

**FEWA-PL-SS-E-0060 REV.0**

**TECHNICAL SPECIFICATION  
BATTERIES, CHARGERS, DC CONTROL AND  
DISTRIBUTION EQUIPEMENT**

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## 1. GENERAL

The battery charger(s) and D.C. distribution board shall generally be provided in separate self contained units housed in separate cubicles, bolted together to form a common board. The battery shall be suitable for indoor installation in a separate battery room.

The batteries, chargers and D.C. switchboards shall conform to the requirements of this Section and where applicable, the other Sections of this Specification with regard to equipment rating, fuses, small wiring, instruments, earthing, switchboards, isolators, cubicles, etc.

Following DC Systems are covered in this section :

1. Design, supply, installation, testing and commissioning of double 110V DC system for station control & protection for 132/11 kV Main Stations

Each system shall consist of:

- battery charger(s)
- battery bank(s)
- d.c. main switchboards for distributing power to the various loads.

For the battery design of the 110V DC system, special reference is made to the tripping features of busbar protection, i.e., all circuit breaker trip coils in one zone shall be initiated at once. Each battery charger, and battery shall at least be capable of delivering the entire rated load for 5 hours and at the end of the 5 hours the following emergency loads such as:

Two operations of tripping of all feeders and subsequent restoration (auto re-closing and/or busbar change for all feeder isolators whichever is the maximum load), plus.

- Spring charging motors (if any) used for breaker closing.
- Emergency lighting load.

In any event, the d.c. load voltage shall not drop below 90 % of its nominal value, after the battery has taken the full continuous load for 10 hours and at the end of 10 hours, the above emergency load. The battery under boost charge and the corresponding charger shall be disconnected from the distribution board by use of selector switches and power contactors. The chargers shall be interlocked so that only one battery may be boost charged at any time in case of double battery system.

Metering circuits shall be wired for remote & SCADA indication.

The batteries shall be protected against over-discharging.

Earth fault detectors for each D.C. busbar shall be provided.

## **2. OPERATING TOLERANCES**

The battery/charger/distribution equipment shall be designed such that the voltage at the distribution board terminal is always within +10% to -15% of nominal voltage using voltage-dropping diodes in multiple stages.

The ripple content of the d.c. voltage shall not exceed 3.0% peak to peak with the battery disconnected and 1% with battery connected.

## **3. BATTERY**

### **3.1 Batteries**

Two sets of 100% duty batteries each with 775 AH capacity (minimum) normally operating in parallel as specified in bill of quantity shall be supplied, each rated to give 100 % of the entire D.C. load on a five hour discharge rate basis and under the site environmental conditions, which includes 30 % spare outlet capacity in order to cater for ageing of the battery. The indicated rating of 775 AH is the minimum requirement. During engineering stage detailed calculation shall be submitted to substantiate the rating. The calculation shall be done in accordance with IEEE - 1115 standard for each substation separately under this contract. As per the calculation if higher battery rating is envisaged then the same shall be supplied without any cost implication to FEWA.

Batteries shall be of the Nickel-Cadmium type and suitable for low rate discharge applications. Batteries shall comply with the requirements of IEC 60623.

The cell containers shall be of robust, impact resistant construction in translucent material permitting visual inspection of electrolyte and shall be having built-in vent caps. They shall be mounted on appropriate wood or steel stands while ensuring that:

- a minimum floor area is taken up and a ground clearance of 300 mm from the floor is provided
- each cell is readily accessible and can be removed from its position without having to remove or shift adjacent cells
- The cell containers shall be marked with maximum and minimum electrolyte levels.
- the lead or nickel plated intercell connectors as well as the cell terminals are suitably insulated by PVC shrouds, sleeving or cover plates
- The batteries shall be shipped uncharged, with the liquid electrolyte shipped in separate non returnable containers. 10% extra electrolyte shall be supplied to account for spillage during transit and erection.
- The minimum voltage at the end of the 5 hours discharge cycle shall be not less than 1.1 volts per cell. The number of cells per battery shall be decided by the Tenderer.
- Float charging (normal) voltage is 1.4 volts per cell and boost charging (after complete discharge) voltage is 1.65 volts per cell.

