1. VRLA-BATTERIES TECHNICAL SPECIFICATION

FOR 2V, 6V, 12V, SLA BATTERY

1.1. Battery Construction

Positive plates are plate electrodes of which a grid frame of lead-calcium alloy holds porous lead dioxide as the active material.

Negative plates are plate electrodes of which a grid frame of lead-calcium alloy holds spongy lead as the active material.

Electrolyte

Diluted sulfuric acid is used as the medium for conducting ions in the electrochemical reaction in the battery.

Separator

Separators, which retain electrolyte and prevent shorting between positive and negative plates, adopt a non-woven fabric of fine glass fibers which is chemically stable in the diluted sulfuric acid electrolyte. Being highly porous, separators retain electrolyte for the reaction of active materials in the plates.

Vent (one way valve)

The vent is comprised of a one-way valve made of material such as neoprene. When gas is generated in erroneous charging, charger malfunctions or other abnormalities, the valve opens to release excessive pressure in the battery and maintain the gas pressure within specific range (0.07-0.44 bar).

During ordinary use of the battery, the valve is closed to shut out outside air and prevent oxygen in the air from reacting with the active material in the negative electrodes.
Positive and negative electrode terminals
Positive and negative electrode terminals may be fasten tab type, bolt fastening type, threaded post type, or lead wire type, depending on the type of the battery. Sealing of the terminal is achieved by a structure which secures long adhesive-embedded paths and by the adoption of strong epoxy adhesives.

Battery case
Materials of the body and cover of the battery case are ABS resins, unless otherwise specified.

1.2 Electrochemical Reactions on Electrodes
The electrochemical reaction processes of the sealed lead-acid battery (negative electrode recombination type) are described below.

Where “charge” is the operation of supplying the rechargeable battery with direct current from an external power source to change the active material in the negative plates chemically, and hence to store in the battery electric energy in the form of chemical energy. “Discharge” is the operation of drawing out electric energy from the battery to operate external equipment.

\[
\begin{align*}
PbO_2 + 2H_2SO_4 + Pb &\rightarrow PbSO_4 + 2H_2O + PbSO_4 \\
\text{(Lead dioxide)} &\text{(Sulphuric acid)} &\text{(Spongy lead)} &\text{(Lead sulphate)} &\text{(Water)} &\text{(Lead sulphate)}
\end{align*}
\]

1.3 Oxygen cycle
In the final stage of charging, an oxygen-generating reaction occurs at the positive plates. This oxygen transfers inside the battery, then is absorbed into the surface of the negative plates and consumed. These electrochemical reaction processes are expressed as follows.

[Diagram of the oxygen cycle]
1.4、Battery Applications

(1) Cycle Use:
Portable VTR/TV, tape recorders, radios, and etc.
Power tools, lawn mowers and vacuum cleaners
Cameras and photographic equipment
Portable personal computers, word processors, portable terminals and etc.
Portable measuring equipment
Portable telephone sets
Various power toys and recreational equipment
Lighting equipment

(2) Standby Use:
Communications and electric equipment
Emergency lighting equipment
Fire alarms and security systems
Various telemeter equipment
Office computers, processors and other office automation equipment
Robots, control equipment and other factory automation equipment
UPS power supplies
Emergency power supplies in power generation plants and substations
Telecommunications

(3) Solar Cell Power Generation:
Street lighting
Water pumping stations
Portable handheld power supplies
Small town power systems

1.5、Features

● Safety Sealing
Sunnyway SLA Batteries prevent electrolyte to help ensure safe and efficient operation.

● Easy maintenance
unlike the conventional batteries in which electrolyte can flow freely, VRLA batteries do not need the specific-gravity check of the electrolyte nor the watering structurally; this makes the battery function fully and makes maintenance easy.
- **Long Life Design**

The use of heavy-duty lead-calcium alloy grids with anti-corrosive construction enable the Sunnyway AGM battery to remain in float service for 10-15 years and the Sunnyway Gel battery to remain in float service for 15-20 years.

- **High Reliability and Stability**

Advanced AGM and GEL production technology and strictly quality control systems ensure battery stability and reliable performance. The voltage, capacity and seals are 100% tested during production.

