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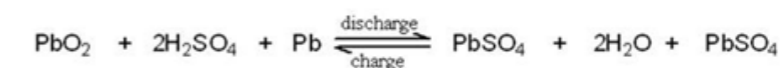
Valve-regulated lead-acid Battery **Service Manual**

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Working Principle

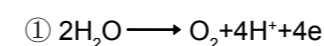
The electrochemical reaction of batteries in charge and discharge process as follows:



In the final stage of charge process, active substance in positive plate transformed to lead dioxide, negative plate has not reached fully charged stage, the process of active substance in negative plate transformed to spongy lead has not finished, oxygen gas generated in positive plate reaches the negative plate through separator pores and reacts with active substance in negative plate, resulting in a depolarized state in the negative plate, and restraining the generation of hydrogen.

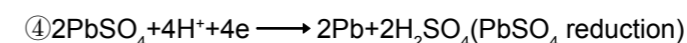
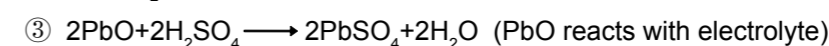
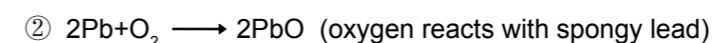
The working principle of electrochemical reaction to realize sealing as follows:

(1) The reaction in positive plate (oxygen generated)



Move to the surface of negative plate through the separator

(2) The reaction in negative plate (oxygen absorbed)

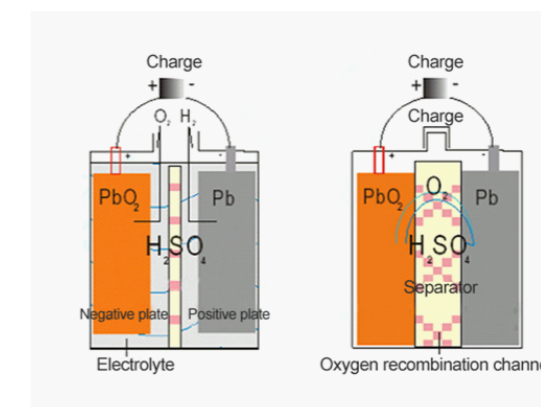


(3) The whole reaction in the negative plate is: $\textcircled{2} + \textcircled{3} + \textcircled{4}$: $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- = 2\text{H}_2\text{O}$

The final production returns to $\textcircled{1}$, and recycles like this.

In general, in the charging process, oxygen gas generated in the positive plate could quickly reach the negative plate and recombine into water through reaction with active substance in the negative plate, no gas escape and water loss, achieving the sealing.

Gas recombination illustration



Battery Transportation

- ⊗ While stocked in factory, battery is in charge state. Terminal of battery should be protected while transit in order to prevent short circuiting. Use of steel or other metal wire are strictly prohibited which could cause short circuit to the battery.
- ⊗ Avoid compressing battery terminal positions and loosening safety valve.
- ⊗ Prohibit the battery upside down placed.
- ⊗ Handle gently; avoid throwing, rolling and exposure to sun and rain.

Battery Storage

- ⊗ Battery should be stored in fully charge state. It is strictly prohibited to storage after discharge.
- ⊗ Battery can be stored in $-10\sim 45^{\circ}\text{C}$ environment. When stored at ambient temperature of $-10\sim 30^{\circ}\text{C}$, every 6 months supplementary charging should be done. When stored at ambient temperature $31\sim 45^{\circ}\text{C}$, every 3 months supplementary charging should be done. For supplementary charging method, refer 5.2: Balanced and Supplementary charge.
- ⊗ Longest storage time (Shelf life) should be not more than 18 months (25°C).
- ⊗ Battery storage location should be away from heat and sparks generating objects.
- ⊗ Battery should be stored in upright position, avoiding pressure on terminals. Safety valve should be tightened. It is strictly prohibited to stack battery without packaging.
- ⊗ Battery should be stored in dry, ventilated and clean environment. Avoid exposing it to radiation, waterlogging and fully closed environment, at the same time should be kept away from heat and direct sunlight.
- ⊗ Battery storage should avoid organic solvents, corrosive substances and gases near the batteries.

Inspection after arrival of batteries

⚙ Before unpacking

- Check battery packing wooden box or carton boxes, if are damaged or deformed.

