Document Reference: XDS-GFS-25-001-R4

Functional Specification

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

Revision History				
Revision	**Date**	**Description**	**Originator**	**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. Summary of changes below:
		
		- Section 2 Network Parameters; Content updated and information added,
		- Section 3 Standards; This section was brought forward and standards listed has been updated,
		- Section 4 Service Conditions; Removed reference to outdoor GIS and corrosion section added and content updated,
		- Section 5 General Requirements; Major changes as outlined below,
		  - Subsection 5.1 General; Content updated, such as statistics required and maintenance moved to section 6.3,
		  - Subsection 5.2 Health and Safety; New subsection,
		  - Subsection 5.3 Warranty; Content reduced as now referred to relevant spec,
		  - Subsection 5.4 Quality Assurance; New subsection,
		  - Subsection 5.5 Design Documentation To Be Provided; New subsection,
		  - Subsection 5.6 Training; New subsection,
		- Section 6 Operation, Maintenance and Service Continuity; Major changes as outlined below,
		  - Subsection 6.1 Layout and Access to the GIS; Content updated, in particular note minimum width between bays increased to 600mm,
		  - Subsection 6.2 Access Platforms; New subsection,
		  - Subsection 6.3 Operation, Inspection and Maintenance Requirements; Major content update in particular note new further subsections,
		  - Subsection 6.4 Service Continuity; This used to be its own section it is now a subsection with minor content update and further subsections,
		- Section 7 GIS Primary Plant; New section with introduction,
		  - Subsection 7.1 Auxiliary Supplies; Format changes only,
			Conor Farrell / Pat Daly	Brendan Murray

		- Subsection 7.2 Labelling and Nameplates; New subsection, - Subsection 7.3 Discharge and Radio Interference Voltage Measurement; Format change only, - Subsection 7.4 Circuit Breakers; Major update to content and subsections, - Subsection 7.5 Disconnectors; Content updated and subsections added in particular note subsection 7.5.6 Disconnectors as Three Position Switches, - Subsection 7.6 Fault Making Earthing Switches; Content updated and subsections added, - Subsection 7.7 Maintenance Earthing Switches; Content updated and subsections added, - Subsection 7.8 Current Transformers; Content updated and subsections added, - Subsection 7.9 Voltage Transformers; Content updated and subsections added, - Subsection 7.10 Surge Arresters; Minor content updated, - Section 8 Bay Local Control Cabinet's; Major content update as per subsections, - Subsection 8.1 Access and Layout Requirements, New subsection in particular note operational viewpoint and implication of free standing LCCs, - Subsection 8.2 Physical Requirements; New subsection, - Subsection 8.3 RTU & SCS LCC Applications; New subsection, - Subsection 8.4 Control wiring and Marshalling; Content updated, - Subsection 8.5 Local Metering; Minor content update - Subsection 8.6 Fault Signalling; New subsection, - Subsection 8.7 Additional requirements; Content updated - Section 9 Interlocking; Content updated, - Section 10 SF6 and PD Systems; Content updated and subsections added, - Subsection 10.1 Gas Systems; Content updated and subsections updated, - Subsection 10.2 Partial Discharge Sensors; New subsection, - Section 11 Enclosures; No change, - Section 12 Earthing; Content updated, - Section 12.1 Electromagnetic Compatibility; No change, - Section 13 Civil Requirements; Major content update, - Section 14 GIS Connection Methods; Content updated in subsections, - Subsection 14.1 GIS Connection to HV Cables; Content updated, - Subsection 14.2 GIS Direct Connection to Transformers, Content updated, - Subsection 14.3 GIS Connection to OHL; Format update only, - Section 15 Testing; New section and subsections, - Subsection 15.1 Routine Tests; New subsection, - Subsection 15.2 Test After Erection; New subsection, - Section 16 Installation; New section and subsections, - Subsection Installation Services; New subsection - Section 17 Equipment Labels Schedule; New section and label examples		

1 INTRODUCTION

This document is a specification defining the functional requirements for 110 / 220 / 400 kV Gas Insulated Switchgear (GIS) for use on, and for connection to, the transmission system.

This document deals with the specific requirements of GIS and is to be read in conjunction with other relevant specifications e.g. XDS-GFS-06-001, 110 / 220 / 400 kV Control, Protection and Metering.

2 NETWORK PARAMETERS

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

The GIS technical parameters are further detailed in the GIS TECHNICAL SCHEDULES XDS-GTS-25-001 / 002 / 003.

The Customer shall submit fully completed and signed TECHNICAL SCHEDULES for EirGrid review in advance of equipment order.

2.1 AC SHORT-CIRCUIT BREAKING CURRENT

The design parameters are specified in EirGrid's 110 / 220 / 400 kV Station General Requirements functional specification XDS-GFS-00-001 and the project specific Single Line Diagram and protection specification.

2.2 DC TIME CONSTANT OF THE RATED SHORT-CIRCUIT BREAKING CURRENT

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

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 45ms.

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.

3 STANDARDS

The GIS installation shall comply with this specification and the latest edition of the standards below. In case of conflict between this specification and any of the IEC standards or national standards, the requirements listed in the Project Functional Specification shall take precedence.

IEC 60034	Rotating electrical machines
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 60060	High Voltage Test Techniques
IEC 60068	Environmental testing
IEC 60099-4	Metal-oxide surge arresters without gaps for ac systems
IEC 60137	Insulated bushings for alternating voltages above 1000V
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 SF6 for use in electrical equipment
IEC 60480	Guide to checking of SF6 taken from electrical equipment
IEC 60507	Artificial pollution tests on high-voltage insulators to be used on ac system
IEC 60529	Degrees of protection provided by enclosures, control gear standards
IEC 61462	Composite Hollow Insulators
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.
IEC 62271-100	High voltage switchgear and controlgear;-High-voltage alternating current circuit breakers.
IEC 62271-110	Inductive load switching.
IEC 62271-102	Alternating current disconnectors and earthing switches

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 62271-203 above 52 kV	Gas – insulated metal enclosed switchgear for rated voltages
IEC 62474:2012	Material declaration for products of and for the electrotechnical industry
IEC 60099-4	Surge Arrestors – Part 4: Metal-oxide surge arresters without gaps for AC systems
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
EN 50110-1	Operation of electrical installations – General requirements
ET103: 2015	National rules for electrical installations – Power installations exceeding 1 kV AC
SI 132/1995	Safety signs regulations 1995 (implements EEC Directive 92/58)
EN 50089:1992/A1:1994	Cast resin partitions for metal enclosed gas-filled high-voltage switchgear and control gear.
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

4 SERVICE CONDITIONS

The GIS will be installed indoors 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.
Condensation in substation buildings shall be considered in the overall design of the building.

