WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-60-03

GAS RECOMBINATION TYPE RECHARGEABLE BATTERY EQUIPMENT

1. GENERAL

1.1 Scope

This standard specification stipulates the requirements for the design, construction and testing of 24V D.C. and 110V D.C. nickel-cadmium gas recombination type rechargeable battery equipment. Each set of battery equipment shall comprise a set of battery cells, a float/boost charger and ancillary monitoring and protection equipment.

1.2 Standards

The battery equipment shall be designed in compliance with the following International Electrotechnical Commission (IEC) Standards:-

IEC 60622 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells

IEC 60623 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells

1.3 Site Operating Conditions

(a) Maximum altitude above sea level – 1000 m

(b) Maximum ambient temperature:-
Average over 24 hours – 35°C
Peak over any 4 hours – 40°C

(c) Minimum ambient temperature – 0°C

(d) Average yearly temperature – 30°C

(e) Maximum relative humidity – 98 %

1.4 Technical Requirements

1.4.1 24V D.C. Battery Equipment

(a) Nominal voltage – 24V D.C.

(b) No. of cells – 20

(c) Rated capacity at 20°C – when fully charged, and with the charging circuit switched off, the battery shall have sufficient capacity to supply the continuous load current for 5 hours with cell voltage not less than 22.8V D.C.

(d) Continuous load current – as specified in the Particular Specification.

(e) Minimum battery life at 20°C – 20 years continuous float charging with 400 charge/discharge cycles. The battery shall be capable of meeting the rated capacity requirements up to the end of service life.

(f) Minimum gas recombination efficiency on charging at 20°C:-

Vented type container – 85% during boost charge and
97% during float charge

Sealed type container – 95% during boost charge and
97% during float charge

1.4.2 110V D.C. Battery Equipment

(a) Nominal voltage – 110V D.C.

(b) No. of cells – 92

(c) Rated capacity at 20°C – when fully charged, and with the charging circuit switched off, the battery shall have sufficient capacity to supply the continuous load current and switching load current at the same time for 5 hours with cell voltage not less than 96.6V D.C. For switching loads, the switching sequence shall consist of 2 current pulses of 1-second duration, separated by one 30-second interval. The interval between two successive switching sequences shall be 30 minutes.

(d) Continuous load current and switching load current – as specified in the Particular Specification.

(e) Minimum battery life at 20°C – same as Clause 1.4.1(e) above.

(f) Minimum gas recombination efficiency on charging at 20°C – same as Clause 1.4.1(f) above.

2. BATTERY

2.1 General

Battery cells shall be of recombination type with the oxygen and hydrogen gases generated during the charging cycle recombined to water and recycled to the cell to minimise loss of water. The cell shall be of nickel-cadmium type and rectangular construction.

2.2 Cell Container

Cell containers shall be moulded from clear translucent or transparent plastic having a high resistance to corrosion by electrolyte. The plastic shall be fire retardant and heat and high impact resistant. The cell containers shall be of robust construction and shall not be formed by welding or adhesion.

Cell containers shall be provided with a self-releasing venting mechanism or pressure relieving valve to prevent build-up of excessive pressure under charging or fault conditions. The mechanism shall be of flame arresting type to prevent propagation of flame to the cell interior due to the presence of an external spark. Under normal operation, the cells shall maintain a slightly positive internal pressure to prevent ingress of dust or harmful gases.

The polarity of each terminal shall be clearly marked. For vented type cells fitted with recombination units, the electrolyte level shall be easily visible through the container. The maximum and minimum electrolyte levels, if applicable, shall also be marked.

2.3 Cell assembly

All required cells shall be supplied. Cells shall be connected by annealed insulated copper bars. Inter-row and inter-rack connections shall be by copper cables of adequate current rating.

To prevent accidental short-circuiting across the battery terminals or with interconnection bars, an insulating shroud shall be provided for each row of battery cells. In addition, the cells shall not explode or rupture under an external short circuit condition at fully charged state.

