Specification

Technical Specification - Batteries and Chargers for HV Installations

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Revision details

Version No.	Clause	Description of revision
1.0	All	General revision
2.0	All	General revision
3.0	All	General revision
4.0	All	Format update, changing ‘shall’, ‘should’ and ‘may’ to must where relevant to Sydney Water, ‘approved’ replaced with ‘accepted’, minor editorial changes elsewhere.
5.0	Section 2	Environmental requirement updated, Outdoor installation restricted
	Section 4	Optimized battery sizing calculation, Provision for consideration of hydrogen release
	Section 5	Optimised Rectifier sizing and redundancy, Introduce requirements for single and dual battery chargers, Introduce maintenance bypass switch, Optimise DC output distribution Improve monitoring by aligning with latest OT requirements.
	All other sections	Minor updates to improve clarity

Introduction

This Specification is for the design, supply and construction of Batteries and Chargers for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification shall be sufficient to ensure safe systems or work or operation.

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Acronyms

Acronym	Definition
AC (ac)	Alternating current
AI	Analogue input
ANSI	American National Standards Institute
AO	Analogue output
AS	Australian Standard
CB	Circuit breaker
DC (dc)	Direct current
DI	Digital input
DO	Digital output
ELV	Extra Low Voltage (i.e. ≤ 50 V AC or ≤ 120 V DC)
GA	General Arrangement (drawing)
HMI	Human machine interface
HV	High Voltage (i.e. > 1000 V AC or > 1500 V DC)
IEC	International electrotechnical commission
IEEE	Institute of Electrical & Electronic Engineers
IICATS	IICATS Integrated Instrumentation, Control, Automation and Telemetry System
I/O	Inputs/outputs
ITP	Inspection and Test Plan
LV	Low Voltage (i.e. greater than ELV but ≤ 1000 V AC or ≤ 1500 V DC)
MCB	Miniature circuit breaker
MSDS	Material safety data sheet
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
SLD	Single line diagram

General Terms & Definitions

Term	Definition
Boost Voltage	A higher-than-normal charging voltage applied to a battery during specific periods to ensure it is fully charged or to recover from a deeply discharged state
Float Voltage	Minimum constant potential necessary to offset internal losses of battery

1. General

1.1 Scope

This specification defines the minimum technical requirements for the design, manufacture, supply, testing and delivery of Batteries and Chargers for High Voltage installations. This specification ensures that Sydney Water will be delivered with installation to the minimum acceptable requirements.

Where conflict exists between this specification and any other nominated source document, SWC must be notified in writing to nominate which will take precedence.

1.2 Proprietary items

Nomination of a proprietary item by Sydney Water does not imply preference or exclusivity for the item identified.

Alternatives that are equivalent to the nominated items can be submitted to Sydney Water for acceptance. The submission must include appropriate technical information, samples, calculations and the reasons for the proposed substitution, as appropriate.

2. Technical Requirements

2.1 General

The battery and charger system must incorporate reliable, modern equipment with a minimum service life of 10 years for batteries and 20 years for chargers. Equipment must come from a standard range with proven performance.

2.2 Environmental Requirements

The batteries and charger system must be designed to suit the following environmental conditions as per Table1.

Table 1. Environmental requirements

Environmental conditions		
Maximum ambient air temperature for indoor equipment		+ 45 ºC
Maximum ambient air temperature for outdoor equipment		+ 50 ºC
Maximum daily average temperature		+ 35 ºC
Minimum ambient temperature (corresponds to “minus 5ºC indoor class”)		- 5 ºC
Maximum relative humidity	For one month	90%
	For 24 hours	95%

Note: Battery chargers must adhere to the environmental requirements of AS4044, clause 8, for operation and storage.

2.3 Key ratings and features

Systems must conform to the criteria outlined in Table 2: Key Ratings and Features.

Table 2: Key ratings and features

Ref	Rating/Feature	Requirement
1	Class	Indoor / Outdoor (the outdoor application must have SW prior approval)
2	Access	Front access
3	Material of enclosure	Steel (Indoor) / Stainless Steel (Outdoor)
4	Enclosure Rating	IP4X minimum (Indoor) IP54 minimum (outdoor)
5	Mounting arrangement	Free standing floor mounted on a hot dipped galvanised plinth (if the plinth is not an integral part of the battery charger from the manufacturer)
6	Accessibility of compartments	Charger compartment - padlock compatible Batteries compartment - padlock compatible
7	Cable Entry	Bottom/Top (bottom entry only for outdoor installations)
8	Gland Plate	3 mm aluminium (undrilled)
9	Input Voltage Rating	230 V ±10%, 50 Hz ± 5%
10	Output Voltage Rating	48 V DC (New Installation)

Ref	Rating/Feature	Requirement
		32 V DC or 110 V DC (only for existing sites. Refer to the need specification for the individual project.)
11	Battery Type	Sealed Lead Acid
12	Digital IO voltage	48 V DC
13	Analogue IO	4-20 mA
14	Communication	Modbus TCP and DNP3

Note: Indoors refers to space enclosed within external walls and roof. All other environments are to be treated as outdoors.

