Narada 南都®

VALVE REGULATED SEALED LEAD ACID BATTERY

6V、12V

OPERATION MANUAL

Version：V1.0

NARADA POWER SOURCE CO., LTD

Contents

Security Instructions

Please read this manual! It provides very important information for security, installation and operation. The information will allow your equipment to provide a better performance and longer service life.

- Do not try to take apart batteries. The spare parts are not inside the battery. Maintenance works should be done by professionals.
- As a result of the battery's latent danger to health and environment, they should be only changed in authorized service center. If you need to change the battery or maintain the equipment, please call the nearest service center.
- Batteries can be reclaimed, if it could not be carefully handled, it would bring a lot of dangers to environment and health. Please check laws to get the valid ways or send the equipment to service center.
- The replacement should be made or supervised by professionals with suitable protection. The batteries for replacement should be used as the same as the old ones in model and type.
- Warning——Do not smoke or use fire near batteries.
- Warning——Do not use any organic cleanser to clean batteries.
- Warning——Do not put the batteries on fire, or they will explode.
- Warning——Do not cut open the batteries. They contain electrolyte which is toxic to skin and eyes.
- Warning——Batteries may cause shock and short. Please remove the watch and jewelry such as rings when replacing the batteries. Also please operate with insulating tools.

Please take care of the following marks in using

				
Warning	Electricity danger	Protecting your eyes	Watch Short-circuits	With adults custody
				
Read the manual	Fire forbidden	Circle use	Do not put batteries into dustbin	The product has passed the UL Safety authentication
				
The product has passed the CE Safety authentication				

Company brief

Narada Power Source Co., Ltd. is one of largest, modernist, and with most advanced potential development ability enterprises. It is a national hi-tech group enterprise who devotes to research, development, manufacture and distribution of chemical power solutions and new green power solutions, and to provide complete solution and services for standby power, motive power and special power. The company was established in sept.1994. At present, the main product is VRLA battery. The company is not only the main supplier of China telecom market, but also export to more than 50 countries and areas worldwide in Europe, America, Asia, Africa, etc.

The company has passed TL9000 &ISO 9001 quality control management system certification, ISO 14001 environment control management system certification, and OHSAS18001 profession safety system certification. On the basis of high quality and excellent service, Narada are realizing grandiose aim which becomes provider of the topping chemical power solutions, the backup system of moving electric ministry and new power solutions.

Narada will enhance to raise general capability and devote to supplying trusty, safe, high capability's products and service to achieve the coexistence in human, nature and energy sources.

With the care and support by our customer, the quality of Narada brand VRLA battery is better and better, and the technical performance arts and crafts performance are also improving and developing. On the base of experiences of initial battery's manufacturing and operating, the company developed the new generation of 6V&12V products adopting international new AGM technology. This manual provides technical characters, installation, operation and maintenance process of Narada brand 6V&12V valve regulated sealed lead acid battery. Because continuous improvement in product development and the limit of technology, we may have some leak or error. We expect consumer to provide valuable advices.

Chapter One Working Principal

The chemical reaction taking place in lead acid battery is as follows:

$$Pb + PbO_2 + 2H_2SO_4 \underset{Charge}{\overset{Discharge}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$

Following by-reaction A takes place in ordinary lead acid battery:

$$2H_2O \rightarrow 2H_2 \uparrow + O_2 \uparrow \text{.....A}$$

This by-reaction makes water loss gradually and pure water need to be added regularly to keep the battery operating normally.

