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Functional Specification

220V Lead Acid Batteries and Chargers

Revision	Date	Description	Originator	Reviewer	Checker	Approver
R0	20/04/2022	First Issue	Vitali Garon	Daniele Giustini	Leon Notkevich, Neil Cowap	Aidan Corcoran, Richard Blanchfield
R1	06/10/2022	Issued for use after industry feedback **changed Batteries to VRLA type**	Vitali Garon	Daniele Giustini	Leon Notkevich, Neil Cowap	Louise O'Flanagan

1 SCOPE

This Functional Specification is applicable for use in offshore wind transmission links delivered by the Customer as Contestable Works, to be owned and operated by EirGrid. The specification relates to the Onshore Compensation Compound (OCC) where GIS (Gas Insulated Switchgear) or AIS (Air Insulated Switchgear) is installed.

This specification should be read in association with the project specific contestable works pack and project documentation and all other relevant functional specifications as issued by EirGrid.

For this specification the term Customer shall refer to Offshore Wind Power Developers, Independent Power Producers responsible for the design and build of assets to be handed over to EirGrid.

This functional specification outlines the requirements for the design, supply, manufacturing and testing of VRLA (valve regulated lead-acid) / sealed type batteries, battery chargers, battery stands, battery/charger connection enclosures and battery supervision facilities for use in Onshore Compensation Compounds, including in voltage regulation / reactive power compensation systems.

2 STANDARDS AND APPLICABLE CODES

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

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

IEEE 1187 (2013) Recommended Practice for Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications' 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

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

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 case of conflict between this specification and any of the listed standards, this specification shall take precedence.

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 SERVICE CONDITIONS

The battery chargers, batteries and battery termination enclosures shall comply with this Specification and with the EirGrid Onshore Compensation Compound General Requirements functional specification OFS-SSS-400.

The following requirements are additional to those stated in the "Service Condition" section of OFS-SSS-400:

Batteries of the VRLA (valve regulated lead acid) type shall be installed in a dedicated 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.

The battery rooms shall be designed so that they are not classified as a hazardous area.

DC loads of potential voltage / reactive power regulation equipment shall also be fed from 220V DC system located in the control building.

A maximum humidity level of up to 95 % shall apply.

4 SERVICE EXPERIENCE

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

At least 10 years' experience in the production of the relevant voltage / current range (or higher) of the VRLA batteries, battery chargers, battery stands, and battery / charger connection enclosures specified, i.e. the "product".

Service experience:

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

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.

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.

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.

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.

5 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 OFS-SSS-400:

Battery Rooms are restricted access areas containing corrosive materials and access to exposed live parts.

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.

Where the Customer is required to work within an existing transmission substation, he will be subject to Irish Health & Safety legislation.

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.

All persons who work with batteries shall be subject to the safety requirements as stated in the standard IEC 62485-2.

Refer to OFS-SSS-417 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 OFD-SSS-511 (relevant signs and labels only as OCC battery shall not be hazardous area).

6 Environmental Design and Hazardous Substances

6.1 Environmental Design and Hazardous Substances

6.2 Legislation

Refer to OFS-SSS-400 for OCC General Requirements.

6.3 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.

6.4 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 OFS-SSS-400.

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

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 OFS-SSS-400.

6.4.1 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.

7 DC SYSTEMS

Table 1 provides a minimum list of products and services required for DC systems in Substations:

Item No.	Products & Services
1	VRLA batteries
2	Battery stands
3	Battery chargers for 220 V DC batteries and DC distribution boards
4	Battery connection boxes
5	Battery supervision cabinets
6	Design, installation, build and testing of batteries

Table 1 - List of products and services for supply of DC systems for OCC

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.

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 DC 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.

The battery is to be used in floating operation mode and will provide emergency power to the DC loads once 400V AC supplies are lost.

The Customer shall submit the detailed design of the battery systems to EirGrid for review. These will include sizing calculations, datasheet, specification, installation, operation & maintenance instructions.