2.4 Standardisation

Equipment must be designed with standard parts and components having a minimum of 10 years remaining of their product manufacturing lifecycle. Parts and components must be standardised as much as possible. All replaceable and consumable equipment must be standard supply equipment. The use of “one off” special designs is not permitted. Installing new and replacing existing battery chargers and batteries must consider standardisation of equipment at the existing facility and other Sydney Water sites.

3. Technical requirements - construction

3.1 General

Single batteries and charger system must be supplied in a floor mounted panel where practical. The panel must be from the suppliers standard range. Each cubicle must provide separate compartments for batteries electrical equipment (charger and distribution equipment) and be fitted with hinged front doors to provide access to each compartment.

The enclosures must be fabricated from new rust-free sheet steel with a coating suitable for the installation environmental conditions . The steel must have a minimum thickness of 2 mm. Structural panels must be suitably reinforced to prevent warping or buckling. Panels must be mounted on a min 75 mm galvanised steel channel plinth if the plinth is not an integral part of the battery charger design from the manufacturer.

All electrical connections and equipment within the cubicles must be shrouded to a minimum of IP2X standard. The equipment shrouding standard must be maintained with the cubicle door open.

For equipment mounted on hinged panels all rear terminals or active parts must be effectively shrouded by clear Perspex covers or equivalent insulation to provide safe working access to equipment located behind such panels.

Lifting lugs must be provided where necessary in the top of the enclosure. All panels must be suitably protected during transport.

3.2 Compartment doors

All compartment doors must be suitably designed and braced to prevent sagging or drumming, taking into account the weight of all mounted instruments and equipment. All panel seams and joins must be continuously welded.

All compartment doors must be fitted with hinges that swing through 120 degrees and be fitted with a latching mechanism to prevent the door from self-closing.

All compartment doors must have earth studs welded on the back of the doors and be equipotentially bonded to the panel frame with minimum 4 mm2 earth conductors.

Compartment doors must be sealed with soft closed panel door seal. Indoor installation must be a minimum of IP 43, outdoor installation must be a minimum of IP 54.

Panel door height exceed 1500mmf must be provided with a three-point latching system with an opening swing of 120 degrees.

All compartment doors must be accessible via the front of the panel and must be fitted with door handles that have padlocking facilities.

3.3 Surface preparation and finish

All exposed stationary metal surfaces must be prepared and painted to provide adequate protection against the adverse effects of the site conditions specified in Section 2.2.

Surface preparation and paint systems must be selected to give a life of not less than the design life of the battery charger.

All Metal finishing, the preparation, pre-treatment of surfaces and painting must be carried out strictly in accordance with Sydney Water Standard specification WSA201 – Manual for selection and Application of Protective Coatings and WSA201 – Sydney Water Supplement and PCS100 – Protective coating standard.

Table 3- Preferred paint colours

Preferred paint colours	Requirement
Electrical Cabinets (Indoor)	RAL7035 (Light Grey) for external surfaces RAL7035 (Light Grey) or White for internal surfaces
Electrical Cabinets (Outdoor)	Unpainted for external Unpainted for internal
Material of enclosure	Steel (Indoor) / Stainless Steel 316 (Outdoor)

3.4 Fixings

All metal handles, hinges, screws and nuts must be of manufacturer's standard finish and suitably protected against corrosion. Externally fitted fixings must be hot dipped galvanised. Cadmium plated fixings must not be used.

All current carrying connections must be with conical washers. Bolt length is to be selected so that approximately two threads protrude on final installation.

All equipment located on equipment mounting plates must be fixed via drilled and tapped holes in the mounting plates.

3.5 Battery cubicles

The enclosures must provide full-width, tiered shelves with battery terminals that are easily accessible upon opening the compartment door. The design must ensure routine maintenance can be performed without the need to remove the cells. The battery shelves must be provided with anti-scratch surface design to ensure the surface protection would not be impacted by the installation and removal of batteries during maintenance work.

3.6 Ventilation and filters

The cubicle enclosures must be designed to ensure adequate ventilation of the battery compartments and screened drip proof pressed louvres must be provided for this purpose.

Cubicles must have removable filters fitted behind louvres to prevent ingress of dust into the cubicle. All filters must be replaceable without the use of tools or removal of equipment or shrouds.

3.7 Outdoor applications

For equipment specified to be installed outdoors the following additional requirements must be included. The design must be provided to SW for prior approval.

Panels must be constructed from stainless steel and must be protected by weather shades. Weather shades must be of stainless steel, stood off 50 mm from the top of the cubicle and must overhang all four sides of the cubicle by 80 mm minimum.

