Pre-Commissioning Procedure and Requirements

XDS-GFS-20-001-R2

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EirGrid

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Revision History					
Revision	Date	Description	Originator	Checker	Approver
R0	01/09/2011	First Issue – This document supersedes XDS-WTS-20-001-R0. Sections 2, 6.8, 6.18 and 6.20 updated	Paul Moran	N/A	Christy Kelleher
R1	09/06/2014	GAR sheet added to appendix Minor revisions to sections 1, 3, 5 and 6	Sandra Howard	N/A	Paul Moran
R2	04-04-2025	Updated based on projects lesson learned	MMD	Daniele Giustini ESB – Due Diligence	Neil Cowap

Contents

1 Scope

The following document sets out the minimum procedures and requirements to be carried out by the customer for the pre-commissioning of a 110kV/220kV/400kV substation to be connected to the Transmission Grid.

This document relates to pre-commissioning in new substations or new assets being connected to existing substations which have not been energised and prior to being handed over to the EirGrid commissioning team.

This document also serves as an aid and tool to the pre-commissioner, but does not relieve them from the responsibility of ensuring ultimate safety, functionality and quality of the pre-commissioned equipment.

The pre-commissioning test requirements and report/sheets included in XDS-GTS-20-001 are not exhaustive. The associated test schedules, RAMS and test results/reports are a minimum pre-commissioning requirement the Customer shall issue to EirGrid for review and acceptance before the substation is handed over to EirGrid for commissioning.

The main aim of this document is to ensure:

- The quality of the equipment and plant is ready and fit for Hand Over to EirGrid for final commissioning.
- All aspects of pre-commissioning shall be clear and auditable.
- All plant and systems must be pre-commissioned to best industry practice, ensuring their correct installation as per design, OEM requirements and are functionally operational.
- The pre- commissioned plant and equipment are cleanly and formally handed over to the relevant party for commissioning.

During the pre-commissioning works, EirGrid reserves the right to witness any, or all, of the customer pre-commissioning and the customer shall provide weekly lookahead schedules of upcoming commissioning works to EirGrid in advance to facilitate witnessing.

Upon completion of the pre-commissioning works, the customer shall arrange for a Customer Pre-Commissioning Handover meeting as further described in Section 6.22.

2 Health and Safety

Safety is a core value of EirGrid and shall be addressed as a priority by the pre-commissioner. All testing and pre-commissioning of new equipment shall be carried out in accordance with the Safety, Health and Welfare at Work Act 2005 and the General Applications Regulations. Method Statements shall be provided by the Pre-commissioner for all relevant activities carried out. Pre-commissioners shall provide evidence of all training carried out as part of their Health & Safety Plan.

Works shall be carried out in accordance with the Customers Health and Safety Plan until such time as equipment is made capable of being connected to the Transmission System.

The Customer's Health and Safety Plan shall take into account of the following minimum requirements:

- Safety, Health and Welfare at Work (Construction) Regulations 2013
- No single phase LVAC shall be used without RCD devices.

- A permit to work and lock-out tag-out safe system of work shall be implemented when equipment is energised during pre-commissioning activities or when applying test voltages
- Insulation testing at 5 kV shall only be carried out when all personnel have been made aware of the intention to test and have been withdrawn from work on the particular equipment.
- Any testing requiring access to high-level equipment shall only be carried out using properly secured access ladders and platforms. The Pre-commissioning RAMS shall consider if a personal safety harness is to be used for specific activities. All testing shall be carried out using the correct test equipment, which shall have the necessary test and calibration certificates available.
- Where functional testing involves the operation of remote equipment special care shall be taken to ensure that such equipment is electrically and mechanically fit for safe operation and that all personnel with access to the equipment area are aware of the operational state.
- Since damage to a HV devices with gas compartments can never be completely ruled out as the consequence of improper shipping and handling, it could burst when being filled to rated pressure. Therefore whilst the HV equipment is being filled, all personnel must remain in a protected location or at a safe distance.
- All personnel shall be withdrawn from the immediate vicinity of any HV equipment before the mechanism is operated for the first time.

Battery systems can discharge extremely high currents. Extreme care must be taken to avoid any possibility of a short circuit being applied to the battery terminals while test connections are being made or broken.

3 Pre-Requisites

The customer shall submit an Organogram of the pre-commissioning team clearly outlining roles and responsibilities together with CVs, accomplished pre-commissioner training for HV plant, previous pre-commissioning experiences, a pre-commissioning test plan, RAMS and programme for the completion of their pre-commissioning responsibilities to EirGrid for review four weeks before testing is planned to start on site. Additionally, the customer shall provide a weekly 2 week lookahead once pre-commissioning commences to allow EirGrid to witness activities as required.

Building general services (such as lighting, heating & power) equipment shall be installed tested and certified in accordance with the requirements of electrical safety certification and the latest edition of IS 10101. Note: this applies regardless of whether the associated equipment is temporary or permanent.

A full set of up to date drawings (including manufacturer's drawings, instructions and pre-commissioning test sheets and marked up installation drawings) shall be available on site for Audit purposes and shall be included in the pre-commissioning pack handed over to EirGrid for acceptance at the commissioning hand over meeting.

The pre-commissioner shall ensure careful mark up of all changes carried out (along with any discrepancies identified) to any design drawings and include these in a pre-commissioning drawing pack to be handed over to EirGrid at the commissioning hand over meeting.

The customer shall ensure that any design changes required during the pre-commissioning phase are verified and approved by the designer before the change is implemented on site.

If significant mark ups are required during pre-commissioning then the drawings shall be revised electronically such that a clean copy is available for the commissioner.

3.1 Pre-commissioning Pre-start Meeting

A meeting prior to the commencement of any testing or pre-commissioning starting shall be held between the Customer and EirGrid Client Engineer. The purpose of which is to discuss and review the above requirements and to inform the customer of the subsequent witnessing and handover expectations of EirGrid. EirGrid's requirements for Fingerprint testing of certain plant shall be discussed and agreed at the pre-start meeting including methodology and scheduling.

4 Test Equipment

The pre-commissioner shall supply all necessary equipment for the testing. All the test equipment whilst pre-commissioning must be accompanied by valid calibration certification.

The Customer shall outline their procedure for controlling test equipment to ensure that only calibrated equipment is used on site.

The Customer shall make copies of test equipment calibration certificates available as part of the pre-commissioning test report and during site audits performed by the Client Engineer.

The following is an indicative non exhaustive list of testing equipment that may be used to complete the pre-commissioning requirements described in this functional specification.

- Multimeter
- Insulation Resistance Tester (IRT) 500 V
- IRT 5 kV
- Micro-Ohm Meter
- Rotoscope
- Voltmeter
- Automated battery discharge test set
- Torque wrench
- Fused test lead
- Ruler, red/black pens, tip-ex or equivalent

Additionally any person entering the battery room shall wear the following Personal Protective Equipment (PPE) as a minimum:

- Antistatic, flame-resistant coveralls – EN ISO 11612, EN1149-5, IEC 61482-2.
- Antistatic safety boots – EN ISO 20345 – Classification A as a minimum.
- Full face visor compliant with EN 166.
- Gloves:

    - Standard safety gloves for work in the battery room not involving movement or hydrometer testing of cells.
    - Safety gloves compliant with EN374-3 for work requiring movement or hydrometer testing of cells.
- For work requiring movement (hydrometer tests)
    - Apron to comply with EN14116, EN ISO 11612.

5 Documentation Of Test Reports/Sheets

Refer to the Technical Schedules for pre-commissioning test sheets. All test sheets must be completed, dated and signed off. The customer shall include all test results and reports the pre-commissioner performed during the pre-commissioning tasks in the hand over documentation to EirGrid (pre-commissioning hand over pack) for final commissioning.

The customer shall ensure the general asset register (GAR) sheets are completed for all assets in the substation and this document shall be included in the pre-commissioning hand over pack.

6 Test Procedures

Refer to Technical Schedule XDS-GTS-20-001 for pre-commissioning test schedules. The customer shall use these technical schedules and this document as a basis of their Pre-Commissioning Test Plan.

