Document Reference: XDS-GFS-09-001-R4

Functional Specification

Station 220V, 48V and 24V Lead Acid Batteries and Chargers

Revision History					
Rev	**Date**	**Description**	**Originator**	**Checker**	**Approver**
R0	31/08/2011	First Issue – This document supersedes XDS-WTS-09-001-R0 and XDS-ETS-09-001-R0	Paul Moran	-	Christy Kelleher
R1	03/01/2012	Battery Stand Insulation changed from 600V to 2kV.	Paul Moran	-	Christy Kelleher
R2	31/05/2012	24 hour rate changed to 10 hour	Paul Moran	-	Christy Kelleher
R3	29/05/2014	Minor changes to sections 4.1, 5.1, 5.3.4, 7.3 and 8.3.1	Sandra Howard	-	Paul Moran
R4	25/09/2020	Updated as per due diligence tracker	ESBI and Niall McMahon	Conor Farrell and ESB due diligence	Brendan Murray

1 SCOPE

This functional specification outlines the requirements for the supply, manufacturing and testing of vented-type Planté lead-acid batteries, battery chargers, battery stands, battery/charger connection enclosures and battery supervision facilities for use in 110 kV, 220 kV and 400 kV transmission substations.

These include requirements for battery DC Voltage levels of 220 V DC (for all transmission system voltages 110 kV, 220 kV and 400 kV), 48 V DC (in the case of 220 kV and 400 kV substations) and 24 V DC (in the case of 110 kV substations).

This Functional Specification is developed primarily for new green-field installations. The requirements for brownfield installations will be considered on a case-by-case basis.

DC systems for telecommunication functions in transmission substations are outside the scope of this specification as they are designed, supplied and installed by ESB Telecoms.

For the purpose of this specification the term Customer shall refer to any party (Independent Power Producers, Demand Customers, Transmission Asset Owner, or other developers) or parties working on behalf of (Supplier, Manufacturer, Vendors or Contractors) the Customer responsible for the supply, manufacturing, design and/or build of the DC systems.

2 STANDARDS AND APPLICABLE CODES

The equipment shall comply with this Specification and other applicable Eirgrid specifications including but not limited to the following:

XDS-GFS-00-001	Substation General Requirements
XDS-GFS-06-001	110 220 400 kV Control, Protection and metering
XDS-GFS-07-001	Station Control Protection and Marshalling Kiosks
XDS-GFS-08-001	Station Auxiliary Power Supplies
XDS-GFS-10-001	Station 220V 48V 24V DC and 230 400V AC Dist Boards
XDS-GFS-11-001	Auxiliary Cables and Wiring System
XDS-GFS-13-001	Substation Civil and Building Works
XDS-GFS-14-001	Station Electrical & Mechanical Services for Transmission System Control Buildings and Compound
XDS-GFS-15-001	Fire Detection & Fire Alarm System

The equipment shall comply with the latest editions of the following Standards.

I.S. 10101	National Rules for Electrical Installations
IEC 60255-5	Electrical Relays - Part 5: Insulation coordination for measuring relays and protection equipment - Requirements and tests.
EN 62305-4	Protection against lightning Part 4: Electrical and electronic systems with structures
IEC 60896-11	Stationary lead acid batteries: Vented types, General requirements and methods of tests.
IEC TR 62060	Secondary cells and batteries- monitoring of lead-acid stationary batteries-user guide
IEC 62271-1	Clause 6.9.2.1 EMC Requirements
IEC 62485-1	Safety requirements for secondary batteries and battery installations – General safety information
IEC 62485-2	Safety requirements for secondary batteries and battery installations – Stationary batteries
IEC 60695-11	Fire hazard testing – Part 11: Test flames
IEC 61439-1	Low-voltage switchgear and control-gear assemblies: General rules
IEC 61439-2	Low-voltage switchgear and control-gear assemblies: Power switchgear and control-gear assemblies
IEC 62474: (Ed.2.0)	Material Declaration for Products of and for the Electrotechnical Industry
BS 6290-2 (1999)	Lead-Acid Stationary Cells and Batteries – Specification for high-performance Planté positive type
I.S. EN 60079	Explosive atmospheres – Part 14: Electrical installations design, selection and erection
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I.S. EN 60079	Explosive atmospheres – Part 14: Electrical installations design, selection and erection
I.S. EN60079-17	Explosive atmospheres – Part 17: Electrical installations inspection and maintenance
IEC 60529	Classification of degrees of protection provided by enclosures.
NEMA PE 5 1997	Utility-type battery chargers

EU ROHS (2002/95/EC) and WEEE (2012/19/EU) Directive published in July 2012

REACH Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 and any amending legislation.

CLP (Classifying, Labelling, Packaging) Regulation (EC) No. 1272/2008 and any amending legislation.

SI No. 132/1995 Safety Signs at places of Work Regulation 1995

S.I. No. 230/2017 European Union (Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres) Regulations 2017.

SI No. 299/2007 Safety, Health and Welfare at Work (General Application) Regulations 2007

ATEX 214 "equipment" Directive 2014/34/EU - Equipment and protective systems intended for use in potentially explosive atmospheres

ATEX 137 "workplace" Directive 1999/92/EC - Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on personal protective equipment (PPE).

All sub-components and sub-installations shall comply with relevant IEC and EN requirements.

In addition, there shall be compliance with the provisions of all relevant Directives of the European Union. In order to confirm compliance, the equipment shall carry the CE Mark in accordance with Directive 768/2008/EC.

The EU Construction Products Regulation (No. 305/2011 – CPR) and sufficient documentation to demonstrate full compliance should be retained.

3 REFERENCE DOCUMENTS

Table 1 Reference Documents

Reference	Title
PG406-D020-093-001 pages =AB+M56/1-3	Battery Supervision Cabinet
XDN-CR-STND-H-001	AIS Substation Indicative Control Room Layout
XDN-LAB-STDN-001	Station Labels

4 SERVICE CONDITIONS

The battery chargers, batteries and battery termination enclosures shall comply with this Specification and with the EirGrid 110/220/400 kV substation general requirements functional specification XDS-GFS-00-001.

The following requirements are additional to those stated in the “Service Condition” section of XDS-GFS-00-001 110/220/400 kV Substation General Requirements:

- Lead-acid batteries of the Planté type shall be installed in a dedicated vented battery room within the control building. Other equipment including battery chargers, connection boxes and battery supervision cabinets shall be located within the adjoining control room.
- A maximum humidity level of up to 95 % shall apply.
- Electrical equipment and installations shall be accordance with the requirements for operation in explosive environments, as outlined in Section 10.

5 SERVICE EXPERIENCE

The Customer shall ensure that the chosen battery manufacturer supplies batteries that have:

a) At least 10 years’ experience in the production of the relevant voltage / current range (or higher) of the Planté lead-acid batteries, battery chargers, battery stands and battery / charger connection enclosures specified, i.e. the “product”.

b) Service experience:

   i. Installation of the product in at least three EU / UK utilities or similar industries.

   ii. service experience for the product range of at least 5 years duration in these EU utilities or similar industry of at least 1,000 units.

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

d) At least 5 years of production 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 products being offered to EirGrid must be manufactured in the same plant which produced the products which are cited as meeting the service requirements outlined in the conditions (b) and (c) above.

6 HEALTH AND SAFETY REQUIREMENTS

The Customer shall ensure that a satisfactory safety risk assessment in accordance with the EirGrid Safe by Design methodology has been completed.

The following requirements are additional to those outlined in the EirGrid Functional Specification XDS-GFS-00-001:

- Battery Rooms are restricted access areas containing potentially explosive atmospheres, corrosive materials and access to exposed live parts.
- In addition to the risk of explosion, 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.
- Part 8 and Schedule 10 of S.I. 299/2007 Safety, Health and Welfare at Work (General Application) Regulations 2007 refer to Explosive Atmospheres.
- Where the Customer is required to work within an existing transmission substation, he will be subject to Irish Health & Safety legislation and all work shall be in accordance with the ESB Network's "Electrical Safety Rules 2006".
- Premises, practices and procedures shall conform to all relevant Health and Safety legislation in the country of manufacture of the DC systems. Audits for compliance may be carried out by EirGrid or a representative.
- All persons who work within battery rooms shall be suitably qualified. Refer to Section 10 for further information.
- All persons who work with batteries shall be subject to the safety requirements as stated in the standard IEC 62485-2.
- Refer to XDS-GFS-13-001 Substation Civil and Building Works for requirements relating to battery room construction including ventilation, floor construction, doors etc.
- Battery room labelling shall be in accordance with XDN-LAB-STDN-001.

7 ENVIRONMENTAL DESIGN AND HAZARDOUS SUBSTANCES

Refer to XDS-GFS-00-001 Substation General Requirements.

7.1 Declaration of Materials

Customers shall submit the equipment manufacturer's declaration of all the materials used in the manufacture of the equipment proposed. This should be along the lines set down in the latest version of IEC 62474.

The declaration shall:

- list all the constituent materials,
- list the % of the equipment by weight,
- state whether they can be recycled at the end of the plant life,
- comment on the method of recycling to be used.

Good environmental design will minimise the use of energy-intensive materials in equipment manufacture and delivery packaging.

The country of origin of the main parts of the product and the country where final assembly and testing takes place must be listed.

7.2 Declaration of Hazardous Substances

Customers shall declare all substances classified as hazardous in the Material, Plant, Equipment and Works (MPE/W) being offered as outlined in the EirGrid Functional Specification XDS-GFS-00-001.

For the avoidance of doubt, no asbestos is to be used in any component of any plant supplied to EirGrid.

7.3 Safety Data Sheets and Packing Waste

Customers shall submit Safety Data Sheets for hazardous substances used in the MPE/W as outlined in the EirGrid Functional Specification XDS-GFS-00-001.