Folding around door openings must be such that dust or water lodged on top of the doors does not enter inside of the panels upon opening of the doors.

3.8 Low voltage (LV) cable termination

All LV cables must be top or bottom entry through earthed, removable gland plates. The LV gland plates must be suitable for the fitting of cable glands for the nominated cable types.

3.9 Earthing

The charger and battery power supply panels must be fitted with a hard drawn tinned copper earth bar (minimally 25 mm x 6 mm) installed at the bottom of the cubicle.

A commercially available brass link bar with 20% additional spare tunnels must be mounted on the earth bar. Each Tunnel must have 2 screws, and tunnel sizes are to suit the expected wire sizes.

The earth bar must not obstruct cable entry into the panel or into internal ducting.

All exposed metal parts must be earthed via the earth bar.

4. Technical requirements - batteries

4.1 Battery design standards

Battery sizing must follow the IEEE485 method, including a 10% design margin and a 25% aging factor. The battery sizing calculation must be provided to Sydney Water during detail design.

The DC load profile as detailed in section 4.2 is defined by one or more load currents and cumulative durations during the specified battery discharge cycle. The DC load profile will typically be a continuous load for the full discharge duration with a short intermittent load at the end of the discharge duration.

The battery system must be designed to be fully functional within the following temperature parameters:

Minimum operating temperature	10 ºC
Maximum operating temperature	35 ºC (average over 24 hours)
Maximum operating temperature	45 ºC (absolute maximum)

The impact of operating temperature on battery capacity and float life must be calculated as part of the design. The temperature correction factor must be set to 1.04 if the installation is located in an air-conditioned environment, otherwise the temperature correction factor must be in accordance with the minimum operating temperature specified above.

Provision as per AS2676.2 must be made to consider the hydrogen release during the battery charger and discharge process when installed in an enclosed environment.

4.2 Battery cells

Unless otherwise specified the type of battery cell supplied must be the sealed lead-acid type batteries to AS 60896. The battery cells supplied must be selected from the range of manufacturers' standard sizes.

All battery cells and cases must be identical. The weight of a single removable battery cell must not exceed 20 kg, Sydney Water Manual Handling procedure must be considered to remove battery cells for maintenance.

The battery terminal voltage fluctuations caused by normal discharge (including both steady-state operation and transient loads) duty must be within ten per cent (10%) of the nominal output voltage with AC power available.

Unless otherwise specified, the performance of batteries must comply with following requirements:

a) Maintain nominal outage voltage for a minimum of four hours without primary AC supply

b) Within these four hours standby time, the batteries must have sufficient capacity to complete full operation of the installation for a minimum for two times

c) At the end of the four hours standby time, the batteries must retain capacity for:

   i. One full operational cycles (trip/close) of all circuit breakers

   ii. Spring charging of 50% of circuit breakers

d) At the completion of above operation steps, the final terminal voltage of the batteries must be greater than 85% of the nominal output voltage.

The cell container material must be of translucent non-aging polypropylene or of other plastic material with similar or superior properties such as high impact resistance, chemical resistance, and temperature resistance.

Bolted solid link connections must be provided between all cells on the same tier. Two independent cable connections must be provided between banks of cells on different tiers.

5. Technical requirements - battery charger

5.1 General

Unless specified otherwise the battery charger must be a Type 3 with the battery connected in parallel in accordance with AS 4044. The charger must be of the constant voltage type with automatic control for regulating the required trickle and equalising rates and must be capable of totally satisfying the battery manufacturers requirements. The Supplied battery chargers must be selected from the manufacturers' standard range, through direct voltage conversion from AC to DC.

The batteries and charger system must be specifically designed for and be capable of operating in parallel with another unit of the same type and sharing the load current. A suitably rated DC isolator must be provided for the connection of the charger output to the battery of a parallel unit in the event of a charger failure in the parallel unit. The isolator operation is an emergency manual function only.

Battery chargers must protect their internal components against harmful transients from the power supply to the rectifier and output, high inrush and overload currents, overcharging to batteries and short circuit conditions. Battery chargers must have reverse polarity protection on the charger output.

The emission of electromagnetic interference generated by the whole unit must conform to the requirements of AS 4044.

5.2 Charger requirements

The battery charger must be self-protected against overload and must be capable of being connected to fully discharged batteries without fuse rupture or component failure and restore the batteries to a charged state without manual intervention. No transformer/rectifier-based power supplies must be accepted.

The incoming power supply must be provided with a current limiting thermal magnetic type moulded case circuit breaker that operates on all active conductors and has a minimum interrupting capacity of 10 kA.

Printed circuit boards (PCBs) must be removable with plug and socket type connectors. All PCBs must have a suitable means to match polarising inserts in receptacles to prevent the wrong card being inserted. Each PCB must be identifiable by being engraved with the Contractor charger type and drawing number. All PCBs used in cubicles must be suitably conformal coated. All PCBs must be interchangeable with other cards of the same type for the same type and model of charger.