- **Safety and Quality certification**

Have Passed VDS, UL and CE tests (Certification # MH26669, # G4M20104-0409-E-16). The production quality control system has passed the SGS ISO9000 Certification.

2. **CHARACTERISTICS**

2.1 **charging**

Charging characteristics (constant voltage-constant current charging) of VRLA batteries are exemplified below.

![Example of constant-voltage charge characteristics by current](chart.png)
2.2、· Discharging

a) Discharge current and discharge cut-off voltage
Recommended cut-off voltages for 2V batteries consistent with discharge rates are given in the figure below. With smaller discharge currents, therefore discharge cut-off voltages are set to the higher side for controlling over discharge. For larger discharge currents, on the contrary, cut-off voltages are set to the lower side.

(Note) Discharge cut-off voltage given are recommended values.

b) discharge temperature
(1) control the ambient temperature during discharge within the range from –15°C to 50°C for the reason described below.
(2) Batteries operate on electrochemical reaction which converts chemical energy to electric energy. The electrochemical reaction is reduced as the temperature lowers, thus, available discharge capacity is greatly reduced at temperatures as low as 15°C. For the high temperature side, on the other hand, the discharge temperature should not exceed 50°C in order to prevent deformation of resin materials which house the battery or deterioration of service life.
c) **effect of temperature on discharge characteristics**

Available discharge capacity of the battery varies with ambient temperature and discharge current as shown in the figure below.

Discharge capacity by temperature and by discharge current.

![Graph showing discharge capacity by temperature and discharge current](image)

d) **Discharge current**

Discharge capability of batteries of expressed by the 20 hour rate (rated capacity). Select the battery for specific equipment so that the discharge current during use of the equipment falls within the range between 1/20 of the 20 hour rate value and 3 times that (1/20 CA to 3CA): discharging beyond this range may result in a marked decrease of discharge capacity or reduction in the number of times of repeatable discharge. When discharging the battery beyond said range, please consult Sunnway in advance.

e) **Depth of discharge**

Depth of discharge is the state of discharge of batteries expressed by the ratio of amount of capacity discharged to the rated capacity.

2.3. **Storage (self discharge)**

Storage condition

Observe the following condition when the battery needs to be stored.

1) Ambient temperature: -15°C to 40°C (preferably below 30°C)
2) Relative humidity: 25 to 85%
3) Storage place free from vibration, dust, direct sunlight, and moisture.
a) Self discharge and refresh charge

During storage, batteries gradually lose their capacity due to self-discharge, therefore the capacity after storage is lower than the initial capacity. For the recovery of capacity, repeat charge/discharge several times for the battery in cycle use; for the battery in trickle use, continue charging the battery as loaded in the equipment for 48 to 72 hours.

b) Refresh charge (Auxiliary charge)

When it is unavoidable to store the battery for 3 months or longer, periodically recharge the battery at the intervals recommended in the table below depending on ambient temperature. Avoid the battery for more than 12 months.

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>Interval of auxiliary charge (refresh charge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 20°C</td>
<td>12 month</td>
</tr>
<tr>
<td>20°C to 30°C</td>
<td>9 month</td>
</tr>
<tr>
<td>20°C to 40°C</td>
<td>6 month</td>
</tr>
</tbody>
</table>

c) Residual capacity after storage

The result of testing the residual capacity of the battery which, after fully charged, has been left standing in the open-circuit state for a specific period at a specific ambient temperature is shown in the figure below. The self-discharge rate is very much dependent on the ambient temperature of storage. The higher the ambient temperature, the less the residual capacity after storage for a specific period. Self discharge rate almost double by each 10°C rise of storage temperature.

Residual capacity test result
d) Open-circuit voltage vs. residual capacity
Residual capacity of the battery can be roughly estimated by measuring the open circuit voltage as shown in the Figure.