4.1 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 busducting to outdoor AIS bushings shall be designed to achieve a High Durability (above 15 years) coating to Category C5-M (ISO 12944-2) suited to environments with high condensation, pollution and salinity.
Evidence of compliance to C5-M standard according to ISO or IEC test methods (eg. 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 outdoor 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.

5 GENERAL REQUIREMENTS

5.1 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.

The GIS equipment supplier shall have:

(a) At least 10 years' experience in the production of the SF6 gas-insulated switchgear specified for use on 110 kV, 220 kV, 400 kV networks as applicable,

(b) Service experience:

- Installation of the GIS on offer in compliance with this specification in at least three EU utilities with a total of at least 90 bays
- With a service experience of the GIS on offer of at least 5 years duration in each of these EU utilities

(c) As an alternative to such experience within the EU, similar experience with British, Swiss, Japanese, Australian, South Korean or US / Canadian utilities would be considered.

(d) At least 5 years production of the GIS on offer in compliance with this specification in the particular 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.

(e) The GIS on offer in compliance with this specification must be manufactured in the same plants which produced the products cited as meeting the service experience requirements outlined in (b) and (c) above

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.

5.2 HEALTH AND SAFETY

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

The risk assessment must 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.

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

5.3 WARRANTY

Warranty requirements shall be as outlined in EirGrid 110 / 220 / 400 kV Station General Requirement's functional specification XDS-GFS-00-001.

5.4 QUALITY ASSURANCE

Quality Assurance requirements shall be as outlined in EirGrid 110 / 220 / 400 kV Station 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.

5.5 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.
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 opes 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 details and any special measures required to mitigate EMI and VFTO"s.

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.

5.6 TRAINING

The Customer shall provide training to ESBN and EirGrid staff as specified in EirGrid's 110 / 220 / 400 kV Station 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.

6 OPERATION, MAINTENANCE AND SERVICE CONTINUITY

6.1 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 (MRE = 1 further defined in Service Continuity section) to the initial development.

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 1 below.

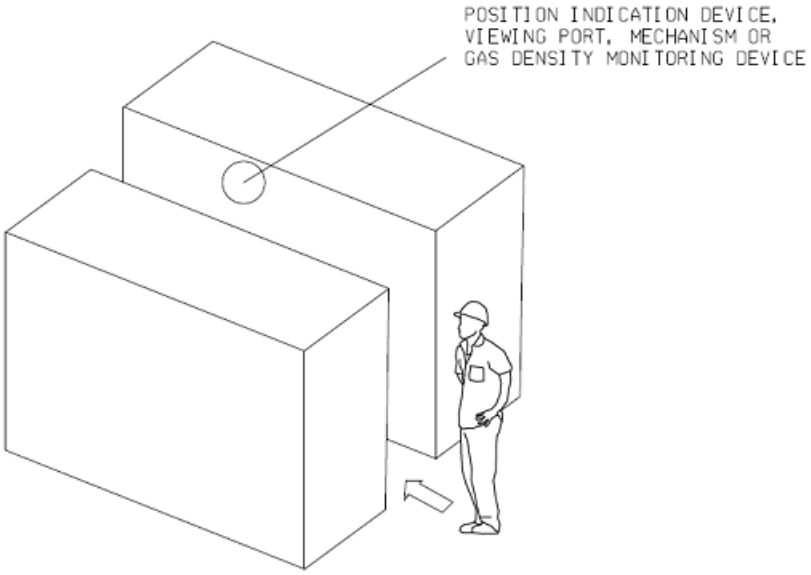


Figure 1: Access for inspection and maintenance to side mounted components

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 **a minimum of 600 mm width** spacing is provided between bays to allow access and movement of persons carrying out operations, regular inspection and maintenance tasks.

Where the Customer proposes to supply free standing LCC's, the cabinets shall be free standing positioned over a cable ope or floor opening to accept the low voltage control cabling. The cabinet shall be swing frame 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.

6.2 ACCESS PLATFORMS

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

The 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 mech 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 allow extension for the ultimate development of the station.

6.3 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 below as 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 the risk assessment to be developed by the Customer for the installation.

Table 1 – 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. (The GIS shall have viewing ports to verify the status of primary contacts of disconnector and earth switches. If primary contacts cannot be readily viewed through viewing ports, then endoscope cameras shall be provided) - 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 SF6 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 - SF6 leak detection – all flanges and insulators
	Every 4 or 5 years	- Mechanical Operation and functional test of all mechanisms - Inspect and lubricate drives and mechanisms
	Every 6 years	- Calibration of SF6 density monitors
	Every 8 or 10 years	- CB timing and contact resistance tests

		- SF6 sampling and testing - CT and VT injection tests - Disconnector contact resistance tests
	Every 20 years	- Change SF6 desiccant / moisture absorbers
Fault Finding	Ad Hoc	- Circuit tracing, mechanism / relay checks and tests

Fixed platforms shall be provided to safely perform the operation and inspection tasks as outlined in section above “Layout and access to GIS”.

These shall be provided and incorporated into the overall switch room design by the Customer.

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.

6.3.1 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").

6.3.1.1 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 and manual control of the maintenance earthing function. This is to allow maintenance testing of the circuit breaker as outlined in the service continuity requirements.

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 must be included within designated bays, in particular busbar coupling bays.

6.3.2 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.

6.3.3 SPARE PARTS

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

The Customer Supplier shall identify those spare parts which he recommends should be held. The spare parts recommended shall be clearly identified on the drawings and maintenance instructions shall be provided by the supplier.

6.3.4 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 the heaters shall be 230 V AC.

6.4 SERVICE CONTINUITY

Availability of the switchgear during maintenance, repair and extension (MRE) shall be maintained as per clause F2 Annex F of IEC62271-203 of 2011.
Also see section “Gas System” in this specification.

Outages of busbars and feeder bays of the installation shall be limited to **one bay and / or one busbar section (MRE = 1)** during the following;

a) the time-based maintenance tasks as referenced in this specification,
b) any extension to the original installation,
c) fault replacement of circuit breakers, busbar disconnectors / earth replacement, CTs and VTs.

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 this service continuity level for the tasks listed above.