A general inspection of all plant and non-plant items in the station shall be made to ensure that the design, IEC standards, Operation and specification requirements are met and that the installation has been completed according to industry's best practices.. All applicable checks shall be completed and the results noted on the relevant Pre-Commissioning Inspection Reports and/or Test result reports

6.1.1 Primary Plant General Inspection

All required tools for operating primary plant shall be available within the substation compound. Primary plant shall be operational as far as practicable, including:

- All switchgear in an operational state with supplies on.
- All AC and DC system components free of earth faults.
- SF6 Gas, or alternative Gas, filled to operating levels.
- Gas quality analysis test results for switchgear including low and insufficient alarm and lockout levels.
- Transformers filled with insulating oil.

All battery system/components should be confirmed to be free of earth faults and any other faults.

6.1.2 HV Connections General Inspection

The following shall be confirmed for HV Connections:

- Connections surfaces shall be suitably prepared and cleaned.

- Contact grease shall be used on connections.
- Where dissimilar metals are bolted together, adequate corrosion resistance measures shall be taken such as a bi-metal plate.
- The receiving contact surface area shall cover the full contact surface area of the lug.
- There shall be no mechanical stress at connections.

All connections to circuit breakers shall be flexible.

6.2 Fingerprinting

EirGrid shall arrange for all HV equipment to be fingerprinted. This is generally carried out during the pre-commissioning phase once all HV equipment is operational, however timing for this task may vary on a project specific basis.

The customer shall make provision for the use of plant to access the equipment for the fingerprinting staff.

6.3 Non-Plant Items General Check

The following shall be confirmed by the pre-commissioner:

- Danger notices fitted to compound fencing, doors and gates. Danger notices shall be mounted on all compound fences at a maximum spacing of 6m and a height of 1.5m to centre of sign.
- Standard locks fitted to main and compound gates and to station doors.
- Appearance of grass, paths, gravel, weeds and site drainage is per EirGrid functional specifications.
- Cable trenches covered by reinforced paving slabs.
- All cable trenches/ joint pits/ excavations are backfilled.
- Paintwork and galvanising are of satisfactory quality and according to EirGrid Functional Specification requirements and expectations.
- Unwanted materials are removed.
- First aid kit and safety rubber mats on site.
- Safety and artificial respiration notices erected.
- Firefighting equipment installed at all approved locations.
- Station telephone in operation & adequately isolated electrically.
- Security fence height at least 2.6 metres, with no climbing aids & a clearance of 2.6m to terminations.
- Pedestrian and main gate are earthed as per design. The pedestrian gate within the main gate shall be bonded to the main gate with appropriate 95 mm^2 PVC insulated copper flexible earth and according to EirGrid Functional Specifications
- Main station inner gates shall be earthed and shall only open inwards.
- Outer station gates shall maintain a minimum of 3 metres clearance, from the inner gate, when in the open position. Any deviation from this requirement should be accounted for in the earth grid study and design.
- All flexible earths shall be located on the inside of the station and shall have clear PVC sleeving on the connector.

- Confirm depth of stone coverage > 150mm.
    - All ducting size correct and installed as per current policy and is certified as clear and free from debris.
    - All station lighting columns shall be earthed. The earthing connection shall be located on the outside of the column and shall be clearly visible.
    - The inner fence shall be earthed at every second paling.

The following shall be confirmed that have been issued and are available where applicable:

- Fire monitoring system certificate of compliance.
- Intruder alarm monitoring system certificate of compliance.

Electrical completion certificate for the building services installation.

6.4 Customer Transformer Commissioning

Customer Transformers commissioning is the responsibility of the customer.

Certain checks must be carried out to ensure the transformer CB opens on the occurrence of a transformer fault i.e. Differential Protection and Buchholz etc.

If the customer intends is to carrying out a stability test on the differential protection, then they shall make EirGrid aware of this so it can be integrated in the programme. If the HV connections onto the transformer are required for this test then this shall be raised at an early stage.

6.5 CT/ VT Pre- Commissioning

Confirmation that the CT/VT are compliant with the specification, manufacturer and project requirements is required during pre-commissioning. Confirmation of conformance to safety clearances, earthing, phasing, oil levels, labelling and other equipment associated to the current transformer.

All nameplates should be checked, so that the rated burden and accuracy class of each Secondary winding, and individual Secondary winding numbers match the design. The Primary rating should also be verified.

All VT secondary fuses should be removed and the VT removable link big **"N"** to earth should be removed before insulation resistance testing. It must be reinstated after insulation resistance testing completion.

The insulation resistance tests are to be carried out to prove that the integrity of the insulation of the current transformer is of good quality. It shall be carried out between the CT/VT primary connection and earth and between all secondary cores and earth. Additionally, insulation tests shall be carried out between all secondary cores and primary connections. These results should be in the order of GΩ's and increasing. Results must be listed in the test sheets provided.

Phasing/polarity-The hard wiring of CT/VT secondary circuits is of vital importance with regards to the reliability and correct operation of any protection scheme and therefore must be checked for correct phasing.

Any spare cores should be wired to the marshalling kiosk and in the case of CT cores, shorted out and earthed.

6.5.1 Current Transformers

The following should be confirmed specifically for the CTs, where applicable:

- CT circuit and nameplate is as per the elementary and EirGrid requirements/approved design.
- CT orientation is as per approved SLD.
- For oil filled CT's, confirm oil level is within the manufacturer's acceptable limits.
- Insulators/casing clean and free from damage.
- Primary ratio re-connection straps firmly bolted on.
- Primary conductors of correct type and size.
- Connections are greased as per manufacturer's instructions.
- Connector bolts marked as torqued.
- CT is mounted as per design/standard and O&M indications.
- Correct size terminals/shorting facility is used for the secondary circuit.
- Cable numbering is correct as per design/standard.
- Correct size, type and colour for wiring has been used, in accordance with the design/specification.
- Core numbers are in the correct terminals in the control panel.
- All CT terminals have been tightened.
- Cabinet heaters are working in the CT/VT Marshalling box.
- CT terminations are secured.
- Correct crimps used and colour coding is correct.
- For relay CT connections, confirm rig lugs are installed instead of ferrules.
- Confirm CT terminal isolating and shorting links are in the correct position for service.
- Confirm shorting facility is oriented as per design/standard.
- CT earthing arrangements are correctly installed as per design requirements and EirGrid functional specifications.
- CT cable screens are earthed.
- Current Transformer Insulation Resistance Test (IRT).

6.5.2 Voltage Transformers

The following should be confirmed specifically for the VTs, where applicable:

- VT circuit and nameplate is as per the elementary and EirGrid requirements/approved design.
- Ferro-resonance resistor is installed on the correct winding.
- VT orientation is as follows:
    - A to the bay.
    - N to the earth
- VT is bolted correctly to steel work or ground level.
- Where applicable, confirm for the primary winding N:
    - Labelling
    - A removable link is in place between earth and the primary winding N and is firmly bolted and secure.

    - Connection to earth shall be verified as being protected.
- Confirm the VT earthing arrangements are correctly installed as per design requirements and EirGrid functional specifications' requirements.
    - Earthing of both star and open delta connected circuits is correct as per design standard.
    - Circuit is only earthed at one point, this should be the 1st cabinet in, from the marshalling box.
    - VT cable screens earthed (at both ends of the VT circuit)
    - VT secondary earth should not be isolatable via isolatable terminals.
- Primary conductors as per design:
    - Connections greased.
    - Connector bolts marked as torqued.
- Correct size and type terminals, fuses, isolating facility and wiring are used for the secondary circuit.
    - Fuses are clean and sealed against water ingress.
    - VT terminations are secure.
    - Where installed, confirm that fuses are the correct rating, greased and free of corrosion.
    - Correct terminations are used.
    - MCBs of correct rating and type are used.
    - All VT MCBs are connected as per design.
    - VT MCB supervision contact to distance relays is wired through a fast acting contact (not an auxiliary contact)
    - VT terminals, MCBs and fuses are in the correct position for service.

