



**PUBLIC POWER CORPORATION**  
**T/NPRD/SUBSTATION & EHV SUBSTATION**  
**SPECIFICATIONS AND EQUIPMENT SECTION**

**June 2007**

**TECHNICAL DESCRIPTION TD- 89/2**  
**BATTERY CHARGER FOR 110 V NICKEL-CADMIUM RECHARGEABLE**  
**BATTERIES FOR 150/20 KV SUBSTATIONS, HAVING THE 20KV PRIMARY**  
**EQUIPMENT INSTALLED OUTSIDE THE CONTROL BUILDING**

**I. SCOPE**

This technical description covers PPC's requirements with regard to the rated characteristics, design features and testing of a battery charger, for the 110 V Nickel-Cadmium rechargeable batteries, for indoor use in 150/20 kV substations, having the 20 kV primary equipment installed outside the control building.

**II. KEYWORDS**

Charger, battery charger, Ni-Cd pocket type batteries, thyristor type charger.

**III. STANDARDS**

The battery charger shall be in accordance with IEC-60146-1-1, IEC-60142-2, and IEC 60529 standards.

**IV. USE**

The battery charger will be used to provide the necessary power to the substation's D.C. loads under normal operating conditions, and at the same time to provide power for charging the battery which is connected in parallel with the battery charger.

**V. OPERATING CONDITIONS**

- |                              |                               |
|------------------------------|-------------------------------|
| 1. Installation              | : Indoors                     |
| 2. Ambient temperature range | : Maximum + 40°C              |
|                              | : Minimum - 10°C              |
| 3. Altitude                  | : Up to 1000m above sea level |
| 4. Relative humidity         | : ≤ 90%                       |

**VI. REQUIRED BATTERY CHARGER CONFIGURATION (LAYOUT)**

The battery charger configuration shall be of the single type and shall be as indicated in Fig No.1 below.

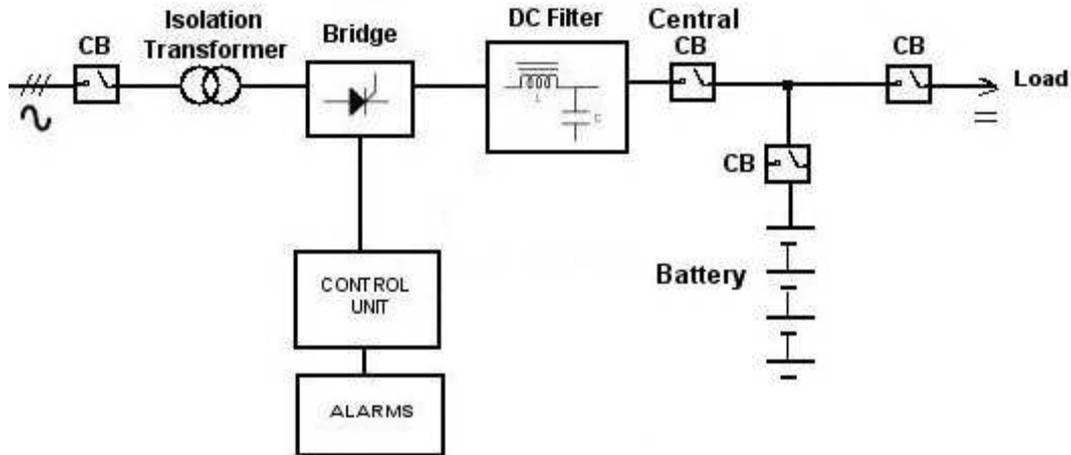


Fig No.1 Battery charger configuration

## VII. BATTERY CHARGER REQUIRED RATED CHARACTERISTICS

- |   |  |
|---|--|
| 1. Type   | : Thyristor type, consisting of silicon controlled rectifiers  |
| 2. Nominal Input Voltage  | : 400 V AC<br>(3-phase, 3-wire, 50 Hz)   |
| 3. Input Voltage tolerance  | : +15%, -20%   |
| 4. Nominal Output Voltage   | : 110 V DC   |
| 5. Output Voltage tolerance for the DC load   | : -15%, +10%   |
| 6. Output voltage tolerance for the battery   | : Whatever tolerance is required by the design of the manufacturer (depends on maximum $V_{pc}$ and minimum $V_{pc}$ of the battery cells) . |
| 7. Charging method  | : Dual, floating and fast with the fast being automatically and manually regulated.  |
| 8. Fast charging time<br>(assuming totally discharged batteries)  | : 6 h  |
| 9. Nominal input frequency  | : 50 Hz  |
| 10. Input frequency tolerance   | : $\pm 5\%$  |
| 11. Nominal Output current  | : 125 A (battery + d.c. load)  |
| 12. Output current variation  | : 0-100% of the nominal value  |
| 13. Ripple (voltage)  | : $\pm 1\%$ rms with battery connected in parallel   |
| 14. Static stability  | : $\pm 1\%$  |
| 15. Audible noise level (at 1m distance)  | : $\leq 65$ dBA  |
| 16. Harmonics   |  |
| The battery charger shall be designed to operate under the following harmonic values (which include the effect of the battery charger itself) |  |
| a. Harmonic distortion (THD) (%)  | : 10%  |
| b. Individual harmonic distortion   |  |
| • odd (%)   | : 5% of fundamental  |
| • even (%)  | : 2% of fundamental  |