In the case of double busbar GIS, the Customer shall provide a method statement outlining how the service continuity requirements are met during;

(i) circuit breaker replacement (incl. interrupter housing),
(ii) CT replacement,
(iii) VT replacement,
(iv) busbar disconnector / earth replacement.

6.4.1 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 for the manufacturing warranty.

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

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

Details of additional gas partitioning chambers 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 MRE1 service continuity requirement of adjacent equipment.

6.4.2 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.

6.4.3 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 (i.e. additional buffer chambers, 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 being induced on the enclosure during switching (VFTO's).

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

7 GIS - PRIMARY PLANT

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 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.

The GIS building layout shall be designed in accordance with the 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.

7.1 AUXILIARY SUPPLIES

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

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.

Note: DC Distribution Board and specific supply designations are outlined in latest revision of the EirGrid Functional Specification XDS-GFS-10-001 "220V / 24 V DC and 230 / 400 V AC Distribution Boards."

7.2 LABELLING AND NAMEPLATES

A labelling schedule shall be submitted by the Customer at detailed design stage for EirGrid's review, which shall comply with the requirements listed below.

The labelling schedule shall detail the material of the label, the text height and width on the label, the actual text for the label and a text description of the mounting location of the label.

The equipment shall be labelled so that each bay and each piece of main equipment and associated position indication / viewing port is uniquely identified with bay and equipment designation per equipment label schedule section on this specificaion.

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

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

In general all information labels shall be black text on a white background.

All labels shall survive the equipment's anticipated lifespan and shall be clear and indelibly printed in English.

The following is a non-exhaust list of the labels:

1. Each GIS bay and its LCC shall be identified as bay designation on the SLD.
2. Each HV switching device, including earth switch 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.

The text of labels on Position Indication devices shall be oriented horizontally to enable easy interpretation and located directly above or below the indicator.

A sample list of the labels including photographs, label materials and a description of the location of the label has been included for reference purposes in the Appendix of this specification.

7.3 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.

7.4 CIRCUIT BREAKERS

7.4.1 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:
  - 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[1] of ~ 500 to 600 ms) and Trip Immediately.
- The circuit breaker shall be capable of repeating the above cycle (Close-Trip-Close-Trip) after a period of 10 seconds.

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

At 220 kV and 400 kV, circuit breakers shall be single pole (independently) operated 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 be 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.

7.4.2 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:

a. rated line-charging breaking current

b. rated cable-charging breaking current

c. rated single capacitor bank breaking current

d. rated back-to-back capacitor bank breaking current

e. rated single capacitor bank inrush making current

f. rated back-to back capacitor bank inrush making current.

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

[1] Time from Trip to Closed position.

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.

7.4.3 Transient Recovery Voltage (TRV) and Rate of Rise of Recovery Voltage (RRRV)

TRV shall be in accordance with IEC62271-100, 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 RRRV across the circuit breaker contacts or to divide the voltage across multiple series breaking contacts shall be made available.

The circuit breaker operation shall be restrike-free.

7.4.4 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 must 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.

7.4.5 Switching small inductive currents

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

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.

7.4.6 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 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 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.

7.4.7 AUXILIARY & CONTROL SUPPLIES

The circuit breaker shall be equipped with an operating mechanism with a single or three phase 400 / 230 V AC or a 220 V DC motor-driven energy accumulator. A +10 % / -15 % tolerance applies to both AC and 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 tripping coils and one closing coil shall be provided, all suitable for 220V DC operation. Both positive and negative poles of the closing coil shall be switched by all operating devices supplied in the switchgear.

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.

Electrically independent implies correct operation of the CB for loss of either of the trip coil DC supplies, i.e. the circuit breaker shall function correctly when either one or both tripping coils are energised.

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

7.4.8 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 both trip coils.

7.4.9 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. 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. 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.

7.4.10 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 control / marshalling cabinet.

7.4.11 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 local control cubicle.

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.

7.4.12 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.

7.5 DISCONNECTORS

7.5.1 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.

The maximum capability of disconnectors to make and break capacitive and inductive charging currents shall be stated in the TECHNICAL SCHEDULES.

All busbar and sectionaliser disconnectors shall have a rated bus-transfer voltage of 10 V as per IEC62271-102. 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 IEC62271-102. The rated bus-transfer current shall be marked on the nameplates of the relevant disconnectors.

7.5.2 Auxiliary and Control Supplies

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 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.

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.

The drive mechanism control shall ensure that each disconnector reaches the fully open and fully closed positions at all times.

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

7.5.3 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, or through some other method. The proposed method should be certified, type tested and is subject to EirGrid approval.

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.

7.5.4 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 padlock with 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.

7.5.5 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 purchasers use.

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

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. 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:

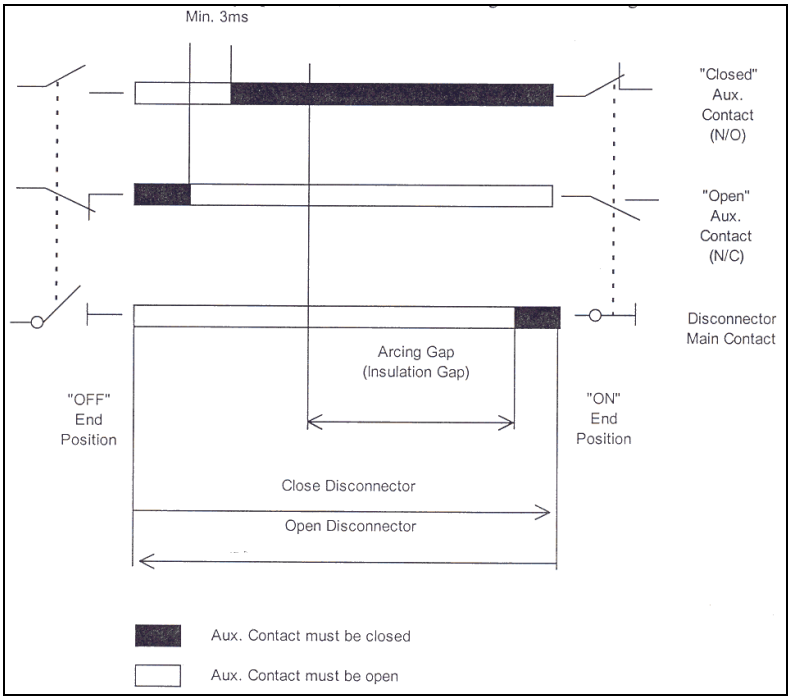


Figure 2: Operating sequence of normally open and normally closed contacts

- The NO contact shall close before the main contacts have passed arcing distance.
- The NC contact shall close after the main contacts have passed the arcing distance.