6.5.3 Insulation Resistance Test (IRT)

The insulation resistance tests are to be carried out to prove that the integrity of the insulation is of good quality. It shall be carried out between contacts, phases, and earth. The following shall be confirmed prior the execution of the IRT:

Conductors that may affect IRT have been removed.

- Earths are not applied during the IRT, cubicle disconnects shall be in the 'Open' position during the IRT.
- Insulators are dry and clean.

The requirements for the IRT are summarised in the table below:

Table 1 CT/VT Insulation Resistance Test

Test No.	Description	Voltage (kV)	Duration	Expected Value (Ohms)
1	All Phases to Earth	5	1 min	> 1 GΩ
2	Across Open poles (CB should be opened prior to this test commencing)	5	1 min	> 1 GΩ
3	Phase to Phase	5	1 min	> 1 GΩ

6.6 Circuit Breakers

6.6.1 General Checks

General checks of the CB must be carried out to ensure compliance with the specification, manufacturer and project requirements. The following should be confirmed as part of the General checks of the CB:

- Conformance to safety clearances, earthing, phasing, gassing, labelling, and other equipment associated to the CB.
- CB has been mounted and installed as per manufacturers instruction and/or designs:
    - CB is orientated correctly.
    - All bolts are torqued and marked where required.
    - Control box and mechanism have been installed in line with manufacturer's instructions.
    - CB Plinth is in satisfactory condition.
    - CB Insulators have no cracks or damage.
    - Paint work is free of rust and galvanizing is according to EirGrid specifications.
- A screen (polycarbonate or aluminium) should be present in the CB control box to confirm access to the mechanical parts is not possible. Access to the SF6, or alternative Gas, filling point shall not be blocked when screens are in place.
- Locking facility on circuit breaker doors is available.
- Circuit breaker doors seals intact.
- CB Indications and colours match design and relevant EirGrid specifications
- Two stage pressure switches monitoring the pressure of the SF6, or alternative Gas, gas compartment should be confirmed. First stage level should be indicated as "low Gas" or "minimum service pressure". Second stage level should be indicated as "loss of Gas" or "Gas lock out". Where the CB operation should be blocked.

6.6.2 Insulation Resistance Test (IRT)

The insulation resistance tests are to be carried out to prove that the integrity of the insulation is of good quality. It shall be carried out between contacts, phases, trip coils and earth. The following shall be confirmed prior the execution of the CB IRT:

Conductors that may affect IRT have been removed.

- Earths are not applied to the CB during the IRT, cubicle disconnects shall be in the 'Open' position during the IRT.
- CB is in 'Closed' position prior to testing.
- CB Insulators are dry and clean.

The requirements for the CB IRT are summarised in the table below:

Table 2 Circuit Breaker Insulation Resistance Test

Test No.	Description	Voltage (kV)	Duration	Expected Value (Ohms)
1	All Phases to Earth	5	1 min	> 1 GΩ
2	Across Open poles (CB should be opened prior to this test commencing)	5	1 min	> 1 GΩ
3	Phase to Phase	5	1 min	> 1 GΩ

Results must be listed in the test sheets provided.

6.6.3 Operational Checks

Operational testing of the CB must be carried out to verify the timing of the electromechanical process and proves the acceptability of the CB for in-service operation.

The customer shall ensure that the ratings of operating coils and auxiliary relays are the correct operating voltage and that trip coils and close coils are not damaged by wrong voltage or constant supply applied. The customer shall also confirm that all MCB ratings and characteristics are in accordance with design/manual and that all MCB open/trip alarms are actuating the correct alarms. Control cabling labelling shall also be in conformity with the cable schedule and EirGrid requirements and maximum voltage labels are fixed to the inside of control boxes.

The customer shall ensure that control box heaters are working and the thermostats are functioning correctly.

6.6.4 Functional Operation

There are various minimum operations that must be done to ensure that the CB is fit to go into service.

Any Local/Remote switches should be shorted out.

Supplies should be checked at the circuit breaker for segregation purposes.

The circuit breaker should be operated remotely from the SMD switch on the control/Mosaic cabinet and NCC.

It should also be operated locally i.e. Pushbuttons.

All circuit breaker mechanisms should be operated manually and electrically, the spring mechanisms shall be charged manually for the first operation.

Local open and close indications should be checked.

The circuit breaker should be tripped from its relay or relays.

The spring/motor circuit, auxiliary contacts, anti-pumping timer, indication and alarms must be tested. These are listed in the test sheet provided.

SF6 Gas-Samples of the SF6 gas, or alternative Gas, must be tested for Dewpoint and purity. The alarm and trip contacts of the gas density/pressure monitoring devices and gas levels must be checked in accordance with the manufacturer's recommendations. All correct functioning of the gas monitoring devices must be verified and results listed in the test sheets provided. The manufacturers recommended connection and filling sequence shall be followed. The Pre-commissioner shall liaise with the Commissioner regarding the timing of this activity to prevent unnecessary duplication of works.

6.7 Disconnectors/ Earthing Switches

6.7.1 General Checks

General checks of the disconnectors/earthing switches must be carried out to ensure compliance with the specification, manufacturer and project requirements.

The disconnector/earthing switch operational checks shall be carried out using the circuit diagram to prove that the disconnector operates from all control positions at nominal voltages. Any adjustments shall be implemented as per the manufacturer's guidance. The auxiliary contacts shall also be checked and proved in both positions and early make/break configurations shall be verified. The mechanical and electrical interlocking must be tested as in specification.. The test results are used to check the integrity of the closed contacts. This test must completed for each phase of the disconnector.

Motorised disconnectors/earth switches shall be operated manually and checked for both freedom of movement in both directions and for correct primary contact wipe. The manufacturer's recommendations for powered operation shall then be followed and electrical operation checked in both directions. Remote operation of the mechanism from the station control building shall be checked.

Manual disconnectors and earthing switches shall be operated and checked both for freedom of movement.

The following shall be confirmed:

- Specifications of the disconnector on the nameplate correspond with the EirGrid Single Line Diagram.
- Disconnector is assembled correctly in accordance with design and manufacturer's specification.
- No physical damage is present (i.e., cracks in porcelain)
- Primary conductors as per design.
- Correct connector is used.
- Bi-metallic plate is in place and is facing the correct way.
- Bushings/Contacts are clean and free from contamination.
- Orientation of the disconnect and level.
- The integrity of the structure and fixings, corrosion protection, lubrication of moving parts, contact condition and greasing.
- Condition of paintwork and galvanising is satisfactory.
- Precautionary pinning and fixings used for transportation have been removed and disconnects may operate freely.
- As per manufacturer's instructions confirm the alignment of the arms and pinning of drive shaft/transmission rods is completed throughout the station.
- Where applicable the heater circuits are functioning correctly.
- The electrical clearance of the disconnect phases:
    - Against each other
    - Against earth.
    - To ground.
    - To fence.

    - Above walkways
- Earthing requirements as per design and to include the following where applicable:
    - Earthed directly to earth grid.
    - Connections crimped correctly.
    - Sharp bends on the earth connections should be avoided.
    - Connections correctly protected from corrosion.
    - Earthing including the mech. box, operating handle and frame.
    - Earth disconnects to have dedicated double earth connection.
    - Single pole disconnects bolted to an earthed metallic structure do not require individual earthing.
    - Triple pole disconnects shall be earthed at the designated earth point. The operating handle shall also be bonded.
    - Flexible sections of earths shall be installed and shrouded as per design.
    - Double earth connections shall be lugged as per design and no insulation shall be under the crimp connection.
    - Nickel plated lugs should be used on galvanise steel works.
- With connections applied the pre-commissioner shall confirm the open and closed alignment of AIS disconnects.