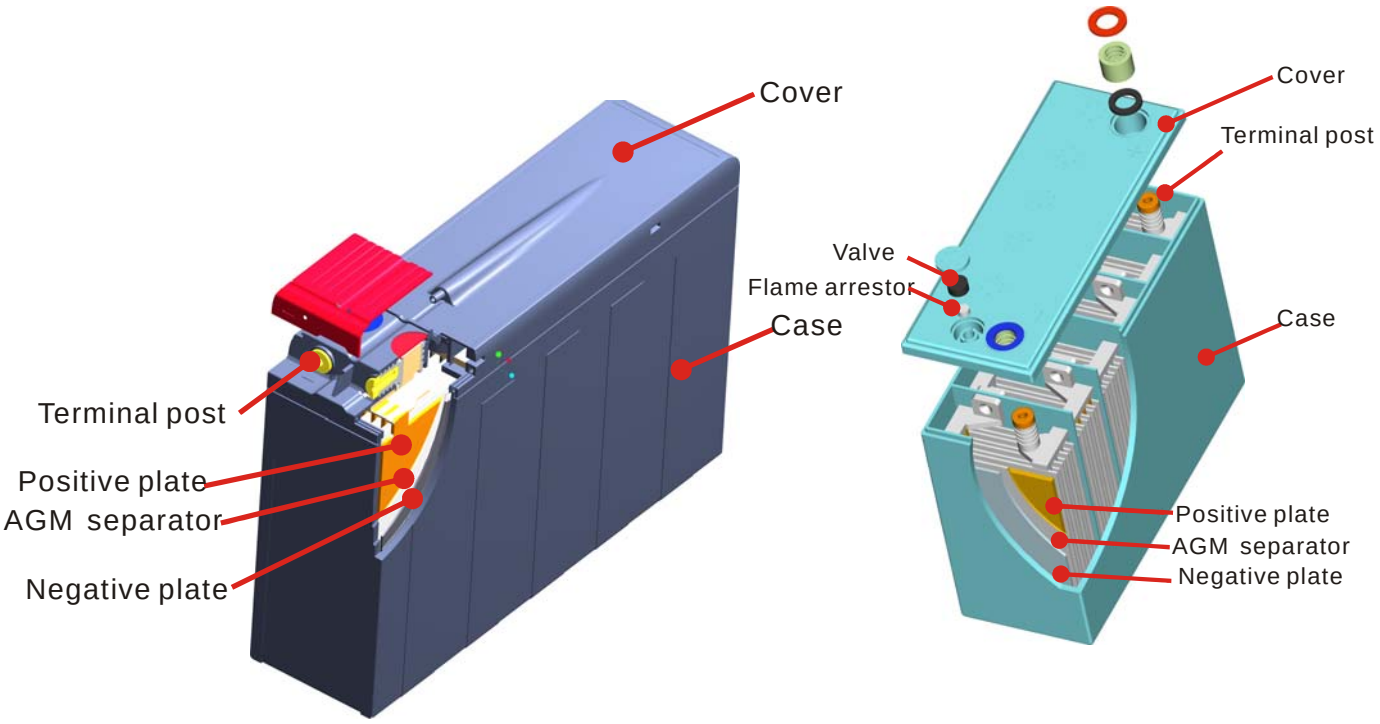
Narada 6V & 12V Battery adopts design of barren-liquor and utilizes AGM (micro porous glass fiber) separator. Thus there is a path existing between the positive and the negative. Also special alloy grid is chosen to increase vent hydrogen over-potential gassing on the negative plate, which prevents generation of hydrogen. Otherwise, the oxygen generated from the positive diffuses through separator to the negative and the oxygen gas reacts quickly and is recombined into water. The reactions are as follows B and C:

$$2Pb + O_2 \rightarrow 2PbO\text{.....B}$$

$$PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O\text{.....C}$$

So it is possible to build 6V &12V battery in sealed structure.

Chapter two Construction



Battery case, cover and cover plate ——made of reinforce ABS plastic with sufficient strength and acid-resistance ability, to prevent leakage of electrolyte and gas;

Terminal post —— with tin-coated red copper insert to reduce internal resistance, and with good conductivity;

Micro porous glass fiber separator——with high oxygenation-resistance and heat-proof ability, and electrolyte can be well absorbed and retained in the separator;

Positive and negative plate —— made of special formula Pb-Ca alloy and active material;

Integer valve—— made of acid-proof, aging-proof synthetic rubber;

Flame arrestor——with acid-proof, explosive-proof functions.

Chapter Three　Operation and Maintenance

1 Operation Condition

Ambient Temperature: The suitable temperature range of the 6V、12Vseries battery is from 15 ℃ to 25 ℃. If the battery is used at high or low temperature, it will affect battery performance.