Each charger must include earth-fault detection and fault clearing modules, adjustable setting range (typically 30-100mA) suitable for the application The design must not cause nuisance tripping from the battery charger normal operation (eg. AC/DC conversion from the rectifier).

The rectifier unit must be modular, for each battery charger system, a minimum of 2 identical units each rated for a minimum of 60% of the maximum load must be installed. All units must operate in parallel with active load-sharing control to ensure equal current distribution. The rectifier unit must support hot- swapping without interrupting DC output. The hot-swap functionality must comply with IEC 60947-3 for isolation and arc flash protection.

Parallel rectifiers must include active current-sharing control to ensure less 5% load imbalance under all conditions, Synchronised Voltage and current output must be managed through the controller on paralleling rectifier units.

Maintenance bypass switch must be provided as part of the battery charger system to allow switch off battery charger controller while maintaining continues power to loads via rectifier and battery banks. As a minimum the maintenance bypass switch should have two different operating positions/modes, they are:

a) Normal mode: Battery charger controller actively manage the rectifier(s) and battery banks.

b) Maintenance mode: Rectifier(s) operates at preset voltage, battery bank supplements the required the load.

5.3 Float and boost charging requirements

Each batteries and charger system must contain a continuous type automatic float/boost battery charger permanently connected to a set of battery cells. Isolating links must be provided.

The batteries and charger system must operate as a floating output unit. Under normal operating conditions the charger must maintain a constant float voltage output. In the event of the battery voltage being low (less than 80% of the nominal voltage), the charger must be able to provide a constant boost voltage to fully charge the battery. When selected to boost charging mode the battery charger must revert to constant voltage float charging after a pre-set time.

Settings of float and boost voltage and boost charge time must be adjustable, and facilities must be provided for selection of manual or automatic boost charging. The float voltage must be set to maintain the battery fully charged with minimal overcharge and water loss and such that regular boost charging is not required. Values of normal in-service float voltage, boost voltage and current limit settings must be clearly marked on the charger cubicle.

Where the battery charger utilises microprocessor control with settings and parameters entered digitally, the entered data is to remain in the memory whilst unpowered for a minimum of one year without the use of a battery.

The float and boost voltages must be maintained in a range of ± 0.5% for simultaneous changes in mains input of ± 5% and load variations of zero to one hundred per cent (0 to 100%). Battery chargers must limit the output voltage to the maximum specified float voltage when the battery load is not connected or open circuited.

5.4 Single and Dual batteries and battery chargers

Single battery charger system is generally suitable for most SW high voltage installation. Kiosk type substation where there are no more than 2 kiosks supplying the same distribution load centre, single battery charger system can be used for the kiosk(s).

Dual battery charger system must be utilised when one of the following conditions presents:

a) The switchboard includes primary and backup protection schemes to perform independent operation, in this instance, each protection scheme must be supplied by its respective battery charger system. Each scheme must independently perform the tripping function and circuits control.

b) Main switchboard have bus bars connected with cables and have different bus sections physically separate by barriers/walls.

c) Critical infrastructure assets nominated by SW.

Unless otherwise specified, in dual batteries and battery charges system, all batteries and chargers system supplied must be identical. Where dual battery charges to be implemented, AC supply to each battery chargers must be supplied from at least two independent bus sections of a LV switchboard each fed from separate upstream sources, preferably equipped with ATS between the two sources of supplies.

For dual battery charger arrangement, each battery charger system must operate independently during normal operation, each battery charger system must be installed in its own standalone cabinet without having shared compartment or component with each other.

5.5 Charger loads

The continuous load on the battery charger will comprise the battery, high voltage switchboard tripping, closing, and racking of equipment, protection equipment, remote control and monitoring of the distribution network, indication devices and PLC equipment.

An intermittent load will comprise the circuit breaker tripping and closing solenoids, circuit breaker spring charging motors, increased operating loads of high voltage switchboard protection equipment.

The battery charger must be adequate to provide the continuous and intermittent loads as detailed for the batter operating duty and also provide these loads while charging a fully discharged battery to ninety (90%) capacity in 12 hours.

5.6 DC output distribution

Each DC load circuit must be individually isolated from all other load outputs by a diode and protected by a suitably rated double pole circuit breaker.

All CBs must have a minimum short circuit breaking capacity exceeding the battery fault level and must be of the two pole thermal magnetic type. The operating handles of all circuit breakers and fuse carriers must be suitable for or provided with suitable adapters for the attachment of warning tags and padlock lockout.

Protective devices such as circuit breakers and fuses must be selected to provide correct discrimination of operation in the event of faults in the main DC circuits of the charger and battery power supply cubicle.

