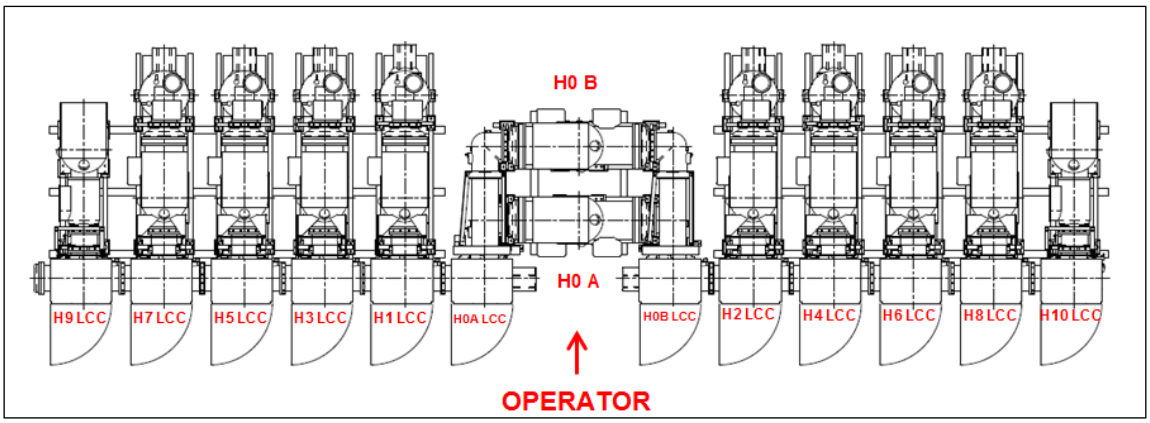


Figure 5: Representation of LCCs integrated in GIS switchgear

Where free standing LCCs are specified for use for a particular installation they shall be installed directly opposite the corresponding GIS switchgear bays, and the operator viewpoint shall be towards the LCCs as indicated in.

LCCs to the left from the operator's viewpoint shall have odd numbers and those to the right shall have even bay numbers.

7.13 Physical Requirements

LCC cabinets shall be arranged to accept control cables from the switchgear on gland plates. Cabinets shall be swing frame type with door opening outwards to the left hand side. All points of control, including AC, DC and VT MCBs shall be located on the front of cabinets to allow operation and inspection without stepping inside or opening the cabinet. Removable gland plates shall be labelled with permanent stickers identifying the Safe Working Load (SWL) that the plate may bear.

All points of control within LCCs shall be located at a height of less than 1800 mm above operator standing level.

The Customer shall;

A. Design, supply and install access platforms, placing all control points within 1800 mm from the access platform standing level – (see also section 6.9).

   or

B. Supply and install freestanding cabinets mounted separately to the switchgear with all controls within 1800 mm of ground level.

7.14 RTU & SCS LCC Applications

In the case of RTU stations, a mimic diagram depicting each individual bay shall contain the relevant operational control and position indications of all HV plant on the LCC (including VT symbols).

In the case of SCS stations, a single Bay Control Unit (BCU) is mounted in the bay specific LCC, the control of which is provided for by the LCD HMI mimic.

The LCC mimic shall be designed with clear positioning and labelling of control discrepancy switches, with the standard ESBN plant designations ***only*** as per project specific SLD and signals list. IEC designations shall not be installed on LCCs.

In double busbar stations, the "A" busbar shall always be shown on top of the "B" busbar.

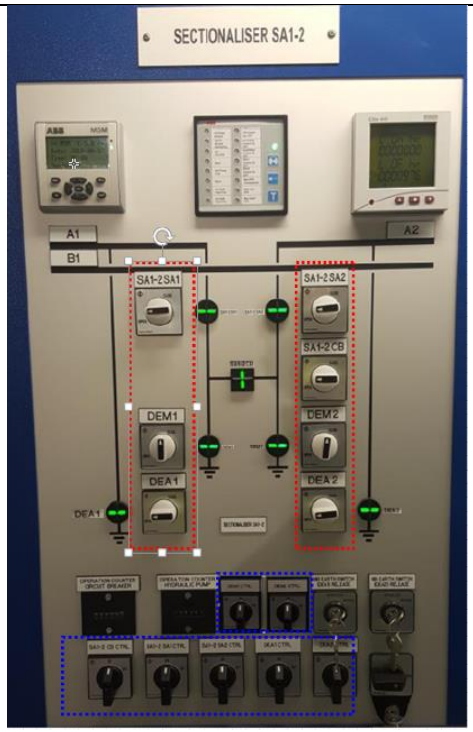


Photo 2 LCC RTU Application

Photo 3 SCS Application

7.14.1 LCC Control Switches & Control On / Off Switches

For RTU applications only, the LCC mimic shall have Illuminated control and discrepancy type switches installed for operational control of all circuit breakers, disconnects and earth switches (maintenance and high speed). The light shall be Steady for correct position, flashing 1:1, 1 s in the discrepancy. A Centralised flashing source is required.

These operational control switches shall be located adjacent to their respective HV plant symbol on the LCC mimic (as illustrated by the red dotted box in Photo 2).

For SCS applications, operational control of the HV plant will be provided via the LCD HMI mimic.

For both RTU and SCS applications, Control On/ Off switches for all HV Plant circuit breakers, disconnects and earth switches (maintenance and high speed) shall be installed on the LCC mimic (as illustrated by the blue dotted box in Photo 2 and Photo 3). With a square base for CB and circle for others.

Where separate motors are provided for disconnectors and maintenance earth switches the customer shall install separate control switches; On/ Off switches.

Position indication of the Control On/ Off switches shall be ganged for each bay to provide position indication to the National Control Centre (NCC) of the remote control status. The NCC shall receive Double Point Status Indications if one or more of the switches are in "Off" position, which will be further outlined in the project specific signal list.

7.14.2 Local / Remote Control Key Switch

The LCC Local / Remote Control Key Switch applies to both RTU and SCS controlled GIS transmission stations.

A dedicated key-switch to permit selection of local or remote control shall be installed in the LCC for each bay. The facility to attach a hold-off notice using a cable tie or similar fastener shall be provided on this key-switch.

This switch is used as a last safeguard for personnel working on HV equipment with full knowledge that all remote commands are blocked and the equipment is safe to carry out commissioning, testing or maintenance.

The switch shall operate as follows:

- In **Local position** operational control can only be performed locally at the LCC. Remote operational control is not possible from the Station Control Cabinet (MIMIC / SCS HMI) or from NCC/ DCC.
- In **Remote position** (Normal operating position) operational control can only be performed remotely via the Station Control Cabinet and NCC/ DCC. Local operational control is not possible from the LCC.