Further, the battery bank terminal cables shall be routed via a double pole wall mounted fuse-switch, and the fuse shall be selected so as to discriminate for a fault on the d.c. bus.

Battery cells shall be clearly identified by permanent numbering. The following information shall be provided on a permanent identification plate with each battery :

- (i) Manufacturer's reference No. & Code
- (ii) Year and month of manufacture
- (iii) Voltage and nominal capacity at 5 hr. discharge rate.

### **3.2 Battery Fuses**

The rating of the battery fuses shall be at least twice the rating of the largest d.c. miniature circuit breaker used in the distribution circuits and shall be so sized that they do not fail through fatigue brought on by normal charge/discharge conditions.

The battery shall be protected by fuses inserted in the connections between the charger(s) and load.

### **3.3 Battery Earthing**

110 volt station batteries shall operate unearthed. Means shall be provided to detect low insulation resistance of all the wiring connected to the battery by the following method and to give an earth fault alarm. Separate alarm indications shall be given for both positive and negative poles.

The earth fault detection circuit shall consist in principle of a resistance connected across the battery output on the distribution side of the fuses with a relay connected between the centre point of this resistance and the earth terminal. Any unbalanced leakage current due to the low insulation resistance of the wiring connected to either pole of the battery shall cause a current to flow in the relay, which will operate at a predetermined value.

The earth fault relay shall be equipped with a minimum of three normally open contacts for local indication and remote alarm circuits.

### **3.4 Battery Accessories**

Each battery shall be provided with the following appropriate accessories:-

- One - cell testing voltmeter equipment including voltmeter and thermometer.
- Two - syringe hydrometers, of suitable scale.
- One - plastic filler bottle of distilled water.
- One - cell bridging connector.
- One - instruction card and record chart.

Electrolyte of normal gravity equal in volume to 10% of the electrolyte of battery bank shall be delivered with each battery bank in unbreakable red containers with screwed stoppers and appropriately labelled.

## **4. BATTERY CHARGERS**

Separate identical 100% duty charger (each rated 250 A) having boost & float facilities shall be offered for each battery. The chargers shall be interlocked so that only one battery may

be boost charged any time. Each charger unit shall be suitable for supplying the initial charging requirements, boost charging the battery subsequent to an emergency discharge and supplying the maximum load whilst on float.

The chargers shall each be housed in a separate cubicle, which shall at least be of Protection Class IP 41. The equipment shall satisfy the requirements of corrosion protection as specified. For wiring, contactors, terminals, etc. reference shall be made to the respective sections of the Specification. The chargers shall be provided with natural ventilation. Forced ventilation is not acceptable.

Cubicle sizes and overall views shall be co-ordinated with. d.c. distribution panels as they shall be erected in the same room.

Chargers of high efficiency, short control response time, low output ripple without battery being connected and rated for continuous output short circuit operation, shall be of solid state full wave fully controlled using silicon rectifiers and complete with all switches, fuses, contacts and instruments. The output voltage shall be regulated from 0 to 100% load even with  $\pm 10\%$  variations in input a.c. supply voltage and  $\pm 5\%$  frequency variations.