Open circuit voltage vs. Residual capacity (20°C)

2.4 Temperature conditions

Recommended temperature ranges for charging, discharging and storing the battery are tabulated below.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge</td>
<td>0°C ~ 40°C</td>
</tr>
<tr>
<td>Discharge</td>
<td>-15°C ~ 50°C</td>
</tr>
<tr>
<td>Storage</td>
<td>15°C ~ 40°C</td>
</tr>
</tbody>
</table>

2.5 Battery life

a) Cycle life
Cycle life (number of cycles) of the battery is dependent on the depth of discharge in each cycle. The deeper the discharge is, the shorter the cycle life (smaller number of cycles), providing the same discharge current. The cycle life (number of cycles) of the battery is also related to such factors as the type of the battery, charge method, ambient temperature, and rest period between charge and discharge. Typical cycle-life characteristics of the battery by different charge/discharge conditions are shown by the below figures.
This date is typical and tested at a well-equipped laboratory.
Cycle times are different for each battery model.
Cycle times are also different from this data when using batteries under real conditions.
Cycle life vs. Depth of discharge

b) Trickle (Float) life

Trickle life of the battery is largely dependent on the temperature condition of the equipment in which the battery is used, and also related to the type of the battery, charge voltage and discharge current. The respective Figures show the influence of temperature on trickle life of the battery, an example of trickle (float) life characteristics of the battery, and the test result of the battery life in an emergency lamp.

Influence of Temperature on Trickle life
3. CHARGING METHODS

3.1. Methods of charging the Valve regulated lead-acid battery

For charging the valve regulated lead-acid battery, a well matched charger should be used because the capacity or life of the battery is influenced by ambient temperature, charge and other parameters.

Charging methods are dependent on battery applications, and the applications are roughly classified into main power application (cycle use) and stand-by/back-up power applications (trickle use).

Classification by application

1. Main power source (cycle use)
   - Standard charging (Normal charging)
   - Rapid charging

2. Stand-by power source (trickle use)
   - Trickle charging
   - Float charging

3.1.1. Main power cycle use

Cycle use is to use the battery by repeated charging and discharging in turn.

a) Standard charging (Normal charging)

For float applications of the battery, the constant voltage charge method is advantageous as it allows the battery to exert full performance.
• **Constant voltage charging method**

This method is to charge the battery by applying a constant voltage between the terminals. When the battery is charged by applying a voltage of 2.45V per cell (unit battery) at a room temperature of 20°C to 25°C, charging is complete when the charge current continues to be stable for three hours. Valve regulated lead-acid batteries can be overcharged without constant voltage control. When the battery is overcharged without constant voltage control, the water in the electrolyte is decomposed by electrolysis to generate more oxygen gas than what can be absorbed by the negative electrode. The electrolyte is reduced, the chemical reactions of charge and discharge become inefficient and hence the battery performance is severely deteriorated. Therefore, exact voltage control and proper charging time in constant voltage charging are essential for securing the expected life of the battery.

**Constant-voltage and constant-current charging method**

This method is to charge the battery by controlling the current at 0.4CA and controlling the voltage at 2.45V/per cell (unit battery) at a room temperature of 20°C to 25°C. Proper charging time is 6 to 12 hours depending on discharge rate.

**constant-voltage constant-current charge characteristic**

b) **Rapid charging**

when rapidly charging the battery, a large charge current is required in a short time for replenishing the energy which has been discharged. Therefore, some adequate measures such as the control of charge current is required to prevent overcharging when the rapid charging are as follows:

- Sufficient charging should be made in a short time for fully replenishing the amount discharged.
- Charge current should be automatically controlled to avoid overcharge even on prolonged charging.
- The battery should be charged adequately in the ambient temperature range of 0°C to 40°C.
- Reasonable cycle life of charge/discharge should be secured.

Typical methods to control charging so as to satisfy the above requirements follow.
• **Two-Step Constant Voltage Charging**

Two-step constant voltage charge control method uses two constant-voltage devices. At the initial stage, the battery is charged by the first constant voltage device of high setup voltage (setup for cycle charge voltage). When the charge current, the value of which is detected by the current-detection circuit, has reduced to the preset value, the device is switched over to switch over to the second low setup voltage (setup for trickle charge voltage). This method has the advantage to allow trickle use application to charge the battery in a comparatively short time for the next discharge.

charging characteristics of the two-step constant voltage control charger

3. **1.2 Stand-by/Sack-up use (trickle use)**

the application load is supplied with power from AC sources in normal state. State-by/back-up use is to maintain the battery system at all times so that it can supply power to the load in case the AC input is disrupted (such as a power failure). There are two methods of charging for this use.

a). **trickle charge (compensating charge)**

- Trickle charge

  In this charge system, the battery is disconnected from the load and kept charged with small current only for compensating self discharge while AC power is alive. In case of power failure, the battery is automatically connected to the load and battery power is supplied. This system is applied mainly as a spare power source for emergency equipment. In this use, if rapid recovery of the battery after discharge is required, it is necessary to consider the recovery charge with a comparatively large current followed by trickle charge, or alternative measures.