7.14.3 Earth Unlock Key Switch

For RTU stations, **a dedicated earth unlock key switch** is installed on the LCCs for Feeder Earth Switches and Customer Transformer Earth Switches as outlined in the project specific interlocking specification.

These dedicated earth unlock key switches are fitted on the Station Control Cabinets / Mimics also.

This key-switch is designed as an additional step for operators (to stop and think) before operating an earth switch.

Please note, that no dedicated earth unlock key switch is required in the case of SCS station LCCs.

For SCS applications, the system's own command logic provides adequate protection. (i.e. if the system requires the operator to go through a two or three step decision process to operate the earth switch this is deemed to provide an equivalent level of protection).

7.15 Control Wiring And Marshalling

Suitable EMC-shielded control cabling between the switchgear and LCCs shall be installed and they shall be BLACK in colour.

The pre-cut lengths of control cable shall arrive pre-terminated on the switchgear or incorporate plug and socket systems to facilitate plug-in connection to the switchgear (excluding CT and VT circuit wiring). Such plug in type connections shall be connected on the exterior of the LCC to ensure EMC rating is maintained.

All current and voltage transformer secondary connections, controls, alarms, indications, AC and DC supplies shall be wired to file terminals.

Where necessary, provision shall be made at the file terminals for connecting and earthing multi-core screened 6 mm^2 for CT circuits and 1.5 mm^2, VT circuits and control cables.

Spare auxiliary switch contacts shall also be wired to the file terminals.

Adequate space shall be provided for the termination and connection of the additional cables required for external future interlocking.

Spare terminals shall be provided (10%) for future use.

File terminal type shall be as follows:

- Terminals for CT secondary circuits shall be Phoenix UGSK / S and URTK / SP.
- Terminals for VT secondary circuits shall be Phoenix URTK / S.

The customer shall submit drawings clearly identifying the physical layouts of the proposed cabinets including all terminals, location of devices, size of trunking, etc.

PVC trunking fitted with PVC covers shall be used within the LCC.

The trunking must be sized to accommodate all the wiring with sufficient spare capacity for future wiring installations.

The proposed cabinet arrangement drawings will be subject to detailed design review.

It shall be possible to bridge-out i.e. short-circuit the current transformer secondary circuits at each of the relevant file terminal blocks.

All interconnections between LCC's for common supplies, position indication. Shall be connected via isolatable type terminals.

Terminals and connections used in the LCC shall be designed to minimise potential disruption when extending the station to incorporate additional future bays. (Particular emphasis is required when designing busbar and interlocking schemes to ensure that the expansion of these schemes allow for the ultimate GIS development.)

This means the terminals and connections used shall be designed to facilitate the disconnection, bypass and removal of a bay and its associated LCC without disruption to the secondary control systems and functioning of adjacent LCC's.

LCC wiring from which extension is to take place shall have disconnector type terminals on critical circuits in order to provide 'minimum disruption' e.g. no disabling of interlocking and busbar protection associated with initial GIS development.

7.15.1 Electromagnetic Compatibility (EMC)

Shielding of the control cables, the LCC, control and marshalling boxes shall be designed to reduce or eliminate the risk of EMC emission. The LCC and GIS shall have been type tested for EMC compliance as per clause 6.9.1.2 of IEC 62271-1

7.16 Additional miscellaneous items

7.16.1 local metering

For RTU applications, a Multi-meter indicating the line voltage and current of each feeder and transformer outlet shall be provided at the LCC for each bay. CT terminals for ammeter connection are to be URTK / SP type.

For SCS applications, the local metering shall be made available in the BCU on the LCC.

7.16.2 Fault Signalling

In addition to any alarm and display of switchgear faults provided locally, each fault device shall have a voltage-free N/C contact, wired to terminals for connection to the substation signal system.

7.16.3 Additional requirements

Fixed lamps with door switches shall be provided in all cabinets.

230 V AC anti-condensation heaters shall be installed in each cabinet.

7.16.4 Cable Voltage Indication and Interlocking

The connection of the Voltage Transformers to the GIS shall be in accordance with the SLD. Standard practice requires the VT to be connected to the cable side of the line disconnector (i.e. QC3 in the case of double busbar installations).

The Contractor shall provide and wire capacitive voltage detection devices (or other approved indication device) into the switchgear on an insulated flange or other point in close proximity to the HV cable connection. The visual display connected to the voltage sensors shall be installed on the front face of the LCC along with the electrical control points.

The detection device shall be approved in accordance with IEC 61243 and shall have a threshold voltage (factory selectable) between 0.1 and 0.3 pu of the nominal voltage. The Contractor sets the detection devices appropriately as required for each installation.

The device shall incorporate voltage free contacts to indicate the presence of voltage and enable integration into the interlocking scheme of the bay or busbar. Contacts shall be rated to switch 220 V DC +10/-15 % at 0.1 A inductive. The device shall incorporate a 'watchdog' or healthy indication status contact which shall be incorporated into the Employer's Bay control unit in event of supply failure or fault with the device.

8 Interlocking

The interlocking conditions are designed to prevent:

- The operation of disconnectors under load.
- The operation of earthing switches on to a locally energised circuit.

An interlocking scheme must be designed so that it is fail-safe i.e. the failure of any part of the scheme must not allow an inadvertent operation.

Primary contacts from the high voltage switchgear shall be used for position indication to the interlocking scheme. Where auxiliary relays are incorporated in the interlocking scheme, they shall be operated in a fail-safe mode. The use of auxiliary relays must be approved by EirGrid.

It shall not be possible to inadvertently store a switchgear open or close command through hold on circuits or other means.

The interlocking design for the station shall be designed to allow for the ultimate development of the station by considering future interlocking modifications during future phases.

The interlocking design for initial phases shall be future proofed in a fashion to limit disruption to existing interlocking circuits when extending the scheme for future bays.

For example, future bay busbar disconnect interlocking coupling conditions in particular shall be designed with a view of minimising modifications to existing interlocking circuits in the live stations.

9 Gas and PD Systems

The Customer shall have available details of all external devices and sub-suppliers, e.g. Gas Density meter or PD Sensor, which the manufacturer proposes to use on the switchgear and have available details of all design provisions taken to prevent corrosion, moisture ingress into the devices and durability for the required lifetime of the switchgear.

9.1 Gas Systems

Except where otherwise indicated, this section applies to all gases used within GIS as an insulating and interrupting medium.

The switchgear shall be divided into individual, separately monitored, gas tight compartments so that maintenance may be carried out on the equipment in one compartment with the remainder of the plant in service. Each gas compartment shall be capable of being fully evacuated within 60 mins by the provided gas equipment.. See also section 6.11 for service continuity requirements.