A main DC circuit breaker must be provided for

a) Each bus section of a switchboard;

b) Each RMU of substation kiosk.

to provide load distribution and isolation.

For each bus section of a HV switchboard or each RMU of substation kiosk, a minimum of two dedicated DC circuit breaker circuit breakers must be provided:

a) One circuit breaker is designated exclusively for the tripping circuit , which includes protection relays and trip coils.

b) The second circuit breaker is intended for all other functions and circuits , such as auxiliary loads and control systems.

For each switchgear panel within the respective LV compartment:

c) One circuit breaker is to be provided for protection and isolation of protection relay and tripping coil. *

d) One circuit breaker is to be provide for protection and isolation for all other functions and circuits such as auxiliary loads and control systems.

* Note when the switchboard is equipped with primary and backup protection scheme, dedicate circuit breakers are to be provided for each protection and their associated tripping coils.

All DC load circuit breakers must be carefully selected to ensure proper coordination between breakers within the same busbar section and across the entire DC distribution system. A minimum16 A circuit breaker must be used as protective device for the distribution of the loads.

A separate dedicated main DC circuit breaker must be provided for remote control and monitoring of the distribution network.

All MCBs must be supplied with a means for locking in the “OFF” position. The locking device must meet the SW LOTO procedure requirements.

All MCBs must have durable “OFF” and “ON” labels in addition to the international “0” and “1”, and have no ambiguity as to which position they are in.

Any modification to the device (e.g. fitting of locking attachments), will only be acceptable if the Supplier has written approval from the manufacturer that the modified device will function to specification.

Where fuses are nominated, fuses and holders must be provided for each pole and equipped with fuse supervision suitable for remote indicators using voltage free auxiliary contacts.

All protective devices must be installed in a compartment, but must be accessible from the front of the cabinet without the need to remove any protective covers or shrouds.

5.7 Controls and indications

Each charger must be provided with digital voltmeter and ammeters display functions to show charging current (output) and discharging (load) current, batteries voltages , a test facility to indicate the stage of charge of battery cells and an automatic/manually selected boost charging facility.

All controls, indications, meters and operation adjustment controls must be installed inside a lockable compartment that is readily accessible from the front of the unit. All indications must be visible via a Perspex window in the compartment door.

The following minimum controls must be provided:

a) Alarm Reset
b) Manual Boost Push Button
c) Incoming Circuit Breaker
d) Output Circuit Breakers - to isolate the DC load
e) Manual termination of boost charging (push button)
f) Battery Test Facilities
g) Operation of maintenance bypass switch

Monitoring signals in form of digital display or individual LED indicating lamps, fitted to the front panels of the enclosures, must be provided for the following as a minimum:

a) AC Input ON
b) Boost Charge Voltage ON
c) Charger Fail (typically includes but not limited to: loss of AC supply, SPD removed/failed, loss of communication, controller failure, rectifier failure, ventilation fan failure, anticondensation heater failure, etc) *
d) Battery Fail (typically includes but not limited to: loss of a battery string) *
e) Low Battery Voltage (For individual battery string voltage lower than 80% of nominal voltage for longer than 15mins)
f) High Battery Voltage (For individual battery string voltage higher than 120% of nominal voltage for longer than 15mins)
g) Earth Fault
h) Maintenance bypass switch not in normal position
i) High temperature warning *
j) Over temperature shutdown. *
k) Battery temperature at no less than 15 min intervals. **

Note:

*. Battery charger system OEM must provide a list of products related typically alarm points for SW to evaluate and agree on monitoring inclusions and setpoints.

**. Provision must be made for battery temperature monitoring via one dedicated temperature sensor located in top part of battery cabinet per battery charger.

Monitoring signals listed above must be made available via Modbus TCP or DNP3. For network sites, DNP3 should only be implemented where IEC61850 based control and monitoring system is available. However, when hardwired monitoring is required, auxiliary relays must be provided with voltage free changeover contacts to allow remote monitoring of each of the conditions listed above. All contacts of the auxiliary relays must be wired to a terminal strip for connection to a PLC system.

The fault indicating lamps and auxiliary relay contacts must remain latched following fault indication and must only be capable of being reset from the latched condition by a manual reset switch fitted to the charger unit after clearance of the initiating fault.

The “Charger Fail” alarm circuits must be arranged to operate only when no current flows into the batteries and the batteries are below ninety-six per cent (96%) of the pre-set float voltage level.

The indicating lamps must be the manufacturer's standard LED type.

5.8 Wiring

All LV and EL wiring is to be installed in a neat and logical manner following standard industry practices.

All LV and ELV wiring must fully comply with the requirements of AS 3000 Wiring Rules. Where the ELV cable is connected to a battery, the cable must comply with AS 4044. ELV cabling external to the batteries and charger must comply with SW technical specification – Instrumentation and control.

All conductors must be flexible stranded tinned copper wire.