Table3-1 battery service temperature

Work state	Service temperature range	Recommended service temperature
Discharge	-40℃～50℃	15℃～25℃
Charge	-20℃～50℃	15℃～25℃
Storage	-20℃～40℃	15℃～25℃

Ambient Humidity: ≤95％

2 Capacity

2.1 Concept of capacity of battery

The capacity of battery is the capacity that battery can be discharged on the established conditions, expressed as signal C. The usual unit of capacity is ampere hour, shortened as AH. Normally we indicate discharge hours rate in lower corner of C. e.g. C_{10} is 10 hours rated capacity, and C_3 is 3 hours rated capacity.

The capacity can be expressed in Rated Capacity or Actual Capacity. The Rated Capacity please sees Table 1-1. The Actual Capacity is the product of the discharge current and the discharge time, the unit is AH.

The way to determine capacity: e.g. when we try to determine 10 hours rated capacity, please discharge with current of I_{10} for 10 hours, if the voltage of battery is larger than 1.80Vpc, it means 10 hours rated capacity is qualified.

2.2 The Influence Factor of the Actual Capacity

The actual capacity is mainly related with the positive and negative active materials and their utilization ratio. The utilization ratio of the materials is mainly influenced by the discharge system, the structure of the battery and manufacture technology. In operation process, the factors that influence the actual capacity are discharge rate, discharge system, end voltage and temperature.

2.3 Discharge Rate

The discharge rate is often described as hour-rate and multiple rates.

If the discharge rate is higher and the discharge current is larger, then the discharge time is shorter, and the capacity which can be discharged is less.

2.4 End voltage

The end voltage is the lowest working voltage below which the battery can't be discharged any more or it will harm the battery. Usually the 10hr rate end voltage of battery is 1.80V/cell, and the 10hr rate end voltage of battery is 1.75V/cell.The batteries are not able to discharge more capacity even if the end voltage is lower because of characteristics of lead acid battery, yet the low end voltage makes great harm to the battery. It will greatly shorten batteries' life especially to discharge the battery to 0V while not to recharge in time. Thus the end voltage should not be lower than what is described in table 3-2, or it will cause over-discharge and make battery failure after several times of over-discharge.

Table 3-2 Discharge End-voltage

Discharge Current（A）	Discharge End Voltage（V/cell）
I＜0.2C	1.80
0.2C≤I＜0.5C	1.70
0.5C≤I＜1.0C	1.55
I≥1.0C10	1.30

3 Temperature

3.1 Available Capacity vs. Ambient Temperature

Temperature affects capacity of the battery. Fig. 3-1 is the available capacity curve vs. ambient temperature. if the temperature drops, the capacity will decrease, for example, the capacity will decrease to 80% of rated capacity if temperature decreases from 25℃ to 10℃; and too low temperature will cause battery long term insufficient charged, also will cause no discharge and negative plates sulfate.

Though VRLA battery can be operated at -15℃, the standard data is the test result at 25℃.

The capacity will increase when temperature rises. For example the capacity will increase to 102% of rated capacity if temperature increases from 25℃ to 50℃. But the capacity increase very little when temperature goes on increasing, and it will stop increase at last. However, it will quicken plates' corrosion and water loss if temperature rises, and shorten battery's life.