⚙ Handling

- Prohibit putting force on terminal area, preventing the terminal damage and sealing parts cracking.
- Avoid battery inversion, rolling, throwing or colliding .
- Avoid using steel or other metal wire to prevent short circuiting of positive and negative terminals.

⚙ Battery check

- Checking battery appearance- no damage or leakage.

⚙ Quantity check

- Count quantity of batteries and accessories box according to the packing list.
- Count the accessories quantity according to the accessories list.
- Count the battery rack accessories quantity according to the installation drawings (if there are racks).

Battery Using Condition

- ⚙ Used in Series: Recommended system voltage is less than 450V, if more than 450V, inform our technical staff, so that they can provide assistance.
- ⚙ Used in Parallel: Recommended three groups or less, if more than three groups, inform our technical for technical assistance.
- ⚙ Radiation conditions: battery spacing is maintained at more than 10mm.
- ⚙ Battery should be installed in clean, dry and ventilated environment with minimum amount of infrared radiation, organic solvent and corrosive gas around. Direct sunlight should also be avoided.
- ⚙ Ventilation conditions: ensure the released hydrogen concentration is less than 0.8%.
- ⚙ Battery installation location should be as close as possible to the load, use appropriate copper cable to avoid increasing line voltage drop. During multiple parallel strings uses, try to make each line drop roughly the same and each string should be equipped with safety fuse device.
- ⚙ Ambient temperature for battery usage is $-20^{\circ}\text{C}\sim+55^{\circ}\text{C}$. Recommended usage temperature range is $25^{\circ}\text{C}\pm 5^{\circ}\text{C}$. Battery life is reduced to half with every increase of 10°C .
- ⚙ Float use condition (25°C): limited current $\leq 0.20C_{10}$, refer following table for float voltage:

Table 1: Floating charge voltage at ambient temperature (25°C)

No.	Product Series	Floating Voltage (V/CELL)	Charging Voltage (V/CELL)	Remarks
1	SP	2.27	2.45	
2	SPG	2.27	2.45	
3	FT	2.25	2.35	
4	GFM-C	2.27	2.40	6V/12V/GFM-100C
5	GFM-C	2.25	2.35	2V
6	GFMG	2.25	2.35	
7	GFM-H	2.25	2.35	
8	GFMU	2.25	2.35	
9	HTB	2.25	2.35	
10	SAJ	2.25	2.40	
11	FTJ	2.22	2.33	
12	FMJ	2.22	2.33	
13	GFMJ	2.22	2.33	
14	OPzV	2.25	2.35	

- ⚙ Equalizing use conditions (25°C): limite current $\leq 0.25C_{10}$, charging voltage can be seen in above table,charging time within 20 hours.
- ⚙ Batteries with different specifications, manufacturers, and capacity should not be mixed.
- ⚙ Battery Replacement: Individuals battery should be replaced when needed. Measuring of open circuit voltage of old and new batteries is required. Proposed voltage difference is less 0.025V/cell for old and new batteries after fully charged.

Battery Installation and Usage

Battery Installation Precautions

- Suggesting match the battery according the battery OCV before battery installation, measured the OCV of the same or similar as one group, the suggested OCV tolerance is 0.02V/cell as one level
- Battery bottom should be installed insulation pad if battery group voltage more than 450V. Check battery's voltage and appearance no abnormal,then install the batteries at their specified locations.
- Battery installation location should not be near heat source (such as heating devices, transformer. etc.) Keep distance more than 100m.
- Battery installation should avoid near the spark device (such as fuses, etc)
- Before connecting, cleanbattery terminals to present metallic luster.
- Remove conductive material during battery installation process to prevent short circuiting between positive and negative terminals.
- It should be noted that battery cannot be used in closed containers.
- After installing battery, ensure that batteries in battery bank are connected properly. Check whether battery is connected correctly with charging equipment or load. Positive terminal should be connected with positive pole of charger or load where as negative terminal of battery with negative pole of charger or load. If not connected properly, it will damage charging device or load equipment.
- Cable and bolts at battery terminal should be installed properly, reducing connection voltage drop.
- Avoid loosening of the bolts at battery terminal, because it causes heat increasing andcausing accidents. Also avoid tightening strongly as it damages terminal, causing leakage. Recommended torque is given below:

Bolt Size	Tightening Torque(N.m)
M5	4-6
M6	8-10
M8	12-14
M10	18-22

Battery installation and connection

- Metal installation tools (such as wrenches) should be wrapped with insulating tape for insulation treatment. Conductive materials such as wrist watch, ring or other metals are strictly prohibited to wear.
- Lifting battery terminals by hand or tools are strictly prohibited during handling process;
- Prevent battery appearance bumps and scratches while handling the battery. Do not touch the battery terminal and safety valve.
- Installation Sequence: Firstly connect the batteries with each other, then connect the battery with charger or load.
- When install batteries in parallel, to follow the connection way in series first, then in parallel.
- The connection wire diameter and length of between battery and battery,battery bank and switch should be reasonable to reduce voltage drop in connections.
- To ensure better heat dissipation conditions, maintain 10mm spacing between the batteries and at least 20mm between battery rows.
- Before and after connection, can put appropriate amount of anti rust agent on battery pole (such as Vaseline).
- After battery is completely installed and connected, checking battery bolts are fastened, positive and negative direction are right. After measure the battery bank voltage and confirm the voltage is right, then connecting it with load equipment.
- After installation, if the power supply do not connect with the AC, the battery bank should not connecte with any load (including power equipment, equipment load), to avoid the little discharge current causing overdischarge.

Battery connected with Power supply system

- Confirm positive and negative voltage on the power supply. Measure the polarity of the power supply equipment access port by multimeter probe. When displayed voltage is positive, it shows that multimeter positive pen is corresponding to positive terminal and vice versa.
NOTE: Multimeter probes must be inserted into relevant sockets correctly according to instructions.
- Battery power supply access port (fuse or switch) should be cut, electrification operation strictly prohibited.
- Battery terminal end and power supply wire should be insulated properly.
- Connected battery terminals with power supply wire negative and positive accurately.
- The connected wire of the battery group should be connected with the positive terminal and negative terminal of the first and end battery of the battery group or the battery bracket bus, and install the insulated device of this part.
NOTE: Positive with positive, negative with negative.
- Measure the polarity of the fuse or switch.
- Use multimeter to detect and record battery terminal voltage.
- If two banks in parallel, accoding the below method connected the bank with lower voltage, e.g. the bank 1# with the lower voltage, first connected bank 1# into the power system and setted float charge parameters, according the terminal voltage of the bank 1# to change the float voltage, adjust the difference between float voltage and battery terminal voltage in $\pm 0.1V$. It can avoid the "fire" phenomenon during installing battery fuse.
- Use the same method to connect the battery bank with higher terminal voltage.
According to battery float voltage standards to set the battery float charge voltage.

Battery Management Parameters Settings

- Battery charging and discharging are controlled by power supply equipment, management parameter setting is critical. Correctly set battery fully charge and discharge protection depends on management parameters, it is necessary to ensure the stable operation of the battery bank.. The
- detailed according to management parameter table, it should be set according to the function of
- different power management device controller.

Battery Use

⚙️ Supplementary Charge

- The battery system is installed, before put into operation, the battery should be charged
- Battery complete float runs every three months, or two or more battery voltage falls below 2.18V, the battery should be charged.
- When battery long-term storage, Supplementary charge time for the battery is given in the following table

Storage Temperature	Supplementary charge interval	Remarks
Below 30°C	Once in 6Months	
30°C-40°C	Once in 3 Months	

- Recommended equalizing Charge/Supplementary Charge method as follow:
- Using constant current 0.1C₁₀~0.15C₁₀A to charge battery bank till battery average voltage rises to equalizing charge voltage, then switch to constant voltage charging. Charging time is generally 10~20h.
- After equalizing charge, for the battery with voltage lower 2.18V/cell,should using0.1C₁₀A discharge for 3-4h, then equalizing charge.

Note: In the current C₁₀ is 10 hour rated capacity. For example, GFM-500 battery,using limitedcurrent 0.15C₁₀A for supplementary charge of 24 batteries. Voltage setting: 24*2.35V / cell = 56.4V, Battery current settings: 500 * 0.15A = 75A. If for 16 pcs of SP12-100, Battery voltage setting:

16 pcs * 6 cell/ pcs * 2.40 V / cell = 230.4V. Battery current settings: 100 * 0.15A = 15A.