7.4 Disposal of Material Found to be Hazardous

Customers who supply the MPE for DC Systems for Substations shall undertake to dispose of it should it be found that the MPE or its packing contains undeclared hazardous substances.

8 Quality Assurance

8.1 Material Workmanship

All materials and workmanship shall be of a suitable type and quality to ensure that the equipment will operate satisfactorily in accordance with the specification.

8.2 Quality Assurance System

Registration to ISO 9001 or equivalent is required. Customers shall provide evidence of current registration to this or other quality standards and shall provide a Quality Manual and an outline of the manufacturing process controls in English. Detailed information on Quality Procedures and Work Instructions shall be made available.

8.3 Product Quality Assessment

If requested during the project evaluation process, the Customer shall make available in the factory, or other convenient location, a fully assembled example of each of the items offered for inspection by EirGrid. Where practical however, a completed unit may also be requested for inspection.

8.4 Disclosure of defects found

In the event of quality problems, identified by the equipment manufacturer, which are likely to cause an impact on equipment after installation by EirGrid, the equipment manufacturer shall inform EirGrid immediately. In the case of faulty MPE being returned, the Customer shall provide a preliminary report within two weeks of receipt of the goods, and a final comprehensive report within a further 4 weeks.

The Customer shall notify EirGrid immediately of any quality issues or defects which may subsequently come to light with this particular MPE.

The Customer shall ensure that the equipment manufacturer complies with this requirement and shall submit a manufacturer's declaration of compliance with quality requirements outlined in EirGrid specification XDS-GFS-00-001.

EirGrid, as end user, reserves the right to audit equipment manufacturer to ensure compliance.

9 DC Systems

Table 2 provides a list of products and services required for DC systems in Substations:

Table 2 - List of products and services for supply of DC systems for Substations

Item No.	Products & Services
1	Planté batteries
2	Recombination filters
3	Battery stands
4	Battery chargers for 220 V DC and 48 V / 24 V DC Planté batteries
5	Battery connection boxes
6	Battery supervision cabinets
7	Design, installation, build and testing of batteries

Battery chargers, connection boxes, battery supervision equipment and DC distribution boards shall be located in the control room adjacent to the dividing wall to the battery room, thereby facilitating short direct cabling routing through the wall to the battery room.

Batteries, stands and related battery equipment and accessories shall be installed in the battery room.

Table 3 - Application of batteries and chargers in Substations:

DC Voltage level	Function
220 V	Supply of critical devices such as protective relays, trip and closing circuit of circuit breaker, supervisory and communications equipment, and switchgear operating circuits in RTU and SCS type substations.
48 V	Supply of alarms and status indicators in RTU type 220 or 400 kV substations
24 V	Supply of alarms and status indicators in RTU type 110 kV substations

The DC supply systems shall be designed to operate with both the positive and negative poles unearthed. The required mode of operation of the DC supply system is floating operation, in which the chargers, the battery and the DC load are connected in parallel.

The charger nominal current shall be rated to feed the normal load and to maintain the battery float voltage. If a temporary increase in the load current exceeds the charger nominal current, the extra load is fed by the battery.

The DC load consists of DC motors, switchgear operating coils, protection relays and other electronic equipment. The voltage tolerance for the DC load is from 85 % to 110 % of the rated DC load voltage.

On failure of the connected charger, the battery shall feed the substation load. The battery shall be capable of feeding the substation load for 24 hours. In the event of any system failure, an alarm shall be initiated indicating the type of failure. The signalling required is stipulated in the “Monitoring Function” section of this document.

The Customer shall provide an operating instruction for operation of the battery systems.

A mimic/ etched illustration shall be fixed securely on the front of the battery charger cabinet outlining the high level configuration of the battery system along with the steps required by an operator to carry out regular operational procedures such as battery charger change-overs and any other regular asset management instructions.

9.1 220 V DC SYSTEM

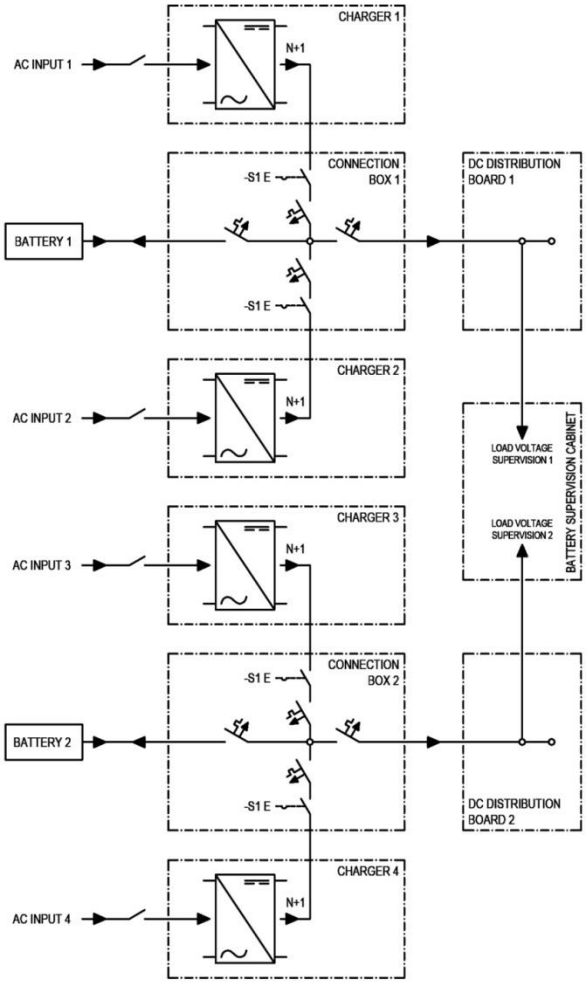

Figure 1- Simplified Configuration for a 220 V DC system[1]

Each transmission substation shall be provided with a dual 220 V DC system. This system, as shown in Figure 1, comprises two sub-systems.

[1] Please note, the illustration above is a functional design for simplified illustration only. In practice the switch S1 shall be designed to be a “make before break type”, with N/C contacts for the in service charger and N/O type contacts for standby charger. This ensures only 1 charger at a time is connected to the battery and distribution board.

Each sub-system comprises of 1 battery, 2 chargers, 1 load voltage supervision circuit, and 1 connection box.

In each sub-system, one of the two chargers works as the main charger, and the other works as the stand-by charger. A change-over switch (S1) is required to interchange between the chargers in case of failure of the charger in service. This switch is manually operated to prevent the risk of automatically connecting a potential fault on the load to the remaining healthy charger.

The chargers in this configuration are required to be inspected and switched regularly to ensure that the stand-by charger is in good condition and ready to be in service when needed. The back-up charger shall be kept energised on the AC side at all time.

These two sub-systems shall be completely independent from each other. Each sub-system shall include its own load voltage supervision circuit. The two load voltage supervision circuits shall be installed in one common cabinet.

9.2 24 V AND 48 V DC SYSTEM

The 24 V / 48 V DC system shall have the configuration as shown in Figure 2.

Each system shall comprise of 1 battery, 2 chargers, 1 load voltage supervision circuit, and 1 connection box.

All the input and output MCB's shall be included in the charger cabinet. The load voltage supervision function shall be completely independent of the associated battery chargers.

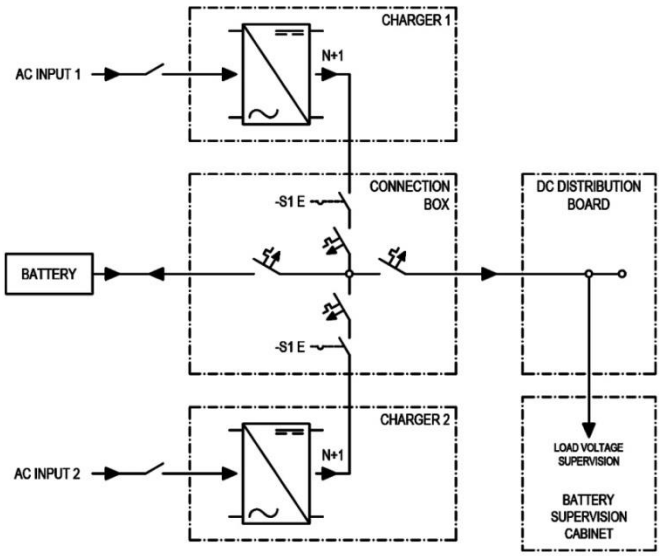

Figure 2 – Simplified Configuration for a 24 V DC or 48 V DC system[2]

[2] See also footnote 1.

9.3 General Requirements

The Customer shall provide a complete working DC system including all equipment, works, testing etc.

The Customer shall provide all auxiliary components as required to complete the DC system including all cabling, terminations, cable routing, ferrules, wiring, gland plates, labelling, signage, etc.

The Customer should refer to XDS-GFS-00-001 and other related Eirgrid standards.

10 Explosive Atmosphere Requirements

Substation battery rooms are classified as follows in accordance with EN 60079:

- Zone 1 in the area immediately surrounding the battery cells; up to a radius of 500 mm for battery capacities up to and including 450 Ah.
- Zone 2 (ATEX Category 1G, gas group IIC) for the rest of the room, including areas up to a radius of 500 mm around the outside vents.

Electrical equipment shall not be installed in Zone 1, or directly in front of vents.

Batteries shall not be installed directly in front of vents.

In addition to conforming with national wiring rules, all equipment installed in this room shall be selected and installed in accordance with IS EN 60079-14 (2014+AC-2016) Explosive atmospheres – Electrical installations design, selection and erection.

Persons carrying out electrical installations and inspections in a potentially explosive atmosphere (i.e. battery room) must have a minimum ATEX qualification equivalent to Compex EX 01 – EX 04 (installation, inspection and maintenance of Ex ‘d’, ‘n’, ‘e’, ‘p’ and ‘i’ electrical installations) plus relevant experience.