17. Battery characteristics
- |                             |                                |
|-----------------------------|--------------------------------|
| a. Type                     | : Ni-Cd rechargeable batteries |
| b. Type of containment      | : Vented                       |
| c. Type of electrodes       | : Pocket                       |
| d. Discharge rate           | : Medium                       |
| e. Nominal Voltage per cell | : 1.2 V                        |
| f. Nominal battery voltage  | : 110 V DC                     |
| g. Voltage tolerance        | : -15%, +10%                   |
| h. Rated capacity           | : 310 Ah (at 20°C ± 5°C)       |

## **VIII. REQUIRED BATTERY CHARGER OPERATING AND DESIGN FEATURES**

1. The battery charger shall be designed for dual charging operation, i.e. for floating and fast (boost), with the fast to be automatically and manually regulated.
2. The bridge shall consist of a 6-pulse controlled thyristor bridge, equipped with silicon controlled rectifiers.
3. The battery charger's output voltage levelling shall be achieved by a DC filter, which shall consist of coils and electrolytic type capacitors.
4. The battery charger shall be designed as to monitor the output current variations and to cut off the supply in case the output current exceeds the nominal value (overload protection).
5. The battery charger shall be equipped with proper filters to limit the voltage and current total harmonic distortion (THD) and individual harmonics to the values mentioned in paragraph VII-16 of this hereby technical description.
6. The isolation of the battery charger shall be achieved by an input isolation transformer.
7. All the metal parts of the battery charger shall be earthed. For this reason an earth terminal (copper bar) shall be provided on the charger's enclosure (cabinet) to which all metal parts shall be connected to. The other end of the terminal shall be connected to the earthing grid of the substation.

## **IX. CHARGING METHOD**

The battery charger should be designed to be capable of performing the following dual charging operations, that is fast (boost) and float charging, specifically:

1. Immediately after restoration of the AC power supply, the charger should detect whether the voltage-per-cell ( $V_{pc}$ ) of the battery cells has dropped below or equals the end-of-discharge voltage level. In the case that  $V_{pc}$  has dropped or equals the end-of-discharge voltage level, the charger will enter the fast rate charging (boost charging) state, which will eventually raise the value of  $V_{pc}$  to a level needed for the requirements of fast charging. This stage provides an accelerated recharging. The duration of the fast rate charge operation should be controlled by a timing relay.



2. After the elapsed time, the timing relay will revert the rectifier output voltage to the float charging operation. In this stage, the charger should equalise the voltage of all the cells of the battery. After this is achieved, the charger should provide a maintenance current, necessary to preserve the battery's charge at 100% of its capacity, compensating for the battery's internal losses.
3. The transition from the one charging stage to other should be performed automatically. However, the charger should also include the capability for manually starting and stopping the fast charging operation via a selector control switch (fast charging automatically/manually) and two (2) push buttons or a control switch for starting and stopping the fast charging operation.

## **X. REQUIRED CHARACTERISTICS OF THE BATTERY CHARGER'S CABINET**

### **A. Cabinet (enclosure)**

1. The specified charging equipment shall be housed in an indoor steel cabinet suitable for floor standing. It will incorporate all necessary controls, indications, interlocks and safety features to prevent any false operations and to ensure proper operation. A passive mimic diagram shall be provided in front of the enclosure, showing in detail the overall system configuration.
2. The cabinet shall be accessible from the front via a door. The cabinet can be installed against the wall, because the air openings (louvers) shall be located either on the sides or on the top of the cabinet.
3. The enclosure should provide a degree of protection of not less than IP20 in accordance with IEC 60529. The floor shall not be considered as forming part of the enclosure.
4. Anti-condensation heaters shall be fitted in the cabinet, controlled by a thermostat.
5. The cabinet shall be designed as to allow bottom cable entry. Cables shall enter and exit through cable glands. The glands shall be part of the supply.
6. The metallic walls of the cabinet shall have a thickness of at least 1,5mm.
7. The cabinet shall be electrostatically painted with RAL 7032 color (grey).
8. Terminal blocks shall be provided for all external connections.  
External connections shall not be made directly to the internal terminals blocks.  
Terminal blocks for the external connections shall be of the rail mounted type and have screw connectors suitable for at least 6mm<sup>2</sup> size conductors.