2.4 Earthing Arrangement

The 110V D.C. battery system shall have both terminals floating with respect to earth. The 24V D.C. battery system shall have the negative pole connected to earth potential unless a floating condition is specified in the Particular Specification.

2.5 Battery Protective Equipment

For vented type battery, two detectors shall be provided on the pilot cells of each battery set to monitor the electrolyte level. One detector shall initiate an alarm at low level and one shall trip the charger at extra low level.

A detector shall be provided for each battery set to monitor its temperature. The detector shall initiate an alarm at battery high temperature.

3. BATTERY CHARGER

3.1 General

The battery charger shall be of solid state type and shall comprise a power supply transformer, rectifiers, float and boost charger control equipment, alarm detection equipment, output load voltage control equipment and accessories.

Ventilation fans may be used for chargers rated above 6 kVA. Chargers rated below 6 kVA shall be designed for natural ventilation with an ambient temperature of up to 40°C. Components shall be rated for continuous operation at not less than 55°C.

3.2 Power Supply

Mains supply to battery charger below 1000 VA input shall be 1-phase 220V 50Hz and chargers over 6000 VA input shall be 3-phase 380V 50 Hz nominal. For battery charger between 1000 VA and 6000 VA, the mains supply can be either 1-phase or 3-phase. Where 3-phase input power supply is used, the ‘mains on’ lamp shall only be lit when all 3-phase voltages are normal and available.

Suitable smoothing devices and radio interference suppression devices shall be incorporated to limit the total harmonic voltage distortion at the power source to 2%.

3.3 Rating

The battery charger shall have both boost and float charge modes. In either mode the charger shall supply the rated load in addition to the battery charging duty.

The charger shall have constant voltage output, with current limiting feature to prevent excessive charging and to optimize the service life of the battery.

The float charger voltage and current settings shall be factory set such that the battery can be charged from 10% to 75% of its rated capacity in 6 hours.

The boost charger settings shall be factory set such that the battery can be charged from 10% to 90% of its rated capacity in 10 hours.

3.4 Charger Control

The load voltage shall be kept within the range of 100%-112.5% nominal over a load range of 0-100%. Automatic voltage controlling devices (e.g. series dropper diodes) shall be provided to maintain the load voltage within this specified range. Suitable time-delay shall be incorporated to prevent the operation of such controllers during a switching duty cycle or a switching transient situation.

The charger output voltage shall be maintained within ±1% of present voltage irrespective of ±6% mains voltage variation, ±2% frequency variation, or 0-100% load current variation.

The charger output voltages and current limits shall be independently adjustable but preset at the manufacturer's works to suit the battery supplied. The charge voltage range shall be adjustable between 100-140% of nominal battery voltage. The current limit shall be adjustable between 50-100% of rated charger output.

The charger shall not be switched to boost charging mode automatically. The boost charging mode shall be selected by manual means only.

During boost charging, the charger shall return to float charging mode automatically after a preset time or when a preset battery voltage is reached, or manually by the operation of a float charge selector/pushbutton.

If the float charge voltage is temperature dependent so as to achieve the declared service life of battery, an automatic negative temperature compensation device shall be provided for float charge control. The device shall be effective over the temperature range from 0°C to 50°C and at least three temperature sensors shall be placed on the cell stack to detect the average temperature of the cells for the regulation of float charge voltage.

3.5 Charger Protective Equipment

3.5.1 General

Unless otherwise specified, the load shall not be disconnected from the battery in the event of a failure of the mains supply, the battery or the charger.

Current limiting circuitry shall be incorporated into both the boost charger and the float charger to prevent damage to the chargers or the battery, in case of a short-circuit, overload or accidental polarity reversal.

An earth leakage detector shall be provided for the 110V D.C. battery to detect the current leakage from either the positive or the negative terminal. An alarm shall be initiated after a time delay of 0.5-3 seconds.

HBC fuses shall be provided at the mains input and at the charger output. Each fuse holder shall be provided with a label indicating the fuse rated current and application.

The charger shall be automatically tripped when the battery electrolyte level is extra low. It shall also be tripped from a normally closed contact upon detection of failure of battery room ventilation by a sensor supplied by others.