During the closing operation the N/O contact must close before the main contact reaches the insulation breakdown gap. During the opening operation the N/O contact ("Closed" signal) must not open before the main contact has passed the contact gap at which re-ignition can occur. The N/C contact must open not less than 3 ms before the closing of the N/O contact. These special contacts shall be directly driven from the disconnector mechanism and are not required on earthing switches.

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

7.5.6 DISCONNECTORS AS THREE POSITION SWITCHES

Where manufacturers propose the use of three position switches for disconnection and maintenance earthing functions, it shall be possible 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.

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

The user shall open the disconnector, lock-off the disconnector mechanism, isolate the electrical supply to the disconnector drive and then close the maintenance earth switch.

Where manufacturers 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.

The above requirement also applies to MV switchgear directly connected to a transmission fed transformer. This is to facilitate Operational Switching in compliance with ESB Networks Safety Rules.

For example, if the customers MV busbar disconnect is a three-position switch, then it shall be possible 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.

7.6 FAULT MAKING EARTHING SWITCHES (QCX)

7.6.1 RATINGS

All busbar earth switches and HV Line / Cable and Transformer bay earth switches must be isolatable 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 relevant values shall be stated in the technical schedule.

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.

7.6.2 Auxiliary and Control Supplies

Each earthing switch shall be equipped with a dedicated 220 V DC (+10 / -15%) motor driven mechanism which will normally be operable electrically from a remote control position and also from the bay local control cabinets.

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.

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 Station Control and Protection 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.

7.6.3 Position Indication

The requirements as outlined in section 6.5.5 Position Indication for Disconnectors shall also apply for Earthing Switches.

7.6.4 Locking Arrangements

The requirements as outlined in section 6.5.4 Locking requirements shall also apply for Fault Making Earthing Switches.

7.6.5 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.

7.6.6 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.

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

It shall be possible to obtain positive confirmation (clear indication) of the position of all Maintenance Earthing Switches either through easily accessible inspection windows, an approved kinematic chain or through some other method.

The proposed method should be certified, type tested and is subject to the EirGrid approval.

7.7 MAINTENANCE EARTHING SWITCHES (QCX)

7.7.1 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.

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

7.7.2 AUXILIARY AND CONTROL SUPPLIES

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.

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 Station Control and Protection 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.

7.7.3 Position Indication

The requirements as outlined in section “Position Indication for Disconnectors” shall also apply for Earthing Switches.

7.7.4 Locking Arrangements

The requirements as outlined in section “Locking requirements” for shall also apply for Maintenance Earthing Switches.

7.7.5 Auxiliary Contacts

The requirements as outlined in section “Auxiliary Contacts for Fault Making Earthing switches” shall also apply for Maintenance Earthing Switches.

7.7.6 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.

7.8 CURRENT TRANSFORMERS

The current transformers shall have the number of cores with ratios, accuracy class and burdens according to the project specific protection specification.

Where the internal resistance RCT specified for a 'Class P' protection core cannot be realised the customer may offer the 'Class PR' or 'Class TPZ' option upon agreement with EirGrid.

The current transformers shall meet the general requirements of IEC publication 61869-1.

In the case of direct connection of GIS to transformers, provision is to be made for a CT in the bus duct section between the bay DE and the transformer bushing for busbar protection purposes (in line with EirGrid Protection requirements).

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.

7.8.1 CT AND VT TERMINAL BOXES

Current transformer and Voltage transformer secondary terminal boxes shall be located outside the high voltage enclosure.

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

An earthing terminal shall be provided within each terminal box for earthing the secondary windings.

For VT terminals all secondary windings shall be capable of being readily disconnected and isolated from ground for testing purposes.

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

The terminals in the LCC shall be Phoenix type as outlined in EirGrid specification XDS-GFS-07-001 and mounted in accessible terminal boxes.

7.8.2 TPZ TRANSIENT CURRENT TRANSFORMERS FOR FEEDER BAYS

Class TPZ cores required in place of class P cores for line feeder bays shall be according to IEC 61869-2 for transient performance protection purposes. The current transformers shall meet the general requirements of IEC publication 61869-1.

Specification details for TPZ cores shall be in accordance with project specific protection specification.

7.8.3 CABLE RING 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. Spilt core CTs are not acceptable.

The current transformers shall have primary ratio, minimum burden and RCT in accordance with project specific protection specification and project specific SLD.

The current transformers shall have an internal diameter of 160 mm to accommodate cable sizes of 1000 mm2, 1600 mm2 and 2500mm2.

The maximum diameter of the 1600 mm2 cable is approximately 130 mm. The maximum diameter of 2500 mm2 cable is approximately 145 mm. The earth return or bonding lead is approximately 25 mm diameter.

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.

For GIS installations where **ring CT's** are installed for billing and check metering, the secondary terminals shall be installed in Meter Marshalling Kiosks in the Cable Basement room as illustrated below.

For GIS installations 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.

Picture 1: Metering marshalling kiosk

7.9 VOLTAGE TRANSFORMERS

7.9.1 GENERAL REQUIREMENTS FOR VOLTAGE TRANSFORMERS

Voltage transformers shall generally meet the requirements of IEC Publication 61869-3.

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

The neutral end of the primary winding shall be brought out through insulated bushings rated at 3 kV for test purposes and suitable for earthing by means of a bolted link.

Secondary terminals shall be located in accessible terminal boxes on the VT.

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

Voltage transformers shall be inductive type with rated voltage factor 1.9 for 30 seconds.

Voltage transformer with multiple secondary windings shall fulfil accuracy requirements of IEC 61869-3. On voltage transformers with multiple cores this applies to each core, the burdens of all other cores being in the range of 0 to 100% of rated burden.

The thermal current rating of individual cores shall be stated. Each secondary winding shall be protected by a HRC cartridge fuse located in the terminal box, connected to the “a” and “da” terminals.

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

The voltage transformer shall be capable of discharging safely the connected cable capacitance.

7.9.2 STAR-CONNECTED SECONDARY WINDINGS

Star-Connected Windings shall have the three phases protected by a miniature circuit breaker in the LCC. The MCB’s technical details and arrangement shall be submitted to EirGrid for approval.

Secondary terminals shall be located in accessible terminal boxes on the VT.

The accuracy class shall be 0.5 for metering and 3P for protection, i.e. dual designation.