## **B. Cooling**

Internal cooling of the battery charger shall be by natural air ventilation, or forced air ventilation by the use of air fan.

The cabinet shall not incorporate cooling air filters that require periodic cleaning and/or replacement, however it shall contain proper louvers which will ease the natural air circulation.

## **C. Accessibility and Maintenance**

The location and grouping of components and auxiliary equipment within the cabinet (enclosure) shall permit easy identification and access for operational, maintenance and repair purposes.

All live terminals of door-mounted equipment having a maximum (peak) voltage of greater than 24 V shall be shrouded or otherwise protected by barriers (insulating shields) to a degree of protection of at least IP 20.

All bare bus bars, live terminals and components located within the cabinet shall be similarly protected by barriers or shrouds to a degree of protection of at least IP 20.

## **XI. CONTROL, INDICATING AND MEASUREMENT AND MONITORING EQUIPMENT**

The front side of the battery charger's cabinet shall be equipped with the following devices.

### **1. Control devices**

- a. One (1) control selector switch for selecting automatic or manual fast (boost) charging operation.
- b. Two (2) push buttons or a control switch of two (2) positions for manually starting or stopping the fast (boost) charging operation.

### **2. Indicating and monitoring devices**

- a. Green light emitting diode (LED), "ON" for indicating that the battery charger is operating.
- b. Red LED, "ON" for battery charger fault.
- c. White LED, "ON" when floating charging is in operation.
- d. Blue LED, "ON" when fast (boost) charging is in operation.
- e. Orange LED, "ON" when mains input voltage is out of limits.
- f. Orange LED, "ON" when output voltage towards the load is out of limits
- g. Yellow LED, "ON", when there is a fault in the earthing system.
- h. A passive mimic diagram of the battery charger configuration.

Below or above each LED there shall be a proper label indicating the function of each LED.

The label shall be legible and of such material as to be time durable (40 years at least) without losing legibility.



3. Measurement devices
  - a. One (1) analog AC voltmeter for the input voltage.
  - b. One (1) analog DC voltmeter for the output voltage (load side).
  - c. One (1) analog DC ammeter for the output current (load + battery).
  - d. One (1) analog DC voltage for the output voltage (battery side).
  - e. All the above voltmeters and ammeter shall be accompanied with proper labeling indicating the use for each one of them. The labeling shall be of such material as to be time durable (at least 40 years).

## **XII. REQUIRED PROTECTION FEATURES OF THE BATTERY CHARGER**

1. In the battery charger's cabinet shall be installed four (4) automatic circuit breakers.
  - One (1) automatic circuit breaker in the input before the isolating transformer
  - One (1) central output automatic circuit breaker
  - One (1) automatic circuit breaker in the output towards the load side
  - One (1) automatic circuit breaker in the output towards the battery side
2. The battery charger shall be designed to protect itself against the following:
  - Overloading
  - Short circuits
  - Reverse polarity
  - Out of limits input voltage (over voltage/under voltage protection)
  - Out of limits output voltage (over voltage/under voltage protection)
3. When the battery charger is operating under the fast (boost) charging mode and there is a need to increase the output voltage of the cells ( $V_{pc}$ ), then blocking diodes will be used towards the load side so that the voltage to the load is limited within the specified limits.

## **XIII. RATING PLATE**

The rating plate of the battery charger shall be of non-corrosive material and shall bear the following indications.

1. Manufacturers name
2. Type of battery charger
3. Serial number
4. Number of input phases
5. Rated input voltage
6. Rated input current
7. Rated input frequency
8. Output indication: "d.c."
9. Rated output voltage
10. Rated output current
11. Range of output voltage
12. Cooling method
13. Displacement factor under rated conditions
14. Degree of protection as per IP



## 15. Overall weight

### **XIV. TESTS**

The charger shall be subjected to the following tests as per IEC-60146-1-1.

#### **A. Type Tests**

The following tests will be performed on one (1) battery charger of the order.

1. Insulation tests. Test voltage = 2000V rms
2. Light load and functional test
3. Rated Current test
4. Power Loss Determination for the battery charger
5. Temperature Rise test
6. Checking of auxiliary devices
7. Checking the properties of the control equipment
8. Checking the protective devices
9. Audible noise test

#### **B. Routine Tests**

The following tests will be performed on all battery chargers of the order. The cost of performing these tests shall be born by supplier.