It is basic policy that work shall ONLY be carried out in a particular gas compartment when the adjacent gas compartments are at maximum of 200 kPa (2 bar) absolute pressure of Gas.

The customer shall demonstrate that Gas barriers provided are designed and tested to withstand the differential pressure resulting from this requirement.

This is required for example to maintain a bay with the busbar still being in service. Where this cannot be achieved normally, extra gas compartments must be included to meet this requirement in the case of double busbar installations. The equipment shall be designed to minimise the outage requirements associated with the construction and commissioning of future substation extensions.

The circuit breaker compartment shall have filters for removal of gas contaminants. Filters shall be accessible for replacement and identifying labels placed on the compartment indicating their location.

The Customer shall submit the details of the methodology utilised to achieve this service continuity level.

9.1.1 Gas Monitoring

9.1.1.1 General requirements

A stainless-steel plate showing the pressure/temperature characteristics for the Gas in the equipment at normal, alarm and insufficient / lockout Gas density shall be affixed to the inside of the control cabinet or appropriate location to ensure easy viewing by an operator. The plate shall state the quantity of Gas contained in the equipment in kg.

Flanges on all compartments shall incorporate non-return valves to allow transducers to be removed and tested while the compartment is fully gassed and energised. In compliance with EU Regulation S17/2014 covering greenhouse gases it shall be possible to remove, re-calibrate and replace the gas density relays, pressure transducers and to extract gas samples with the main equipment in service – i.e. without the need for evacuation of the gas, disassembly of the equipment or removal of the density monitor.

Calibration certificates for all transducers shall be provided with the technical documentation of each order.

For circuit breaker compartments, the second stage of monitoring shall prevent any further operations of the equipment through a fail-safe lock out device.

Easy access to gas density relays and gas filling points shall be provided while minimising the lengths of piping required.

A gas schematic drawing showing all HV functional devices (Gas barriers, compartments, Gas filling points and associated labelling) shall be displayed on the wall opposite the HV plant for operators and maintenance personnel.

The drawing shall conform (as closely as possible) to the physical layout of the GIS equipment and shall show all gas barriers, valves, piping and monitors.

9.1.1.2 Local Gas density/Pressure gauges

Each Gas compartment shall be fitted with a gas density monitor(s) and associated gauge(s) to provide local pressure indication and remote indication of pressure status.

Where busducts are installed, the Contractor shall position the densimeters within the building where possible.

Gauges shall indicate 'gauge' pressure in kPa, i.e. pressure relative to atmospheric pressure, and shall be temperature compensated for a temperature of 20ºC.

Scales shall have sufficient gradations to facilitate visual confirmation of pressure changes over a period of time and shall be coloured in accordance with the gas operating levels and alarms as follows:

Green:	Correct operating pressure range
Yellow:	Low gas pressure corresponding to first stage alarm
Red:	Insufficient gas pressure corresponding to second stage alarm (and lockout for circuit breakers):
Yellow or orange	Overpressure

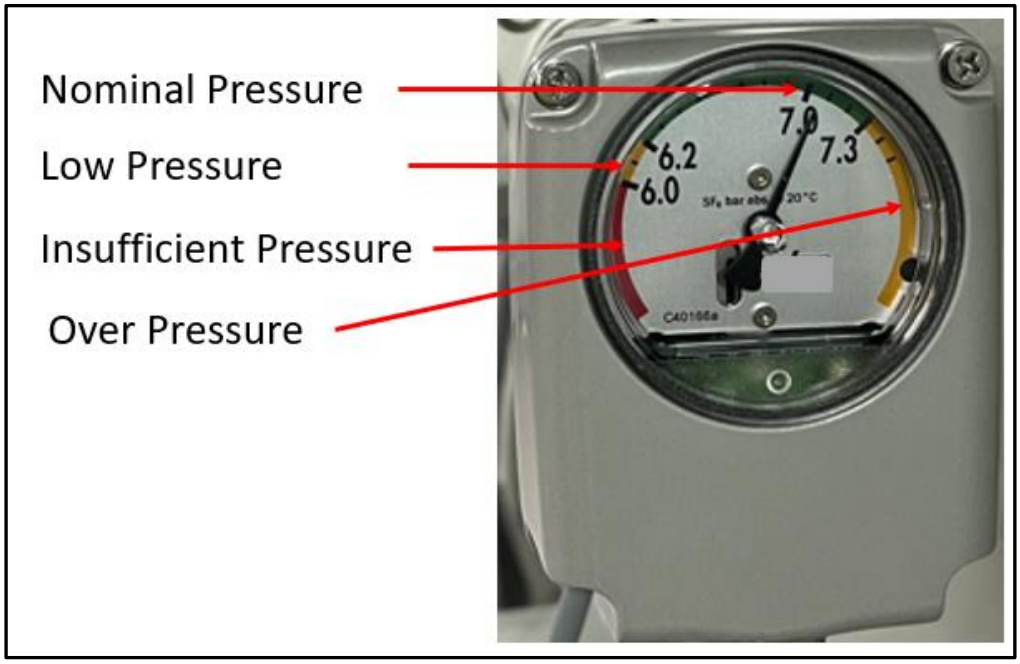


Figure 6 Example of densimeter with colour coding for the various pressure stages

Where gauges are of the analogue type they shall be fitted with a mechanical pointer, damping mechanism and scaled faceplate.

Gauges shall be clearly visible from ground level, or fixed platform as appropriate.

Gauges positioned below 1800 mm shall not protrude outwards into walkways surrounding the switchgear. This is to prevent strike damage from moving equipment such as trollies and gas carts. Protective shields shall be otherwise provided and fitted.

Local gauges have three or four voltage free contacts for alarm and tripping purposes, arranged as follows:

Non-Circuit Breaker compartments

- The first stage alarm contact shall operate when the gas has dropped below "normal operating pressure".
- A second stage contact shall operate when the gas reaches the limit for safe operation of the equipment.

- A third contact shall operate when the pressure increases to the overpressure limit.

Circuit Breaker compartments

- The first stage alarm contact shall operate when the gas has dropped below “normal operating pressure”.
- Two second stage contacts shall operate when the gas reaches the limit for safe operation of the equipment.

  One of these contacts will be used for alarm purposes and the other for tripping/ lockout.
- The fourth contact shall operate when the pressure increases to the overpressure limit.

9.1.1.3 Digital Monitoring System

A complete system shall be provided for remote monitoring of Gas pressure in each compartment, including hybrid type density/pressure sensors, transducers and associated works.

Density/ pressure sensors shall have a leakage detection accuracy of 0.5 % or less, or 0.1 % or less in the case of a hermetically sealed system.

The output of transducers shall be an industry standard non-proprietary or non-OEM specific analogue or digital signal suitable and shall be interfaced to an appropriate data collection unit in the LCC.