10.1 Cables

All cables used in a hazardous area shall be XLPE outer sheathed and LSHF (low smoke halogen free). They shall be circular and compact. Any bedding or sheath shall be extruded. Fillers, if any, shall be non-hygroscopic (i.e. having little or no tendency to absorb moisture).

PVC Cables shall not be used.

10.2 Wiring Methods

There shall be no PVC (thermoplastic) trunking allowed in the battery room due to surface area limitations for static build-up prevention (see I.S. EN 60079-14, Section 6.5.2).

PVC conduit with a diameter of up to 20 mm is permitted.

For all of the following wiring of electrical fittings a label with the supply circuit ID needs to be applied at each fitting, either on the fitting or on cable close to the fitting, to allow for quick isolation in case of fault.

10.3 WIRING FROM BATTERY TO CONNECTION BOX

The positive and negative output poles of each battery shall be located adjacent to the dividing wall to the control room and as close as possible to the appropriate connection box on the other side of the wall to minimise the length of cable prior to the location of the short circuit protective device.

The positive and negative pole of each battery shall each be wired to the appropriate connection box terminal using a single core stranded copper XLPE LSHF cable. The cable size is typically 25 mm^2, however the Contractor shall confirm the required size.

Connections to the batteries shall be torqued as per the manufacturer's instructions.

An insulated shroud/cap shall be fitted over the terminal post connections.

A 20 mm diameter Kopex flexible conduit shall be provided from this point into a wall mounted 20 mm diameter PVC conduit (one per pole).

The PVC conduits (one per pole) should enter the battery room at a height of approximately 1 m above the top of the battery terminals through separate wall openings.

The conduit shall be fitted into a conduit sealing device where it enters/leaves the Battery Room to prevent the transmission of gases or liquids from the hazardous areas to non-hazardous areas from within the conduit. This sealing device can be a 20 mm PVC conduit angle fitting or inspection elbow with a removable lid such that a sealing gun can be inserted into the fitting to properly seal all around the cable with conduit sealing compound to prevent spread of hydrogen gas into the Control Room.

The openings in the wall around where the conduits enter the Battery Room shall also be properly sealed, both in the Battery Room and the Control Room.

Note: Steel conduit is not permitted for containment of battery supply cables due to the risk of short circuit from cable to the earthed conduit.

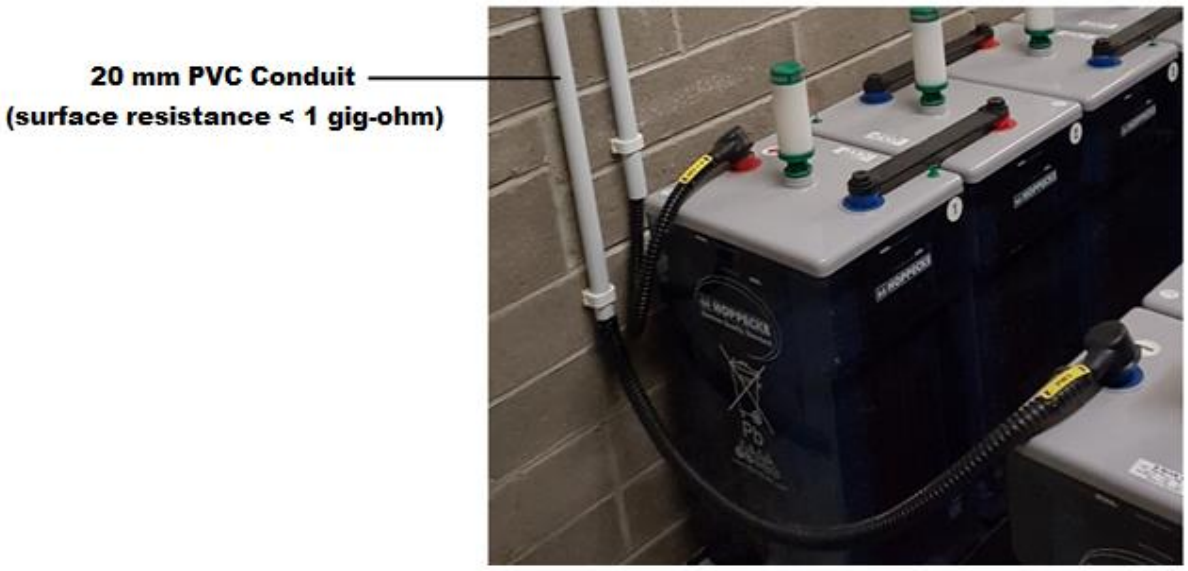

Figure 3 – Battery Termination Wiring

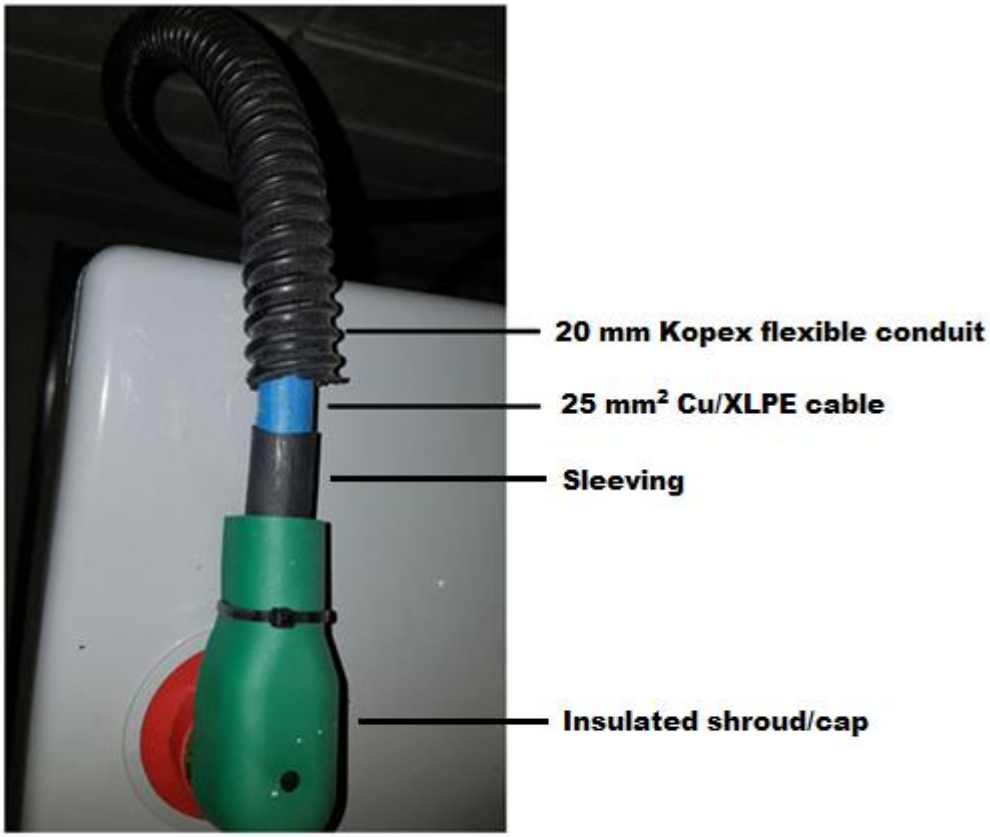

Figure 4 - Close up of Battery Termination

10.4 BATTERY ROOM LIGHTING

The battery room lighting, including emergency lighting, shall be ATEX Category 2G (Zone 1) or Category 3G (Zone 2), Ex rated (Ex ‘d’, ‘e’ or ‘m’) with a maximum temperature class of T1 (450 °C) which is suitable for use in a gas group IIC (Hydrogen) explosive atmosphere.

Any associated enclosures (e.g. junction boxes) shall be Ex rated (Ex ‘d’ or ‘e’) and all accessories (e.g. cable glands, blanking plugs, reducers etc.) shall also be Ex rated appropriate to the equipment they are connected to (e.g. for Ex ‘d’ equipment the glands shall be Ex ‘d’ rated).

The supply to the battery room lighting shall be protected by a 2-pole MCB (to provide isolation of both live and neutral supplies into the hazardous area).

Luminaires shall not be installed directly above vented cells or in areas where pockets of gas could accumulate locally.

There shall be a minimum of 500 mm separation between luminaires and batteries.

Light fittings should be fixed to the wall or suspended at more than 500 mm from the ceiling, such that fittings are not located vertically above batteries, and any maintenance work shall be possible without entering the air space above the battery cells.

An example of battery room lighting wiring is provided in Appendix A.

10.5 BATTERY ROOM HEATING

The battery room shall be maintained at a minimum ambient temperature of 15 °C.

The battery room shall be heated by an ATEX Category 2G (Zone 1) or Category 3G (Zone 2), Ex rated (Ex ‘d’ or ‘e’) heater/s with a maximum temperature class of T1 (450 °C) suitable for use in a gas group IIC (Hydrogen) explosive atmosphere.

The heater/s shall be switched through a contactor (located in the distribution board) controlled via an Ex ‘d’ rated air sensing thermostat mounted in the battery room.

The supply to the battery room heating shall be protected by a 2-pole MCB (to provide isolation of both live and neutral supplies into the hazardous area). The supply shall also be protected by a 30 mA sensitivity RCD. This MCB and RCD combination can either be from a separate MCB and RCD or a dedicated 2-pole RCBO (combined MCB and RCD).

The supply to the heater/s shall be broken by a 2-pole switched-fused spur, which shall be mounted on the outside wall of battery room.

Any associated enclosures (e.g. junction boxes) shall be Ex rated (Ex ‘d’ or ‘e’) and all accessories (e.g. cable glands, blanking plugs, reducers etc.) shall also be Ex rated appropriate to the equipment they are connected to (e.g. for Ex ‘d’ equipment the glands shall be Ex ‘d’ rated).

An example of battery room heating wiring is provided in Appendix A.

11 BATTERY DETAILS

The battery is to be used in floating operation mode to provide emergency power to the DC load.