1. Insulation
2. Light load and functional
3. Checking of auxiliary devices
4. Checking the properties of the control equipment
5. Checking the protective devices
6. Power factor measurement
7. Measurement of ripple voltage and current
8. Measurement of input total harmonic distortion and individual harmonics of the battery charger.

### **XV. DATA WHICH MUST BE SUBMITTED BY ALL BIDDERS**

All bidders are requested to submit, in their technical offer, the following information.

1. Charger preliminary outline drawing (front & side and bottom view).
2. One line diagram of the battery charger.
3. Preliminary schematic diagram of charger.
4. Description of operation of the battery charger.
5. Brochures, technical pamphlets and any other information which is deemed necessary for the technical evaluation process.
6. All bidders are required to answer all items of **Attachment A**. Failure to comply or partial filling of the attachment will constitute sufficient reason for rejection of the offer.
7. Any available type test certificates for the type tests of paragraph XIV-A. Acceptance or not lies at the judgment of PPC SA



#### **XVI. ITEMS WHICH MUST BE SUBMITTED BY THE SUCCESSFUL BIDDER**

1. Complete physical drawing of the battery charger unit (front view, top view, side view and bottom view) for approval (3 sets) prior to the construction of the battery charger.
2. Detail schematic and wiring drawings of the battery charger (3 sets) for approval, prior to construction.
3. One line diagram of the battery charger (3 sets) for approval, prior to construction.
4. Maintenance instructions in detail.

#### **XVII. WARRANTY**

The supplier must provide a warranty of three (3) years, beginning from the date of delivery of the charger, for damages by faulty design, or by unreliable components, or by combination of the two.

#### **XVIII. PACKING**

The charger shall be delivered inside a robust wooden frame and covered with extremely strong plastic.



**ATTACHMENT "A"**  
**BATTERY CHARGER FOR 110 V NICKEL-CADMIUM RECHARGEABLE**  
**BATTERIES**

*All bidders must provide the following data. Failure to comply in full shall constitute sufficient reason for rejection of the offer.*

1. Type of charger (short description) :.....  
:.....
2. Manufacturer :.....
3. Nominal input voltage :.....
4. Number of phases of input voltage supply :.....
5. Frequency of input :.....
6. Nominal output voltage for the load :.....
7. Nominal output voltage for the battery :.....
8. Output voltage tolerance for the d.c. load :.....
9. Output voltage tolerance for the battery :.....
10. Input frequency tolerance :.....
11. Nominal output current  
(battery + d.c. load) :.....
12. Output current variation :.....
13. Ripple (voltage) :.....
14. Static stability :.....
15. Noise level :.....
16. Charging method :.....
17. Float charging required time for  
fully charging the battery, assuming  
discharged battery :.....
18. Fast (boost) charging required time  
for fully charging the battery,  
assuming discharged battery :.....



- 19. Total harmonic distortion (THD) : .....
- 20. Individual harmonic distortion
  - a. odd (%) : .....
  - b. even (%) : .....
- 21. Indicate operational ambient temperature range capability : .....
- 22. Is the battery charger capable of floating charging? : .....
- 23. Is the battery charger capable of fast (boost) charging automatically and also manually? : .....
- 24. Is the battery charger of a 6- pulse controlled thyristor bridge? : .....
- 25. Is the thyristor bridge equipped with silicon control rectifiers? : .....
- 26. Is the battery charger equipped with DC filter for output voltage levelling? : .....
- 27. Is the battery charger equipped with overload protection? : .....
- 28. Is the battery charger equipped with filter or filters to limit harmonics to the specified levels? : .....
- 29. Is the battery charger equipped with an isolation transformer? : .....
- 30. Is an earthing terminal provided for earthing all metal parts of the battery charger? : .....
- 31. Output voltage during fast (boost) charging
  - a. Towards the d.c. load : .....
  - b. Towards the battery : .....
- 32. Output voltage during float charging
  - a. Towards the d.c. load : .....



- b. Towards the battery :.....
- 33. Is the front door of the battery charger cabinet equipped with a passive mimic diagram? :.....
- 34. Is accessibility to the battery charger obtained through the front door? :.....
- 35. Is the battery charger cabinet suitable for floor standing? :.....
- 36. Is the battery charger cabinet equipped with air openings (louvers) on the sides or on that top, for air ventilation? :.....
- 37. Indicate the degree of protection as per IP of the battery charger's cabinet :.....
- 38. Is the cabinet equipped with anti-condensation heaters controlled by a thermostat? :.....
- 39. Indicate the cooling method of the battery charger :.....  
:.....  
:.....
- 40. Is the cabinet equipped with air filters? :.....
- 41. Thickness of the walls of the steel cabinet :.....
- 42. Type of steel used in the cabinet of the battery charger :.....
- 43. Is the cabinet designed for bottom cable entry or exit? :.....
- 44. Is the cabinet equipped with cable glands for the cable entry or exit? :.....  
:.....
- 45. Method of painting of the cabinet and type of color :.....  
:.....