The neutral ends of the primary winding shall be brought out through insulated bushings rated at 3 kV for test purposes and suitable for earthing by means of a bolted link.

7.9.3 OPEN-DELTA / RESIDUAL VOLTAGE SECONDARY WINDINGS

One core per voltage transformer shall be used in open delta configuration.

The open-delta circuit (3 Voltage Transformer) shall be protected by a single pole miniature circuit breaker in the LCC on the ‘a’ side only. The MCB’s technical details and arrangement shall be submitted to the EirGrid for approval.

The open-delta windings additionally shall meet the requirements of IEC 61869-3.

The winding accuracy class shall be 3P unless otherwise stated in the project specific protection specification.

7.9.4 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 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 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.

7.9.5 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.

7.9.6 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:

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

7.9.7 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 chamber.

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 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 customers Integrated Control and Protection relay located within the bay LCC.

7.9.7.1 SECONDARY OUTPUT AND ACCURACY CLASS

The sensor or system shall provide a secondary voltage of 0 to 100 V / √3 to the customers 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
- -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 %).

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 mm2, 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.

7.10 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 SF6 / 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.

For 110 kV:

- They are to have a reference voltage of 114 kV, LIPL (max) of 295 kV, nominal discharge current 10kA and IEC Discharge Class 3.

For 220 kV:

- They are to have a reference voltage of 228 kV, LIPL (max) of 592 kV, nominal discharge current 10kA and IEC Discharge Class 2 as a minimum.

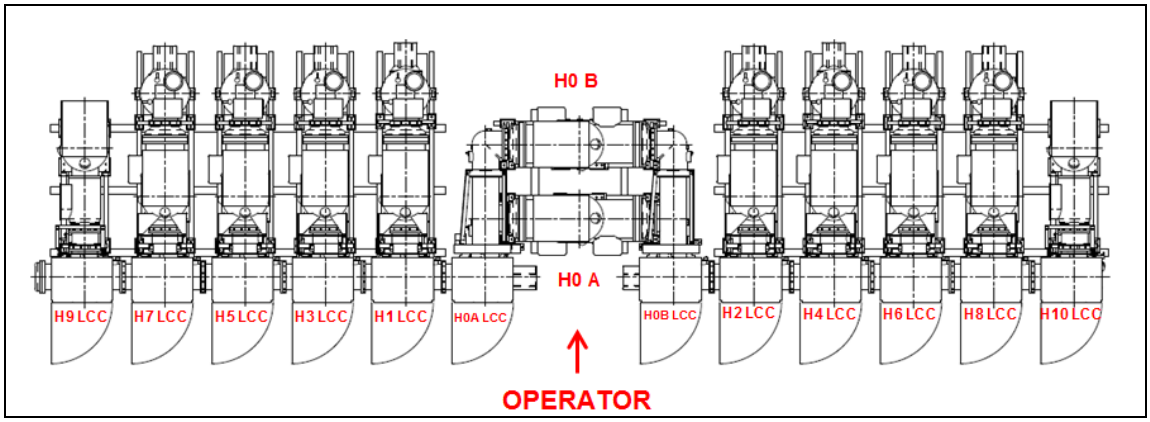
For 400 kV:

- They are to have a reference voltage of 396 kV, LIPL (max) of 1029 kV, nominal discharge current 10 kA and IEC Discharge Class 2 as a minimum.

8 BAY LOCAL CONTROL CABINETS (LCC)

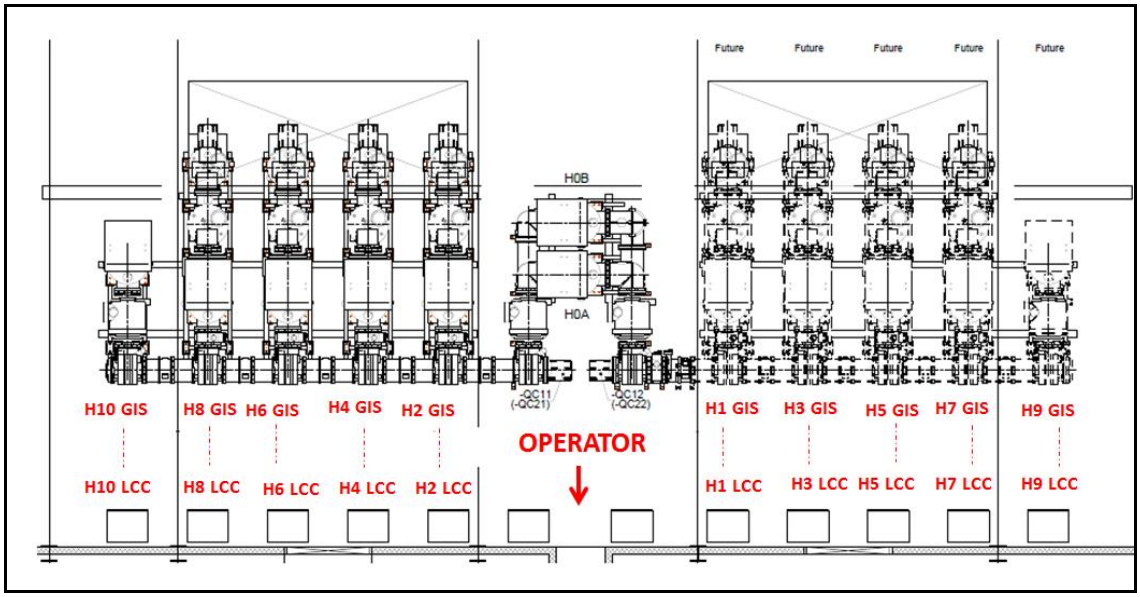
8.1 ACCESS AND LAYOUT REQUIREMENTS

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 preferably integrated within the GIS switchgear as shown in *Picture 1*. LCCs are required for local plant operation during commissioning, testing and maintenance for both RTU and SCS applications.



Picture 1: Representation of LCCs integrated in GIS switchgear

Where free standing LCCs are installed opposite the GIS switchgear, the LCCs shall now become the operational viewpoint and they shall be arranged such that the LCCs to the left have odd numbers and those to the right have even bay numbers.
Note, the GIS associated LCCs shall be located directly opposite the switchgear as shown in *Picture 2*.



Picture 2: Representation of free sanding LCCs in front of GIS switchgear

8.2 PHYSICAL REQUIREMENTS

The LCCs shall be located at a height, from ground level, of less than 1800 mm.