⚙️ Battery Discharge Test and Endjudgement

• Battery dischargeprotection end voltagesettings

Generally according to the discharge current and discharge protection end voltagein the following table 3corresponding settings:

Table 3 discharge current and discharge protection end voltage setting table:

Discharge Current (A)	End Voltage (V / cell)	Discharge Current (A)	End Voltage (V / cell)
Below 0.1 C ₁₀	1.80	0.5 C ₁₀ -0.7 C ₁₀	1.65
0.1 C ₁₀ -0.2 C ₁₀	1.75	0.7 C ₁₀ -3 C ₁₀	1.5
0.2 C ₁₀ -0.5 C ₁₀	1.70	Above 3C ₁₀	1.3

Note:

- 1)During battery discharging, single batter end voltage cannot drop below the specified value in the above table.
- 2)Battery should be charged within 24 hours after discharging to prevent irreversible sulfation resulting in capacity reduction.

• Capacity Test

For the battery regular capacity test, you can choose one of two capacity test methods the following:

⊙ Off-line Measurement Method

- 1)The battery break away from the system after fully charged, then standing for 2 hours, then using external Intelligence discharger or dummy load method at 25±5°C condition, according to the Sacred Sun product's constant current discharge datasheet to do the discharge.
- 2)Terminal voltage, environmental temperature, and time should be measured before discharging.
- 3)Measure and record ten times of the battery voltage, discharge current and room temperature during discharging. Discharge current fluctuation shall not exceed 1% of the specified value.Measure at any moment at the end of discharge period, in order to accurately determine the time of reaching discharge end voltage.
- 4)Discharge current multiplied by discharge time is the battery capacity. While discharging, if the temperature is not 25°C, actual measured capacity should be converted to 25°C capacity Ceaccording to the following temperature compensating formula:

$$Ce=Cr / \{ 1+K(t-25^{\circ}\text{C}) \} \text{----- (A)}$$

Formula: t- temperature during discharge; K- temperature coefficient (K=0.006/°C at C₁₀ discharge; K=0.008/°C at C₃ discharge; K = 0.01/°C at C₁ discharge)

5) After discharge, charge the battery group in accordance with page 11 supplementary charging method for fully capacity charge

⊙ On-line Measurement Method:

1) In DC power supply system, adjust the output voltage of the rectifier to the protect voltage (such as 45V), the battery supply the actual load of the power supply, turn on the power or battery capacity detection device for testing (should include automatic detection function). Finding the lowest voltage and lowest capacity battery during the discharge process, and then take this battery as the capacity test object.

2) Turn on power supply devices equalizing charge function for battery equalizing charge. When the battery charging current is stable for 3 hours without fluctuation, then battery is charged with full capacity.

3) Do the 10 hours discharge test for the battery which find out during the Step 2. Measure and record battery terminal voltage, temperature, discharge time and room temperature before and after discharge. Record the measurements once every hour. When discharged to near final voltage, measure at any moment in order to accurately determine the discharge time.

4) Discharge current multiplied by discharge time is the battery capacity, If room temperature is not 25°C. Apply formula (A) to convert to 25°C capacity.

5) After discharge test, recharge the battery with the charger to restore its capacity.

Note:

- a) Batteries for UPS system are not recommended for off-line measurement capacity test.
- b) For online measurement and checking capacity test, if UPS device itself has battery discharge test function, you need to turn-on battery discharge detection function for battery discharge. If UPS do not have this function, you need to shut off its AC input, and then do the discharge test.

Matters needing attention:

- a) Battery capacity test methods mentioned above are commonly used in routine maintenance work. Online/Offline measuring method must guarantee the normal operation of the system during the test. In advance you should know about whether planned power outages. So, standby generator should be in good condition.
- b) Before do the battery capacity test, should do one preventive detection by using multimeter, resistance meter, conductivity meter to observe battery performance.
- c) To ensure the accuracy of the battery capacity test, should use professional online testing instrument and intelligent discharge devices for testing.

• **Battery discharge protection end voltage settings**

The lag battery with lower voltage during discharge process, so the lag battery should be measured during the discharge state. If the end of discharge voltage in three consecutive discharge cycle were lower than above 5% of average voltage, it can be judged as the lag battery in the group. When appear the lag battery in the battery group, should using equalizing charge method to charge the battery group.