  While the type and capacity of the battery is determined by the back-up time and the load (current consumption) during power failure, some reserve power should be taken into account considering such factors as ambient temperature, capability of the charger and depth of discharge.
• equalization charging

As a team batteries continues to be charged over a long period (e.g. 3 months), or 90mV difference in a charging team voltage has been discovered, which may result in a significant difference in the battery life. Therefore, equalization charging should be adopted. Which should control a narrow range charging voltage with initial current of approx 0.1CA.

• Float Charge

Float system is the system in which the battery and the load are connected in parallel to the rectifier, which supplies a constant-voltage current.

In the float system, capacity of the constant-voltage power source should be more than sufficient against the load. Usually, the rectifier capacity is set at the sum of the normal load current plus the current needed in order to charge the battery.

3.2 charging methods and applications of VRLA-batteries.

<table>
<thead>
<tr>
<th>Application/charging method</th>
<th>Normal charging in 6 or more hours; constant voltage control</th>
<th>Two-step constant voltage control</th>
<th>Constant current control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle use</td>
<td>Control voltage: 7.25 to 7.45V/6V battery; 14.5 to 14.9V/12V battery, 2.35 to 2.40V/2V battery initial current: 0.4 CA or smaller (2V battery 0.25CA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trickle use</td>
<td>Control voltage: 6.8 to 6.9V/6V battery; 13.6 to 13.9V/12V battery, 2.25 to 2.30V/2V battery</td>
<td>Initial charging with current of approx 0.15CA, followed by switching voltage to trickle charge.</td>
<td></td>
</tr>
<tr>
<td>Float use</td>
<td>Control voltage: 6.8 to 6.9V/6V battery; 13.6 to 13.9V/12V battery, 2.25 to 2.30V/2V battery Float charging compensates for load fluctuations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>equalization charging</td>
<td>Control voltage: 7.25 to 7.45V/6V battery; 14.5 to 14.9V/12V battery, 2.35 to 2.40V/2V battery initial current: 0.4 CA or smaller (2V battery 0.25CA)</td>
<td>Charging with current of approx 0.1CA.</td>
<td></td>
</tr>
<tr>
<td>Application example</td>
<td>General uses, cellular phones (bag phones), UPS, Lanterns, Electric tools</td>
<td>Medical equipment, personal radios</td>
<td></td>
</tr>
</tbody>
</table>

Note* equalization charging usually indicate stationary VRLA battery. For details, please contact us.
3.3  charging parameter

a) Temperature Compensation of Charge Voltage

Charge voltage of the battery should be compensated to the ambient temperature around the battery, as shown in figure 27. Main reasons for the temperature compensation of charge voltage are to prevent the thermal runaway of the battery when it is used in high temperature conditions and to secure sufficient charging of the battery when it is used in low temperature conditions. Prolongation of service life of the battery by the above-described temperature compensation is expected as follows:

- At 30°C: prolonged by approx. 5%
- At 35°C: prolonged by approx. 10%
- At 40°C: prolonged by approx. 15%

In low temperature zones below 20°C, no substantial prolongation of the battery life can be expected by the temperature compensation of charge voltage.

**Curves of charge voltage and ambient temperature**

![Graph showing the relationship between charge voltage and ambient temperature.](image)
b) Charge Time

Time required to complete charging depends on factors such as depth of discharge of the battery, characteristics of the charger and ambient temperature. For cycle charge, charging time can be estimated as follows:

(1). When charge current is 0.25Ca or greater:
\[ T_{ch} = \frac{C_{dis}}{I} + (3 \text{ to } 5) \]

(2). When charge current is below 0.25CA:
\[ T_{ch} = \frac{C_{dis}}{I} + (6 \text{ to } 10) \]

Where: \( T_{ch} \) = Charge Time
\( C_{dis} \) = Amount of discharge before this charging (AH)
\( I \) = Initial charge current (A)

Time required for trickle charge ranges from 24 to 48 hours.