6.7.2 Disconnect IRT

The following IRT shall be completed:

Table 3 Disconnect Insulation Resistance Test

Test No.	Description	Voltage (kV)	Duration	Expected Value (Ohms)
1	HV to Earth (Disconnect both Opened and Closed)	5	1 min	> 1 GΩ
2	In both closed and open positions (Between R,S and T poles)	5	1 min	> 1 GΩ
3	Insulation across open contacts	5	1 min	> 1 GΩ

Results must be listed in the test sheets provided.

6.8 Surge Arrestors

6.8.1 General Checks

General checks of the Surge Arrestors must be carried out to ensure compliance with the EirGrid specification, manufacturer and project requirements The test results shall be recorded on the Surge Arrestor Pre-Commissioning Test Sheet provided. The collection of all data from the nameplate must also be included in the test sheets. The earthing of the surge arrestor must be checked to ensure that the earthing leads have a short and direct path to earth and must be free of sharp bends.

The following shall be confirmed:

- Confirm that specifications of the surge arrestors on the name plate corresponds with the specifications listed on the SLD or the detailed electrical construction schematics for the cubicle it is installed in.
- Assembled correctly in accordance with design and manufacturers specifications.
- No physical damage present (cracks in porcelain, cuts in silicone rubber)
- All surface contaminants have been removed (green algae)
- Earthing requirements are as per approved design and EirGrid specifications
    - Minimum amount of bends.
    - Connection method
    - Where applicable visually confirm the surge arrestor is earthed directly to the earth grid.
    - Connections crimped correctly.
- Connections correctly protected from corrosion.
- Arcing horns have been removed from within the protection zone.
- IP rating of surge counter where provided. IP 67 minimum required.
- Primary conductors correct type size.
- Connections are greased as per manufacturer's instructions.
- Clearance between ug and surge arrestor steelwork is correct.

6.8.2 Surge Arrestor IRT

The following IRT shall be completed:

Table 4 Surge Arrestor Insulation Resistance Test

Stack Section	Voltage (kV)	Duration	Expected Value (Ohms)
HV to Middle	5	1 min	> 1 GΩ
Middle to Base	5	1 min	> 1 GΩ
HV to Base	5	1 min	> 1 GΩ
Insulated bolts to Earth	5	1 min	> 1 GΩ

Results must be listed in the test sheets provided.

6.9 Busbars And Supports

6.9.1 General Checks

General inspection, including confirmation to safety clearances, earthing arrangements, greasing of contacts, condition of paintwork and porcelains. Where the busbar has been jointed, a ductor test must be done on that joint to ensure the contact is of low resistance.

The following shall be confirmed:

- Busbar MVA rating matches the specification, SLD and approved design
- All insulators voltage ratings are correct.
- Busbar type is correct (Cross Sectional Area or material type etc).

- Busbar is assembled correctly in accordance with design and manufacturers specification.
    - No physical damage present. All insulators supporting the busbar section are intact.
    - All metal work bolted correctly.
    - Supporting metal work is earthed correctly and directly to the earth grid.
    - Earth stirrups and parking bars installed as per design.
    - Bi-metallic plate is in place and is facing the correct way.
    - Expansion Joints installed as per design.
- Phasing of the busbars is in accordance with the layout drawing and phasing diagram (in general R,S and T from the centre of the station)
- The integrity of the structure and fixings (corrosion protection, contact condition and greasing)
- Busbars are clean and free from contamination.
- No corrosion on connections and/or rusting of metalwork.
- GIS installations confirm the SF6 gas, or alternative Gas, pressure is filled to the rating plate value for all compartments.
- Mechanical earths should be confirmed for freedom of movement as per the manufacturer's manual.
- Earthing stirrups are not located in close proximity to live parts and are located as per agreement with EirGrid

The following electrical clearances shall be confirmed for each busbar phases:

- Against each other.
- Against earth
- Busbar to ground.
- Busbar to fence.
- Busbar above walkways.

6.9.2 Busbar IRT

The following shall be confirmed prior to the execution of the IRT:

- All sectionaliser disconnects are closed.
- All cubicle busbar disconnects are open.
- All earths are removed from the section of busbar under test.
- VT primary earths are removed, or VT isolated from the Busbar under test.

The following IRT shall be executed:

Table 5 Busbar Insulation Resistance Test

Test No.	Phase to Phase	Phase to Earth	Voltage (kV)	Duration	Expected Value (Ohms)
1	R to S	R to Earth	5	1 min	> 1 GΩ
2	S to T	S to Earth	5	1 min	> 1 GΩ
3	T to R	T to Earth	5	1 min	> 1 GΩ

Results must be listed in the test sheets provided.

6.10 GIS Pre-Commissioning

Pre-Commissioning of GIS Equipment shall be completed as per manufacturer's recommendations. At a minimum, the following shall be checked, confirmed and results/descriptions included in the pre-commissioning report:

- Civil Works:
    - Conformity with design.
    - Conformity with Health and Safety Irish legislation requirements
    - Conformity of the assembly with manufacturer's recommendations.
    - All openings are sealed and/or temporary protection measures against pollution have been provided for any outdoor erection works.
- GIS Components:
    - Conformity with design (sealing of pipe junctions, tightness of bolts and connections, interlocking).
    - Conformity of the assembly with manufacturer's recommendations.
    - Dielectric tests on main circuits.
    - Partial discharges measurements.
    - Measurement of the resistance of the main circuit.
    - Gas Tightness Tests.
    - SF6 or alternative gas quality verifications.
    - Checking of density switches operation during gas filling.
    - Checking of gas pressure.
    - Checking of gas pressure alarms
- Circuit Breaker
    - Conformity with design.
    - Conformity of the assembly with manufacturer's recommendations.
    - Check of electrical circuits.
    - Checks of insulation / extinguishing fluids.
    - Mechanical tests and measurements.
- Disconnector and Earthing Switches
    - Conformity with Design.
    - Mechanical Operating Tests.
- Current Transformers:
    - Compliance of assembly.
    - Conformity with Design.
    - Power frequency voltage withstand tests on secondary terminals.
- Voltage Transformers
    - Compliance of assembly.
    - Check of shock detector.
    - Power Frequency voltage withstand tests on secondary terminals.
- LCC
    - Conformity with design.
- Final Inspections

- Paint Coating checks.
- General arrangement assembly.
- Earthing Circuit assembly.
- Visual Checking.

6.11 Torquing

Torquing of busbar connections shall be as per manufacturer's recommendations.

The torque wrench used shall be certified where required.

EirGrid shall arrange for the torquing of busbar connections to be witnessed.

6.12 Protection Relays And Other Integrated Electronic Devices

General checks of the relays and Substation Control System must be carried out to ensure compliance with the specification, manufacturer and project requirements.

Protection relays and other devices, including but not limited to, Substation Control Systems, event recorders, alarm systems etc. shall be powered up and verified to be operational by the customer. In relation to alarm systems and stand-alone event recorders, the Pre-commissioner will be responsible for uploading of initialising text. Any programmable meters or transducers shall be programmed by the pre-commissioner.

6.12.1 General Checks

The protection / IED equipment shall be examined to confirm the following:

- Nameplate ratings as per appropriate application design or substation SLD and nominal voltage and current values.
- No physical damage.
- No ingress of moisture, dust or any other particle which could impair the performance of the equipment.
- No damage to keypad or HMI.
- No signs of contact erosion due to arcing or corrosion.
- No signs of excessive heating.
- All wiring and connection should be secure.
- All wiring should be cable tied and looms routed in acceptable appearance for the commissioner.
- Labelling is appropriate to the application.

6.12.2 Initial Power Up

This process shall follow the manufacturer's recommendations for initial power-up.

As a minimum, however, the following procedure shall be carried out;

The power supply input terminals of the device shall be disconnected from the cabinet supply wiring.

The appropriate DC supply MCB shall be closed.

The magnitude and polarity of the DC supply voltage at the disconnected wiring shall be checked. Disconnected wiring shall be clearly labelled to ensure correct re-connection.

The appropriate DC supply MCB shall be opened.

The power supply input terminals of the device shall be re-connected to the cabinet supply wiring.

The appropriate DC supply MCB shall be closed.

The magnitude and polarity of the DC supply voltage at the power supply input terminals of the device shall be checked.