The cabinets shall be arranged to accept control cables from the switchgear at the rear of the cabinet on gland plates. The cabinet 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 the cabinet to allow operation and inspection without stepping inside the cabinet. Removable gland plates shall be labelled with permanent stickers identifying the Safe Working Load (SWL) that the plate may bear.

Where points of electrical control on the LCC cannot be located less than 1800 mm above floor level the Customer shall;

- Design, supply and install permanent platforms fixed to the GIS placing all control points within 1800 mm from the top of the platform;

  Or

- Supply and install freestanding cabinets mounted separately to the switchgear. If the LCCs are mounted separately and opposite the switchgear, operational control should be such that an observer standing in the centre of the station facing the LCCs will see bays to the left of the mid sectionaliser given odd numbers and those to the right even numbers.

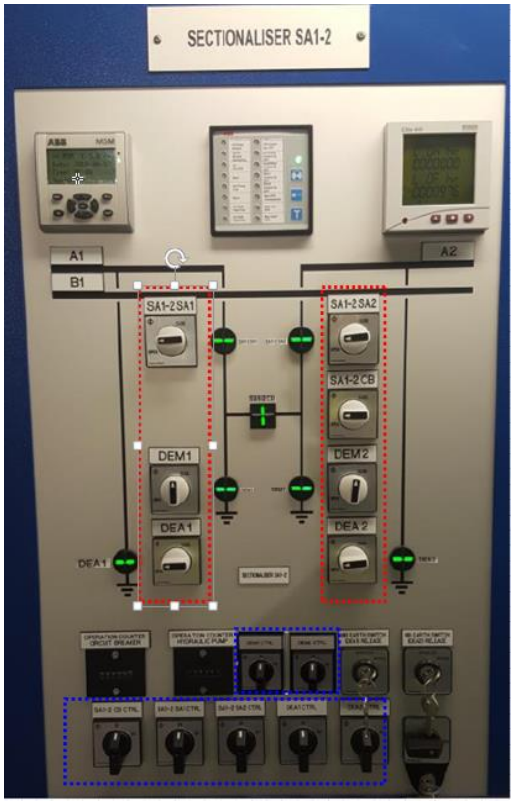
8.3 RTU & SCS LCC APPLICATIONS

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 switches, semaphores 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.



Picture 2: LCC – RTU Application

Picture 3: LCC – SCS Application

8.3.1 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).

These operational control switches shall be located adjacent to its respective HV plant symbol on the LCC mimic (as illustrated by the red dotted box in picture 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 picture 2 and 3).

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 in series for each bay to provide position indication to 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.

8.3.2 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 should operate such that when in **Local position**:

- Operational control can only be performed locally at the LCC, restricting remote operation control from the Station Control Cabinet (MIMIC / SCS HMI) or the NCC.

The switch should operate such that when in **Remote position (Normal Operation)**:

- Operation control can only be performed remotely via the Station Control Cabinet and NCC / DCC, hence restricting operation control from the LCC.

8.3.3 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 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).

8.4 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).

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 (CT and VT circuits) and 1.5 mm^2 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 are to 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, voltages etc. 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.

8.5 LOCAL METERING

For RTU applications, a Voltmeter and Ammeter 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.

8.6 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.

8.7 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.

A pre-wired plug and socket arrangement is the preferred method of wiring (excluding CT & VT circuit wiring).

9 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 for position indication to the interlocking scheme shall be used. 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.

10 SF6 GAS AND PD SYSTEMS

The Customer shall have available details of all external devices and sub-suppliers, e.g. SF6 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.

10.1 GAS SYSTEMS

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. Refer to Service Continuity section for further information.

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 2 bar absolute pressure of SF6.

The customer shall demonstrate that SF6 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 chambers 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.

10.1.1 GAS MONITORING – DENSITY MONITORS AND DISPLAYS

All gas compartments shall contain hybrid density monitors to provide low-gas blocking commands and alarms. A 4-20 mA electrical transducer shall also be incorporated in the density monitor to remotely display the pressure at the local control cabinet (LCC). Busbar compartment monitoring shall be independent of individual HV bay monitoring.

The gas density monitoring devices shall be temperature-compensated and shall have three or four voltage free contacts for alarms at three stages. The first stage alarm is activated when the gas density has dropped below “normal operating pressure”. The second stage at the lower limit of gas density for safe operation of the equipment (“low operating pressure”) – two contacts shall operate at this gas level. An alarm shall also be raised when a pressure increase occurs.

The density monitor faceplate shall be scaled in Bar (absolute) and colour coded for the three pressure stages as follows;

Normal operating pressure:	Green
Low operating pressure:	Yellow or orange
Insufficient operating pressure:	Red

All density monitors shall be positioned so that the mechanical pointer and scaled faceplate are visible from ground level. Monitors, 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.

Digital monitoring and displays shall be provided on a ‘per bay’ system with the necessary data collection unit housed in the LCC. The ‘per bay’ gas monitoring digital display units shall clearly identify all gas compartments, the pressure of each compartment and an indication of health e.g. Green / Yellow / Red.

Voltage-free contacts of the device shall also generate first and second-stage alarms as well as for pressure increase. The system shall be self-monitoring incorporating processor watchdog alarm and generate an external alarm via voltage free contacts in the event of auxiliary supply loss, transducer failure or processor failure.

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.

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. The enclosure shall be designed so that pressure rises caused by internal arcs are limited to a safe level. Exhausts (if any) shall be directed away from personnel. Pressure coordination shall allow a first-stage protection to clear a fault before pressure-relief device operation, which itself should occur before burn-through.

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 (SF6 barriers, compartments, SF6 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.

10.1.2 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 SF6 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 380 Vac operating voltage
- Dry filter, particle filter, evaporator, SF6 bottle scale
- 10 meter long interconnecting hoses with DN20 fittings
- Pre-filter unit and on board storage tank

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

10.1.3 SF6 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.

10.1.4 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:

i. Static positions, i.e. Pipe flanges etc.
ii. Dynamic positions, i.e. Disconnector / Earthing Switch Drive shafts, etc.
iii. Design life of seals
iv. Drawing and detail of the ‘O’ ring sealing design used
v. Details of gas detection methods
vi. Details of gas sampling methods with the plant in service
vii. Details of Gas pipework and connectors

10.2 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.

11 ENCLOSURES

The enclosures shall comply with IEC 62271-203 and the relevant European standards. The enclosure 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 enclosures 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.

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 the Transient Enclosure Voltage (TEV) shall be described by the Customer.