Summary

C) Charging temperature

(1) charge the battery at an ambient temperature in the range from 0°C to 40°C.

(2) optimum temperature range for charging is 5°C to 30°C.

(3) charge at 0°C or below and 40°C or higher is not recommended: at low temperatures, the battery may not be charged adequately; at high temperatures, the battery may become deformed.

(4) For temperature compensation values, see a).

d) Reverse charging

Never charge the battery in reverse, as it may cause leakage, heating or bursting of the battery.

e) Overcharging

Overcharge is an additional charge after the battery is fully charged. Continued overcharging shortens the battery life. Select a charge method which is specified or approved for each application.

f) Charging before use

Recharge the battery before use to compensate for capacity loss due to self-discharge during storage.
3.4、Precautions charging

1) When adoption charging methods and charging conditions other than those described in the specifications or the brochures, thoroughly check charging/discharging characteristics and life characteristics of the battery in advance. Selection of appropriate methods and conditions of charging is essential for safe use of the battery and for fully utilizing its discharge characteristics.

2) In cyclic use of the battery, use a charger equipped with a charging timer or charger in which charging time or charge amount is controlled by other means; otherwise, it will be difficult to judge the completion of the charge. Use of a charger as described above is recommended to prevent undercharge or overcharge which may cause deterioration of the battery characteristic.

3) Continue charging the battery for the specified time or until the charge completion lamp, if equipped, indicates completion of charging interruption of charging may cause a shortening of service life.

4) Do not recharge the fully charged battery repeatedly, as overcharge may accelerate deterioration of the battery.

5) In cyclic use of the battery, do not continue charging for 24 hours or longer, as it may accelerate deterioration of the battery.

6) In cyclic service of the battery, avoid charging or more batteries connected in parallel simultaneously: imbalance of charge/discharge amount among the batteries may shorten the of batteries.

4、The Installation of Batteries

4.1 Installattion style

A、Installed in Battery Chest

For incapacious places, in order to decrease the floor area of batteries and to keep them uniform with equipments, batteries can be installed in battery chest (connection layout attached).
B. Installed in Battery Rack

This mode can decrease the floor area of batteries as well as apply to different arrange of battery voltage. According as different voltage and capacity required, the batteries can be separated into monolayer single column or multiplayer multi-columns. The batteries can be lying horizontally or vertically according to their laying orientations.

- Installation Instance. series installed in battery rack:

![Fig.4-1 The Sketch Map of Installation in Battery Rack](image)

1. In virtue of attachment plate <4>, connect the bracket<6> at the left of battery carrier with the horizontal baffle of the rear <7> with a M8×20 bolt <5>, and need not to fasten it closely.

2. In the same way, connect the bracket on the right with horizontal baffle of rear well, and does not fasten it closely.

3. Aim the bulge of the orientation sheath of bottom splint<2> at the recession of the active rack part, then insert one M10×25 hexagonal socket bolt <3> into the orientation sheath, connect them with a spanner, but don’t fasten up closely. Finally connect other battery splints well.

4. Adjust all connections among the parts, and if there is no misplacing, fasten every bolt tightly.

5. Move battery rack into battery room, put the side without transverse baffle towards outside, make marks on the points which are corresponding to the feet of battery rack.
(6) Move battery rack away, bore a hole where a mark is made with an electric hammer, then clear up the installing site.

(7) Put the expanded bolt into the hole, then move battery rack back, and fasten it well.

(8) Put battery into battery rack, and connect battery line well according to their layout.

(9) Install other two horizontal baffles to the battery rack, and connect them firmly.