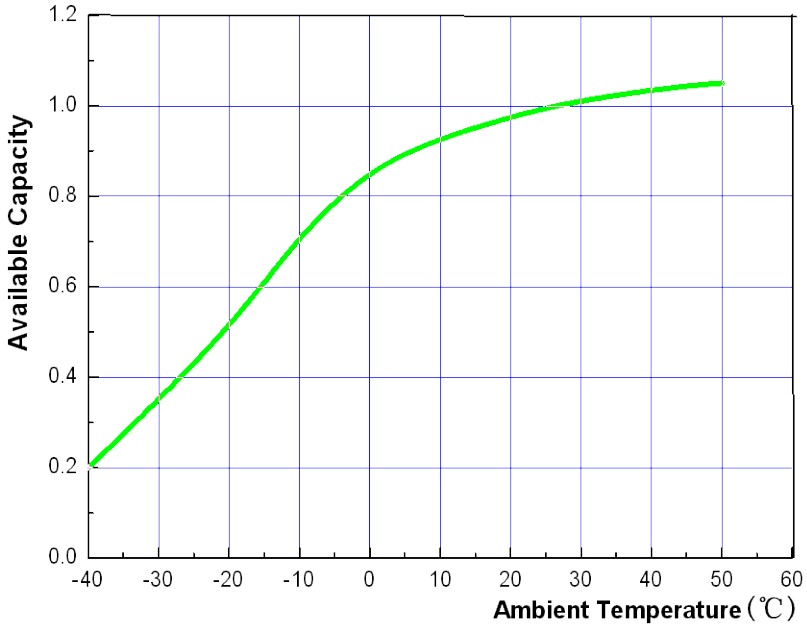


Fig.3-1 Available Capacity vs. Ambient Temperature

3.2 Temperature and Floating Voltage

The purpose of choosing proper floating voltage is to make the battery operate in a best condition. If the floating voltage is higher, and then the floating current is also higher, it will accelerate corrosion of the grid and shorten life of the battery. If the floating voltage is lower, the battery can't be kept in fully charged state; this will cause sulfate, decrease the capacity, and also shorten the life of the battery.

Table 3-3 is floating voltage of narada 6v、12v battery at 25℃. And temperature compensation coefficient is -3mV/℃/cell

Table 3-3 Floating Voltage OF Narada battery（25℃）

Series	Floating voltage （V/cell）
MP	2.250
Acme	2.250
TT	2.250
HR	2.275
GP	2.275
MPG	2.250
AcmeG	2.250
TTG	2.250
HRG	2.270

The formula to calculate float voltage at different temperatures:

$V_T = V_{25} - (T-25)\times 0.003$

V_T—Floating charge voltage at T temperature

V_{25}—Floating charge voltage at 25℃,

When the float voltage is lower than 2.20V/cell or higher than 2.30V/cell after being adjusted by temperature compensation coefficient, we suggest stopping making temperature compensate and charge the battery with 2.20V/cell or 2.30V/cell.

3.3 Temperature and equalization charge

VRLA battery needs equalization charge periodically to guarantee normal operation. Table 3-4 is equalization voltage of Narada 6v &12v battery at 25℃. And temperature compensation coefficient is -5mV/℃/单元.

Table 3-4 equalization charge of narada battery(25℃)

Series	Equalization charge（V/cell）
MP	2.40
Acme	2.40
TT	2.40
HR	2.40
GP	2.40
MPG	2.40
AcmeG	2.40
TTG	2.40
HRG	2.40

The formula to calculate equalization voltage at different temperature:

$V_T = V_{25} - (T-25)\times 0.005$

V_T—Equalization charge voltage at T temperature

V_{25}—equalization charge voltage at 25℃,

When the boost voltage is lower than 2.30V/cell or higher than 2.45V/cell after being adjusted by temperature compensation coefficient, we suggest to stop making temperature compensate and charge the battery with 2.30V/cell or 2.45V/cell.

3.4 Ambient Temperature vs. Battery Life

Higher temperature will harm the battery and reduce battery life. When temperature exceeds 25℃, the battery life will decrease half per 10℃ temperature rises. For example, the designed life of battery at 25℃ is 10 years, when battery operates at 35℃, for a long period of time the actual life is only 5 years.

$t_{25} = t_T \times 2^{(T-25)/10}$

Notes：T is the actual ambient temperature;

t_T is designed life at T ambient temperature

t_{25} is designed life at 25℃ ambient temperature

The heat disseminates performance of VRLA battery is bad, it's liable to cause thermal run away when heat accumulates. Please improve ventilation and temperature condition when room temperature is high. The distances between batteries should not be smaller than 10mm. Please also adjust the float voltage and equalization voltage according to the manual.

4 Charge and discharge requirements

4.1 Equalization charge

Equalization charge is needed in following conditions:

a The floating voltage of at least two batteries are lower than 2.18V/cell;

b Floating operation is more than three months.

The method of equalization charge is: First charge the batteries with the constant current of $0.1C_{10}A$ ～$0.15C_{10}A$ till the average voltage of the batteries increases to 2.4V/cell(25℃), then charge the batteries with constant voltage of 2.4V/cell, the time of equalization charge is 24 hours.

4.2 Charge after discharge

The batteries need to be charged in time after discharge. The charge method is constant current and limited voltage charge: Charge the batteries with constant current of $0.1C_{10}A$～$0.2C_{10}A$ till the average voltage of the batteries increases to a certain voltage, then charge the batteries with this constant voltage till finishing charge, meanwhile the current will reduce.