220 V DC System

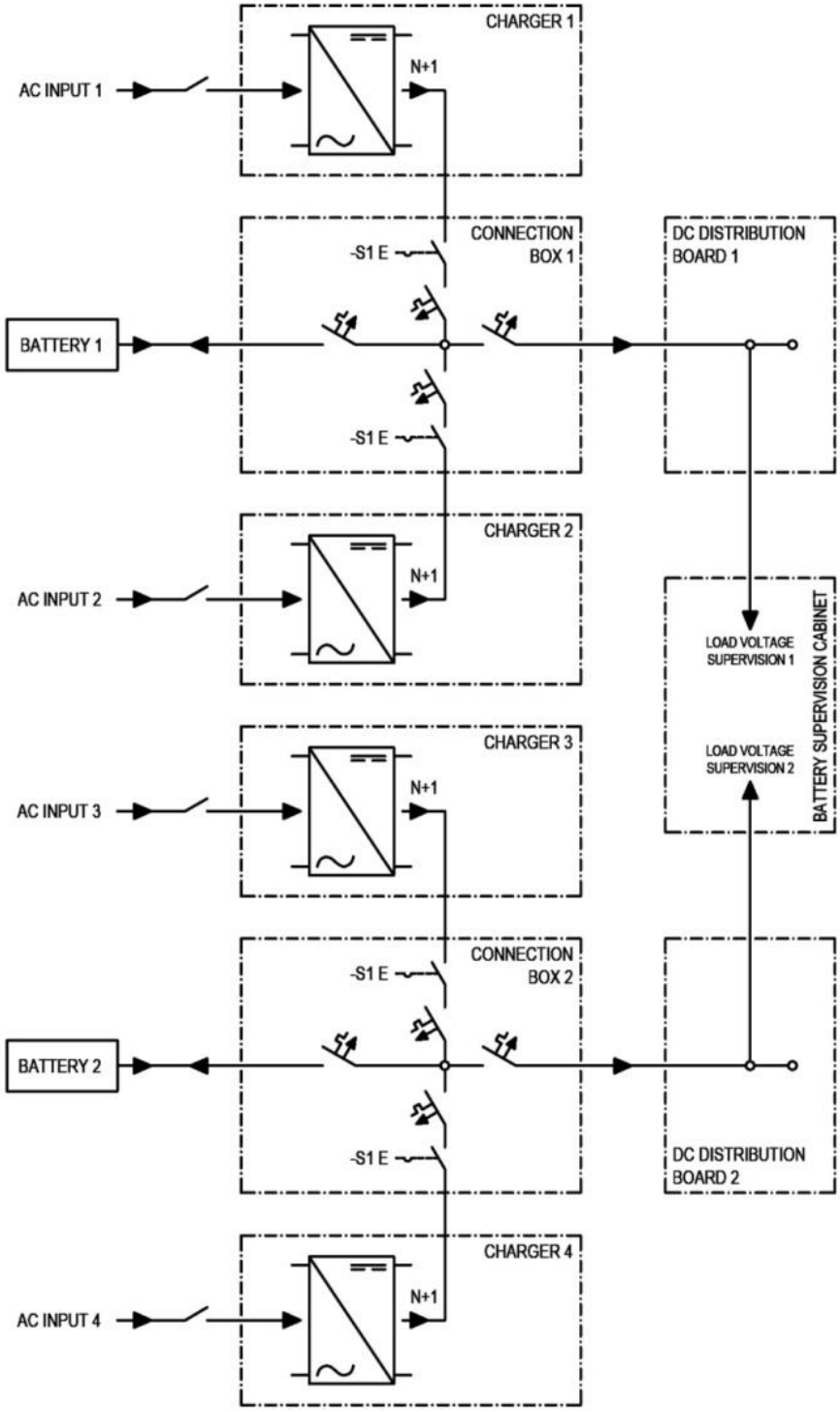

Figure 1 - Simplified Configuration for a 220 V DC system

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

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 work 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 times.

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.

7.1 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.

Any abnormalities, alarms in DC Charger, distribution or battery systems shall be sent to SCADA. Communication links (Modbus, IEC 60870-5-104 or similar) can be used.

7.2 BATTERY ROOM REQUIREMENTS

Minimum battery room temperature shall be 15 °C and the battery sizing should be done to this temperature. Maximum battery room temperature shall be 25 °C.

If necessary, heating or/and HVAC shall be provided to maintain the above temperature range if the room temperature is outside the given range.

Minimum of two hydrogen gas detectors shall be placed above the battery banks. In case of hydrogen gas detection, an alarm shall be sent to SCADA.