3.5.2 Alarm Detectors

Devices for detecting the following alarm conditions and initiating visual display shall be provided.

(a) Mains failed (in case of a 3-phase charger, failure of one phase shall initiate alarm)

(b) Fan failed (where installed)

(c) Charger temperature high

(d) Charger output overvoltage (adjustable from 100% to 140% battery nominal voltage)

(e) Charger output undervoltage (adjustable from 80% to 95% battery nominal voltage)

(f) Load supply overvoltage (adjustable from 110% to 130% battery nominal voltage)

(g) Load supply undervoltage (adjustable from 80% to 95% battery nominal voltage)

(h) Charger phase imbalance (for 3-phase charger only)

(i) Earth leakage (where installed)

3.5.3 Remote Alarms

Terminals & volt-free changeover contacts shall be provided for transmitting a common ‘battery fault’ alarm signal for remote monitoring. Auxiliary relays may be provided for this purpose.

3.6 Monitoring and Control Equipment

The following equipment shall be flush mounted on the front of the cubicle/panel for control and monitoring of the battery system:-

(a) Mains ON/OFF switch (key lockable)

(b) BOOST/FLOAT charge manual selector or pushbutton (key operated)

(c) Ammeter, charger output; scale 0-120% charging current limit.

(d) Ammeter, battery load; scale 0-150% rated continuous load.

(e) Voltmeter, charger output; scale 70-120% nominal charger voltage

(f) Voltmeter, load output; scale 70-120% nominal battery voltage

(g) LED type indicating lamps:-

(i) Mains failed (red)
(ii) Earth leakage (where installed) (red)
(iii) Electrolyte level low (where installed) (red)
(iv) Charger failed (red)
(v) Fan failed (where installed) (red)
(vi) Charger temperature high (red)
(vii) Battery temperature high (red)
(viii) Charger voltage high (red)
(ix) Charger voltage low (red)
(x) Load voltage high (red)
(xi) Load voltage low (red)
(xii) Battery room ventilation failed (red)
(xiii) Mains on (green)
(xiv) Float charging on (blue)
(xv) Boost charging on (amber)

(h) Lamp test push button

Digital type ammeters and voltmeters with an accuracy class of 1.5 and 1.0 to IEC 60051 respectively shall be provided.

3.7 Output Circuits

For a 110V D.C. battery charger, 5 output circuits (2 protected by 100A HBC fuses and wired to M10 load terminals and 3 protected by 16A HBC fuses and wired to M8 terminals) shall be provided. For a 24V D.C. battery charger, 3 output circuits protected by 16A HBC fuses and wired to M8 terminals shall be provided. All load terminals shall be of hard drawn copper, stud type, and shall be shielded with PCP shrouds.

4. BATTERY AND CHARGER PANELS

4.1 Panel Construction and Equipment Layout

Each set of battery cells shall be accommodated in one or two panels with front access doors. For panels exceeding 750mm in width, double-leaf doors shall be provided. Stepped cell racks shall be provided within the panel. The charger shall be accommodated in a segregated cubicle in the battery panel with separate access doors or in a panel separate from that of the associated battery to prevent ignition of local concentrations of hydrogen and oxygen by adjacent operational arcing parts. When

the battery and the charger are accommodated in separate panels, the panel heights shall be equal. The panels or cubicles shall be designed for front access with full length swing doors. A detachable cable gland plate and suitable terminals for cable connection between charger and battery shall be provided.

Panels shall be of free-standing type fabricated from sheet metal steel of 2 mm min. thickness, suitably braced to form rigid structures. Degree of protection of panels shall be IP 32 to IEC 60529. Cubicle covers shall have return flanges fitted with gaskets.

The design of the battery panel shall allow adequate ventilation during charging and discharging. The battery panel ventilation air flow shall not pass over any electronic equipment or into the charger compartment. Sufficient space shall be allowed in the battery compartment to permit maintenance work without interruption to the battery supply. Cells in the battery panel shall have headroom not less than 200 mm.