Verification of the operational state of the device shall be by reference to front panel power indicators, screen text messages, or other indications as appropriate for the particular device.

The labelling of the DC supply MCB shall be checked.

Segregation of supplies to relays (duplicate scheme) should be checked to ensure supplies are not crossed.

Supplies should be checked at all binary inputs and outputs.

Note*

Primary relays should never be powered up and down in close succession. A time delay of a minute or so before re-energising its power supply.

6.13 SCADA

The following shall be confirmed by the pre-commissioner for the SCADA:

- RTU signal supply is wired as per design.
- RTU command and status supply is wired as per design.
- Applicable equipment is suitable for the intended application and that the equipment model/type number, current and voltage ratings are correct.
- Panels and equipment associated with SCADA, signalling and metering have the following labelling applied:
    - Panel identification labels.
    - Safety notices and warning labels.
    - Maximum voltage labels.
- Station mimic/mosaic panels have the following:
    - Correct representation of the station according to the approved SLD.
    - Equipment representation and control of equipment is clear and unambiguous.
    - Appropriate control switches and indications are in place.
    - Identification labelling of all bay and busbar components are correct.
    - Correct RAL colours are used to represent the voltage level of the equipment.
    - Any potential means of bypassing a busbar sectionaliser in the station is clearly outlined.
    - The position of measurand displays or digital measurand fields correctly reflect the location of where the measurement is obtained.

The following shall be confirmed for BCUs or integrated bay controls on protective devices (if applicable):

- Correct representation of bay/cubicle equipment layout according to the approved SLD.
- Identification of labelling of all plant and components is correct.
- External labelling of switches, controls and LEDs are correct.

The following shall be confirmed for the main SCS operator interface:

- Correct representation of the station and equipment layout according to the

approved SLD.
- Equipment representation and control of equipment is clear and unambiguous.
- Appropriate control switches and indications are in place.
- Labelling of components, bays/cubicles and busbars are correct.
- Correct RAL colours are used to represent the voltage level. Refer to EirGrid's functional specification XDS-GFS-06-for colour codes relate to the SLD.
- Bay control units installed correctly.
- Wiring to star coupler correctly installed.
- That input/output signals from source to bay unit correct.
- All Fibre cabling is installed in fibre ducting within station ducting.

Pre commissioner shall not operate a main substation mimic panel in a live substation.

6.14 Cabinets

The following shall be confirmed by the pre-commissioner:

- Manufacturers documentation attached, all cabinet manufacturers installation and as-built schematics provided.
- Cabinet mounted on support rails and bolted down correctly.
- Cabinet earth conductor connected and secure in the cabinet and to the earth ring.
- Cabinet contents confirmed against design schematics and marked up accurately if required.
- Cabinet identification labels fitted to front and rear.
- All cabinet equipment labelled correctly.
- All required cabinet equipment fitted (MCB, relays, switches, test sockets etc) and correctly labelled.
- Cabinet doors bonded.
- Wiring and terminations checked for tightness.
- Max voltage level warning labels fitted.
- All trunking installed appropriately and lids fitted correctly.
- Cabinet appearance neat and internal wiring managed adequately.

The following shall be confirmed on the cabinet earthing:

All equipotential bonding shall be complete as per design, this may be a visual inspection or require a continuity check, using a multi meter, where a visual inspection may not confirm an earth connection.

- All cable screens are shrouded and connected to earth.
- Earthing of cabinets as per standard designs.

6.15 LV Cables And Wiring Checks

Checks shall be carried out in detail with the cable schedule to ensure that all cables are glanded correctly into the correct cubicle or equipment at each end.

Checks shall be carried out in detail with the wiring/termination drawings to ensure that all cores are terminated in the correct position at each end and that all terminals a tightened correctly.

Checks shall also be made for correctness of cable size, number of cores, core colours, ferrules, cable numbering, and termination method.

The following shall be confirmed by the pre-commissioner:

- All stranded cables have correct ferrules used.
- All ferrules correctly crimped.
- No connections hidden in trunking.
- Cable cores not damaged during installation.
- Terminal bridging links are installed and tight.
- AC/DC board cabling is glanded correctly.
- EMC rated glands should be used:
- On any cabling within the GIS room (not needed outside of the switch room). No earths should be brought into the LLC/ protection cabinet.
- Main point of the EMC rated gland (Agro or similar) is that the earth screen should not go past the gland and into the LCC / mech box. Instead, the earth is distributed around the metal enclosure via the metal gland plate.
- No cut/slots in the LCC for cable entry are allowed unless the screen is appropriately earthed in advance.
- Cable identifications is in place, core numbers are visible on field wiring and are faced outwards.
- Correct colour coding of all conductors used in AC/DC board. ETCI regulations apply to the cables in the AC board.
- Cable screens are correctly earthed as required
- The correct earth neutralising arrangement is installed and as per the design.
- All battery system/components should be checked/verified as free of earth and any other faults.

5 kV shall be used for HV primary equipment except VT primary voltage which should be limited to 2 kV.

500 V shall be used for all secondary wiring and Insulated Supports.

6.16 Earthing

The customer must ensure that all the appropriate equipment is connected to the earth grid. An inspection of all earthing connections must be carried to ensure that the joints are correctly compressed or welded. Earthing layouts should be available, detailing the size and number of connections required.

6.16.1 General Substation Earthing

The following shall be confirmed, regarding general substation earthing:

- All substation trunking, cable trays and cable ladders are earthed and bonded in line with accepted design and EirGrid specification requirements.
- Earths are applied to the substation entrance doors/gates in line with design requirements.
- Substation earthing bar installed as per design requirements.
- All metallic objects are bonded to the substation earth grid.

- Substation perimeter fencing is earthed in accordance with specific design requirements.
- Earthing insulation has not been compromised through installation i.e., no splits or cracks on installed insulated conductor, no sharp bends.
- Handrails, lighting columns and station gates are earthed as per design requirements.
- Earth connections are secured properly as per design requirements.
- No third-party fences (e.g., IPP, Telecoms, Farmers) connected to the substation perimeter fence.
- The pre-commissioner shall liaise with the telecoms provider to confirm correct provision of isolation facilities for the public telephone system from local earth.
- Where copper earth conductor is supported on galvanised steelwork, contact between the two shall be prevented to avoid galvanic action.
- Perimeter fence earthed at correct intervals as per design.
- That crimps are inspected, made correctly, and stamped with a die appropriate for the size of the conductor.
- No Earth connections are present in the battery room

A ductor test of all connections made from the yard equipment to the earth grid must also be done. These tests must be discussed with EirGrid prior to being carried out. The Pre-commissioner shall liaise with the telecoms provider to ensure correct provision of isolation facilities for the public telephone system from local earth.

6.16.2 Connections Above Ground

The pre-commissioner shall confirm the following:

- A contact resistance test is completed on all connections above ground.
- All connections are secure by completing a pull check.
- All bolts connecting earths to metal work shall be marked as torqued. A sample check shall be completed to confirm.
- All bolted earthing connections shall be a single conductor, except the flexible earth on the compound gate or station doors.
- There should not be two earthing lugs connected to the same bolt, the only exception where two lugs may be used is for substation gates.

6.16.3 Earth Grid Contact Resistance Testing

A contact resistance test shall be completed on all connections below ground. The earth grid contact resistance testing may need to be completed by the pre-commissioner or receive results from earth grid installer with a picture and resistance value for all connections. A unique identifier and picture shall be created for each joint to be tested.

The test set shall be connected across each joint in question using the manufacturers test leads/Kelvin clamps for all contact resistance tests. The air temperature shall be recorded at the time of the test and the resistance value of each connection shall be confirmed.

Using the four-wire method with the use of Kelvin clamps, 100 A (min) DC shall be injected across the joint and record the resulting resistance value. Resistance may be calculated using the formula $R = \rho L/A$ where:

- ρ is the resistivity of the material.