⊙ **Charging**

• **Floating Charge (Float)**

Charging Parameters:

- ⊙ Floating voltage should be setted according to Table 1
- ⊙ Maximum Charge Current: $0.25C_{10}$
- ⊙ Temperature Compensation Coefficient: $-3.5\text{mV}/^{\circ}\text{C}/\text{cell}$ (at 25°C basis)
- ⊙ Charging Voltage fluctuation range: $\pm 0.02\text{V}/\text{cell}$

Note:

- a) Voltage of single battery at initial stage will have deviation, which will be unity after 6 months of floating operation.
- b) The effect of battery setted floating voltage too low or too high: prolonged too high (over-charge) will increase battery water loss, accelerate grid corrosion, capacity fading acceleration or even have risk of thermal runaway, prolonged too low (insufficient charge), supplementary charge can not satisfy the battery self-discharge at the floating state, and capacity loss after discharge but before equalizing charge. The battery have sulfation risk. at long term insufficient charge.

• Equalizing Charge (Equalize)

Charging Parameters:

- ⊙ Charging voltage to be setted according to table 1.
- ⊙ Maximum Charging Current: $0.25C_{10}$
- ⊙ Temperature Compensation Coefficient: $-3.5\text{mV}/^{\circ}\text{C}/\text{cell}$ (at 25°C basis)
- ⊙ Charging Voltage fluctuation range: $\pm 0.02\text{V}/\text{cell}$
- ⊙ Exxit equalizing charge condition: battery reference charging current value generally set $0.005C_{10}$ — $0.01C_{10}$.

Notes:

Normal float operation cannot perform this operation. Use equalizing charge under one of the following situations:

- ⊙ Battery discharge capacity more than 10% of rated capacity.
- ⊙ Stored more than 3 months
- ⊙ Appear single cell floating voltage less than $2.18\text{V}/\text{cell}$.
- ⊙ Continuous float charging for 3~6 months or appear lag battery in the battery group.
- ⊙ Full floatingoperation more than one year.
- ⊙ After battery installation and debugging, and before use
- ⊙ After done battery capacity test.

• Precautions in charge

In the initial 72h after installation and debugging, battery output voltage should be measured once every 2h to verify stability of power supply output voltage. Should also be checked every 6 months to prevent any abnormal operation of power supply which may cause damage to the battery.

Current at the end of charging is generally lower than $0.005C_{10}\text{A}$ and remain stable. If current is higher than this value for long time, need to check whether the charging voltage is accurate.

When environment temperature changes more than $25\pm 5^{\circ}\text{C}$, power supply equipment shall be controlled with temperature compensation function and temperature probe is closely attached to the central location, side-loading battery when changing, power supply will automatically adjust the charging voltage to avoid battery from being overcharge or undercharge.

Battery charging terminates, under normal circumstances when the battery reaches one of the following conditions, may be regarded as the charge termination:

- 1) For AGM battery, the charged capacity is 1.1-1.15 rate of the released capacity, For the GEL battery, the charged capacity is s1.02-1.08 rate of the released capacity
- 2) Later charging, charging current is less than $0.005C_{10}\text{A}$.
- 3) Later charging, the charging current for 3 hours do not changed.

Battery Maintenance

Cleaning Notes:

Battery appearance, terminal area and working environment should be kept clean and dry.

In battery cleaning process, avoid use of electrostatic cleaning tools.

Clean the battery with damp cloth. Prohibit the use of gasoline, alcohol and other organic solvents; also do not use cloth containing these substances.

Inspection and Maintenance

VRLA batteries are not maintenance-free batteries, battery operation process gradually changes with time. In order to ensure good battery usage, operational management and control are very important. To understand the operation status of batteries and equipment and to prevent accidental damage, daily maintenance is required. Periodically check and record the measurement using the following method for batteries used in UPS system room, base station (including outdoor station).