Table 4- LV and ELV wiring requirements (Internal to the panel)

Item	Min Conductor Size	Wire/ Conductor type	Wiring / Conductors - Colours
ELV for control and monitoring signal	1.5 mm^2 Cu	0.6/1 kV PVC/PVC insulated V-90 to AS/NZS 5000.1	Active/Positive – Light Grey Neutral/Negative – Light Grey
All battery connections and DC distribution	2.5 mm^2 Cu	0.6/1 kV PVC insulated type V90 to AS/NZS 5000.1	Positive – Red (RD) Negative – Blue (BU)/Black (BK)
240 V AC control when supplied from same compartment or SCA In all other cases	2.5 mm^2 Cu	0.6/1 kV PVC insulated type V75 to AS/NZS 5000.1	Active – Brown (BN) Neutral - Black (BK) Active- Orange (O) Neutral - Black (BK)
Earth conductors	4 mm^2 Cu	0.6 /1kV PVC insulated type V90 to AS/NZS 5000.1	Green Yellow (G-Y)
Instrumentation twisted pair conductors	1.5 mm^2 Cu	PVC/Overall Screened/PVC, insulated type V90 to AS/NZS 5000	Positive – White (W) Negative – Black (BK)
Ethernet		Shielded CAT 6	Blue
Conductors connecting voltage free relay contacts where the voltage is undefined	1.5 mm^2 Cu	0.6 / 1 kV, PVC insulated type V90 to AS/NZS 5000.1	Active/Positive – Violet (V) Neutral/Negative

All LV and ELV wiring must be installed in plastic cable duct with clip-on covers, flexible conduit is to be provided from panel to door. Cable ducts are to have 30% spare capacity. Panel to door wiring must include a loop to relieve stress and must be anchored at the panel and the door. No joints in runs of wiring (i.e. at locations other than at terminals) must be permitted. Where wiring is to pass through cut-outs in panelling, the hole must be bushed.

All LV and ELV wiring must be arranged so that the line side is connected to the top of the respective device.

Adhesive wiring supports are unacceptable.

All terminal strips and individual terminal blocks must be labelled using proprietary labelling/numbering systems.

All conductors must be terminated at both ends with pre-insulated crimp terminations. They must be of the correct size for the conductor and must be applied with the terminations manufacturer's tool.

a) Ring type termination lugs must be used for terminating to stud-type terminals
b) Lip blade termination lugs must be used for terminating to rail-type terminals
c) U shaped termination lugs must be used on selector switches and similar small equipment.

Solder connections are not acceptable.

All conductors must be uniquely numbered at both ends in accordance with the respective schematic diagrams.

All field wiring must be marshalled at terminal strips suitable for the maximum current ratings considering DC and high in-rush loads.

Terminals must comply with the following requirements:

a) Tunnel type connectors
b) No more than 2 conductors must be terminated on each side of each terminal
c) All terminal strips must maintain a degree of protection of IP2X
d) All field cabling must be terminated on one side of each terminal strip and all panel wiring must be terminated on the other side of the terminal strip
e) For clarity, provide barriers between groups of terminals having different functions (e.g. between terminals for 240 V AC supply, DC output and signal terminals)
f) Provide a separate earth terminal for each field cable
g) All terminal blocks must be uniquely numbered in accordance with the respective schematic diagrams
h) All terminals must be uniquely numbered in accordance with the respective schematic diagrams.

MCBs must be provided for isolating all auxiliary power supplies.

5.9 Interfaces with external systems and equipment

Interfaces between the batteries and charger system and external systems and equipment must be provided in accordance with Sydney Water SCADA/IICATS requirements.

As a minimum the monitoring signals c), d), e), f), g), and k) listed in section 5.7 must be implemented in SCADA/IICATS.

6. Identification and labelling

All electrical equipment forming part of the batteries and charger system must be readily identified in the English language by a label in accordance with the relevant standard and this Specification.

All labelling and nameplates must be in accordance with nomenclature used on the relevant electrical Drawings and Schedules provided by Sydney Water.

All labels must be permanent, free from fading, engraved, embossed or pressed multi-layered thermosetting plastic or metal. Labels must be secured suitable coated machine screws into tapped holes. Departures from these requirements must require the written pre-approval of Sydney Water.

All equipment labels must be mounted on a fixed portion of the enclosure directly adjacent to the device.

Each battery must be labelled with manufactured dates.

Terminal block group labels must be manufactured of the material and mounted in accordance with the standard procedures adopted by the terminal strip manufacturer. Terminals must not be made of brittle material.

Generally, labels must be manufactured to the following specification.