As a minimum, suitable Surge Voltage Limiters (SVLs) are to be installed between the GIS enclosure and cable terminations on each feeder and transformer bay.

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.

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's laid including photographic evidence of joints and details of types of crimps and connections used.

12.1 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.

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

Heating shall be provided in the relay rooms, store room, mess room and battery room in the GIS buildings. Thermostatic controls to be provided for operation of all heaters routed through a timer.

A temperature control system shall be installed in the relay rooms to maintain the ambient room temperature at a level which allows each device to function correctly in accordance with relay manufacturers guidelines. The temperature in the relay rooms shall not fall below 10 °C.

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.

14 GIS CONNECTION METHODS

14.1 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 Publication 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 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.

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.

Provision shall be made at the HV cable compartment to allow isolation of the cable from the GIS circuit with the minimum dismantling of plant and no requirement for the evacuation of SF6 gas.
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:

Pfisterer Connex terminations:

- 110 kV: 1,000 mm2 Al / Cu XLPE (Size 6)
- 110 kV: 1,600 mm2 Al / Cu XLPE (Size 6)
- 220 kV: 1,600 mm2 Cu XLPE (Size 6S)
- 400 kV: 1,600 mm2 Cu / PB XLPE (Size 8)
- 400 kV: 2,500 mm2 XLPE (Size 8)

NXT KSEEV terminations:

- 110 kV: 1,000 mm2 Al / Cu XLPE (Size 4)
- 110 kV: 1,600 mm2 Al / Cu XLPE (Size 6)
- 220 kV: 1,600 mm2 Cu XLPE (Size 6)
- 400 kV: 1,600 mm2 Cu / PB XLPE (Size 9)
- 400 kV: 2,500 mm2 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.

14.2 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.

14.3 GIS CONNECTION TO OVERHEAD LINES (WHERE APPLICABLE)

The SF6 / 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 SF6 gas. 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

14.3.1 110 kV CLEARANCES

Clearances relating to 110 kV bushings are as follows,

- 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 43.3 mm / kV.

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

14.3.2 220 kV CLEARANCES

Clearances relating to 220 kV HV bushings are as follows,

- 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.

14.3.3 400 kV CLEARANCES

Clearances relating to 400 kV HV bushings are as follows,

- 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.

14.4 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.

15 TESTS

EirGrid may wish to witness type and / or routine tests, or visit the factory during the manufacture of the switchgear.

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.

15.1.1 ROUTINE TESTS

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

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

15.1.2 TESTS AFTER ERECTION

After erection on site, the customer shall subject the complete switchgear to on-site tests as detailed in IEC 62271-203.

These tests shall include:-

- Power Frequency withstand voltage tests at 80 % of full value.
- Partial Discharge measurements.
- Special Tests as outlined below.

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

No changes to the equipment shall occur on site without agreement in advance.

Any proposed changes to the technical records provided prior to equipment delivery must be communicated clearly and agreed in advance.

15.1.3 SPECIAL TESTS

In additional to the on-site IEC recommended tests the following requirements apply:

- 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 may be witnessed if applicable.

- Chambers shall be opened and cleaned as per the specified procedure utilising the correct equipment and procedures.

- The time durations for the HV test with PD measurement shall be extended so that the switchgear is subjected to 1.1 Un for a minimum of 60 minutes after the stress voltage. PD monitoring shall take place over this extended period.

    - The purpose of this 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 customer shall provide permission for the site HV tests, to be performed only on completion of the additional operations test. Should any flashovers occur during the subsequent HV test the customer will specify additional cleaning and test procedures.

16 INSTALLATION

16.1 INSTALLATION SERVICES

16.1.1 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
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 Purchasers 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 SF6 pressure alarms), signals and position indication contacts to the local control cabinet.
o) Gas quality tests – dew point and % SF6
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 SF6 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 test and results for commissioning handover.

17 EQUIPMENT LABELS SCHEDULE

1. A general durability is required of all labels. They should not fade with sunlight (UV) or on contact with oil. The preferred fixing method is bolting. If bolting is not possible an approved adhesive (Loctite 5065-EN) shall be used. The contractor may recommend alternative fixing arrangements but these shall be subject to agreement with EirGrid.

2. Labels shall be BLACK lettering on a WHITE background.

3. Any labels that have to be placed on covers should have a matching non-removable label inside the area being covered.

4. Labels should not obscure manufacturer labels.

5. Labels on transparent doors or covers shall not obstruct the visibility of any equipment located inside the door or cover.

6. In certain circumstances adhesive labels ('stickers') can be used, if the rigid labels can't be mounted in the appropriate location. This option is only valid indoors and must first be agreed with EirGrid.

7. Labelling shall be visible to an operative from all positions on the switchgear, especially when viewing position indicators etc.

8. All text on labels shall be orientated to be read horizontally when placed on the switchgear.

9. Brackets shall be used where required to ensure labels are sufficiently upright and visible.

10. If a bay is spare, the word SPARE should be included in the labelling.

11. Other than the main bay labels, text can be abbreviated if required to fit a label to a certain location, e.g. H0A SECT for H0A SECTIONALISER

12. The label size depends on the text size: a guideline is that the label border should be half the text height; e.g. for 70 mm high text, the border shall be 35 mm outside the text.

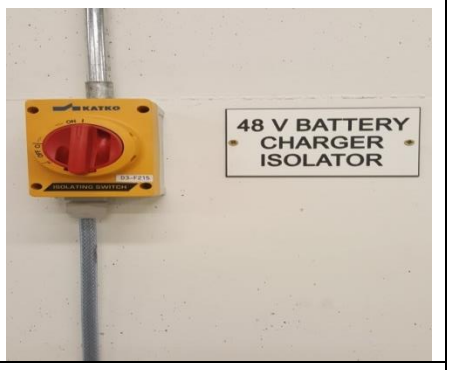
13. Other than the main bay labels, text size can be altered if required to fit required information onto a certain location / surface. The label border shall be a minimum 10 mm outside the text.

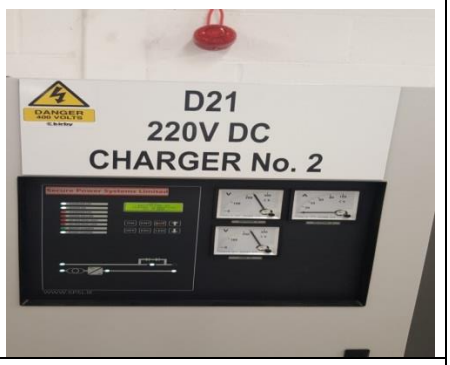
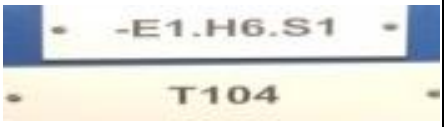
14. On the following pages of this document a sample labelling document for different 220 kV and 110 kV bay types are shown. These are a guideline only to show the type of labelling information required. The sample bay names used for the line and transformer bays will need to be updated accordingly.