The Customer shall submit the detailed installation, operation & maintenance instructions for the offered batteries.

11.1 AMPERE-HOUR CAPACITY

The rated battery cell voltage shall be 2 volts.

Table 4 shows the typical requirements for batteries in 110 kV, 220 kV and 400 kV substations.

Table 4 - Battery Types, Ratings and number of cells

Battery Installation	Number of cells / string	Minimum C10 Capacity @ 20°C, to 1.85 Vpc [Ah]
220 V Inst. 1	104	60
220 V Inst. 2	104	160
220 V Inst. 3	104	200
220 V Inst. 4	104	300
220 V Inst. 5	104	400
48 V Inst. 1	23	200
48 V Inst. 2	23	300
48 V Inst. 3	23	400
48 V Inst. 4	23	600
24 V Inst. 1	12	200

The battery size will be determined by the substation load, this shall be the responsibility of the Customer.

DC peak duration shall be 5 s.

The voltages, number of cells and capacity requirements shall be as specified within the Technical Schedule.

11.2 BATTERY CONSTRUCTION

Batteries shall be comprised only of single-cell lead acid Planté cells. The cell containers and cover shall be made of heat, impact and acid-resistant, non-corrosive material. The container material shall be transparent.

Electrolyte level limit marks shall be clearly visible on all sides of each cell container such that levels can be easily checked when the cell is in service.

Each cell shall be fitted with a suitable flame-retardant vent plug on its cover. The vent plug shall have a filter which will prevent escape or spreading of acid fumes but will allow free exit of hydrogen and oxygen generated inside the cell during the charging process. The vent plug shall be suitable for accommodating the installation of a recombination unit.

Another hole shall be provided on the cover of each battery cell. This hole shall allow samples of electrolyte to be taken with a hydrometer, without any obstruction, for checking the electrolyte specific gravity. The hole shall be covered with a plug or cap.

Cell markings shall comply with IEC 60896-1 Amendment No.2. All cells shall be numbered consecutively.

Battery cells shall be permanently marked with the manufacture details. This information shall include manufacturer's reference number, the month and year of manufacture, the voltage and the nominal capacity at the 10 hour discharge rate. The capacity indicated shall be the capacity available to the end of its service life.

Battery cells may be delivered with or without electrolyte:

- With electrolyte: the cells shall be fully charged by the supplier prior to delivery.
- Without electrolyte: the cells shall be dry and ready for filling with electrolyte. The Customer shall deliver the batteries to the battery room in a substation and shall fill them with electrolyte and charge them to the fully charged state.

The designed service life of the batteries shall not be less than 20 years under the service conditions described in the specification.

Estimated battery life under normal charge conditions should be stated.

The specific gravity of the electrolyte (sulphuric acid) when the battery is fully charged at 20ºC shall be 1.22 kg/l.

The positive and negative terminal posts of each battery cell shall be clearly and indelibly marked for easy identification. They shall have provision for inter-cell or outgoing cable connectors.

The battery shall be supplied with fully insulated inter-cell copper connectors. After connecting the battery cells together by using the inter-cell connectors, the terminal posts shall be covered with rubber caps or other suitable devices whose top shall be easily opened to allow access to the terminal posts for voltage measurement.

11.3 BATTERY INSTALLATION

Vented (Planté) type battery cells shall be installed on supporting stands in the battery room.

Cell terminals and inter-connectors on assembled high voltage batteries shall be shrouded or otherwise arranged such that accessible exposed conductors do not have a potential difference between them greater than 60 V.

11.3.1 BATTERY ROOM

The battery room shall be a dedicated naturally-ventilated room within the control room, with at least two external walls.

Screened vents shall be installed to achieve natural air flow across the batteries with at least two inlet vents at low level on one external wall, and at least two vents at high level on another external wall.

The Customer shall provide a calculation to demonstrate that the area of vents is sufficient to ensure that the concentration of hydrogen in the battery room cannot exceed 4 % by volume in accordance with IEC 62485-2.

Refer to the Technical Drawings and the civil specification for further requirements.

Refer to Section 10 for Explosive Atmosphere requirements.

Only single row battery stands may be located against a wall.

The Customer shall submit a detailed layout drawing of the battery room. Battery rooms shall be capable of facilitating the required number of battery cells as well as sufficient space for the installation, commissioning and maintenance of the batteries.

11.4 BATTERY STANDS

The supporting stands shall be made of metal and be constructed to provide rigid support for the batteries.

The battery stands shall be located to allow safe access to each cell for topping up purposes.

Battery stands and their support rails shall be insulated to 2 kV.

They shall be treated with acid-resistant coatings. In addition to this acid resistance, the insulation on the support rails shall be heat resistant.

The drawings of the proposed battery stands shall be submitted to EirGrid for review.

The battery cells shall be installed in rows on the support; and the cells shall be arranged such that their name plates and the edges of all plates are visible from access areas.

The height of the battery stands shall be such that the tops of the cells on the upper tiers are not more than 1.5 m above floor level.

All battery stands shall be isolated (typically consisting of a coated surface). Battery stands shall be arranged to a minimum of 800 mm apart.

11.4.1 ACCESSORIES

The following accessories shall be provided for each battery bank:

1. Voltmeter with ±3 V scale.
2. Lifting handle / device to allow simplified manipulation of an individual cell.
3. Wall mounting instruction chart with following information:
    a) Cell parameters
    b) Battery parameters
    c) Inspection requirements and procedures

4. Set of connecting hardware.
5. Cell numbering system.
6. Portable thermometer with a measuring range from -20 C to +50 C
7. Portable hydrometer syringe with the reading range for specific gravity from 1.10 to 1.40 kg/l; the hydrometer syringe shall have an internal thermometer that will measure the temperature of the electrolyte and will include a conversion scale to correct the specific gravity reading.
8. Cell topping-up bottle for adding distilled water.
9. Two cell bridging connectors.
10. Two cell electrolyte-pouring funnels.
11. Log Book.
12. Rubber Apron & Gloves (large size e.g. No. 10).
13. Full face mask.
14. A hand-operated siphon tube with a suction bulb for emptying any cell into a container.
15. Refer to civil specification for eye wash requirements.

All instructions shall be in English.

The Customer shall provide any other items of equipment not listed required to ensure the continued maintenance of the battery system.

11.4.2 RECOMBINATION UNITS

Recombination units shall be fitted on each cell.

The battery shall be equipped with a catalytic recombination system to reduce the ventilation requirement by 50 % according to IEC 62485-2, as well as to increase the maintenance-free period over the whole service life of the battery.

The recombination system shall be equipped with a bi-directional valve to increase the recombination efficiency, especially at low gassing rates, to a level of at least 95 %. The recombination system should allow for a charger voltage of up to 2.40 volts / cell.

The possible gas exchange between the recombination system and the environment shall be realised via a ceramic filter to make the whole system explosion proof and to prevent any escape of acid fumes to the battery room. The recombination system shall be designed to keep the required functionality over the entire lifetime of the battery.

11.4.3 BATTERY CONNECTIONS

1. Inter-cell connections - The Customer shall ensure that all inter-cell connections are terminated as per the manufacturer’s recommendations. They shall ensure that all terminations are cleaned and adequately protected against corrosion by coating the electrical connector elements with a layer of a protective, preferably non-conductive,

viscous material such as silicone, prior to pressure contacting or welding of the electrical connector elements. The silicone shall be removed only at the point of contact between the connector elements while retaining a surrounding protective barrier against the corrosive effects of the cell components and particularly corrosive fluid organic electrolyte materials in high-energy density cells.

2. Connections between cell rows - Connections shall be made with XLPE insulated copper cables (see 10.1).

3. External connections to battery charger cabinet - Connections shall be made with XLPE insulated copper cables (see 10.1).

4. In order to minimise the risk of accidental short circuit or earth fault, the Customer shall ensure that the length of cable runs are kept to a minimum. In accordance with this requirement, all battery ancillary equipment shall be mounted on the adjoining wall of the battery room with the control room.

5. The connections from the batteries to the battery termination enclosure shall be continuous. (see 10.3)

12 BATTERY CHARGERS

12.1 CONFIGURATION

Battery chargers shall be switch-mode chargers, in general they shall comply with the requirements of NEMA standard PE 5 - 1997.

The chargers shall comply with EMC requirements as specified in IEC 62271-1 (Edition 2.0 2017-07 clause 7.9.2.1).

They shall be capable of working properly in a room containing electronic equipment.

They shall be capable of operation with or without a battery connected.

Indication instruments, lamps and switches shall be flush mounted on the front of the charger cabinet.

Noise from the chargers shall be less than 32 dB(A).

Chargers shall comprise the following components:

- Sheet steel cabinet as specified under Section 13 - Charger Cabinet Design
- Surge protection device (SPD)
- AC input MCB
- Switch-mode rectifiers (see Section 12.3)

- Charger controller (see Section 12.6)
- Diodes for limiting the output load voltage
- Local indications
- Alarm signals for remote indication

12.2 AC INPUT SUPPLY

The AC supplies, available in substations, to feed the chargers are as follows:

- Voltage: 400 / 230 V ± 10 %
- Frequency: 50 Hz. ± 2.5 %
- Earthing system: TN (downstream of system neutralizing point)
- Active power factor: greater than 0.95

In accordance with the EirGrid functional specification XDS-GFS-08-001 “Auxiliary Power Supply“ the AC supplies to battery chargers shall be:

- For 220 V DC chargers: 1 or 3-phase as required depending on ratings
- For 48 V DC chargers: single phase
- For 24 V DC chargers: single phase

Surge protection device class II+III shall be installed on the AC input inside the charger cabinets. SPDs to be coordinated with upstream SPDs in accordance with EN 62305 Part 4. Use of the same manufacturer is the preferred means to demonstrate coordination of upstream and downstream devices.