Full information of signal formats, protocols etc. shall be provided as part of the design information to enable operators to replace sensors and transducers where required.

Digital monitoring and display units shall be provided per bay.

Each digital display unit shall:

1. Provide a digital visual display showing all gas compartments, the pressure of each compartment in kPa and a colour coded indication of health – corresponding to the coloured pressure ranges indicated in 9.1.1.2
2. Provide voltage-free contacts for first and second-stage pressure alarms and over pressure alarm.

Digital systems shall be self-monitoring incorporating processor, watchdog alarm i.e. they shall generate an external alarm via voltage free contacts in the event of auxiliary supply loss, transducer failure or processor failure.

All data shall be accessible via a non-propriety or non-OEM specific (i.e. open source) interface.

Data shall be downloadable in an open source data format file, e.g. .xml or .csv and capable of being remotely accessed via mobile networks directly by the Employer. SIM cards for mobile service providers shall be provided by the Employer where required. The monitoring data shall be directly accessible by the Employer and not via OEM specific cloud-based services.

9.1.2 Gas Service Cart and Connections

The gas service connection for each gas compartment shall be readily accessible without the use of special access equipment.

A gas filling / sampling valve, type DILO DN20 shall be fitted to the equipment. These shall be directly incorporated onto the switchgear compartment casings at manufacturing stage. The provision of adaptor valves or similar transition fittings to facilitate this type of connection is not acceptable. Gas-tight covering caps shall be provided for all fittings.

The Customer shall supply a DILO type Gas service cart for the installation and maintenance of the equipment on handover of the station with the following;

- Gas compressor, oil free suction and vacuum pump rated for operation from a 400 V supply.
- Dry filter, particle filter, evaporator, Gas bottle scale

- 10 m long interconnecting hoses with DN20 fittings
- Pre-filter unit and on board storage tank

Or in the case of clean air, the provision of a clean air generator to be discussed on a project by project basis.

The gas cart shall be on a chassis suitable for lifting by forklift and stored in a suitable indoor location in the station.

9.1.3 Gas Alarm System

The Customer shall connect each gas density alarm to the station alarm system. Facilities shall be provided to allow temporary blocking of density alarms from an individual gas compartment.

9.1.4 Sealing

The enclosures shall be designed to limit the gas leakage within the anticipated life-span to very low levels. The lifetime of the gas tight seals shall be at least equal to the anticipated lifetime of the plant (i.e. 40 years).

The GIS equipment shall have a maximum annual gas leakage not exceeding 0.1 % per annum per compartment.

The Customer shall submit the following information in their Submission:

1. Static positions, i.e. Pipe flanges etc.
2. Dynamic positions, i.e. Disconnector / Earthing Switch Drive shafts, etc.
3. Design life of seals
4. Drawing and detail of the 'O' ring sealing design used
5. Details of gas detection methods
6. Details of gas sampling methods with the plant in service
7. Details of Gas pipework and connectors

9.1.5 Pressure Relief

The Customer shall provide details of the pressure relief system design including the basic principle of its design and operation.

The pressure relief system shall allow operation under normal conditions and first-stage protection to clear a fault before pressure-relief device operation.

Pressure relief devices shall operate before burn-through.

The Customer shall demonstrate coordination of overpressure relief devices with protection in accordance with Table 4 and Annex D of EN 62271-203.

Overpressure resulting from an internal arc shall not result in hazardous emission of decomposition products or material fragments of the equipment.

Pressure relief devices shall be equipped with a deflector to control the direction of emission to effectively manage any danger to operators.

The location of pressure relief devices and vents shall be coordinated with the wider installation design, including room design and building services as part of the overall system risk assessment.

9.1.6 Gas Specification

Documentation shall be provided for each installation and item of equipment filled on site with gas. Documentation shall record the quantity of gas placed in each compartment in kg and the total overall volume of Gas in the equipment. All records provided shall be in absolute pressure only.

Documents shall be provided with all gas on site indicating the quantity of gas contained, and quality control measurements appropriate for the gas.

For SF6 the quality control measurements to be included are indicated in Table 6.

Where gases other than SF6 are used, equivalent quality control measurements shall be documented, following the standards to which the gas is manufactured.

Details shall be provided of the degree of gas deterioration which can be tolerated in circuit breaker interrupter compartments and the recommended time interval between replacement of any absorber material. Details of necessary absorber material and gas treatment shall be given.

9.1.6.1 SF6

All SF_6 gas used to fill/top up equipment shall comply with IEC 60376.

New gas within the switchgear shall comply with Table 6 when sampled from the compartment after filling:

Table 6 SF6 Specification

Minimum % SF_6 purity and quality	99 %
Minimum Dew point value measured at 20 C and at 1 bar absolute pressure.	- 36°C (200 ppmv)
Maximum SO_2 value	0 ppmv

Alternative gases shall comply with IEC 63360 (new non-SF6 gases) when sampled from the compartment after filling

9.1.7 Storage of Gases on site

Cylinders containing gas shall only be stored on site for the duration of the installation and commissioning works for which it is required.

Any gas cylinders on site after this period shall be removed.

Empty bulk storage cylinders supplied with the equipment may remain on site for future maintenance works only where agreed by the TAO for the particular project.

9.1.8 Testing Quality and Handling

Testing quality and Gas handling work shall be performed in accordance with IEC 62271-4 with consideration of CIGRE best practice. Where a discrepancy exists between the IEC and the quality limits as specified in 9.1.6, the latter shall apply.

9.2 Partial Discharge Sensors

The Customer shall incorporate partial discharge sensors within the switchgear at manufacturing stage. The sensors shall be UHF or other similar type that may be connected to the station monitoring system at a future stage of the switchgear lifetime. Barrier or window type sensors may be utilised.

An external monitoring system is not required at this stage. The purpose of the sensors shall be to detect internal PD activity when the switchgear is in service and not under test conditions.

Connection of an external monitoring system to the sensors shall be facilitated via an industrial standard shielded connector (BNC coaxial or similar) externally located on the switchgear casing. No additional wiring or connections are required.

In the case of three-phase encapsulated switchgear the Customer shall provide a single sensor per bay and busbar section. For single-phase encapsulated switchgear the Contractor shall include single sensors on each bay and busbar phase at suitable locations. Locations of the sensors shall be indicated on physical drawings of the switchgear.