Table 5. Labels

Label function and location	Typical label size (mm)	Text colour / Background colour	Label description	Text height (mm)
Batteries and Charger Cubicle main label - Mounted at the front top centre of the cubicle	400 L x 100 H	Black / White	Battery designation Substation Name 48 V PROTECTION DC SUPPLY	20 20 10
Battery Cubicle Label - Mounted at the front top centre of battery compartment door	120 L x 4 0H	Black / White	48 V DC XX off Sealed Lead Acid Cells Cell Manufacture / Cell type FAULT CURRENT: xxxA	7 7 5
All compartment door mounted equipment labels (e.g. Controllers, indication lights, selector switches, pushbuttons etc) - Mounted on front and rear of LV compartment door below equipment		Black / White		3
All compartment internally mounted equipment labels (e.g. control relays, control MCBs, Terminals etc) - Mounted on top or below equipment consistently throughout the installation		Black / White		3

6.1 Safety labels

Warning labels must be attached as required by AS 4044, AS 2676 and where any potentially hazardous or unusual operational situation may exist.

These labels must comply with the requirements of AS1319.

As a minimum, the following labels must be provided (where applicable):

- Danger – Risk of battery explosion as per AS 2676 series
- Caution – Battery voltage and prospective fault level as per AS 2676 series
- Emergency Information – Instructions for dealing with electrolyte burns as per AS 2676 series.

In addition, all incoming AC circuit breakers, fuses or other isolating devices must be labelled as follows:

DC battery charger 240 V AC Supply

Not to be switched off without permission

6.2 Label schedule

A label schedule showing details of each label must be submitted for approval prior to manufacture of the relevant labels.

7. Testing requirements

7.1 Factory inspection

Sydney Water must be provided with opportunities to witness factory tests. The Contractor must advise the Sydney Water representative in writing six weeks prior to any scheduled testing.

7.2 Routine (factory) testing

Prior to shipment, the equipment must be completely assembled and tested by the Contractor in accordance with the relevant Australian Standards and the following minimum test requirements:

a) Verify installation has the correct wiring, connections and labels.

b) Operational tests to check the function of all items of equipment

c) Test charger output voltage regulation under specified load condition as per the design Verify performance of float and boost mode including switching between the two modes.

d) Validate paralleling and load sharing performance

e) Verify protection function including but not limited to short circuit, over load, battery over charge and thermal as per the design.

f) Validate earth fault detection and insulation resistance on all equipment and wiring

g) Validate communication and remote monitoring performance.

h) Conduct discharge test to verify batteries rated capacity.

i) Verify uniformity in cell voltages and internal resistance.

Sydney Water reserves the right to call for a demonstration of the ability of the equipment to withstand a short circuit of the charger output for a specified duration.

The Contractor must supply all test results for each charger and battery unit with the equipment manuals.

7.3 Site testing

Testing item in 7.2 are to be repeated on site with the system fully integrated, and if any defects in workmanship, design or materials appear, which were not apparent during factory testing and it must remain the responsibility of the Contractor to rectify such defects on site, free of charge. In addition to the items mentioned in the 7.2 following tests are to be included during the site testing as a minimum :

a) Validate protection performance with upstream and downstream equipment.

b) Conduct full load testing to ensure stable operation for the installed loads.

The Contractor must supply all test results for each charger and battery unit with the equipment manuals.

8. Quality assurance and inspection and test plans

The Contractor must implement a quality system that complies with the requirements of ISO 9001 for the equipment.

The Contractor must submit for approval two project-specific Inspection and Test Plans (ITPs) for the Batteries and Charger System:

a) Factory ITP - covering all off-site activities i.e. engineering, design, supply, testing, resolution of factory defects/punch lists, release for delivery, preparation for transport, etc.

b) Site ITP - covering all on-site activities i.e. delivery to site, unloading, installation, assembly, site testing, resolution of site defects/punch lists, handover, etc.

The ITPs must identify the standards and/or procedures as well as the acceptance criteria that must apply for each stage in the ITPs.

Unless approved otherwise by Sydney Water, all standards, procedures and acceptance criteria included in the ITPs must comply with the requirements defined in this specification.

Perform all work on the batteries and chargers in accordance with the approved ITPs.

Sydney Water must be given the option of witnessing all inspections and tests including type tests, (routine) factory tests and site tests. Sufficient notice (14 calendar days for tests on site, 42 calendar days for test elsewhere in Australia, 42 calendar days for tests outside Australia) must be given to enable the necessary travel arrangements to be made. Sydney Water may elect to appoint third party inspector(s) to witness inspections and tests.

9. Spare parts

The battery charger OEM must provide a list of recommended spare parts with valid reason to Sydney Water for evaluation. Sydney Water spare parts assessment process must be followed to determine the spare parts required for the project to procure and handover to Sydney Water.

9.1 Routine maintenance spare parts and / or tools (for defects liability period)

Provision must be made to procure replacement spare parts and tools for the commissioning period and up to end of the defect's liability period.