For 48V200AH and 12V2000Ah batteries the installation as shown below:

![Diagram of 48V200AH rack installation]

Figure X 48V200AH rack installation
4.2 The Requirement of Installation and Some Cautions

4.2.1 The Requirement of Installation

- Keep battery away from the heat sources and things apt to produce spark, and the safe distance should be greater than 0.5m.
- Keep the battery away from straight sunshine, and do not put it in sealed container and such conditions as great radioactivity, infrared radiation, ultraviolet radiation, organic solvent gas and corrosive gas.
- The battery chamber/room should be equipped with normal lighting and urgency lighting system, and the illumination utensil should be fixed above corridor.
- The battery chamber ground should have enough bearing capacity, and when the battery is fixed on the floor, the requirement of weight bearing should be offered to the building construction specialty. Battery can be assigned in individual battery chamber in A.C or D.C distribution room, and around the battery there should be adequate space to allow aeration and maintenance.
- As to the places where the density is up to class 7, fasten battery shelf with foundation bolt or groovy steels.
4.2.2 Please pay attention to following items during battery installation:

- As a charged drained battery when leaving factory, it must be carried carefully in transportation and installation to avoid short circuit.
- Because the voltage of the battery groupware is relatively high, existing the danger of electric impact, so one should load or unload the battery line with insulating tools, and install or carry battery with insulating glove, apron and safe glasses. When carrying battery, one can't wrench the terminals and the relief valve. Don't put the tools, sundries and other conductive materials on battery.
- Muddy wire terminal or loose connection may cause the battery to strike sparks, so we must keep the terminals in junction clean, and tighten the connecting wire, making torsion reach 11.3 N.M (specified value) and don’t produce the twisting stress to the terminals.
- The connections between the batteries, between battery fittings, between battery group and equipments should be rational and convenient, and the voltage should be as low as possible. The batteries of different specifications, different batches, and different performances should not be interconnected together. Before install terminal connector and turn on the battery wrench, to assure it is correct to install, one should check the total voltage of battery system, examine whether the positive and negative pole is joined correctly, whether battery is joined firmly, whether the relief valve have become flexible.
- When contact batteries strings with the charger or the load, disconnect one terminal wire, and turn off the charger or load circuit switch to avoid short circuit. Make batteries mutual connections properly; connect the positive pole of the batteries to positive pole of either the charger or the load.
- The battery case can’t be washed with organic solvent. Can’t use the fire extinguisher of carbon dioxide to put out battery fire, but special dry powder fire extinguisher is available.
- Because Sacred Sun GFM series battery leave factory in wet charged state, please check the open circuit voltage of single battery before installation, and the value should not be lower than 2.09V/cell under normal condition. If lower than this value, then adding charge is necessary before application.
- Before the battery is installed, check the safety valves of every battery to assure the connections are firm. If you find one flexible, fasten it closely immediately.
- The system connected with battery cell may have a high voltage, so much care should be paid when installing to avoid electric impact.
5、Inspections and maintenance

Preparation for VRLA Battery Periodic Inspections & Maintenance

For optimum reliability, it is recommended that the battery system be monitored quarterly. If the battery system incorporates an automatic monitoring system to gather the electrical and environmental data, the quarterly checks are limited to the evaluation of the recorded data and a visual inspection of the battery. In general the types of inspections to be made during periodic maintenance include:

- Visual battery inspection
- Battery system capacity test
- Battery system voltage inspection
- Ambient temperature
- Individual battery float voltage inspection
- High rate load test
- Electrical resistance and tightness of inter-unit connections

A test of the individual unit resistance, impedance or conductance, while optional, is also recommended on a periodic basis. This data and its trends can be a valuable aid in troubleshooting the system and predicting the need for a system capacity test.

Prior to starting the periodic maintenance activity assure that all the required maintenance tools and equipment is available and functional. Notify anyone who will be affected by the intended maintenance or troubleshooting activity.

All, all units in the battery should be numbered so as to facilitate the recording and analysis of data unique to each unit.

Tools and Equipment Required for Inspections & Maintenance

At a minimum, the following tools and equipment are required to maintain and troubleshoot SUNNYWAY’s VRLA Battery.

1. Digital voltmeter
2. Current clamp
3. Impedance tester
4. System load bank
5. Recorder
6. Insulated socket wrenches
7. Insulated box end wrenches
8. Torque wrench
9. Screw driver
10. Rubber gloves
11. Face shield or goggles
12. Portable eyewash
13. Fire extinguisher

**Quarterly VRLA Battery Inspection**

The following inspection should be completed quarterly.