The ventilation of the battery room shall ensure that hydrogen gas concentration never exceeds 1% of volume (equivalent of 25% of Lower Explosion Limit, LEL). Ventilation can either be natural or forced. In case of forced ventilation, 2 x 100% redundancy is required with an alarm to SCADA in case of any fan or power supply failure.

The battery rooms shall be designed so that it is not classed as a hazardous area.

Batteries shall be placed on the supporting stands made of metal and be constructed to provide rigid support for the batteries. Battery stands and their support rails shall be insulated to 2 kV and shall not be connected to the earthing system. 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 battery room shall be design so to provide adequate access for any future maintenance activities, including a replacement of any single battery without removing other batteries.

Further requirements are also given in OFS-SSS-417 and OFS-SSS-418 specifications.

8 Battery Connection Details

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.

Connections between cell rows - Connections shall be made with XLPE insulated copper cables.

External connections to battery charger cabinet - Connections shall be made with XLPE insulated copper cables.

In order to minimise the risk of accidental short circuit or earth fault, the Customer shall ensure that the length of cable runs is 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.

The connections from the batteries to the battery termination enclosure shall be continuous.

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 so to have a 1000mm corridor between them. In exceptional circumstances a reduced space between battery stands can be considered by EirGrid, in any case this cannot be less than 800 mm and the Customer have to provide a Risk Assessment for the installation, replacement and maintenance of the batteries and their connections.

9 Battery Construction

VRLA type batteries shall be used.

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.

The design life of VRLA batteries shall not be less than 12 years under the service conditions described in the specification.

9.1 Accessories

The following accessories shall be provided for each battery bank:

Voltmeter with ±3 V scale.

Lifting handle / device to allow simplified manipulation of an individual cell.

Wall mounting instruction chart with following information:

Cell parameters

Battery parameters

Inspection requirements and procedures

Set of connecting hardware.

Cell numbering system.

Portable thermometer with a measuring ranges from -20 C to +50 C

Two sets of gloves for battery handling

Two cell bridging connectors.

Eye wash facility.

All instructions shall be in English.

The Customer shall provide any other items of equipment not listed required to ensure a safe and continued maintenance of the battery system for the entire expected battery life.

In addition to the above, all tools, accessories recommended by manufacturer for battery maintenance, installation activities shall be provided to EirGrid.

10 Battery Chargers

10.1 Configuration

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

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, at any time, shall be less than 32 dB(A).

Chargers shall comprise the following components:

Sheet steel cabinet as specified under Section 11 - Charger Cabinet Design

Surge protection device (SPD)

AC input MCB

Switch-mode rectifiers (see Section 10.3)

Charger controller (see Section 10.4)

Diodes for limiting the output load voltage

Local indications

Alarm signals for remote indication

10.2 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 neutral point)

Active power factor: greater than 0.95

In accordance with the EirGrid functional specification OFS-SSS-403 “Auxiliary Power Supply “the AC supplies to battery chargers shall be 1 or 3-phase as required depending on ratings.

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 OFS-SSS-403Station Auxiliary Power Supplies.

10.3 RECTIFIERS

The chargers shall be Switch Mode (SM) chargers. 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:

LED	Indication
Green	System Healthy
Yellow	Non-Urgent / Minor Alarm

LED	Indication
Red	Critical / Major Alarm

Table 2 - Rectifier LED's

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:

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

Table 3 - AC Ripple Requirements

10.3.1 DC OUTPUT

Charger rated output voltage = Rated DC load voltage.

Rated Output Voltage	Rated Output Current
220 V DC	40 A
220 V DC	50 A
220 V DC	60 A

Table 4 - Charger output ratings

The values listed in Table 4 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 OCC 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 3.

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.

10.3.2 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:

Initial charge with constant current charger I which is in the range $I = 2 \times I_{20}$ to $4 \times I_{20}$ (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.

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.

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 $2.35 < U_1 \leq 2.40$ 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.

10.4 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.

10.4.1 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 5

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

10.4.2 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.

10.4.3 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.

10.4.4 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.

Item of Plant	Alarm	Designation	Major/ Minor	Colour
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			

Item of Plant	Alarm	Designation	Major/ Minor	Colour
	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 5 - List of Charger and Connection Box signals

The bulleted list below are Notes on Table 5. 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 10.5. 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 10.3.