The certain voltage can be equalizing voltage or floating voltage. When the discharge depth is large (such as larger than 10% C_{10}), equalizing voltage is recommended, which will make charging more sufficient. We can also determine the voltage according to initial current. When current is large than $0.05C_{10}A$ (the reference current when transfer to equalizing charge), we recommend equalizing charge. the time of charge is 24 hours. Or the value of charge current is not varied for continuous three hours under the condition of constant voltage, we can determine the charge is finished.

We can raise charge current if batteries need to be fully charged in a short time, but the current cannot be higher than $0.25C_{10}A$。

4.3 Battery Recharging Method

This method is used for battery charging for the first time after installing or battery recharging after long time storage.

- **Recharging Parameter**

We use equalizing charge to recharge the batteries, the parameter is as below:

1 Charging mode: equalizing charge;

2 Charging voltage: (2.40±0.02)V/cell, for -48V system, charging voltage is 57.6V;

Charging voltage (made up with 12V monobloc) = 2.40 × 6 × battery quantity

Charging voltage (made up with 6V monobloc) = 2.40 × 3× battery quantity

3 Current limited: $0.10C_{10}$ (A);

4 Cut-off condition: the charging current is less than $0.005C_{10}$ with another extended 3 hours or charging time reached 16 hours;

- **Recharging Procedure**

1. Connect the batteries in series with cables or copper bars, and make sure that all the screws tightened with each joint, then connect the anode of battery group to the anode of charging equipment (charger), and the cathode of battery group to the cathode of charger. Pay attention, a breaker or fuse should be connected in the circuit in order to protect the batteries and charger, the capacity of breaker or fuse should be 1.5 times of circuit maximum current.

2. Turn on the charger, set the charging voltage and current according to 3.1 Recharging Parameter.

3. Turn on the breaker or fuse, and then turn on the charger to recharging batteries.

4. Stop charging when reaching the cut-off condition. At the last one hour before finishing, test the battery voltage one by one, the battery which voltage is below 2.16V/cell should be dealt with the method in chapter 3.3, if that battery still can not accord with the requirement, it should be rejected.

- **Cycle Procedure**

We can use the method as below to recharge the batteries after long time storage (for example: more than 1 year):

First connect the batteries in series to the charger, discharge batteries with constant current $0.25C_{10}$ (A) for about 3 hours. Then use the method in chapter 3.2 to charge the batteries. Stop charging when reach the cut-off condition

If the capacity still can not be renewed by this method, this means the batteries fail because of long time storage or other reasons.

- **Battery Capacity Test Method**

If we can not confirm whether the long time storage batteries can be used again after the cycle in chapter 3.3, capacity should be checked as follow:

1. Discharge batteries with constant current of $0.1C_{10}$ (A);

2. During discharge, test battery voltage one by one once an hour. When the voltage reaches 1.9V/cell, test the voltage once ten minutes in order to check and record discharge time of each battery exactly, till the voltage reaches 1.80V/cell. Record time and calculate the capacity.

3. Stop discharging when all the battery voltages are below 1.80V/cell. Immediately recharge the batteries for 16 hours with constant voltage of (2.40±0.02)V/cell and current limited of $0.15C_{10}$ (A);

How to judge capacity: Compare actual capacity (actual capacity = discharge current in A × discharge time in hour) with rated capacity. If actual capacity is more than 80% of rated capacity, the battery can be used after recharging; If it is less than 80% of rated capacity, the battery should be charged for 24 hours and be discharged for another time to test capacity, if it is still less than 80% of rated capacity, then the battery already fails and can not be used.

- **Charging Equipment and Tools**

No	Tool	Explanation	Purpose
1	Battery Test Equipment or Power System	If there is no Battery Test Equipment, we can use Power System instead of it.	Used to recharge and test batteries
2	multimeter	Precision: 5mV	Test battery voltage
3	amperemeter	Precision: less than 3%	Test charge and discharge current
4	monkey spanner		Tightening the screws
5	screwdriver		Prize up battery top cover

- **Attention Proceedings**

1. Use battery testing equipment to recharge batteries, if there is no equipment, the power system can be used. Pay attention to the parameter of charge and discharge.