10 Ventilation and Safety Considerations

10.1 Gas Safety Notes

10.1.1 SF6

CIGRE Document TB 276 states the following:

- "Pure SF_6 is odourless, tasteless, non-toxic, non-corrosive, non-flammable and chemically inert at ambient temperature. It does not support combustion.
- "Although the gas is non-toxic, it does not support life, as it is not oxygen. Equipment containing SF_6 must not be entered without adequate ventilation and personal protection equipment."
- "As the gas is heavier than air, areas below ground level, poorly ventilated or unventilated areas (i.e. cable ducts, trenches, inspection pits, drainage system, etc.), may remain full of SF_6. Personnel must be aware of the danger of asphyxiation in such places"
- "like any gas but oxygen, a concentration greater than 19% of SF6 in the air is considered as potential risk of asphyxiation."
- Table 6 provides general measures when working with SF_6 switchgear.

Training is mandated for work in the vicinity of SF_6 switchgear.

PPE is mandated for opening of SF_6 gas compartments and work on open compartments.

10.1.2 Gases other than SF6

Full details are not known at this time.

The Customer shall provide full safety notes and any recommended procedures from the manufacturers associated with working with the gas used.

The Customer shall provide training to ESB staff on recommended practices for handling of the gas and operation and maintenance of the equipment, including consideration of arcing events, resultant breakdown products and controls/PPE required.

10.2 Risk Assessment

The Customer shall carry out a risk assessment to determine the risks due to working with the gas used as insulating and interrupting medium, and propose suitable control measures appropriate to different tasks, including ventilation during work activities and the use of personal oxygen monitoring devices.

Where the use of personal oxygen monitoring devices is recommended for certain tasks this shall be reflected in appropriate signage.

Where the installation has a cable basement this signage shall be included in the sign to be located at the top entry to the basement, adjacent to the ventilation control panel. Refer to XDN-LAB-STND-001 Station Labels for further details.

10.3 Installations with Cable Basements

Oxygen displacing gases, including methane can accumulate in basements and confined spaces and can therefore be hazardous to persons working in basements.

The Customer shall design and provide a mechanical ventilation system for all new GIS installations which have a cable basement.

The Customer shall demonstrate that the capacity of the system is sufficient to meet building regulations, taking into account the size of the basement, occupancy and other factors as required.

The ventilation system shall operate independently from the lighting system and shall be controlled from a dedicated control panel located at or close to the hatch at the top of the access stairwell to the basement.

The ventilation system will be operated according to the following guidelines:

1. Work in cable basements will not be permitted during gas handling works on equipment (e.g. filling or degassing of switchgear) to avoid the hazard to staff of accidental leakage e.g. due to valve failure or hose rupture.
2. The basement ventilation system will be operated while persons are working in the cable basement – provided such works are consistent with item 3.
3. Ventilation shall not be operated when there is a known leakage of SF_6 or any gas with a GWP greater than zero, unless for health and safety reasons.
4. In the event of a leak of SF_6, or any gas with a GWP greater than zero, the operator is required to contact the specialist TAO SF_6 team.

The risk assessment provided by the Customer shall identify the depth which the SF_6 will occupy in the basement area, and shall identify the corresponding risks to persons working in this area and the appropriate control measures.

The results of this analysis will inform the operation and maintenance of the plant including the appropriate response in the event of SF_6 leaks.

The ventilation system shall incorporate a basic air filtering facility to remove particles from the extracted gas in the event of a rupture of a switchgear gas compartment. Any risks associated with the operation and maintenance, of the ventilation system, e.g. replacing filters etc. shall be incorporated into the risk assessment.

Refer to XDN-STND-001 Station Labels for details of signage requirements adjacent to the basement ventilation control panel.

11 Compartments

Compartments forming part of gas insulated switchgear shall comply with IEC 62271-203 and the relevant European standards. Compartments shall be designed so that pressure rises caused by internal arcs are limited to a safe level. The method used shall be described. Where pressure release devices are used, they must be installed so as to eject debris away from normally accessible areas to minimise danger to personnel.

The method of bolting adjacent compartments shall ensure long-term electrical conductivity to allow the flow of sheath induced currents and shall ensure continuous impedance for transient switching over-voltages. The design shall compensate for thermal expansion if necessary. If electrical segregation is necessary, special precautions shall be taken into account to avoid sparking across the flanges.

12 Earthing

The building provided for the switchgear shall have an earth conductor around its perimeter.

Refer to XDS-GFS-12-001 Earthing and Lightning Protection and XDS-DGA-00-001 General Arrangement Earthing Practice Drawings.

Provision shall be made for connecting the GIS switchgear to the substation earthing system so that touch and step voltages are kept at safe levels.

The steps taken to minimise Transient Enclosure Voltage (TEV) shall be described by the Customer. This shall include:

- Measures to keep bonding leads short and reduce inductance as far as possible.
- Measures to reduce the high frequency impedance of the earthing system around GIS switchgear through the use of meshes etc. Surge Voltage Limiters (SVLs) between the GIS enclosure and cable terminations on feeder and transformer bays.
- The Contractor shall be responsible for the implementation of the measures mentioned above.

If a number of compartments form one earthed unit, earth continuity shall be ensured across the flanged connections. An earthed unit shall be earthed at one position only.

Control units and mechanism boxes not earthed through connection to the main casing, shall have appropriate earthing terminals provided. The earth bar located within the LCC shall have a direct connection to the main earth installed around the GIS. The earth bar within the LCC shall not be earthed via indirect connections (i.e. through the GIS enclosure). The size of the earth used shall be reviewed by the Employer.

An earthing layout drawing, identifying all points of connection of the switchgear to the earth grid shall be provided with the detailed design.

During the laying of the earth grid the Customer shall keep Earthing Quality Assurance records of the earthing system as it is laid, including photographic evidence of joints and details of types of crimps and connections used.

12.1 Application of Sheath Voltage Limiters at GIS Enclosure

HV Cable sheaths and cable terminations shall be protected against voltages arising from short circuits and transient high voltages arising from GIS switching.

Protection From Short Circuits

In single point cable bonding schemes, the sheath is directly earthed at one end, and earthed via a Sheath Voltage Limiter (SVL) at the remote end. The SVL is designed to present an open circuit during normal operation, and conduct to ground in response to sheath voltages arising during fault conditions.

The sheath at the GIS switchgear end of the cable is directly earthed, and the sheath at the remote end is earthed via an SVL. Refer to the 110 kV, 220 kV and 400 kV Underground Cable Functional Specification CDS-GFS-00-001 for further details and requirements.

Protection from Switching Transient Overvoltages

Switching of GIS switchgear, in particular closing of disconnects, creates Very Fast Transient Overvoltages (VFTO's) and Transient Enclosure Voltages (TEVs). These phenomena manifest themselves as high potential

differences of very short duration between the body of the GIS and accessible metallic parts[8], even where such items are directly bonded to earth[9].