Monthly Maintenance Inspection Items

Item	Content	Standard	Maintenance
1-Temperature detection	1-Measure and record battery terminal and container temperature by using infrared thermometer. 2-Use infrared thermometer to measure ambient temperature.	1-Ambient Temp: $-20^{\circ}\text{C}\sim+55^{\circ}\text{C}$ 2-Recommended Temperature: $25\pm 5^{\circ}\text{C}$	1-Battery temperature compensation functions turned on and properly install the battery temperature probe. 2-Turn on room temperature conditioning equipment such as air-conditioning.
2-Battery float voltage measurement	Measure floating voltage on positive and negative terminal of the battery group with multimeter.	Measurement and control module display operating voltage differences within 0.05V	Even after adjusting, if monitoring module shows inconsistency, replace or repair it.
3-Battery Appearance	Check the battery container whether bulging, leakage and damage.	Normal Appearance	Confirm reason for abnormal appearance, if it affect normal use, replace it
	Check for dirt stains	Clean Appearance	Clean dust and dirt with damp cloth
	Check the connection cables, terminals, etc. without oxidation, rust & other abnormalities	No oxidation, rust	If you find oxidation or rust, replace the connecting wire, and swab terminal with Vaseline etc.
4- Joints	Use hex wrench to tighten loose bolts.	Securely connected	If found bolt loosened, tighten it
	1-Battery cables, terminals clean non-corrosive. 2- Spring washers, flat washers complete installation and follow the installation sequence	No evidence of corrosion	If slight corrosion when connecting bar removed, clear with cloth. If severe corrosion, replace the connection bar and clean terminal with sandpaper after tightening.
5-Safety Valve testing	Whether there is white crystalline or liquid surrounding the safety valve.	No crystalline or liquid surrounding the safety valve	1-For crystalline, using cloth to clean up. 2-If there is crystal and liquid, clean it with cloth. Check and tighten the safety valve

Quarterly Maintenance Inspection Item
Except the above monthly maintenance, add the following items:

Item	Content	Standard	Maintenance
1-Measurement of each battery floating voltage	Measure each battery floating voltage by use multimeter.	Battery floating voltage differential pressure should meet the following standards: 2V series 90 mV 6V series 240 mV 12V series 480 mV	If deviations from the reference value, discharge the battery group and then equalizing charge, after change to float charge and run two months, if there are still deviate from the reference value, replace the battery.
2.Using equalizing charge to recover the lag battery	Using the equalizing charge voltage charge the battery 10 hours or more, if severe lag, do three times discharge cycles.	Single battery discharge voltage in the battery group should meet the following standards: 2V 200mV 6V 350mV 12V 600mV	If battery cannot be repaired, should be replaced.

Annual Maintenance inspection items
Except the above quarterly maintenance items, add the following items

Item	Content	Standard	Maintenance
1- Discharge test	Disconnect the AC, take load discharge or discharge online method, released capacity is 30%-40% of rated capacity.	At the end of discharge, battery voltage should be more than 1.90V/cell, differential pressure should meet the following standards: 2V series 200mV 6V series 350mV 12V series 600mV	The battery voltage is lower than a voltage reference value or the differential pressure is greater than the reference value, discharge the battery, then equalizing charge, then change to float and observation of 1-2 months, if still exceeding the reference value contact with supplier.
2- Capacity Test	Use on-line or off-line intelligent discharge device for discharging batteries, the end voltage is 1.80V / cell	Capacity to maintain more than 80%	Measure and record various parameters and each battery end voltage during the discharge test, for the lag battery do the correspond disposal.
3-Measure and verification the management parameters.	1-Measure limited charging current. 2-Equalizing charge starts, ends automatically 3-Battery discharge protection automatic start.	Actual operation parameters meet with the setting parameters	Power equipment failure repair.

Precautions for Use and Maintenance

- Please use insulated tools when operation and maintenance, any metal objects to be put on top of the battery shall be strictly prohibited;
- Please do not use any organic solvent to clean batteries;
- Please do not take down safety valve or add any substance into battery
- Please do not smoke or set out fire near batteries.
- Please keep battery fully charged within 24 hours after discharge, avoid capacity affected
- Check whether safety valve twisted tightly or not, but please do not take down it.
- Do not make the battery over discharge. Stable DC and DG is equipped to guarantee battery with long life. Start the DG once a month to check it can work properly.
- Battery should be installed in the place which away from heat and sparks source, should be placed in clean environment. Recommended battery room temperature is 15°C~35°C. Preferably 25°C temperature should be maintained using air-conditioning. Damp, poor ventilation, direct sunlight and other similar environment definitely shorten battery life (at 35°C battery life will be half). Therefore, a clean environment, good ventilation conditions, ambient temperature and no sunlight is very necessary. In addition, to facilitate the maintenance of the battery, leave appropriate room space for maintenance.