The battery chargers shall be of the constant voltage float type each with boost charge facilities. Each charger shall be capable of maintaining the battery fully charged and delivering the DC load output when operating alone but will normally work in parallel in case of double battery bank system. For single battery system, the charger shall be capable of maintaining the battery fully charged and delivering the DC load output

The charger shall

- be designed for ambient temperature 50°C.
- have the possibility to adjust and set the charger output voltage and current limit values separately for each operating mode of the charger. The adjustable range shall be the limits of maximum and minimum outputs.
- automatically switch into the boost charging mode when the battery has discharged above a preset value. A battery charge/discharge ampere-hour sensing device shall be provided to control the boost mode on/off switching as well as the boost charging time.
- be capable of recharging within twelve hours the battery bank to a condition enabling the battery for another cycle of emergency discharge. Simultaneously, the charger shall be capable of feeding the rated load of the entire d.c. busbars.
- have alarms grouped and connected to the alarm fascia locally and to the remote control panel & SCADA, as required by FEWA during design.
- indication of the signal "Charger faulty" shall be suppressed in case of a failure of the a.c. supply to the charger.
- have operating characteristic in accordance with DIN 41772/DIN 41773 or equivalent. The charging characteristic shall be to the approval by FEWA. However, the battery manufacturers recommendations for float/trickle, equalising and boost charging shall be taken into consideration.

- have output voltage failure detection insensitive to switching surges or transient loss of voltage due to faults on the power system, or during auto-changeover of the input a.c. supply.
- have load sharing and current limiting circuits built-in each module.
- have a soft start feature.
- have a.c. input isolation by the use of a two winding transformer.
- each be housed in a separate cubicle having a protection of at least IP41.
- have RFI- Interference protection at least equal to mode "N" according to DIN VDE 0875.

Maintenance and operation instruction manuals and spare parts reference list shall be supplied.

## **5. D.C. CONTROL AND DISTRIBUTION BOARD**

The DC Control and distribution board shall be equipped with MCBs.

The equipment shall be capable of carrying, making and breaking the maximum possible fault current and details of the make-up of this shall be provided. Curves of battery current plotted against time under short circuit conditions shall be supplied.

Outgoing distribution cables shall be connected directly to the relevant MCB.

Cabling and wiring terminations shall be shrouded to avoid accidental short circuit or earthing of the battery. PVC insulation shall be used for fuse wiring connections.

Suitable means shall be provided such that when the charger is operating in float charge mode and when switching to boost charge mode the voltage at the outgoing distribution terminals shall be automatically limited to within the tolerances as specified elsewhere in this Section. This shall be achieved by the insertion of voltage dropping diodes into the input circuit and the diodes shall have a rating of at least twice the board's standing load. A minimum of three diode strings (stages) shall be provided which shall be inserted into the input circuit of DCDB in stages to provide the range of voltage control in DCDB within limits as specified elsewhere in this section. It is preferred that during float mode the diode assembly shall not be included in the circuitry.

Suitable alarm relays shall be provided to monitor at the distribution board both high and low battery voltages to pre-set values. The relays shall be fitted with variable time delays adjustable between 0-30 seconds. The relays shall indicate the fault condition locally and shall have two sets of voltage free contacts for indication to SCADA and the RCP.

### **5.1 D.C. Distribution**

The panels shall house all distribution necessary for the station D.C. circuits; they shall at least be of protection class IP41 with self cooling, with separate panels per battery system. Bottom plate of the D.C.D.B. shall be of detachable type for entry of out going feeder cables.

Twenty percent spare feeders, fully equipped, shall be provided.

The arrangement shall be as per drawing No. FEWA-PL-SS-E-0021 Rev. 0.

The D.C. panels shall have an alarm table aux (sub-panel) for alarm indications such as:

- lamp test
- supply infeeds off
- D.C. feeder trip (one for all feeders per panel)

In addition, provision for having one general D.C. alarm connected to the alarm panel in the station control room shall be provided.

D.C. ammeters and voltmeters shall be provided.

## **6. INSTRUMENTS, INDICATIONS AND ALARMS**

### **6.1 General**

All the instruments and indicators shall be visible from the front of the cubicle with the door closed and their functions clearly labelled with screw-on labels. Mimic diagram shall be provided in each charger DCDB with suitable neon lamp indications.