Suitable Surge Voltage Limiters (SVLs) shall be installed between the GIS enclosure and cable terminations on each feeder and transformer bay to mitigate against VFTO's/TEV's.

All bonds and connections shall be as short as possible and designed to limit inductance.

At a minimum four SVLs shall be provided per phase, and shall be evenly spaced around the circumference of the cable termination. The exact number of SVL's shall be determined by design and agreed with the Employer.

The Customer shall submit their design to EirGrid for approval including:

- SVL Characteristics

  The preferred rated voltage of SVLs for 220 kV applications is 8 kV, and the preferred rated voltage for 110 kV applications is 6 kV.
- Details of Cable Terminations
- A bonding diagram – showing the bonding of the SVLs for protection against VFTO's. This can be included as part of the cable bonding diagram required in the 110 kV, 220 kV and 400 kV Underground Cable Functional Specification CDS-GFS-00-001.

The following types of installation are possible:

Type A This is the preferred type of connection where the cable sheath and extraneous metallic parts of the termination are galvanically connected and bonded to the frame of the GIS via SVLs. See Figure 7.

Figure 7 Type A Connection of SVL for Protection against VTFOs (showing one SVL per phase only)

[8] Accessible metallic parts include cable sheaths and extraneous metallic parts of the termination. These parts can be galvanically connected by the design of the cable termination.

[9] Direct earthing of cable sheaths at GIS switchgear is achieved by passing the sheath back through the associated external ring CT in the cable room before being bonded to an earth bar.

Type B In this type of connection the external metallic parts of the termination are not galvanically connected to the cable sheath within the cable termination. The external metallic parts of the termination are bonded directly to the GIS frame and bonded to the cable sheath via an SVL.

The effectiveness of this type of connection is limited by the additional length and inductance of the connection from the bottom of the SVL to the cable sheath. See the example photo in Figure 8.

Figure 8 Type B Connection of SVL for Protection against VTFOs (showing one SVL per phase only)

12.2 Electromagnetic Compatibility (EMC)

Attention should be given to the design of the earthing system and to the shielding of cables, cubicles, cabinets and marshalling kiosks to reduce the risk of EMC problems.

13 Civil Requirements

The equipment shall be arranged for erection indoors on a clear slab foundation in a building to be provided by the Customer.

The GIS switch room hall shall be designed to cater for the ultimate development of the station ensuring that the future switchgear works are considered in its entirety i.e. ensure the battery room is suitably located not to interfere with future expansion of GIS and cable basements.

HV cable opes and aux cable opes shall be fire sealed using industry approved firestop methods and materials to prevent fire spread.

For additional civil and heating requirements please refer to the latest revision of EirGrid Substation Civil and Building Works specification XDS-GFS-13-001.

It is the responsibility of the Customer to oversee compliance with the current building regulations as outlined in the Building Control (Amendment) Regulations (BC(A)R2014) including Part L – Conservation of Fuel and Energy.

13.1 GIS Connection Methods

13.1.1 GIS Connection to HV Cables

The assignment of responsibilities in the area of the GIS switchgear / HV cable interface shall be agreed between the Customer and EirGrid (or shall be the responsibility of Customer where they are responsible for the delivery of both) and shall be in accordance with IEC 62271-209.

The Customer shall ensure the switchgear supplier co-ordinates the design of the cable sealing end housing with the H.V. cable supplier.

Adequate space shall be provided at the rear of the GIS cable compartment for practical and safe installation of cable terminations. Removable floor covers shall be provided behind the GIS to facilitate insertion of HV cable terminations by an installer standing on a temporary platform in the cable room. Solid floors shall be installed rather than steel meshed flooring between the GIS hall and the HV cable basement to mitigate risk of falling objects into basement.

The design shall take account of the movement, vibration and expansion variations. If the earthing system of the GIS and the HV cable are isolated from each other the open connection shall be protected against over-voltages by suitably rated sheath voltage limiters.

This should be achieved with g-in type connectors. In this case, the switchgear manufacturer shall provide the sealing end housing factory fitted with integrated plug-in sockets.

Cable connection terminations shall be plug-in type connectors according to IEC 62271-209. The following examples are standard cable size connections currently installed on the Irish transmission system for reference only:

13.1.2 Pfisterer Connex terminations:

110 kV: 1,000 mm^2 Al / Cu XLPE (Size 6)

110 kV: 1,600 mm2 Al / Cu XLPE (Size 6)

220 kV 2500 Al / Cu XLPE (Size XX)

220 kV: 1,600 mm^2 Cu XLPE (Size 6)

400 kV: 1,600 mm^2 Cu / PB XLPE (Size 8)

400 kV: 2,500 mm^2 XLPE (Size 8)

13.1.3 NKT KSEV terminations:

110 kV: 1,000 mm^2 Al / Cu XLPE (Size 4)

110 kV: 1,600 mm^2 Al / Cu XLPE (Size 6)

220 kV: 1,600 mm^2 Cu XLPE (Size 6)

400 kV: 1,600 mm^2 Cu /PB XLPE (Size 9)

400 kV: 2,500 mm^2 XLPE (Size 9)

The cable termination box support steelwork shall be designed by the manufacturer to allow entry and connection of the incoming cable without removing the box from the switchgear. The support steelwork shall be designed to ensure sufficient clearance is available to install and retract the cable plug.

Provision shall be made to ensure the cable box and connected cables remain in position in the event of a circuit breaker replacement being carried out.

13.1.4 GIS Direct Connection to Transformers

The assignment of responsibilities in the area of GIS switchgear / transformer interface shall be agreed with EirGrid and the Customer and shall be in accordance with IEC / TS 61639.

The Customer will be required to co-ordinate the design of the transformer bushing housing with the transformer supplier where applicable.

GIS direct connections to transformers are prohibited as this connection method inhibits regular maintenance activities such as condition assessment of HV transformers.

13.1.5 GIS Connection to Overhead Lines (where applicable)

Gas / Air Bushings shall comply in general with IEC Publications 60137.

The bushings may be condenser type, either non oil-filled condenser graded insulation type or insulated with Graded insulation bushings shall be equipped with a measuring tap for the measurement of the capacitance and power factor of the bushing.

High Voltage bushing insulator housings shall be of composite insulation and silicon rubber sheds.

The terminals, which shall comply with IEC 62271-301, shall be flat with hole/ holes 14 mm diameter at 50 mm centres or, alternatively, 30 mm diameter round terminals. The Customer shall include full particulars of the proposed terminals in the TECHNICAL SCHEDULES.

The rated static terminal loads for bushings at 110 kV shall be as follows:

Static cantilever load 2 kN *

The minimum rated static cantilever load for bushings at 220 kV and 400 kV shall be as follows:

Static cantilever load 4 kN *

* per IEC 60137 this requires a 2,000 A rated bushing for heavy load level II.