- L is the length of the section under test.
- A is the cross-sectional area of the earth conductor.
- The resistance of any unit length of conductor with a joint or splice shall not be more than the resistance of an equivalent length of conductor without any joint.
- Where deviations are noted, the Pre-commissioner shall:
- Investigate the quality of crimps made.
- Investigate possibility of damage to earth grid.
- Investigate length of conductor section tested.
- Re-check test connections.

6.17 Battery, Chargers & Battery Room

All cell voltages must be measured and documented. Load tests and discharge tests must also be completed according to manufacturer's requirements. All connections must be checked for proper tightness. General inspection of the batteries and the battery room should be carried out to ensure compliance with the specification, relevant standards, H&S, manufacturer and project requirements.

6.17.1 Battery Room

The following to be confirmed by the pre-commissioner, where applicable:

- Battery room layout as per EirGrid's functional specifications and approved design.
- EirGrid have completed the battery room ATEX inspections, and the certificate is available to the Pre-Commissioner.
- Cleanliness of battery. Where cleaning is required confirm that the cells are cleaded using a water moistened cotton cloth only. A dry cloth or any synthetic material that may build a static charge should not be used.
- Battery to be accessible to allow maintenance work and installation.
- An absolute minimum distance of 800 mm between battery racks, but it should be in line with accepted project design
- As per manufacturer's instructions, confirm tightness of cell connections on individual terminals and confirm they are also protected from corrosion.
- Electrolyte level confirmed as specified on the individual cells and no leaks observed.
- Electrolyte level indicators are affixed at the correct level on front of all cell containers.
- All warning labels are in place as per specification.
- Battery bank and individual cell labels are clear and unambiguous.
- Capacity of battery matches design.
- Mounted to floor correctly.
- Mechanical shrouding of + & - terminals.
- Metal battery stands should not be earthed.
- Ventilation is provided inside the battery room as per design.
- First aid and safety equipment is available.

- Battery room light switch is located outside, within 1.5 m of the battery room door. It shall be explosive proof and shall have its function labelled.
- Battery room door signage fitted.
- Steel conduit or trunking installations shall not be permitted.
- Heating system suitable and set to maintain temperature as per battery manufacturer guidelines.
- Earthed heater distance should be greater than 1.5 m from the battery.
- The mounting height of heater on wall should be between 300 – 400 mm above the floor level to bottom of the heater.
- Segregation of the positive and negative cables (Where fuses are not installed)
- Positive (+) and Negative (-) wiring should be kept separate from the MCB/fuse connection box to the battery, with separate holes through the wall and into separate conduit in the battery room.
- Wiring to the battery from the MCB connection box (in the Control Room) is a separate single core stranded (not solid) copper /LSZH cables installed in 20 mm rigid PVC-U (unplasticized) conduit. (PVC Conduits > 20 mm diameter are not permitted due to potential static build-up hazard)
- The cable size for the wiring of the battery from the MCB box is 25 mm^2, this needs to be confirmed from the site-specific schematic drawings.
- The insulation colours shall be brown for positive (+) and gray for negative (-).
- Battery room lamps, fittings and sensors are appropriately rated for application.
- Light fittings shall not be installed directly over the battery, but rather in between the battery rows, oriented in parallel to the battery racks.
- Confirm all fittings have no unused entry holes without blanking elements.
- Confirm a proper gas tight sealing compound is installed around cables entering/exiting battery room, on both sides of the wall, to prevent the spread of the explosive atmosphere from battery room into the rest of the control building.
- The following accessories should be supplied with the battery as per EirGrid specification:
    - Voltmeter with ±3 V scale for batteries with single cells or scale as appropriate in the case of batteries with monobloc units.
    - Lifting handle/device to allow simplified manipulation of individual cell or monobloc units as applicable.
    - Wall mounting instruction chart with following information:
    - Cell parameters.
    - Battery parameters
    - Inspection requirements and procedures.
    - Cell or monobloc numbering system.
- In the case of vented batteries, the following should also be supplied:
    - Thermometer.
    - Portable hydrometer syringe with temperature correction scale.
    - Cell topping-up bottle for adding distilled water.

6.17.2 Battery Charger

General inspection of the Battery chargers should be carried out to ensure compliance with the specification, relevant standards, H&S, manufacturer and project requirements.

Insulation, continuity, operation, control voltages, protection, indication, signals, earthing must be checked and ensured it conforms to manufacturer's requirements.

The following to be confirmed by the pre-commissioner for the battery charger:

- Correct cable termination of incoming AC cable and outgoing DC cable and the cable connection for the following:
- Battery and charger
- MCB/Fusebox
- A stable incoming AC supply to the battery charger.

Low/high, float and equalise voltage set points as per:

- Specific manufacturer's instructions or
- Values taken from the following table:

Table 6 Battery Alarm Levels

Alarm Level and Charge Set Point Voltage Levels	Lead Acid Cells (Volts per cell)	Alkaline Cells (Volts per cell)
Low Voltage Alarms	2.11 V	1.32 V
High Voltage Alarms	2.35 V	1.52 V
Float Voltage	2.25 V	1.41 V
Equalise Voltage	2.4 V	1.7 V (max)
LVD Voltage	1.85 V	

- The low voltage dropout (LVD) contactor is of the N/C type to prevent inadvertent operation. An LVD contactor is used when the output voltage from the charger is not available, the battery should discharge via the load. When the battery voltage is lower than the pre-set final discharge voltage, the LVD should disconnect the battery form the load to prevent deep discharge of the battery. When the charger returns to operation, the charger controller should control the LVD contactor to reconnect the battery to the system.
- Charger mounted securely and no signs of physical damage.
- The charger door opens without obstruction.
- Battery charger fan and heater are working correctly.
- Louvered air vents on the lower and upper part of the front door and the rear panel are not obstructed. Dust filters should be fitted onto the air vents.
- Cabinets located correct distance from wall and adjacent cabinets.
- The air vents should provide adequate ventilation for cabinets with enclosed VRLA batteries.
- All fuses and MCB's associated with the charger and fuse boxes are rated correctly.
- Cables are correctly connected and numbered as per design schematics.

- Terminals for the alarm circuits need to be suitable for 2 x 1.5 mm2 conductors to facilitate looping.
- Link extraction/insertion tool present in fusebox.
- Battery Charger technical records:
- Detailed as-built electrical schematics, including details of connections, wiring and terminal arrangements for battery charger cabinets. One set of these schematics to remain with the charger cabinet.
- Instructions for the safe handling of lead acid batteries.
- Detailed installation, commissioning, operation and maintenance instructions, including technical manuals for proprietary equipment.
- Routine test reports for each product and summary of all routine tests.
- The following measurement indications should be provided on the front door of the integrated charger cabinet:
    - Voltmeter, indicating load voltage. This voltmeter should be installed with a voltage selection switch (on the charger cabinet door) which should allow the indication of P-N, P-E and N-E voltages.
    - When the voltage selection switch is at P-E or N-E position, it should not cause an earth fault in the system.

The following shall be confirmed for the labelling of the battery chargers:

- Fuse cabinet is clearly labelled. Labelling should include a description of the fuse/MCB/Link arrangement.
- Boost instructions.
- LVD link instructions (where applicable)
- Alarm terminal schedule.
- Individual labelling of MCBs
- Individual labelling of contactors.
- Danger label on door.
- Max. voltage label for AC and DC voltages.
- Output terminal markers.
- Alarm terminal markers.

6.17.3 Station Battery Capacity Test

An equalising battery charge as per manufacturer's instructions shall be completed, to confirm voltages and specific gravity result across all battery cells under test. The equalising charge should be completed no more than 7 days before the discharge test. Once completed, all battery chargers connected to the battery under test shall be switched off.

The following parameters shall be measured:

- Battery room temperature prior to testing and at 95% of discharge time
- Electrolyte density.
- Voltage of each cell.
- Temperature of at least one cell out of every ten.

- Voltage of the complete battery system.