### **6.2 Battery Charger**

Each battery charger shall be provided with the following instruments :

- (a) Charger Output Voltage Voltmeter (0-120% max. boost output)
- (b) Charger Output Current Ammeter (0-150% max. rated output)

Indications of the following status and alarm conditions shall be provided on each charger. These indications and alarms shall relate solely to their associated charger, i.e. they shall not be influenced by any condition associated with the alternate charger.

- (a) Rectifier Healthy
- (b) Mains Healthy
- (c) Boost Charge Activated
- (d) Float Charge Activated
- (e) Charger Output Failure
- (f) Charger Output Over voltage

A BATTERY CHARGER (1/2) FAIL summary alarm, comprised of the mains failure, charger output failure and rectifier failure conditions, shall be provided in the form of at least three sets of voltage free contacts for each charger for use with the supervisory alarm scheme, to provide remote indication of these alarm conditions on the substation common control panel and to operate a local indicator, labelled BATTERY CHARGER 1 (2) FAULTY, to be mounted near the above instruments, one for each respective charger. This alarm shall not be initiated when any one charger is taken out of service.

### **6.3 DC Distribution Board/Battery**

The D.C. distribution board shall be provided with the following instruments which shall be mounted near those provided for the chargers.

- (a) Output Voltage Voltmeter (0-120% max. rated output).
- (b) Battery Charge/Discharge Current Ammeter (0-200% normal standing load)
- (c) Distribution Board Load Ammeter (0-150% normal standing load)

The D.C. system shall be fitted with monitoring devices to check the continuity of the battery circuit. In particular an alarm shall be provided if a battery fuse fails or if the battery circuit impedance rises above a predetermined level due to poor intercell connection or any other reason.

Monitoring devices shall be provided to detect voltage regulator failure, high d.c. voltage and low D.C. voltage conditions. These devices shall incorporate variable time delays adjustable between 0 to 30 seconds.

A common alarm shall be generated by the above monitoring devices for which at least three sets of voltage free contacts shall be provided for use with the supervisory alarm scheme, to provide remote indication of this alarm condition on the common control panel and to operate a local indicator, labelled BATTERY FAULTY, which shall be mounted near the charger indicators.

### **6.4 Inverter Panel**

One inverter panel of free standing type with 2x50% capacity shall be supply to invert 110V DC volts to 230 V AC to feed all emergency light fittings. The inverter DC supply shall be taken from main DCDB. Contactor of suitable rating shall be provided which shall operate automatically in the event of failure of normal AC supply to feed all emergency light fitting with AC supply.

The rating of each inverter shall be 4 KVA but not limited to cater 50 % of the emergency lighting loads and shall also cater 10% spare capacity of the normal emergency lighting loads.

The inverters shall each be housed in a separate cubicle, which shall at least be of Protection Class IP 41. The equipment shall satisfy the requirements of corrosion protection as specified. For wiring, contactors, terminals, etc. reference shall be made to the respective sections of the Specification. The chargers shall be provided with natural ventilation. Forced ventilation is not acceptable.

Cubicle sizes and overall views shall be co-ordinated with. d.c. distribution panels as they shall be erected in the same room.

### **6.5 Annunciators**

Alarms and indicators may be provided in the form of an annunciation panel. These shall include facilities for selecting manual/automatic acceptance of alarms and the overall scheme shall include facilities for relays to operate in contact follower mode such that in the event of the initiating relay resetting, the repeat relays in remote equipment shall also reset automatically.

**6.6 Alarms and Indications**

Each charger shall have facilities to provide or display the following alarms and indications with proper mimic diagrams.

<u>Local on Charger Panel</u>	<u>Remote Control Panel</u>	<u>SCADA Alarms</u>
Mains failure	Charger 1 or 2 faulty	Charger 1 or 2 faulty
Charger Output failure	Charger 1 or 2 faulty	Charger 1 or 2 faulty
<u>Indications</u>		
Main ON		
Rectifier ON		
Float Charge		
Boost Charge		

The battery/distribution system shall have facilities to provide and indicate the following alarm indications.