46. With regard to the terminal blocks,  
does the battery charger conform  
to the requirements of paragraph X-8? :.....
47. Is the front side of the battery  
charger cabinet equipped with:
- a. One (1) control selector switch  
for selecting automatic or manual  
fast (boost) charging? :.....
  - b. Two (2) push-buttons or one (1)  
control switch of two (2) positions  
for starting and stopping the manual  
fast (boost) charging operation? :.....
48. Indicating devices
- a. Is the front door of the cabinet  
equipped with a green LED for indicating  
battery charger operation? :.....
  - b. Is the front door of the cabinet  
equipped with a red LED for indicating  
battery charger fault? :.....
  - c. Is the front door of the battery charger's  
cabinet equipped with a white LED  
for indicating floating charging? :.....
  - d. Is the front door of the battery charger  
cabinet equipped with a blue LED for  
indicating fast (boost) charging? :.....
  - e. Is the front door of the battery charger  
cabinet equipped with an orange LED for  
indicating that mains input voltage is  
out of limits? :.....
  - f. Is the front door of the battery  
charger cabinet equipped with an  
orange LED for indicating that  
load voltage is out of limits? :.....
  - g. Is the front door of the battery  
charger cabinet equipped with a  
yellow LED indicating fault  
on the earthing system? :.....
  - h. Are all the above seven (7) LED  
accompanied with proper labels? :.....



- i. Are the labels legible and of durable material? (40 years, al least) :.....
- j. Is the front door equipped with a passive mimic diagram of the charger? :.....

49. Measurement devices

- a. Type of the input voltmeter :.....
  - 1. Range of the input voltmeter :.....
  - 2. Manufacturer of the input voltmeter :.....
  - 3. Accuracy of the input voltmeter :.....
- b. Type of output voltmeter for the load :.....
  - 1. Range of the output voltmeter :.....
  - 2. Manufacturer of the output voltmeter :.....
  - 3. Accuracy of the output voltmeter :.....
- c. Type of the output ammeter (load + battery) :.....
  - 1. Range of the output ammeter :.....
  - 2. Manufacturer of the output ammeter :.....
  - 3. Accuracy of the output ammeter :.....
- d. Type of the output voltmeter for the battery:.....
  - 1. Rang of the output voltmeter :.....
  - 2. Manufacturer of the output voltmeter :.....
  - 3. Accuracy of the output voltmeter :.....

50. Is the battery charger equipped with three (3) automatic circuit breakers as indicated in paragraph XII-1?

- 1. Automatic circuit breaker in the input of the battery charger before the isolating transformer :.....
  - a. Rated Current :.....
  - b. Breaking Current :.....



- c. Current at which the automatic circuit breaker is set to operate in case of fault :.....
- d. Type and manufacturer :.....
  
- 2. Central output automatic circuit breaker
  - a. Rated Current :.....
  - b. Breaking Current :.....
  - c. Current at which the automatic circuit breaker is set to operate in case of fault :.....
  - d. Type and manufacturer :.....
  
- 3. Automatic circuit breaker in the output towards the load side
  - a. Rated Current :.....
  - b. Breaking Current :.....
  - c. Current at which the automatic circuit breaker is set to operate in case of fault :.....
  - d. Type and manufacturer :.....
  
- 4. Automatic circuit breaker in the output towards the battery side
  - a. Rated Current :.....
  - b. Breaking Current :.....
  - c. Current at which the automatic circuit breaker is set to operate in case of fault :.....
  - d. Type and manufacturer :.....
  
- 53. Is the battery charger protected against:
  - a. Overloading? :.....
  - b. Short circuit? :.....
  - c. Reverse polarity? :.....
  - d. Out of limits input voltage? (overvoltage / undervoltage) :.....



e. Out of limits output voltage?  
(overvoltage / undervoltage)

.....

53. Type description and manufacturer  
of blocking diodes used to limit the  
output voltage towards the d.c. load during  
the fast (boost) charging

.....

.....

.....

54. Type, and manufacturer of the  
silicon control rectifiers

.....

55. Type, manufacturer and cross section  
of the cables used for connecting the  
battery charger to the battery and d.c. load

.....

56. Weight of the battery charger

.....