Battery Replacement

⚠ Replacement Judgment

- Check from discharge test, if the capacity cannot meet the usage requirements, battery should be considered replaced.
- If single battery floating voltage exceeds the reference value, you should consider replacing.

⚠ Replacement period

- Batteries in float or cyclic use has a certain life cycle, it is necessary to consider the use mode, environmental temperature, system safety level and other factors, replace the battery before arrive in the battery service life. Fully guarantee power system safe and reliable operation.
- Old batteries should be recycled in timely according to relevant domestic rules and regulations.

Note




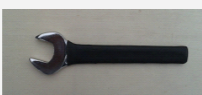





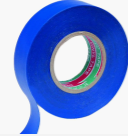
- ⚠ The battery should be used in accordance with applicable environment and use, if outside the designated uses, it might make battery leakage, explosion or other accidents.
- ⚠ Forbiddissembling, alteration, destruction, throwing, strong impacting the battery, as it may cause battery leakage, heat or even explosion.
- ⚠ Forbidputting the battery into water, fire or heat.
- ⚠ Forbid short circuit between battery connections.
- ⚠ If battery total voltage exceeds 45V, wear insulated gloves and apply other safety measures before start working. If safety measures are not taken, there will be danger of electric shock.
- ⚠ Maintenance and measure, avoid facing the battery tops,angle or distance should be maintained.
- ⚠ Battery plates and separators absorb sulfuric acid, in case of batteries mechanical damage, should avoid sulfuric acid contacting with skin, clothes or eyes. In case of contact with eyes, wash immediately with plenty of water, if serious case should go to hospital..
- ⚠ It is beter for battery life in temperature range of $25\pm 5^{\circ}\text{C}$

Common Fault & Trouble shooting

Fault	Reason	solutions
Battery liquid leakage	Nature fault	Replace the battery. Coordinate to solve the problem according to the fault cause
	Human failure	
Insufficient Battery capacity	some individual battery is not connected firmly	Maintenance personnel should make a comprehensive inspection of the site, measuring and recording all the terminal voltage of the battery, and check the operating or test records, inspect equipment operating parameters, check the battery connections if it is fastened and tightened.
	Insufficient capacity of some individual battery	Maintenance personnel should make a comprehensive inspection of the site, measuring and recording all the terminal voltage of the battery, and check the operating or test records, inspect equipment operating parameters, make the charge and discharge test, and observe carefully if the charge and discharge is done according to the requirements , dealing with according to the specific circumstances.
	Battery bank overcharges or undercharges	The temperature compensation probe breaks off, battery group overcharges or undercharges, execute according to the standard requirements. The charge and discharge time is insufficient and causes the sulfation.
	The battery group over discharge	Check the discharge protection voltage of the battery group.
	Close to the normal float charge or cycle life termination	

Fault	Reason	solutions
Battery case bulging	some individual battery safety valve becomes invalid, long-running lead to severe dehydration causes case bulging	Install the qualified products for the user
	some individual battery float charge voltage is high, the long time overcharge operation causes the case bulging	
	some individual battery is short-circuited or reverse polarity causes the whole group case bulging	
	The temperature of battery room is too high	The maintenance personnel should analysis the fault completely and systemically, coordinate with the customer, at last confirm the solving method.
	overcharge the battery group for a long time	
	The battery group over discharges and the recovery current is too high	

Tool Manual

No.	Names	Pictures	Notes
1	claw hammer		open packing container
2	straight screwdriver		open packing container
3	hexagon socket screw spanner		battery connecting cable installation
4	socket spanner		battery connecting cable and battery cabinet fixing installation
5	shifting spanner		battery connecting cable and battery cabinet fixing installation
6	FLUKEFLUKE 15B/17B multimeter		measuring voltage
7	spirit level		level measurement in battery cabinet installation
8	electric hammer ϕ 16 percussion bit		battery cabinet's foot margin bolt installation punching
9	Measuring tape		battery cabinet installation measurement
10	insulation tape		insulation treatment during installation