The Customer shall ensure that the AC Supply complies with this requirement and with the requirements in the EirGrid specification XDS-GFS-08 Station Auxiliary Power Supplies.

12.3 RECTIFIERS

The chargers shall be Switch Mode (SM) chargers. Each charger shall be equipped with a number of switch mode rectifiers. If N is the number of rectifiers which are necessary to feed the maximum load, then N+1 rectifiers shall be required for the charger. This requirement is called ‘N+1 redundancy of rectifiers’. Should any single rectifier fail, the remaining rectifiers shall be capable of providing the required DC power to the load and recharge the batteries in float charging mode as required.

Each rectifier module shall be designed for field replacement without the need for specialised tools or test equipment. They shall be plug-in type, hot swappable.

The charger shall be designed to accommodate at least two positions where rectifiers can be installed in future. Each future rectifier position shall have a blank cover.

Each rectifier shall have internal AC input over-current protection or shall be protected by an appropriately rated and approved fuse / MCB.

Each rectifier shall have the capability to independently shut down if the rectifier senses an over-voltage condition on its output. Each rectifier shall be diode or circuit breaker protected on the DC output to ensure that a fault in the rectifier will not short the DC bus.

The rectifier shall protect itself from an output short circuit by limiting the output current to a maximum value of 105 % of its rated output current. Once the short circuit is removed, the rectifier shall resume normal operation without manual restart.

The output voltage of the rectifiers shall be fully adjustable by the charger controller. The output voltage range of the rectifiers shall be suitable for charging the connected battery.

Local LED's shall be provided on each rectifier to indicate the following:

Table 5 - Rectifier LED's

LED	Indication
Green	System Healthy
Yellow	Non Urgent / Minor Alarm
Red	Critical / Major Alarm

The efficiency of each rectifier from 50% load to full load shall be greater than 85% under nominal AC input voltage. The efficiency shall include the series diodes or any other output protection device.

AC ripple on the rectifier DC output shall meet the following requirements:

Table 6 - AC Ripple Requirements

Ripple frequency	Ripple magnitude
10 Hz – 100 MHz	< 15 mV RMS
10 kHz – 100 kHz	< 40 mV peak to peak

12.4 DC OUTPUT

Charger rated output voltage = Rated DC load voltage.

Table 7 - Charger output ratings

Rated Output Voltage	Rated Output Current
220 V DC	40 A
220 V DC	50 A
220 V DC	60 A
48 V DC	20 A
48 V DC	30 A
48 V DC	40 A
24 V DC	30 A

The values listed in *Table 7* are the common output ratings for chargers for EirGrid Substations. However the Customer shall ensure the chargers are adequately rated to meet the load in the particular substation.

- Charger voltage stability: ± 1% of the pre-set output voltage, for full range of the output voltage
- Charger maximum overload: 150% of the rated output current (1 s)

The output voltage of the charger, after the dropping diodes, when the charger is connected to the load, but not to the battery, shall meet the requirements of AC ripple as specified in *Table 6.*

The chargers shall have the facility to operate in an equalise / boost charge mode without exceeding the upper limit of load voltage tolerances (110% of the rated DC load voltage). This may be achieved by automatically inserting voltage-dropping diodes into the load circuit during the period of equalise / boost charge.

Where required, voltage-dropping diodes shall be fitted together with contactors and voltage-sensing relays etc. required for their operation. Their maximum continuous and short-time rating shall be in accordance with the standing and peak load requirements. The voltage limiting facility shall be activated immediately (without any time delay) on selection of the equalise / boost charge mode.

12.5 OPERATING MODES

Chargers shall be capable of recharging a completely discharged battery to its fully charged state within 10 hours, while maintaining the specified standing load.

The charge profile shall be IU_1U_2 in accordance with IEC 62485-2, Annex A. This charge profile shall have 3 stages:

1. Initial charge with constant current charger I which is in the range I = 2 × I_{20} to 4 x I_{20} (IEC 61056-1: 2012-02, Edition 3.0, Clause 6.1.3), or specified otherwise by the battery manufacturer, until the battery voltage reaches to the boost charge voltage U_1.

   Note: I_{20} is the discharge current which the battery discharges for a duration of 20 hours from its fully charged state to the final discharge voltage of 1.75 volts / cell, at a specified temperature.

2. Charge with a constant voltage equal to the boost charge voltage U1 (Boost charge) until the current does not change by more than 0.1 × I20 within two consecutive hours.

3. Charge with a constant float voltage U2 (Float charge) for undetermined duration.

The charger shall also be capable of performing an equalise charge to a battery to equalise the large differences between the battery individual cell voltages.

The equalise / boost charge voltage shall be in the range 2.35 < U_1 ≤ 2.40 volts / cell for Planté batteries. The boost charge mode can be selected between auto or manual charge.

Each charger in its normal float-charging mode of operation shall automatically float-charge its associated battery at a constant float voltage U_2 of 2.23 to 2.25 volts / cell, according to the battery operation instruction.

Provision shall be made on the charger(s) to limit the charging current to the battery, in all circumstances, to safe values specified by the battery manufacturer.

12.6 CHARGER CONTROLLER

Charger controller functions can be divided into three main groups: monitoring, indication and control functions.

Charger control software working on the Microsoft Windows operating system shall be provided. This program shall allow the user to view the status of the charger and to set up or change the setting parameters of all monitoring & controlling functions.

12.6.1 MONITORING FUNCTIONS

The monitoring facility of the chargers including all necessary sensors and monitoring units shall perform as outlined by IEC TR 62060. It shall continuously monitor the charger and/or battery parameters and shall be capable of generating the alarms or status indications as shown in Table 8.

Each alarm shall be mapped to either a major or minor alarm.

- **Major Alarm**

  - A major alarm indicates that the charger has suffered a failure or failures that could affect the ability to provide sufficient power to support the load.

  - The charger controller shall have the capability to combine all major alarms to generate a single consolidated major alarm.

  - Visual indication of this alarm condition shall be provided on the front panel of the controller by a red LED and marked Major. In addition, a set of change-over contacts shall be made available to provide remote indication of the alarm.

- **Minor Alarm**

  - A minor alarm is a warning which indicates that the charger has suffered a failure or failures that although not affecting the ability of the DC system to support the load.

  - The charger controller shall have the capability to combine all minor alarms to generate a single consolidated minor alarm.

  - Visual indication of this alarm condition shall be provided on the front panel of the controller by a yellow LED and marked Minor.

- **External Alarms**

  - External alarms in the form of volt-free contacts can be connected to the inputs of the charger controller.

  - The controller shall have the capability to monitor and report on up to four external contact closures.

Table 8 - List of Charger and Connection Box signals

Charger monitor	Charger healthy	Charger healthy	Indication	Green
	Charger fail	System major alarm	Major	Red + C2
	Low float voltage			
	High float voltage			
	Charger overload			
	Low output voltage			
	High output voltage			
	Equalised/ Boost	Equalised/ Boost	Indication	Screen
Rectifier monitor	1 rectifier fail	System major alarm	Major	Red + C2
	2 rectifiers fail			
	Rectifier over temperature			
	Rectifier comms lost			
	Rectifier current limit	System minor alarm	Minor	Yellow
Battery monitor	Battery current limit	System minor alarm	Minor	N/A
	Battery discharging	System major alarm	Major	N/A
	Battery temperature low	System major alarm	Major	N/A
	Battery temperature high			
	Temperature sensor fail			
	String fail			
Load monitor	Low load voltage	Low load voltage	Major	Red + C3
	High load voltage	High load voltage	Major	Red + C4
DC MCB's	DC MCB open/trip	DC MCB open/trip	Major	Red + C5
Input monitor	Mains fail	Mains fail	Major	Red + C6
Earth fault monitor*	Positive earth fault	Earth fault	Warning	N/A
	Negative earth fault	Earth fault	Warning	

Table 8 Notes

- All events should be displayed (indicated) on the LCD display, with facilities for the local user to acknowledge and reset cleared events.
- Events which are categorised as Major alarms should activate the "Major Alarm" LED as described above.
- Events which are categorised as Minor alarms should activate the "Minor Alarm" LED as described above.
- Events which are categorised as Major alarms should activate a volt free "Major Alarm" contact.
- The full list of required volt free output contacts is as follows:
    - C1: Charger healthy

- C2: System major alarm
- C3: Low load voltage
- C4: High load voltage
- C5: DC MCB open/trip
- C6: Mains fail
- C7: Earth fault*

* Note that earth fault monitoring is described separately in section 12.7. Provision of earth fault protection within the charger is optional, and if provided should not interfere with the operation of earth fault protection in the battery supervision cabinet.

- LEDs for each rectifier are described separately in section 12.3.
- Signals for remote indication to the control centre are described in Appendix B.

12.6.2 CONTROLLING FUNCTIONS

A control switch shall be installed on the charger front panel. The function of this switch is to switch the AC supply for the charger ON or OFF.

The charger controller shall be capable of performing the following controlling functions:

Output Voltage Control

The controller shall allow the user to establish a nominal operating voltage for the charger by setting the charger output voltage parameter. The voltage setting will reflect the required output voltage at 20°C.

Auto Battery Discharge Test

With this function, the charger controller shall monitor the discharge capability of the battery to reveal deterioration conditions of the battery over time.

When this function starts, the output voltage of the rectifiers shall be reduced to a value lower than the operating voltage of the charger. The rectifiers then shall be switched off; the battery shall supply power to the load. The battery voltage shall be monitored. The test passes if, after the test duration, the battery voltage remains higher than the predetermined value.

A facility shall be provided such that test can be scheduled to occur at a regular interval; and/or can be started or stopped manually; and/or started by an external relay contact or an external switch.

This test shall not function when the battery is on boost charge or equalised charge; or during the lock-out period after an AC supply failure.

12.7 BATTERY SUPERVISION CABINET

A battery supervisory cabinet is required for each battery voltage.