Once the above are completed, the cable to one battery charger unit shall be disconnected (Terminals CH1 Pos and CH1 Neg). This should facilitate switching On the load bank to the battery via C/O switch and fuses. One cable at a time shall be disconnected to reduce the risk of a short circuit. Where no changeover switch is available, a temporary switch fuse arrangement may be required between the load bank and the battery.

The load bank to be used for the discharge shall be connected. The load shall be matched to the ampere rating for the battery under test (i.e. 100 Amp Hour battery = 10 hours by 10 amps) The load current shall be kept constant and the time of the test start shall be recorded.

The following parameters shall be recorded every hour of the discharge period:

- Each cell voltage.
- Each cell specific gravity.
- One cell temperature (One in every 10).
- Voltage of the complete battery system.
- Confirm battery connections for excessive heating (use of infra-red thermometer).
- Once the battery discharge period has elapsed:
- The load bank shall be disconnected,
- The battery cable connections shall be reconnected and the connections with the original schematic shall be confirmed.
- Switch on the charger and when charge voltage has recovered and current has dropped below limitation, perform a boost charge of the battery.
- The test shall be terminated if the battery voltage reaches the results n* Uf, where n = number of cells and Uf Selected final discharge voltage. Additionally, the discharge shall be terminated when a cell has reached a voltage of U = Uf – 200 mV or a monobloc battery with n cells has reached a voltage of U = Uf - √n * 200 mV.

6.18 Interlocking

The pre-commissioner must ensure that this interlocking scheme is tested properly to ensure safe operation of the switchgear. Interlocking test is to be performed in compliance with EirGrid project interlocking requirements.

The following shall be confirmed:

- The permissive and blocking action of the mechanical interlock are functioning correctly in accordance with manufacturer’s instructions. Confirmation shall be achieved by operating the device in all operating positions and switching arrangements.
- The correct type of auxiliary contacts from the HV equipment are used for interlocking circuitry, including interposing realys in the interface cabinets
- All permissive and blocking conditions shall be confirmed in both directions.
- Interlocking between circuit breakers and disconnectors to confirm disconnectors do not make or break load currents.

- Interlocking between disconnectors and earth switches to confirm that:
- Earthing Switches should not be closed onto a locally energised circuit.
- Disconnectors should not potentially energise an earthed section via closed earthing switch.
- Cross transformer interlocking conditions to confirm that it is not possible:
- To energise the transformer when an earth switch is applied on either the HV or LV side.
- To close an earth disconnector when the transformer is live from either side.
- To energise the transformer from the lower voltage side.
- Where applicable, all interlocking tests should conform:
- To the approved interlocking conditions associated with the station issued by the station designer.
- Dedicated interlocking document for the station.

6.19 AC And DC Distribution System

General inspection of the AC and DC Boards and distribution systems should be carried out to ensure compliance with the EirGrid specification, relevant standards, H&S, manufacturer and project requirements.

AC and DC distribution boards should be checked to be labelled correctly as per schematics and EirGrid labelling specification and initiate the correct alarms/signals when tripped. The polarity of all MCB's should be checked.

6.19.1 AC Sub Circuits

Confirm the following for all protective devices:

- Rating
- Device Type
- MCB Type B or C for
- Lights/sockets and motor control circuits
- MCB Type D for
- Supplies to battery chargers.
- RCD 30mA

Confirm polarity of each sub circuit:

- Phase to Phase – 400 V
- Each Phase to Earth – 230 V
- Phase to Neutral – 230 V
- Neutral to Earth – 0 V

For three phases confirm polarity using a rotoscope.

Confirm that MCBs and fuses correctly isolate each circuit. There are generally several MCBs per circuit. Operate the MCBs one at a time and check all points to confirm relevant voltages are existing, i.e. to confirm segregation of supplies, complete the following:

- All MCBs are switched on before the test begins.
- Switch off the protective device under test.

- Confirm loss of voltage at expected location.
- Turn the protective device ON to confirm the voltage returns.

Confirmation of all AC protective devices auxiliary contacts should be completed by the Pre-Commissioner. Two signals should be available on all priority MCBs, confirm conformity with design.

- MCB Open Signal
- MCB Trip Signal

6.19.2 AC Supplies IRT

The following shall be confirmed prior to the execution of the AC Supplies IRT:

- All AC supplies are OFF.
- All switches are ON.
- Where possible all electronic equipment is isolated.
- Lamps have been removed.
- All circuits are terminated or isolated.

Using a 500 V insulation resistance tester, an IRT shall be completed. The test arrangements and expected results are summarised on the table below:

Table 7 AC Supplies Insulation Resistance Test

Test No.	Test Point A	Test Point B	Voltage (V)	Duration	Expected Value (Ohms)
1	Phase	Phase	500	1 min	> 1 MΩ
2	Phase	Earth	500	1 min	> 1 MΩ
3	Phase	Neutral	500	1 min	> 1 MΩ
4	Neutral (Remove Neutral to earth connection)	Earth	500	1 min	> 1 MΩ

Results must be listed in the test sheets provided.

If the results are lower, the circuits shall be isolated to identify the suspect circuits and complete the following:

- Switch off all AC supplies.
- Perform an IRT test between the phase conductors of each sub circuit and the circuit under test.

Where surge protected devices are installed, the IRT test voltage may be reduced to 250 V DC (Min result allowed 1 MΩ).

6.19.3 DC Sub Circuits

The pre-commissioner should confirm the following:

- The correct DC supply magnitude & polarity at the main switch of the board under test using a multimeter.
- No stray AC voltages are present on the incoming DC circuit, using a multimeter on the AC setting.

Measure the voltages of the main board circuitry and each outgoing circuit by completing the following:

- Positive to negative.
- Positive to earth.
- Negative to earth.

The reference to earth system used on the batter under test. Each DC system results may depend on the battery system used (24 V, 48 V, 220 V). Where the centre of the battery is referenced to earth then the following should apply:

Table 8 DC Battery Voltages

Confirm Test Set Up	220 V	48 V	24 V
Positive to Negative	220 V DC	48 V DC	24 V DC
Positive to Earth	+110 V DC(Red to + and Black to Earth)	+ 24 V DC (Red to + and Black to Earth)	+ 12 V DC (Red to + and Black to Earth)
Negative to Earth	-110 V DC(Red to - and Black to Earth)	- 24 V DC (Red to - and Black to Earth)	- 12 V DC (Red to - and Black to Earth)

Note: Tests are completed on the feed side of the main DC Isolator Switch

Polarity of each DC MCB should be confirmed at the MCB and the field wiring terminals if fitted by confirming the following:

- The MCB feeding side and polarity should be as per manufacturer requirements.
- DC polarised MCB + and – markings are correct.
- Load wiring is connected to the correct side of the DC MCB as per manufacturers drawings.
- Each DC circuit should be confirmed for correct designation and confirm no Negatives or Positives supplies are crossed with other circuits of any voltage (AC or DC), as follows:
- Switch off one sub circuit MCB and confirm loss of supply.
- Supply should be interrupted on the positive and negative pole when MCBs are opened.
- Switch this MCB back on to confirm that supply is restored.
- Repeat this process for all MCBs fitted.
- All DC protective devices auxiliary contacts should be completed during Pre-commissioning. The following two individual signs should be available on all MCBs.
- MCB Open Signal.
- MCB Trip Signal

6.19.4 DC Supplies IRT

The following shall be confirmed by the pre-commissioner prior to the DC Supplies IRT:

- All switches are on.
- Main incoming DC switch is in the “off” position.
- All MCBs closed.
- LEDs removed.

- All circuits are terminated or isolated (where termination is not possible)

Using a 500 V insulation resistance tester, an IRT shall be completed. The test arrangements and expected results are summarised on the table below:

Table 9 DC Supplies Insulation Resistance Test

Test No.	Test Point A	Test Point B	Voltage (V)	Duration	Expected Value (Ohms)
1	Positive	Negative	500	1 min	> 1 MΩ
2	Positive	Earth	500	1 min	> 1 MΩ
3	Negative	Earth	500	1 min	> 1 MΩ

Results must be listed in the test sheets provided.