13.1.5.1 110 kV Clearances

Clearances relating to 110 kV bushings are as indicated in

Table 7.

Table 7 Clearances for 110 kV Bushings

Item	Clearance
Minimum height above ground of bottom of insulator bushing	2300 mm
Minimum height above ground of live parts of bushing	3400 mm
Minimum distance between live parts of bushings connected to adjacent phases	1100 mm
Minimum distance between live parts and earth	1100 mm

The Reference Unified Specific Creepage Distance (RUSCD) shall be in accordance with IEC 62271-1 and IEC 60815 for rated voltage and heavy pollution level 53.7 mm/kV.

In certain cases a higher RUSCD value for very heavy pollution level 53.7 mm/kV may be required.

13.1.6 220 kV Clearances

Clearances relating to 220 kV bushings shall be as indicated in Table 8.

Table 8 Clearances for 220 kV Bushings

Item	Clearance
Minimum height above ground of bottom of insulator bushing	2300 mm
Minimum height above ground of live parts of bushing	4700 mm
Minimum distance between live parts of Bushings connected to adjacent phases	2700 mm
Minimum distance between live parts and earth	2400 mm

The Reference Unified Specific Creepage Distance (RUSCD) shall be in accordance with IEC 62271-1 and IEC 60815 for rated voltage and heavy pollution level 43.3 mm/kV.

In certain cases a higher RUSCD value for very heavy pollution level 53.7 mm/kV may be required.

13.1.7 400 kV Clearances

Clearances relating to 400 kV HV bushings shall be as indicated in Table 9.

Table 9 Clearances for 400 kV Bushings

Item	Clearance
Minimum height above ground of bottom of insulator bushing	2300 mm
Minimum height above ground of live parts of bushing	6400 mm
Minimum distance between live parts of Bushings connected to adjacent phases	4750 mm
Minimum distance between live parts and earth	4100 mm

The Reference Unified Specific Creepage Distance (RUSCD) shall be in accordance with IEC 62271-1 and IEC 60815 for rated voltage and heavy pollution level 43.3 mm/kV.

In certain cases a higher RUSCD value for very heavy pollution level 53.7 mm/kV may be required.

13.2 GIS Connection to AIS Equipment

Where connection to HV AIS equipment is involved, EirGrid will advise on the Customer requirements. Reference should be made to the latest revision of the applicable Single Line Diagram.

14 Tests

EirGrid shall reserve the right to witness type and /or routine tests and/or site tests, or visit the factory during the manufacture of the switchgear. This shall also include the testing of any device / apparatus manufactured by subcontractors and supplied to the OEM as part of the overall GIS. All the individual items of equipment offered such as circuit breakers, instrument transformers, disconnectors and earthing switches shall have been fully type-tested at an independent testing station in accordance with the relevant IEC Publication, and the test certificates or reports obtained shall be submitted for approval.

Voltage transformers shall have been type-tested to prove their capacity to discharge cable capacitances.

14.1.1 Routine Tests

All of the tests prescribed in the relevant IEC Publication shall be made on each assembled unit before shipment.

Routine tests of the equipment shall include gas leakage testing. Details of the routine gas leakage test shall be submitted to EirGrid.

In the case of the instrument transformers, winding tests and coil tests shall be carried out.

14.1.2 Tests after Installation

After erection on site, the Contractor shall subject the complete switchgear to on-site tests as agreed with the Employer. Please note the requirements of the Employer supersede the minimum requirements outlined in IEC 62271-203:2022.

The following tests shall be carried out as a minimum: -

1. Power Frequency withstand voltage tests at 100 % of factory test value for a minimum 1 min.
2. Partial Discharge measurements, utilising sensitive UHF method, over a minimum period of 5 min at the defined voltage (min 1.2 Ur)
3. And in addition also see Special Tests as per 14.1.3 below

The necessary plant to carry out the prescribed test must be provided by The Contractor for the duration of the test.

No changes to the equipment shall occur on site without agreement in advance with The Employer. Any proposed changes to the technical records provided prior to equipment delivery must be communicated clearly to The Employer and agreed in advance.

The Employer reserves the right to observe site tests. Adequate notice (two to three weeks prior to the test as a minimum) shall be provided.

Every piece of HV equipment added or replaced to the installation following the initial site test shall be subjected to a high voltage withstand test after installation as quality assurance verification and reassurance for the warranty period applicable to the new component. This applies to any item of equipment replaced as a result of flashover or fault during the test and warranty period.

The Contractor shall note this requirement and ensure on-site rated filling pressures of the compartments are designed accordingly.

Table 10 Operation, Inspection, Maintenance and Repair Activities

The following routine tests shall be carried out in accordance with IEC 62271-203:2022, clause 8 - Routine Tests	Subclause
a) Dielectric test on the main Circuit	8.2
b) Tests on Auxiliary and control circuits	8.3
e) Measurement of the resistance of the main circuit	8.4
d) Tightness Test	8.5
e) Design and visual checks	8.6
f) Pressure tests of enclosures	8.101
g) Mechanical Operation tests	8.102
h) Tests on auxiliary circuits, equipment and interlocks in the control mechanism	8.103
i) Pressure test on partitions	8.104

14.1.3 Special Tests

In additional to the on-site HV tests the following requirements of the Employer apply for the particular contract enquiry:

1. Two hundred (200) mechanical switching operations to be performed on the circuit breakers on site prior to the Power Frequency Withstand Voltage test. This test shall be witnessed by staff from the Employer and counters recorded
2. In the event of flashover not deemed as cleaning, Chambers shall be opened and cleaned as per the specified procedure utilising the correct equipment and procedures
3. With regard to UHF PD measurement the following steps shall apply (see Figure 9 below) post application of 100 % test voltage for 60 seconds
    a. UHF PD measurement at 1.2 Ur for 5 minutes
    b. UHF PD measurement at 1.1 Ur for 20 minutes without cleaning flashover
    c. Where a cleaning flashover has occurred during the first 20 minutes (see II above) UHF PD measurement at 1.1 Ur shall be repeated for 60 minutes.
    d. Where a phase resolved PD behaviour or irregular PD patterns is observed at any point during testing the UHF PD measurement at 1.1 Ur shall be conducted for 60 minutes.

Note the maximum permissible partial discharged measured shall be 5 pC.