Each cabinet shall be a wall-mounted sheet steel construction with hinged front door. Cable entry may be through bottom or top cable entry or both.

The minimum degree of protection of cabinets shall be IP 21 in accordance with IEC 60529 when the door is closed and IP 2X when the door is open.

An earthing point with M12 fixing shall be provided for connection to the substation earthing system.

Each cabinet shall contain a supervision circuit for each battery supervised.

Each circuit shall include:

- One (1) battery supervision relay which monitors the load voltage and insulation strength of one DC distribution board. When an earth fault or high/low voltage occurs at one DC board, its battery supervision unit shall activate the relevant alarm.
- One (1) voltmeter indicating load voltage with a voltage range from 0 – 120 % of the rated load voltage.
- One (1) voltage selection switch with 3 positions, P-N, P-E and N-E. The switch shall be connected to the voltmeter and P, N, E voltage in such a way that it shall allow the voltmeter to indicate the P-N voltage when the switch is in the P-N position, and indicate Zero (0) when the switch is in P-E or N-E position. In the latter case, the switch shall not cause an earth fault in the system.

The layout and schematic diagram of this cabinet shall comply with the latest version of ESB drawings PG406-D020-093-001, page +AB+M56/1-3.

The battery supervision unit shall provide the following signals in the form of C/O contacts for remote indication of each battery supervised, independent of monitoring features provided by the charger.

Table 9 - List of Battery supervision cabinet signals

No	Signal	Signal type	Description
1	Battery Earth Fault	Major alarm	Earth Fault
2	Load Voltage Fault	Major alarm	Load voltage is too high or too low

13 CHARGER CABINET DESIGN

The following requirements are additional to the requirements as outlined in EirGrid Functional Specification XDS-GFS-07-001 Substation Control and Protection Cabinets:

A sample of the product / components, may be requested during the design review process.

The inspection for product quality assessment conducted by the Customer during the project evaluation process will cover two areas:

1. Verification of the adequacy of the proposed cabinet construction to house all of the installed equipment without damage to the equipment or the cabinet during transport, installation and service.

2. Verification of the suitability of the proposed cabinet construction for installing equipment as required by this specification.

13.1 CABINET

Charger cabinets shall be free standing or wall mounted, with 2 side panels, rear panel/ door, bottom plate, roof plate and hinged front door. All panel / door / plate edges shall be reinforced against distortion.

Cabinet frames shall be made of sheet steel with a minimum thickness of 1.5 mm. The cabinet frame shall be rigid, and free from flaws, twists and bends.

The cabinet frames shall be either fully welded frames or bolted frames, provided they are strong enough to house all of the installed equipment without damage to the equipment or the cabinet during transport, installation and service.

All side and rear panels of cabinets shall be made of sheet steel. The minimum thickness shall be 1.5 mm for each panel and roof.

The front door shall be made of sheet steel with a minimum thickness of 2 mm.

The bottom plate shall be made of at least 1.5 mm thick stainless or galvanised sheet steel to prevent corrosion.

Cabinets shall have bottom or top cable entry or both, as required by the enquiry schedules for the particular application. Cable entry areas shall provide adequate glanding space for all cables and leave free space of at least 25 %.

The minimum degree of protection of the cabinet shall be IP 41, in accordance with IEC 60529, with the door closed and IP 2X with the door opened.

Louvered air vents shall be provided on the lower and upper part of the front door and the rear panel. The air vents shall be built in such a way that the cabinet shall meet the specified IP protection requirements. Dust filters shall be fitted onto the air vents.

Access to all necessary connections shall be possible with the front door open. However, live parts in cabinets shall be accessible only after internal covers are removed (by using tools). Cable trunking is not considered edequate as a cover for live parts. Inside the cabinet, suitable racks shall be provided to offer adequate support for the enclosed equipment.

An earthing point with M12 fixing shall be provided for connection to the substation earthing system.

Cabinets shall be painted or have other corrosion protection to withstand the conditions referred to in Section 4 - Service Conditions. The paint colour should be RAL 7035.

Sufficient fixing points shall be provided on the bottom frame of the cabinet for bolting the cabinet firmly to the floor.

Door opening shall be possible without the use of any tool.

Doors shall be able to be opened to 180°. Doors shall be metal hinged and provided with individual handles. Concealed hinges are preferred. No door shall exceed 800 mm in width.

A padlock provision shall be available for each door access. It shall be suitable for fitting of the Purchaser's padlock which has a maximum diameter of 7 mm.

Cabinets shall be suitable for lifting by a fork-lift.

The lifetime of cabinets shall be at least 25 years. All materials used in cabinets shall be in good condition during that lifetime.

13.2 WIRING

Internal wiring shall conform to IEC 60227 and EirGrid specification XDS-GFS-07 Station Control and Protection Cabinets and Marshalling Kiosks.

All internal wires shall be multi-strand flexible copper conductor type.

Each end of an internal wire shall be fitted with a crimp connector whose style and size shall be suitable for the connection to the target terminal. Wherever the terminals accept ring crimp connectors, this connector type shall be used.

All wires shall be insulated for the highest voltage level in the enclosure.

All wiring shall be methodically arranged and shall follow an orderly and tidy pattern, grouped in a logical manner according to the circuits involved.

All wiring shall be adequately supported and protected from mechanical danger. Wiring shall be arranged so that access to terminals or other apparatus will not be impeded.

The connections of wires to terminal points (terminals of equipment or terminal blocks) shall be made properly and tightly to minimise connection resistance and eliminate sparking at the connections.

There shall be complete wire runs between terminal points, i.e. wires shall be jointed or terminated at terminal points only.

Where the terminal design allows, the connection of a maximum of two wires to a terminal connection point is acceptable.

Short loops covering a distance under 100 mm shall not run in trunking. Wiring between devices shall not be under strain.

A maximum allowance of 50 mm slack shall be made in the length of each wire at the point of connection to the terminal in order to permit re-termination of the wire at least once without causing the need to disturb the main run of the wire.

Wiring in the cabinets shall be accommodated in trunking. Each trunking shall have the capacity to accommodate all the wiring plus 40% spare space.

13.3 TRUNKING

All trunking shall be open-slot type, fitted with covers. Trunking and their covers shall be made of PVC.

The dimensions of trunking shall not be less than 40 mm wide and 60 mm deep.

The minimum clearance between trunking and a terminal block, or an equipment item, shall be 25 mm.

The minimum clearance between the bottom plate and the lowest trunking shall be 120 mm.

Trunking shall have facilities for cable tying to support the cables inside it.

13.4 EARTHING

The cabinet shall be equipped with an earth bar which shall be made from high-conductivity hard-drawn copper with a minimum cross-sectional area of 20 mm × 5 mm.

The earth bar shall have an external earth terminal which is suitable for connecting to 95 mm^2 copper conductor.

The earth bar shall have threaded holes for bonding the cabinet enclosure, all device metal cases, and the screens of all cables which will be terminated in the cabinet.

Suitable bolts shall be provided for these bonding connections.

The threaded holes on the earth bar shall be M5. The centre to centre distance between two adjacent holes shall not be less than 30 mm.

The panels, roof and bottom plates, and doors of the cabinet shall be bonded together, and then bonded to an earth bar by copper straps of minimum 6 mm^2.

Each device metal case shall be bonded directly to an earth bar (not looped together) by a copper conductor of minimum 6 mm^2.

All earth straps and earth conductors shall have green-yellow outer insulation.

13.5 TERMINALS

All terminals shall be of the enclosed screw type. They shall have universal housing feet which allow the terminal blocks to be easily snapped onto the DIN rail profiles NS 35.

The terminals for connection with the input cables shall be suitable to accept a conductor of at least 35 mm^2 cross-sectional area.

The terminals for connection with the output cables shall be suitable to accept a conductor of at least 10 mm^2 cross-sectional area.

The terminals connecting to the alarm circuits shall be suitable to accept a conductor of at least 1.5 mm^2 cross-sectional area.

Terminals shall be coloured grey.

13.6 NAMEPLATE

13.6.1 CHARGER NAMEPLATE

The charger cabinet shall have a nameplate which shall be securely fixed on its front door.

Nameplates shall be made of durable material. The text on a nameplate shall have a good contrast to the nameplate background. The dimensions (W x H) of each nameplate shall be approximately 100 × 50 mm.

The nameplate shall provide the following information:

- Name of the manufacturer
- Date of manufacture
- Weight (kg)
- Input AC voltage & current
- Output DC voltage & current
- Maximum 50 Hz withstand voltage (kV / 1 min)
- Reference documents (Schematic drawing No., Layout drawing No.)
- CE marking (see Section 2 – Standards and Applicable Codes)

The information given on the nameplate shall be in English.

13.6.2 BATTERY NAMEPLATE

The following information shall be inscribed on each battery cell or bloc:

- Name of the manufacturer
- Date of manufacture
- Battery trademark
- Battery cell / bloc nominal voltage
- Battery nominal capacity at a reference temperature
- Weight (kg)
- CE marking (see Section 2– Standards and Applicable Codes)
- The information given on the nameplate shall be in English.
- Information in accordance with the requirements of IEC 60896-1 or 60896-2, as appropriate, shall be provided on each battery cell.

The above inscription shall be durable and shall have good contrast to the cell / bloc container surface.

14 CONNECTION BOX

The connection box enclosure shall be of sheet steel construction with hinged front door. It shall be free standing or wall mounted, bottom or top cable entry or both, as stated in the Committed Project Parameters for the particular application.

The minimum degree of protection of the cabinet shall be IP 21 in accordance with IEC 60529, when the door is closed and IP 2X when the door is open.

An earthing point with M12 fixing shall be provided for connection to the substation earthing system.

The connection box shall include a charger change-over switch.

The change-over switch shall allow one charger to be in service while the other is in standby, i.e., not energised. The change-over circuit shall be arranged such that there shall be no interruption in the battery-to-load connection during the process of changing over the chargers (e.g. by using make-before-break contacts of the switch).