If the results are lower, the circuits shall be isolated to identify the suspect circuits and complete the following:

- Switch off all DC supplies.
- Perform an IRT test between the phase conductors of each sub circuit and the circuit under test.

6.20 Schematics

If the schematics have been altered during pre-commissioning, then the commissioning copies shall be:

- Revised by the Design Project Manager or Pre-Commissioner and re-issued for the commissioning phase or, in case of minimal changes then accurately marked up in black pen on the commissioning copies.
- Indication shall be by means of highlighting in a consistent colour.
- Schematics shall be kept clean and terminal numbers should not be obscured by any marking completed during the pre-commissioning process.
- Where circuits are shown on more than one drawing, all interactions should be clearly marked on each drawing indicating in all cases where to find the connected sections in the other drawing.
- Where apparatus has been wired to an elementary that is of a revision earlier than the current standard, it shall be confirmed that no changes that were made between revisions were ‘with retrospection’. If the current elementary has changes ‘with retrospection’ then all changes should be made to the wiring and all schematics marked up accordingly.
- Copies of all elementary drawings (A1 Size) to which the scheme was built shall be available on site.
- Test sockets should be wired according on the contemporary elementary and the socket standard shall be included on the relevant drawing.

6.20.1 As built drawings supplied by third parties

Instructions for the highlighting and marking up of schematics should be communicated to and followed by all third parties involved in any part of pre-commissioning. This includes those detailed below.

Factory supplied panels - Where panels or other equipment is supplied by an outside

manufacturer, a full set of verified “As-Built” schematics shall be included with each panel.

All inter-panel loops, internal loops, external connections etc. shall be marked up in all associated schematics and pre-commissioned accordingly.

Each panel shall be functionally proven.

All derogations, be they material, schematic or elementary should be noted on the as built schematics and have all necessary paperwork provided to cover such derogations.

All temporary connections made to allow for functional testing at manufacture stage should be removed.

Where sections of the manufacturer’s schematics relate to external equipment, those references shall be marked up on the as built schematics, detailing external connections and the relevant drawing function.
Where manufacturers are wiring several panels to the same schematic, a separate and specific drawing shall be provided for each panel.
All equipment and components used in the manufacture of panels shall be fit for purpose and capable of continuous use unless otherwise clearly stated. e.g., coils, varistors, resistors, diodes, switches, test sockets etc.

6.20.2 RTU/AAP Documentation

As built wiring tables for the RTU shall be available on site with the RTU. Alarm signals shall be tested and a list shall be made available following pre-commissioning.

6.20.3 SCS/SLC Documentation

A schedule of alarms, control and PI for the SCS system accurately reflecting it as built programming shall be available with the SCS system.

6.21 HV Cables

Specific cable system pre-commissioning requirements are detailed in the EirGrid Cable specification.

See CDS-GFS-00-001 110kV 220kV 400kV Cable Specification

A cable system pre-commissioning dedicated report shall be developed by the pre-commissioner detailing the test completed and their results for EirGrid acceptance.

6.22 Labels

Labelling throughout the site must be checked in accordance with EirGrid specification.

All plant labelling shall be checked for conformance with the design and layout drawings as well as meeting current electrical safety regulations. Labelling shall comply with the following principles and EirGrid labelling standards;

All plant and equipment shall be clearly identified.

All operating functions shall be clearly identified.

LV cabling as per design.

Labels shall be of appropriate format, size and quality for the environment in which they are installed.

In accordance with good practice, where no standard labelling format or text has been defined, the pre-commissioner should confirm that all equipment including LEDs, pushbuttons, external switches and indication lamps have the correct equipment identification labelling, with the function or indication clearly stated.

6.23 Clearances

It is essential that the Pre-commissioner confirms that physical clearances are correct as per design requirements and General Functional Specification, XDN-GFS-00-001.

6.24 Civil Checks

General inspection of the civil works should be carried out to ensure compliance with the specification, relevant standards, H&S, material manufacturer and project requirements. Fresh water supply, drainage, results of cubic tests for concrete slabs, verification of layout of the station complying with civil drawings, substation fence to be stand alone, floor tiling, walls, trenches, etc

6.25 Miscellaneous Checks

Verify mounting and condition of all equipment installed is according to the design/drawings, telephone circuits, lighting, lightning protection, alarm systems, fencing, gates, doors, locking facilities, windows, toilet, entrance, yard layout, access, stoning, spares and tools for all equipment , general cleanliness, tidiness etc

6.26 Pre-Commissioning Handover Report

The following minimum information shall form the basis of the pre-commissioning Handover report:

- Pre-Commissioning Test Sheets (for each item of equipment)
- Test reports and laboratory analysis for each item of equipment.
- 2 sets of marked-up ‘as-built’ drawings – construction set
- 2 sets of marked-up ‘as-built’ drawings – master set
- 2 sets of manufacturer’s instructions.
- If significant mark ups are required during pre-commissioning, then the drawings shall be revised electronically such that a clean copy is available for the commissioner.
- Electrical Installation Completion Certificate (for station building electrical installation)
- Battery Discharge Test Sheet
- Pre-Commissioning Handover Certificate
- Earth grid Installation Completion Certificate
- Schedule of test equipment used and copies of the calibration certs of same
- CVs of pre-commissioning personnel
- Snag list

On completion of the pre- commissioning tests, the customer shall arrange for a Pre-Commissioning handover meeting to be held with EirGrid to analyse and discuss the results. Under no circumstances will handover to commissioning take place while defects which EirGrid consider are unsatisfactory remain.

Where a particular plant or non-plant item is not directly covered by one of the pre-commissioning inspection reports included in XDS-GTS-20-001-R2, a new pre-commissioning inspection report should be produced, and its contents agreed with the client’s project manager before pre-commissioning commences.

6.27 Customer Pre-Commissioning Handover Meeting

Upon completion of pre-commissioning of the works (or section of the works) that shall be handed over to the EirGrid Commissioner, the following shall take place:

1. Upon completion of pre-commissioning, Customer presents completed documentation in accordance with Section 6.21 (Pre-Commissioning Handover Report)
2. EirGrid Client Engineer shall select a random sample of up to 20% of Test Sheet to physically inspect (noting that all tests and inspections shall be facilitated by the Customer) with the following outcomes:
    a. Should the inspected checklist items pass, the process proceeds to step 3
    b. Should the inspected checklist items fail, then all checklist items may be checked (implication on handover to EirGrid commissioner then assessed and agreed with EirGrid)
    c. For minor inconsistencies on or between the test sheets, EirGrid may at their discretion agree to witness the resolution of the issue and allow the process to progress to point 3
3. EirGrid carries out joint site inspection of the plant and equipment with customer pre-commissioner where certain operations are requested to be carried out.
4. Following a successful functional demonstration, the substation is then handed over to the EirGrid for Commissioning.

The following set of schematics (A3 size) should be available for the Commissioner at the handover meeting:

- Two complete sets of commissioning schematics,
- two sets of manufacturer's instructions and one set of XDS-GTS-20-001-R2 Station Pre-Commissioning Test Schedules.

7 Appendix

MAJOR - GENERAL ASSET REGISTRATION SHEET															
Station Name		Work Centre (Wxxx)	Leave Blank			SLD No & Revision (Geodart/Geolas)									
Station Number		Dististribution / Transmission (D/T)	Leave Blank			TA Number / Authorisation Number	Leave Blank								
Cubicle Name		WBS Number	Leave Blank												
Cubicle Number		MO/WO Number (if apr	Leave Blank			Built as designed? Y/N	All design changes must be marked on SLD ar								
NT Installer	PRINT NAME	Phone No				Additional Information:									
	SIGNATURE														
Date															
Commissioner	PRINT NAME	Phone No	Declaration of Fitness												
	SIGNATURE		Number	Date											
Date															
Registration Status	Asset Class	Manufacturer	Year of Manufacture	Model Number	Serial Number	Voltage Rating	Current Rating	Trafo, CT / VT Ratio	Short Circuit Rating	Type	Size	Verification	Protection Relays	Commissioning Report	