4.2 Surface Treatment and Paint Finish

The surface treatment and paint finish of panels shall be suitable for use under the possible corrosive environment associated with battery equipment. The fabricated structure shall receive appropriate surface treatment prior to painting with polyurethane or other approved alkali-resistant paint. A minimum of 2 undercoats and 2 top coats shall be applied over a compatible primer and the overall dry film thickness shall be between 0.05 and 0.09 mm. The exterior colour of the panels shall be grey to BS4800, Shade 18B21 or equivalent and the interior colour of the panels shall be white.

4.3 Rating Plate

A stainless steel rating plate with alkali-resistant lettering shall be provided for each battery panel and charger panel. The battery rating plate shall indicate the power input ratings, the rated battery voltage, nominal ampere-hours at 5-hour discharge rate, model and number of cells, cell terminal voltage at end of discharge, electrolyte type, level and relative density at 20^{o}C.

4.4 Anti-condensation Heater

For each panel and cubicle where condensation is likely to be present, an anti-condensation panel heater complete with a humidity sensor and 16A double-pole isolating switch shall be fitted to each separate enclosure.

5. ANCILLARY EQUIPMENT

The following equipment and accessories shall be supplied. A metal box shall be provided for the instruments and tools for each set of battery.

(a) Centre zero voltmeter -2.5V to +2.5V for cell voltage measurement.

(b) Set of tools including insulated box spanners, and cell take off lugs.

(c) Mineral jelly for regreasing cell terminals (4 cans of 0.4 kg tins)

If vented type cells fitted with recombination units are offered, the following accessories shall also be supplied:

(d) Siphon hydrometer with scale graduated in 0.005 units

(e) 0-50°C mercury bulb thermometer with 0.5°C graduations

(f) Electrolyte filling funnel

6. INSPECTION AND TESTING

6.1 General

An Independent Inspection Body (IIB) shall be nominated by the Contractor and approved by the Employer/Engineer to carry out an inspection of the battery and charger equipment and to witness tests at the manufacturer's works. The Contractor shall inform the IIB at least seven days before the intended date for the tests and provide him with a complete set of drawings approved by the Purchaser.

6.2 Acceptance Test Requirements

6.2.1 Physical Inspection

The following features of the battery and charger equipment shall be checked by the IIB, for compliance with the Specification and the approved drawings:

(a) Dimensions

(b) Construction, finish and quality

(c) Rating markings

(d) Components integrity

6.2.2 Performance

The battery charger shall be tested at the Manufacturer's Works, under simulated battery and load conditions.

The following tests shall be conducted by the manufacturer to be witnessed by the IIB:

(a) Demonstration of the adjustable range of output voltage under float charge and boost charge.

(b) Demonstration of the adjustable range of current limit under float charge and boost charge.

(c) Verification of the limits of output voltage across load as per Clause 3.4.

(d) Operation checks on protective devices specified in Clauses 2.5 and 3.5.

(e) Operation checks on alarms and indicators as per Clause 3.5 and 3.6.

(f) Demonstration of float charge and boost charge settings and automatic return to float charge mode from boost charge mode in accordance with Clause 3.4.

6.3 Site Commissioning Tests

A site commissioning discharge test shall be conducted by the Contractor to verify the rated capacity of the supplied battery.

The Contractor shall replace any cells or components that are found not to comply fully with the specification during this test. The continuous output current used for this commissioning test shall be the rated value at the 5-hour discharge rate.

The voltage of battery cell at the end of the test shall be no less than that stated in Clause 1.4.

7. TECHNICAL DATA TO BE SUMITTED

The following information shall be submitted for assessment upon request by the Employer/Engineer:-

(a) Battery discharge characteristic curves.

(b) Characteristic curves showing Amp-hour output and cell life versus ambient temperatures between 0°C - 50°C.

(c) Characteristic curves showing charging time vs. charging voltage at 20°C.

(d) Performance and technical data of the battery charger.

(e) General arrangement drawing of charger and battery panel.

(f) Type test certificate of battery cells to IEC 60622/60623.

- End of this Specification -