In addition to selecting the output of each charger the changeover switch shall also select all other functions, including dropping diodes, signals etc. as required.

A link shall be provided to allow dropping diodes to be excluded from the circuit.

The change-over switch shall be provided with one spare volt-free normally closed contact for each switch position selected. Those contacts shall be rated at 240 V DC, 0.3 A.

An ammeter shall be provided to indicate charger output current.

15 TESTING

15.1 TYPE TESTS

Where relevant type test reports are available for the following type tests, these may be accepted in lieu of testing subject to the approval of EirGrid.

The chargers shall also have been type-tested to prove their rated operating characteristics in normal and equalise charging modes, e.g. check of DC output voltages, voltage ripple, output currents, current limiting, efficiency and temperature rise tests.

The test results shall be included in the Customer / Design Review.

15.2 TESTS ON BATTERY

The batteries shall have been successfully type-tested in accordance with IEC 60896-11 or IEC 60896-21, as appropriate.

1. Recharger Test on Battery / Charger - A recharge test shall be performed on each type of battery/ charger unit in order to check the recharge characteristics.

2. Efficiency Test on Charger - An efficiency test shall be performed on each type of charger. Phase input current, total power input (VA), DC output voltage, power factor and efficiency shall be recorded with standing load DC output current and repeated at 90 %, 100 % and 110 % of the nominal AC input voltage.

3. Temperature Rise Test on Charger - A temperature rise test shall be carried out on each type of charger with temperature measurements taken at all likely hot spots.

4. Battery charger and connection box wiring shall withstand a test voltage of 2 kV AC 50 Hz for one minute and an impulse voltage test of 5 kV according to IEC 60255-5.

15.3 ROUTINE TESTS ON CHARGERS

Routine factory tests shall include insulation tests on the wiring of each charger. These shall consist of a 2 kV power frequency test for one minute, measurement of insulation resistance, and a 5 kV impulse voltage test, in accordance with IEC standard 60255-5.

15.4 LOAD TEST ON CHARGER

A load test shall be performed on each charger. DC output voltage shall be measured when charging the battery off load, while delivering standing load current, and while delivering maximum charger current. This shall be done for both float and boost charging operation, and with 90 %, 100 % and 110 % of AC input voltage applied.

15.5 TESTS ON COMPLETION (SITE ACCEPTANCE TESTS)

Site acceptance tests shall be performed on complete installations as part of the commissioning procedure. Commissioning of the installation on site shall be carried out without the substation standing DC load being connected. Unless otherwise stated the site acceptance tests shall be carried out by the Customer's skilled staff.[3]

Site acceptance tests shall include a capacity test on the battery, recharge test on the battery/ charger unit in order to check the recharge characteristics, operation check on all instruments, protective devices, signals / indications, and insulation resistance measurement on all equipment.

Commissioning of the installation on site shall be carried out without the substation standing DC load being connected.

The commissioning tests of batteries and chargers shall include:

1. Battery Visual Inspection:
    a. No physical damage
    b. Electrolyte levels are correct and no leaks observed.
    c. Positive and Negative conductors installed and rated as specified.
    d. Vents in battery room as per design.
    e. Confirm electrical installation has been inspected and verified for ATEX compliance.
    f. Availability and access to First Aid /safety equipment
2. Battery Specific Test:
    a. Following the manufacturers guidelines fully charge the batteries and record the Specific Gravity and Cell voltage of each cell.
    b. Conduct discharge test according to manufactures guidelines
    c. Record specific gravity and cell voltage measurements at prescribed intervals during the discharge cycle.
3. Substation battery chargers:
    a. Verify Charger Changeover Facilities & Fusing
    b. Verify charger set point voltages

[3] Safety Note – Refer to Health and Safety notes in Section 6.

c. Verify correct operation of charger control and alarm functions
d. Verify battery supervision earth fault sensitivity levels
e. Verify battery supervision under & over voltage alarm levels

15.6 BATTERY DISCHARGE TEST

A discharge test shall be carried out, over a 10-hour period on the substation batteries and results documented in the pre-commissioning test sheets.

All battery cells shall have passed the ten-hour discharge period in advance of general substation pre-commissioning commencing. Batteries should be fully charged before testing commences.

The manufacturer's instructions for the automated battery discharge test set shall be followed to ensure correct and safe connection of the battery supply to the test set.

The battery manufacturer's instructions shall be followed to ensure that the battery is fully charged before the test commences. The batteries should be equalise charged (boost charged) for an uninterrupted period beforehand (which may take up to 72 hours) and must be visibly gassing.

The charger is then switched off, cell voltage and specific gravity are measured.

As specified above battery charger and load currents shall be measured. It shall additionally be confirmed that, following discharge of each battery to a voltage corresponding to the end of its ten-hour discharge period, the battery can perform the duties specified in Committed Project Parameters for the end of the discharge period.

EirGrid shall be informed of when the discharge test will take place and may witness this test.

16 INSTALLATION

The equipment will be installed by the Customer's skilled staff in accordance with the manufacturer's instructions. These instructions shall be clear, shall be specific to the equipment being supplied and shall be in the English language. They shall cover all aspects of equipment installation up to and including putting into service. Instructions for lifting shall be clearly illustrated and all lifting points shall be clearly identified.

While installation is the responsibility of the Customer, EirGrid requires that a copy of the manufacturer's installation instructions be provided.

Installation Support

The Customer may be required to provide suitably qualified persons for on-site corrections / modifications / installation.

These staff shall be subject to all Health & Safety requirements.

17 DELIVERY

17.1 APPROVAL OF TEST RESULTS

At the conclusion of factory routine tests, results shall be submitted to EirGrid.

18 MAINTENANCE

18.1 SPECIAL TOOLS

The Customer shall list in the attached schedule of Special Tools (part of Technical Schedules) any special tools required for maintenance of the Material, Plant and Equipment. The tender shall include for a complete set of special tools per type of Material, Plant and Equipment involved. All such tools shall be provided with clear instruction in English as to their function and operation.

18.2 SPARE PARTS

The Customer shall guarantee the continuing availability of the complete range of spare parts for the MPE proposed.

The Customer shall list in the attached schedule of Recommended Spares (part of Technical Schedules) those spare parts which the manufacturer recommends should be held by EirGrid.

All recommended spare parts, types and quantities plus any additional requirements of EirGrid shall be agreed with EirGrid.

All spare parts shall be provided with a description of their function and a complete installation instruction with associated drawings. All instructions shall be in English.

EirGrid may require supply of all or any of the recommended spare parts, at its discretion. The spare parts recommended shall be clearly identified on the drawings and maintenance instructions which shall be included in the tender. Spare parts shall be delivered suitably packed and treated for long periods in storage. Each package shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts

list in the maintenance instruction, the required details of which are listed in the Product Specification.

19 WARRANTY

The Material, Plant and Equipment (MPE) including all components and accessories, shall be fully guaranteed against all defects arising from faults in design, manufacture and workmanship for a period of up to 5 years from commissioning and for batteries 5 years from delivery.

The attendance of specialist personnel to resolve problems with the Material, Plant and Equipment (MPE's) operation will be required should it be required during the warranty period. All defects notified within the above warranty periods shall be rectified entirely at the Customer's expense.

Acceptance by EirGrid of MPE following successful testing shall not relieve the Customer of his obligation to supply MPE fully capable of meeting the requirements of this Specification.

Should any design fault become apparent to EirGrid or to the Customer after the expiry of the above periods, the Manufacturer shall deliver all components necessary to correct the fault, together with all necessary instructions and specialist assistance, free of charge.

20 COMPLIANCE WITH SPECIFICATION

20.1 DEVIATIONS FROM SPECIFICATION

All deviations from the requirements of this Specification and the accompanying Enquiry documentation shall be listed in the attached schedule of Deviations from Specification (part of Technical Schedules).

20.2 CONFORMITY OF MPE/W WITH THIS SPECIFICATION

Where the Customer in the course of the contract proposes a deviation from the detailed requirements of the Specification, he shall make a written application for approval of such deviation to EirGrid and he shall list each deviation in the Schedule of Deviations and highlight the proposed deviation on the relevant drawings. Except in the case of a deviation specifically approved in writing by EirGrid the Customer shall be responsible for ensuring the conformity of the Material, Plant, Equipment and Works (MPE/W) with the Specification, notwithstanding any general approval or lack of approval of design submissions by EirGrid.

21 ACCOMPANYING DOCUMENTATION

Communications and all documents shall be in English.

The Customer shall complete all sections in the Technical Schedules, including the schedule of “maintenance” for all equipment.

21.1 TO BE SUBMITTED UPON PROJECT INITIATION / DESIGN REVIEW

The following information shall be submitted for review:

1. Full technical particulars of batteries and chargers, including battery cell details and wiring diagrams, and in particular, details on methodology used to predict battery life.
2. Outline dimensioned drawings of complete equipment: batteries on supporting stands, chargers and battery termination enclosures.
3. Drawings showing arrangements for installation.
4. Tests or calculations estimating the battery lifetime.
5. Test results of the insulation level.
6. The drawings of the proposed battery stands.
7. The discrimination calculations for MCB distribution.
8. Reference list for equipment similar to that being offered.
9. The manufacturer shall indicate the number of years for which the models offered have been in service with Electricity Utility Companies.
10. The manufacturer shall supply a list of clients where the offered batteries and chargers have been used. The list shall include details of quantities, location and years in which supplied, along with e-mail address of contact persons.

The above list is not exhaustive and does not preclude the Customer from disclosing any further information pertaining to the Item of plant.

Plant offered without the complete submission of the above requirements may be rejected

The following information is to be submitted to EirGrid according to the agreed programme:

1. Calculations of battery capacities, charger ratings, load & recharging times
2. Detailed load testing of each battery
3. Physical arrangement of cells in each battery.
4. Calculations to demonstrate that % hydrogen is within permitted limit.