9.2 Long-term maintenance / strategic spare parts and special tools

Provide a priced list of optional recommended spare parts for long-term maintenance activities and strategic planning, as well as any special tools required to perform long-term maintenance activities.
Sydney Water must be provided opportunities the decided whether to purchase some (or all) of these recommended spare parts and tools.

The spare parts list must be prepared with regard for the need to restore the charger to service in less than four hours following any failure.

10. Manuals and drawings

10.1 Deliverables during design stages

Following deliverables must be provided at the appropriated design milestones, including but not limited to:

a) Layout drawings

b) Datasheets

c) battery charger and battery bank sizing calculation sheets.

d) Assembly drawings

e) Assembly manuals

f) Battery charger and battery bank schematics

g) DC distribution Single Line Diagram

10.2 Post design deliverables

One paper copies of erection, maintenance and operating manuals in accordance with Clause 10 of AS 4044 must be supplied.

One electronic copy of all manuals, drawings and test results must be provided on suitable electronic media in PDF file format as a minimum.

If a programmable microprocessor-based controller is used in the charger, the Contractor must provide an electronic copy of all settings files, along with any proprietary software and/or licence necessary for programming the controller and the required interface cable. Before purchasing any proprietary equipment, the Contractor must consult SWC to determine the specific requirements. Where a password is required to access the settings, this password must be provided in the manual.

Equipment manuals provided must contain details of all aspects of the operation and maintenance of the supplied equipment, a detailed parts list of all major components and copies of all factory test results.

Electrical circuit diagrams must be supplied either with the manuals or as separate A3 size drawings. All drawings must be supplied electronically in an AUTOCAD compatible format.

Equipment manuals and drawings must not contain descriptions or details of alternative equipment not specifically used in the supplied equipment.

Maintenance manuals and regimes must be specific for each site installation, in particular with respect to the maintenance timeframes required for the environmental conditions of the specific site.

11. Packaging and delivery

The Contractor must pack all equipment for delivery such that it will not be subject to any damage, or deterioration due to any environments through which the equipment may pass during delivery. Refer to AS 2676.2 section 5 for specific battery cell requirements.

The Contractor must make good any damage or deterioration that has resulted from the delivery.

The Contractor must provide for Sydney Water, documents detailing the following information:

a) Number of crates to be delivered

b) Items that are in each crate

c) Total weight of each crate

d) Any special lifting requirements for each crate

e) Any obligation that Sydney Water may have when the items are delivered, such as immediate unpacking, storage requirements etc.

12. Reference documents

The Batteries and Chargers and all associated equipment and materials must be designed, manufactured and tested in accordance with the latest revisions of the Federal and State statutory requirements, applicable Australian and IEC Standards, as well as the Sydney Water standard specifications.

Document type	Title
Legislation	- Latest edition of the Work Health and Safety Act - Latest edition of the Service and Installation Rules of New South Wales
Policies and procedures	- WSA201 - Manual for Selection and application of protective coatings - Supplement to WSA201 - Manual for Selection and application of protective coatings. - PCS100 - Protective Coatings - Sydney Water Emergency Stop Policy
Other documents	- D0002010 - Engineering Standard governance
Standards	- AS 1627: Metal finishing - Preparation and pre-treatment of surfaces - AS 2676.2: Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings - AS 2700: Colour standards for general purposes - AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules) - AS/NZS 3111: Approval and test specification - Miniature overcurrent circuit-breakers - AS 4044: Battery Chargers for Stationary Batteries - AS 60038: Standard voltages - AS 60146: Semiconductor Converters - AS 60529 (IEC 60529): Degrees of protection provided by enclosures (IP Code) - AS 60896 (IEC 60896): Stationary lead-acid batteries - AS/NZS 60898.1 (IEC 60898): Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Circuit-breakers for AC operation - AS 60947 (IEC 60947): Low-voltage switchgear and controlgear. Please note: Some parts still exist as AS/NZS 3947 - AS62040: Uninterruptible power supplies (UPS)

12.1 Conflicts between specification, standards and/or codes

Review the above standards and make use of them where they are applicable. Identify any conflicts between the above standards and recommend which criteria to use. The Contractor must refer any conflicts in the information to Sydney Water for clarification.

Ownership

Ownership

Role	Title
Group	Water and Environment Services
Owner	Manager of Engineering Modernisation
Author	Technical Director- Electrical

Change history

Version No.	Prepared by	Date	Approved by	Issue date
1	Robert Lau / Andrew Manganas / Paul Zhou	05/12/2014	Norbert Shaeper	05/12/2014
2	Robert Lau / Andrew Manganas / Paul Zhou	21/09/2016	Norbert Shaeper	21/09/2016
3	Robert Lau / Paul Zhou	14/09/2018	Ken Wiggins	14/09/2018
5	Paul Zhou	20/02/2020	Steve Keevil-Jones	20/02/2020
5	Paul Zhou/ Hedi Aghdam	28/02/2025	Norbert Schaeper	07/03/2025