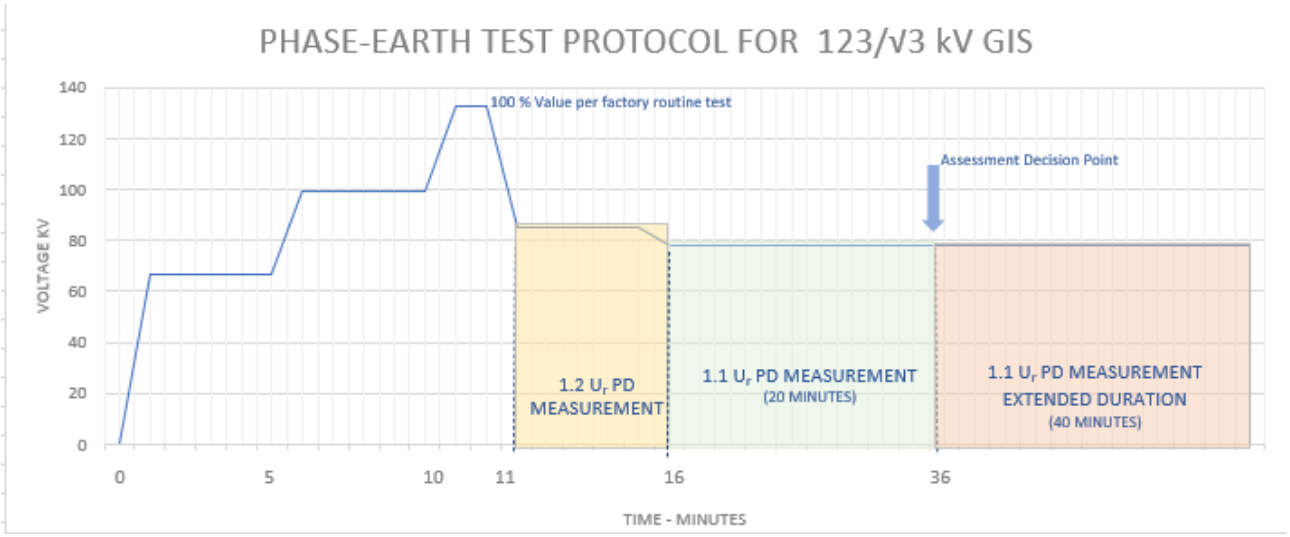


Figure 9 Test Protocol for 123 kV rated Switchgear

4. For extensions to existing GIS the new equipment shall be tested prior to coupling using the above criteria outlined in sections 2.35.03 and 2.35.04. Following this testing the new extension switchgear coupled with the existing switchgear shall be tested at a test voltage level agreed with the Employer where the age and original test voltage of the switchgear is considered.
5. If the rated voltage of the VT is below the specified Ur stipulated in 2.34.04 the VT shall be tested to the VTs rated voltage. The VT shall be then disconnected from the test circuit via the IID for the 100% factory level voltage test only. Post this voltage level test the VT shall be reconnected for the remainder of the testing and PD measurement.
6. HVDS system shall be tested and verified using the HV Kit.

The purpose of the mechanical conditioning test is to determine if particles are created by these operations and alternatively to enable the removal of any particles left over during assembly and shaken out by transport to site or dislodged due to these mechanical operations. Particles found shall be retained for analysis.

The Employer shall provide permission for the site HV tests, clause 2.35.03, to be performed only on completion of the additional operations test. Should two or more flashovers occur in any compartments during the subsequent HV test the Employer shall specify additional cleaning and test procedures to be carried out by the Contractor before testing can recommence. Note: HV Testing plan shall record gas values as per this specification which supersedes IEC. Values shall also be recorded in atmospheric values (absolute) as per the Employers norms and not vessel pressure.

15 Installation

15.1 Installation Services

15.1.1 Supply, Installation and Assembly Service

The Customer is responsible for the supply, delivery and installation of the switchgear and associated control cabinets onsite.

All necessary tools, gas handling equipment, outdoor crane, forklift and lifting facilities shall be provided by the Customer.

As a minimum the Customer shall complete the following works as part of the installation and assembly service;

a) Delivery, offloading, installation and assembly of the switchgear, Including all Health and safety documentation including method statements and risk assessments. A document shall be provided confirming date of putting into operation in line with EU reg (EU) 2024/573.

b) Installation of all switchgear, control cabinets and cabling between switchgear and local control cabinets.

c) Gas filling to rated operating pressure.

d) Functional checks and verification of the mechanical and electrical operation of all disconnectors, fault-make and maintenance earth switches, circuit breakers.

e) Electrical operation of all disconnectors, fault-make and maintenance earth switches, circuit breakers from the bay control unit at the local marshalling cabinet.

f) Verification and function of all mechanical position indication devices.

g) Verification and function of all auxiliary contacts wired to local control cabinet.

h) Circuit breaker spring charging circuits.

i) Primary injection of each phase current transformer to confirm ratio and polarity.

j) Primary injection of each phase voltage transformer to confirm ratio and polarity.

k) Verification of current and voltage measuring circuits to the bay control units.

l) Functional checks and verification of inter-bay and in-bay interlocking scheme.

m) Functional checks and verification of all gas monitoring relays and auxiliary contacts.

n) Functional checks and verification of all alarms, (including Gas pressure alarms), signals and position indication contacts to the local control cabinet.

o) Gas quality tests – dew point and % Gas.

p) Calibration tests of density monitors and pressure sensors.

q) Confirmation of all rating plate information as per approved documentation.

r) Tests after erection as per 2.32.03

s) Gas tightness and seals check. Confirm integrity of all seals, joints and valves are free of Gas leakages following filling to rated pressure.

t) Complete site test documentation detailing all functional checks and tests carried out on each individual bay and the entire installation.

Works on site shall be carried out in accordance with Irish health and safety regulations.

Upon completion of on-site testing of the assembled switchgear the customer shall pre-commission the primary GIS plant as listed above and in accordance with EirGrid pre-commissioning requirements specification XDS-GFS-20-001.

The customer shall provide a full set of documentation including factory and on-site testing and results for commissioning handover.

16 Response to Equipment Faults Pre-handover Period

Contractors may be required to operate an installation for a period before handover to the TAO, as may be defined in the project specific requirements.

Where specified, the Contractor may be responsible for the equipment while in live operation for an initial guarantee period while connected to the TAO network.

In the event of fault occurring, F-Gas by-products may be produced and lie within the faulted compartments.

The risk of contaminants being released to the environment shall be minimised and the safety of all staff shall be ensured in accordance with safe working practices.

The requirements for Personnel Protective Equipment (PPE), monitoring, disposal of tools and equipment used shall be adhered to. At a minimum, the required PPE shall include:

1. A PAPR (Powered Air Purifying Respirator) unit
2. Filters
3. inner and outer gloves
4. inner and outer chemical protective suits
5. wellington boots
6. set of safe working procedures - communication, signage, first aid kit.

The Contractor shall take note of the minimum PPE requirements, site working procedures and take instruction from the TAO F-Gas specialist team.