Signals for remote indication to the control centre are described in Appendix A.

Any abnormalities, alarms in DC Charger, distribution or battery system shall be sent to SCADA.

10.4.5 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:

10.4.6 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.

10.4.7 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.

10.5 BATTERY SUPERVISION CABINET

A battery supervisory cabinet is required.

The 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 the supervised battery.

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 battery supervision unit shall provide the following signals / alarms to SCADA.

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

Table 6 - List of Battery supervision cabinet signals

11 CHARGER CABINET DESIGN

The following requirements are additional to the requirements as outlined in EirGrid Functional Specification OFS-SSS-402 for Control and Protection Cabinets and Marshalling kiosks:

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

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.

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

11.1 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 adequate 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 3 - 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 a padlock which shall have a maximum diameter of 7 mm.

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

The lifetime of the cabinets/ kiosks shall be at least 40 years. All materials used in the cabinets/ kiosks shall be expected to be in good condition during that lifetime.

11.1.1 WIRING

Internal wiring shall conform to IEC 60227 and EirGrid specification OFS-SSS-402 for 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.

11.1.2 TRUNKING

All trunkings 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.

11.1.3 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 2 x 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.

11.1.4 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.

11.2 NAMEPLATE

11.2.1 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.

11.2.2 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.

12 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.

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.

A digital ammeter shall be provided to indicate charger output current.

13 Testing

13.1 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 review 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 and issued to EirGrid for review.

13.2 Tests On Battery

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

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.

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.

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.

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.

13.3 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.

EirGrid may witness routine tests on chargers.

13.4 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.

13.5 TESTS ON COMPLETION (SITE ACCEPTANCE TESTS)

Site acceptance tests shall be performed on complete installations as part of the commissioning procedure, EirGrid may witness these tests. 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 suitably qualified and skilled staff.[1]

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.

[1] Safety Note – Refer to Health and Safety notes in Section 5.

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
    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

13.6 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, agreed 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.

14 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.

15 Delivery

15.1 Review of Test Results

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

16 Maintenance

16.1 Special Tools

The Customer shall list any special tools, software required for maintenance of the Material, Plant and Equipment. The Customer shall provide 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.

16.2 Spare Parts

The Customer shall list in the schedule of Recommended Spares 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.

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.

17 Compliance with Specification

17.1 Deviations from Specification

All deviations from the requirements of this Specification and the accompanying Enquiry documentation shall be listed and submitted for EirGrid review through an approved Deviation (Derogation) procedures. Only approved deviations are accepted.

18 Accompanying Documentation

Communications and all documents shall be in English.

18.1 To be submitted for Design Review

The following information shall be submitted for review:

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.

Outline dimensioned drawings of complete equipment: batteries on supporting stands, chargers, and battery termination enclosures.

Drawings showing arrangements for installation.

Tests or calculations estimating the battery lifetime.

Test results of the insulation level.

The drawings of the proposed battery stand.

The discrimination calculations for MCB distribution.

Reference list for equipment similar to that being offered.

The manufacturer shall indicate the number of years for which the models offered have been in service with Electricity Utility Companies.

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.

18.2 TO BE SUBMITTED PRIOR TO HANDOVER

The following requirements shall be applicable:

Two hard-copies and one soft-copy of the technical record folder shall be submitted for each product.

This folder shall include:

Technical schedules of the supplied products.

Physical layout drawings of the assembled battery, chargers, and enclosures, including dimensions, installation details and cable entry arrangements.

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.

Instructions for the safe handling of VRLA batteries and details of any other residual hazards.

Full set of test records covering FAT, installation, pre-commissioning, and commissioning.

Operation and maintenance instructions, including technical manuals for proprietary equipment.

Details of end-of-life decommissioning & disposal requirements.

Routine test reports for each product and summary of all routine tests.

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 (if available)

ACAD.dwg

Misc.dxf

19 TRAINING

The Customer shall submit a training plan which shall describe in detail how the Customer proposes to train EirGrid staff for operation of future EirGrid assets.

Training requirements will be detailed further in OFS-GEN-009 - Operation and Maintenance General Specification.

20 APPENDIX A – 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
- 220V DC Battery Charger common trouble

  (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.