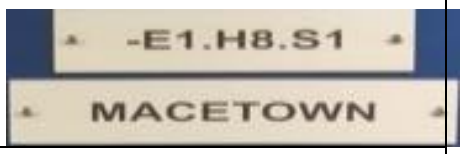
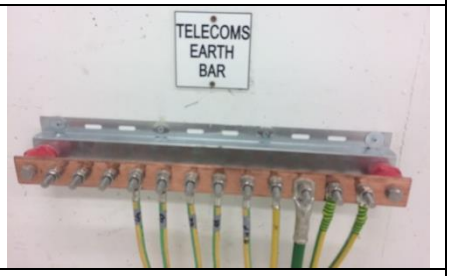
#	*Label Text*	*Text Size (mm) (b x h)*	*Material*	*Mounting Location*	*Photo / Drawing*
1	**Station Name** **110kV** **Substation** **SCADA EQUIPPED STATION REMOTE CONTROL OPERATIONS CAN OCCUR WITHOUT WARNING. NOTIFY CONTROL CENTRE IF YOU ARE WORKING IN THE STATION**	Large (to suit door)	Traffolyte	On door at front of control building	
2	**110 kV CABLE ROOM**	400 x 250	Traffolyte	On door leading into cable room	
3	**R** **S** **T**	120 x 120 120 x 120 120 x 120	Traffolyte	On wall where cables lead out of station	
4	**H6 T104**	To suit switchgear	Traffolyte	On transformer bay facing outwards towards the busbar	
5	**H4 CORDUFF**	To suit switchgear	Traffolyte	On line bay facing outwards towards the busbar	

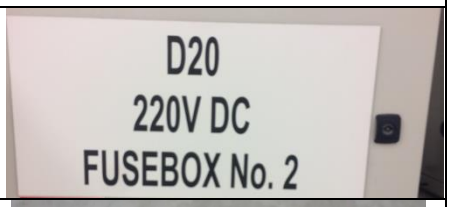
6	-QB1 DA **H6** -QC1 DEM1	40 x 40 (x3)	Traffolyte	Located on each bay (eg. H6) at the disconnector for the busbar & the earthing switch	
7	**M19 H0A Protection Panel**	140 x 55	Traffolyte	Located on the front of the protection panel, at the top	
8	**BATTERY ROOM** ATTENTION RESTRICTED AREA This room contains dangerous chemicals and live exposed parts	400 x 300	Traffolyte	Located on front of door leading into battery room	
10	**H0A SA1-2 CB**	To suit switchgear	Traffolyte	Located on circuit breakers for each sectionaliser, level with GRP raised-access platform.	
11	**H2 T102**	To suit switchgear	Traffolyte	Double busbar connection to transformer bay	

12	-QB11 SA1-2 SA1 **H0A** -QC1 DEM1	40 x 40 (x3)	Traffolyte	Located at the disconnector for sectionalising & the earthing switch, facing outwards away from the busbar	
13	**H10 COUPLER K2 CB**	500 x 175	Traffolyte	Located on the coupler,	
14	**H8 MACETOWN CB**	500 x 175	Traffolyte	Located on front of circuit breaker	
15	**A1 BUSBAR** **B1 BUSBAR**	200 x 80 200 x 80	Traffolyte	Located at the edge of each busbar	 

16	**ROLLER SHUTTER DOOR ISOLATOR**	100 x 100	Traffolyte	On wall beside switch for roller shutter door isolator	
17	**48 V BATTERY CHARGER ISOLATOR**	160 x 100	Traffolyte	On wall beside switch for the battery charger isolator	
18	**M13 Signal Cabinet** **D1 ALARM UNIT**	140 x 55	Traffolyte	Located over alarm unit on signal cabinet	
19	**D13 220V DC CHANGEOVER SWITCH**	450 x 295	Traffolyte	Located on box under changeover switch, outside the battery room	

20	**D21 220V DC CHARGER No. 2**	450 x 250	Traffolyte	Located on charger box, outside the battery room	
21	**M11 BATTERY SUPERVISION PANEL**	360 x 250	Traffolyte	Located on front of battery supervision panel	
22	**MAXIMUM VOLTAGE AT THIS LOCATION IS 400V AC**	110 x 30	Traffolyte	Located on all distribution boards	
23	**SECTIONALISER SB1 - 2**	200 x 55	Traffolyte	Located on front of sectionaliser panel	
24	**-E1. H10. S1** **COUPLER K2**	160 x 55 200 x 55	Traffolyte	Located on coupler panel, in the GIS switchroom	
25	**-E1. H6. S1** **T104**	160 x 55 200 x 55	Traffolyte	Located on transformer bay panel, in the GIS switchroom	

26	**-E1. H8. S1** **MACETOWN**	160 x 55 200 x 55	Traffolyte	Located on LCC, in the GIS switchroom	
27	**GIS SWITCHROOM**	400 x 250	Traffolyte	Located on door outside the GIS switchroom	
28	**A1 BUSBAR** →	140 x 60	Traffolyte	Located on busbar	
29	**SUMP PUMP ISOLATOR**	100 x 100	Traffolyte	Located on wall, beside sump pump isolator	
30	**TELECOMS EARTH BAR**	100 x 100	Traffolyte	Located over telecoms earth bar, in control room	
31	TELECOMMUNICATIONS 48V DC DISTRIBUTION BOARD	130 x 25	Traffolyte	Located on top of distribution board	

32	**GENERAL STATION ALARM** **PRE-SWITCHING SIREN**	150 x 150	Traffolyte	Located underneath their respective alarms, in the GIS switchroom	
33	**220V BATTERY NO.2**	610 x 195	Traffolyte	Located on wall over respective battery, inside the battery room	
34	**D20 220V DC FUSEBOX No. 2**	200 x 60	Traffolyte	Located on the fusebox, outside the battery room	
35	**T102 Customer Interface Kiosk**	300 x 145	Traffolyte	Located on front of customer interface kiosk	
36	T104 Mech Box	To suit panel	Traffolyte	Located on front of CB mechanical boxes