<u>Local at Battery /Charger Panel</u>	<u>Remote Control</u>	<u>SCADA</u>
Battery fuse failure	Battery faulty	Battery faulty
Battery circuit faulty	Battery faulty	Battery faulty
Low D.C. volts	Battery faulty	Battery faulty
High D.C. volts	Battery faulty	Battery faulty
Earth fault +ve	Battery faulty	Battery faulty
Earth fault -ve	Battery faulty	Battery faulty

The inverter system shall have facilities to provide and indicate the following alarm indications.

Inverter 1	ON
Inverter 2	ON

**7. CUBICLES**

All equipment, in cubicles of free standing type where applicable, shall either be housed in individual sheet steel cubicles or alternatively all of the equipment shall be housed in one single cubicle segregated into compartments by sheet steel separators to a protection class of class IP41.

Individual cubicles shall have a hinged front cover with locking facilities, giving full access to all components and cable connections. Where a cubicle is segregated into compartments individual lockable access doors shall be provided for each compartment. All controls and relays shall be placed inside the cubicles. Where ventilation openings are provided these shall be fitted with drip-proof louvers and fine mesh wire or perforated screens to exclude small insects and vermin. Each cubicle/compartment shall be adequately ventilated for continuous operation in the outdoor ambient shade temperature specified elsewhere in this specification.

A gland plate shall be provided sufficient for all incoming and outgoing cables including spare capacity, and shall be mounted not less than 200 mm from the base of the cubicle. Where all the battery, charger and distribution equipment is housed in a common cubicle particular attention shall be made with regard to the routing of cables from the base of the cubicle to the respective compartments taking account of ease of installation, segregation from the battery compartment etc.

The complete battery, charger and distribution units shall be designed to enable a complete charger to be removed and replaced with ease and without disturbance to the remainder of the equipment and wiring. Facilities shall be provided for testing batteries and chargers without load disconnection.

The minimum thickness of sheet steel used in the construction of cubicles, compartments etc. shall be 2.5 mm throughout.

All meters and indication lamps shall be flush mounted on the front of the cubicle and their function clearly indicated with screw-on labels.

## **8. SHIPPING AND SITE ASSEMBLY**

The batteries shall be shipped as cells filled with electrolyte and assembled at Site, and the initial charge made.

## **9. TESTS AT FACTORY**

### **9.1 Type Tests**

Type test reports for tests performed on battery, charger and DCDB as per relevant IEC where applicable, shall be submitted. If evidence of successfully carrying out the above tests is not available, the above tests shall be carried out on one unit in presence of FEWA without any extra cost.

- Battery - Type test in accordance with IEC.623
- Battery Charger - Type tests according to IEC 60146
- DC Switchboard - Type tests according to IEC 60439.

### **9.2 Routine Tests**

Routine tests shall be carried out in accordance with IEC on all battery banks, chargers, Inverter and DCDB shall include the following tests, but not necessarily be limited to them:

- Battery - In addition the Contractor shall demonstrate that the battery will perform the duties specified in accordance with this specification
- Battery Charger - Routine tests according to IEC 60146
- DC Switchboard - Routine tests according to IEC 60439.

## 10. TEST AT SITE

All tests shall be carried out at site in accordance with IEC on all battery banks, chargers, inverter and DCDB. Any test found necessary by FEWA during commissioning, the same shall be carried out without any contractual implication.

## 11. APPLICABLE STANDARDS

IEC 60623	Vented nickel cadmium rechargeable single cells
BS 5634	Testing potassium hydroxide used in alkaline cells.
BS 381C	Specification for colours for identification coding and special purposes.
BS 4417	Specification for semiconductor rectifier equipments.
IEC 60146	Semiconductor converters.
BS 88	Cartridge fuses for voltages upto and including 1000V AC and 500V DC