1. Assure the battery room is clean, free of debris and with proper lighting.
2. Assure that all facility safety equipment is available and functional.
3. Measure and record the air temperature within the battery room.
4. Visually inspect the battery for:
   a. cleanliness
   b. terminal damage or evidence of heating
   c. container or cover damage
5. Measure the DC voltage from each polarity of the battery to ground and detect any ground faults.
6. Measure and record the individual unit DC float charging voltage, and current.
7. Measure and record the system equalization voltage, and current.
8. Measure and record the temperature of the battery cabinet inspections.

**Semiannual VRLA Battery Inspection**

The following inspection should be completed semiannually.

1. Repeat the quarterly inspection.
2. Randomly measure and record the resistance/conductance of the individual units to trend the condition of the individual units over time and to detect dramatic differences between individual units and the norm.

**Annual VRLA Battery Inspection**

The following inspection should be completed annually.

1. Repeat the semiannual inspection.
2. Re-torque all of the inter-unit connecting hardware. This can be omitted if the connection resistance is measured and found to have not increased more than 20% from the value recorded at installation.
Biannual VRLA Battery Inspection

The battery should be capacity tested every two years at the service load or at the battery rating related to the service requirements. Ideally, this will be the same rate at which it was acceptable when tests were run upon installation.

Data Analysis and Corrective Actions

The data accumulated during the periodic maintenance activities should be recorded on a form. Following is an explanation of how the data would be interpreted and the corrective action to be taken. However, it must be recognized that this explanation is not all inclusive and the analysis and corrective decision must be made by personnel familiar with VRLA batteries and their operation and failure modes.

VRLA Battery Regular Maintenance Record

<table>
<thead>
<tr>
<th>Type</th>
<th>Place</th>
<th>Status</th>
<th>Number of Battery</th>
<th>Total Voltage(V)</th>
<th>Current(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Voltage(V)</th>
<th>No.</th>
<th>Voltage(V)</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td>12</td>
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</tbody>
</table>

Check by sight | temperature

Result
Note:

If more than 24 units of batteries, another form should be attached.

For multi-cell batteries, the voltage of each cell should be recorded.

Caution;

If problems are found in each process, corrections should be taken immediately,
1. Equalized charging
2. Contact our customer service staff for replacement of batteries.
Or else it will affect the capacity and life of the batteries.

6. Ordinary Troubles and Disposal Methods

<table>
<thead>
<tr>
<th>Troubles</th>
<th>Reasons</th>
<th>Disposal methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage of terminals</td>
<td>Terminals distorted</td>
<td>Remove to another place; not to distort terminals when installation Prevent overcharging Confer with the supplier</td>
</tr>
<tr>
<td></td>
<td>+Pole show up for Overcharge seriously</td>
<td></td>
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<tr>
<td></td>
<td>Terminals failed to seal</td>
<td></td>
</tr>
<tr>
<td>Case bulging</td>
<td>Overcharging, and positive plates expand</td>
<td>Prevent from overcharged; strengthen ventilation Adopt proper float charge voltage The manufacturer improve safety valve</td>
</tr>
<tr>
<td></td>
<td>Failed safety valve</td>
<td></td>
</tr>
<tr>
<td>Capacity shortage</td>
<td>Plates sulfated</td>
<td>The batteries should be used according to the specification, and complementary charged in time Prevent from overcharging, improve the reliability of safety valve, and fasten it before installation Safety valve</td>
</tr>
<tr>
<td></td>
<td>Electrolyte dried</td>
<td></td>
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<tr>
<td></td>
<td>Safety valve failed</td>
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<td></td>
<td>Life terminated</td>
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</tr>
<tr>
<td>Electrolyte dried</td>
<td>Exhaust valve become disabled</td>
<td>Check periodically Prevent from overcharging Select proper float charge voltage, and charge properly</td>
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<td></td>
<td>The case broke</td>
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<td></td>
<td>Poor encapsulation between the case and lid</td>
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<tr>
<td></td>
<td>Voltage Overcharging</td>
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<tr>
<td></td>
<td>High float charge voltage</td>
<td></td>
</tr>
<tr>
<td>Terminals are exothermic</td>
<td>Joints become flexible</td>
<td></td>
</tr>
<tr>
<td>Float charge voltage is uneven</td>
<td>The internal resistance and the like is uneven</td>
<td>Equilibrium charge for 12—24h</td>
</tr>
</tbody>
</table>