21.2 TO BE SUBMITTED PRIOR TO ORDER BEING PLACED

The following requirements shall be applicable:

21.2.1 MANUFACTURING PROGRAMME AND PROGRESS REPORTS

A detailed manufacturing programme, covering all the equipment, shall be submitted within six weeks of the date of order. Thereafter, reports of progress against this programme shall be submitted at 2 month intervals up to and including the date of despatch of the completed order. EirGrid shall be advised of any divergence from the submitted programme immediately on occurrence.

21.2.2 TECHNICAL RECORDS

On pre-commissioning handover, two hard-copies and one soft-copy of the technical record folder shall be submitted for each product.

This folder shall include:

1. Technical schedules of the supplied products, which highlights the differences between the product values and the required values.
2. Physical layout drawings of the assembled battery, chargers and enclosures, including dimensions, installation details and cable entry arrangements.
3. Detailed as-built electrical & physical drawings, including details of connections, wiring and terminal arrangements for battery charger cabinets; one set of these drawings to remain with the charger cabinet.
4. Instructions for the safe handling of lead acid batteries and details of any other residual hazards.
5. Detailed installation, commissioning, operation and maintenance instructions, including technical manuals for proprietary equipment.
6. Details of end of life decommissioning & disposal requirements.
7. Routine test reports for each product and summary of all routine tests.
8. Declaration of Conformance confirming that the delivered products conform to the submitted guaranteed rated values and characteristics and the as-built drawings reflect the actual status of the delivered products.

In addition, a complete electronic set of drawings on disc shall be supplied in PDF and native source format and in one of the following formats:

- Microstation.dgn
- ACAD.dwg
- Misc.dxf

22 TRAINING

The Customer shall submit a Training Plan which shall describe in detail how the Customer proposes to train ESB staff. This plan shall be provided at least 8 weeks before the training course and at least 4 weeks before the commissioning of the plant. The courses shall cover plant familiarisation, fault diagnosis and testing and all aspects of plant maintenance. Training instructors shall be knowledgeable and experienced in the manufacture, erection, testing and maintenance of the equipment and shall have good communications skills in the English language. The training shall also be provided on site during the construction period.

23 APPENDIX A – BATTERY ROOM ELECTRICAL INSTALLATION EXAMPLES

The following examples are provided for information only, and do not represent instructions.

23.1 EXAMPLE WIRING OF EX LIGHT FITTINGS

- A 3 core (L-brown, N-blue and PE-green/yellow) 1.5 mm^2 Cu/XLPE/SWA/LSHF cable is installed from the Distribution Board up to the wall on far side of Battery Room.
- The cable is run from tray/trunking through hole in Battery Room wall, and sealed to prevent the spread of the potentially explosive atmosphere of the battery room into the rest of the control building.
- From where cable enters the Battery Room the cable is run and clipped to the first light fitting on circuit.
- An appropriate Ex gland suitable for SWA (e.g. universal Ex ‘de’ gland for Ex ‘d’ or Ex ‘e’ fittings, such as Hawke 501-453 or equivalent), is fitted as per gland manufacturer’s instructions.
- The cable is connected to the light fitting.
- Wiring continues from gland at first far end of 1st fitting into the 2nd fitting via gland etc. up to the last fitting.

Figure 5 - Example cable wiring to Ex light fitting

23.2 EXAMPLE WIRING OF EX HEATERS

- A 3 core (L-brown, N-blue and PE-green/yellow) 2.5 mm^2 Cu/XLPE/SWA/LSHF cable is installed from the distribution board up to wall on the far side of the battery room on cable tray or in steel trunking.
- The cable is run from the tray/trunking through the hole in the battery room wall. A seal is installed around all cables entering/exiting the battery room, on both sides of the wall, to prevent the spread of the potentially explosive atmosphere from the battery room into the rest of the control building.

- From where cable enters the battery room it is run and clipped up to the heater.
- An appropriate Ex gland suitable for SWA (e.g. universal Ex ‘de’ gland for Ex ‘d’ or Ex ‘e’ fittings, such as Hawke 501-453 or equivalent) is fitted as per gland manufacturer’s instructions.
- The cable is connected to the heater.
- Only one heater is installed per circuit.

Note: The mounting height of heaters on wall should be between 300 – 400 mm above floor level to bottom of heater.

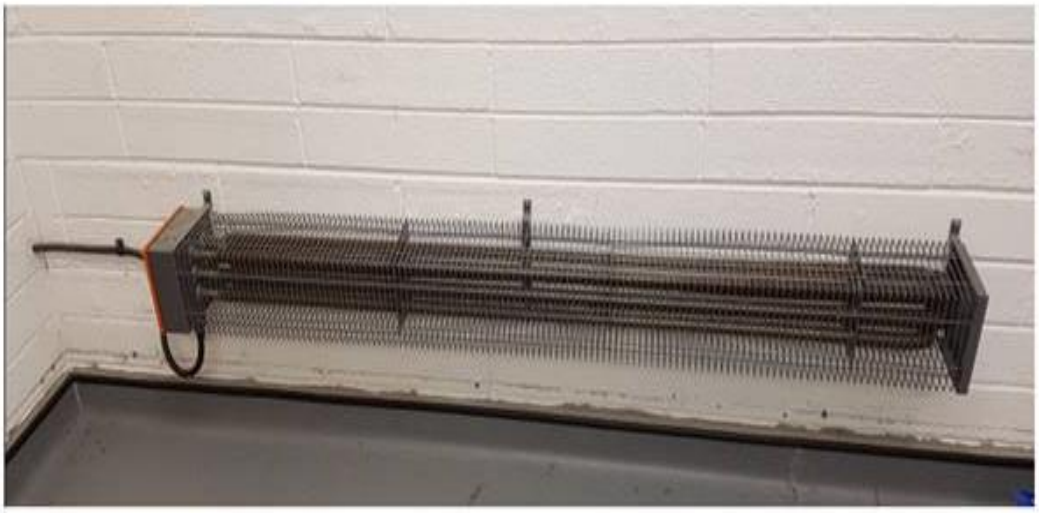

Figure 6 – Example cable wiring to Ex heater

23.3 EXAMPLE WIRING OF EX THERMOSTATS

- A 2 core (L-brown, L switched-blue, with brown sleeving over the blue core) 1.5 mm^2 Cu/XLPE/SWA/LSHF cable is installed from the distribution board up to the wall on opposite side of the battery room on cable tray or in steel trunking.
- A cable is run from tray/trunking through a hole in battery room wall and a seal is installed to prevent the spread of the potentially explosive atmosphere of the battery room into the rest of the control building.
- From where cable enters the battery room, it is run and clipped up to the thermostat.
- An appropriate Ex gland suitable for SWA (e.g. universal Ex ‘de’ gland for Ex ‘d’ or Ex ‘e’ fittings, such as Hawke 501-453 or equivalent), is fitted as per gland manufacturer’s instructions.
- The cable is connected to the thermostat.

23.4 EXAMPLE WIRING OF INTRINSICALLY SAFE THERMOSTATS AND SENSORS

- A 3 core (L-brown, N-blue and PE-green/yellow) 1.5 mm^2 Cu/XLPE/LSHF cable is installed from the distribution board up to a barrier box on wall on far side of the battery room on cable tray or in steel trunking.
- This cable is connected to the input (safe area side) of an Ex 'ic' (or higher, i.e. 'ib' or 'ia') galvanically isolated barrier (not a zener barrier) mounted here (Control Room) in the safe area.

  Note: The earth core is connected to the earth terminal in the barrier box, which will be connected to the case of the barrier box where metallic.
- A 2 core instrumentation type screened cable, light blue in colour, is connected to the output (hazardous area side) of the barrier. This cable insulation must be capable of withstanding a dielectric test of twice the voltage of the intrinsically safe circuit or 500 V r.m.s., whichever is the greater.
- This cable is run through a hole in the battery room wall. All cables entering/exiting the battery room are sealed, on both sides of the wall, to prevent the spread of the potentially explosive atmosphere of the battery room into the rest of the control building.
- From where the cable enters the battery room it is run and clipped up to the thermostat/sensor.
- An appropriate gland on cable or IP seal between gland and fitting is installed to achieve the required IP rating.
- For consistency and easy identification, it is preferable to use an Ex 'e' or Ex 'd' rated light blue coloured gland, even in the case of a single I.S. circuit where an Ex rated gland may not be strictly required.
- The cable is connected to the thermostat or sensor.

Notes for Intrinsically Safe circuits:

- At the galvanic barrier connection box, the 'safe area' non-I.S. cable cores are kept separate by at least 50 mm from the 'hazardous area' I.S. cable cores.
- Any spare cable cores are connected into spare terminals at each end (i.e. at Ex 'i' equipment and at barrier end), via ferrules. These spare terminals are insulated from earth, at both ends.
- Cable screens at both ends of the cable are twisted together and earth sleeving is put on and crimped into a ferrule and connected to a spare terminal at both ends. The spare terminal at the hazardous area is not connected to earth but left isolated. The spare terminal at the safe area is an earth terminal which is connected to the general LV earthing system.
- The barrier box contains a light blue label stating the following, or technically equivalent, text:

  "WARNING - Intrinsically Safe Circuits. DO NOT OPEN WHEN ENERGIZED".

24 APPENDIX B – REMOTE CONTROL CENTRE ALARMS LIST

The following list of alarms is indicative only.

- 220 V DC Battery Charger No. 1 Fail
- 220 V DC Battery Charger No. 1 AC MCB Trip
- 220 V DC Battery No. 1 Overvoltage
- 220 V DC Battery No. 1 Undervoltage
- 220 V DC Battery No. 1 Earth Fault

  (etc. for other batteries and chargers)

Refer to the project signals list for details of the required remote control centre alarms.

The required signals in the signal list shall be created by ganging together the appropriate signal contact outputs from the charger or other locations.