2. In order to prevent exceptional condition, person should be specially assigned for battery recharging all the time.

3. Battery terminals should be bright and clean. Check and clean terminals before connecting in order to decrease contact resistance.

4. A circuit breaker must be stringed in the circuit to prevent battery from damaged because of wrong connection.

5. Make sure all the screws tightened reliably, otherwise there will be spark and heat while closing the circuit, this may cause battery burnt.

6. Pay attention to prevent short-circuit while connecting, all the tools should be insulating.

7. Strictly prohibit connect anode and cathode in reverse.

8. Avoid over-charge; otherwise, battery life will shorten. The maximum charging time by constant voltage of 2.40V/cell and current limited of $0.15C_{10}$ (A) should be not more than 24 hours.

5 Storage

All lead acid batteries experience self-discharge in open circuit. The result is that open circuit voltage decreases, and the capacity also decreases. During storage please note:

a The self-discharge rate is related with ambient temperature. The self-discharge rate is smaller when the ambient temperature is lower, otherwise is larger. The required temperature of battery's storage environment is from 5℃ to 30℃. The storage place must be clean, ventilated and dry;

b An important parameter in storage is open circuit voltage, which is related with density of the electrolyte. If the open circuit voltage is lower than 2.10V/cell, or have been stored for long time, the batteries should be charged to avoid damage caused by self discharge;

Storage temperature	Longest interval
over 30℃	once 3 months
under 30℃	once 6 months

c All batteries, which are ready to store, should be fully charged before storage. It's suggested to record the storage time in the periodic maintenance record and record the time when another necessary supplemental charge should be made;

d The quality certificates and packages of 6V、12V batteries record the latest charge time of the batteries, next charge time can be calculated according to this charge time.

6 Maintenance

In order to assure service life, the batteries should be correctly inspected and maintained. The maintenance methods of batteries are recommended as follows

6.1 Monthly Maintenance

Implement following inspection every month:

— Keep the battery-room clean;

— Measure and record ambient temperature of the battery-room;

— Check each battery's cleanness; check damage and overheating trace of the terminal, container and lid;

— Measure and record total voltage and floating current of the battery system.

6.2 Quarterly Maintenance

6.2.1 Repeat monthly inspection;

6.2.2 Measure and record floating voltage of every on-line battery. If more than two cells' voltages are less than 2.18V/cell after temperature adjustment, the batteries need

equalization charging. If the problem still exists after adopting above-mentioned measures, the batteries need yearly maintenance or even three years' maintenance. If all methods are ineffective, please contact us.

6.3 Yearly Maintenance

6.3.1 Repeat quarterly maintenance and inspection;

6.3.2 Check whether connectors are loose every year;

6.3.3 Make a discharge test to check with exact load every year, discharging 30-40% of rated capacity.

6.4 Three-year Maintenance

Make an 80% capacity test every year after three years' operation.

6.5 Operation and Maintenance Precautions

A Insufficient Charge

If the floating voltage is not set correctly (too low or not compensate according to temperature), the battery system will in an insufficient charge state for a long period of time. When the electricity is out, the battery may not be able to work because the acid is sulfated and the capacity is decreased.

B Over Charge

Please do not neglect the performance of rectifier to transfer floating charge to equalization charge. If the rectifier cannot transfer charge modes because of its wrong performance or none adjustment, the battery system is always in an equalization charge state. Thus may cause serious problems for battery, such as water loss, life decrease, thermal run away deformation, etc.

C Too low or too high temperature

We have mentioned that too low temperature will affect the capacity of battery. While too high temperature will also cause problems, such as water loss, life decrease, thermal run away, deformation, etc.

D Too low end voltage

The end voltage is also an important protection method for battery. The battery shall stop discharge when reaching a certain voltage (The normal end voltage is 1.80V/cell at 10h rate). If the end voltage is too low, it will be difficult to recharge the battery and decrease the charge efficiency, thus reduce the life of battery.

E Put the battery aside after discharge

If the battery is put aside without charge for a long time after discharge, it will affect the capacity and life of the battery. Because in the negative, some large size $PbSO_4$ will be formed which is difficult to transfer to active Pb.

Chapter Four Battery Installation

1 Unpacking and Inspection

1.1 Inspection: battery appearance-no damage;

1.2 Sort and count: no missing components;

1.3 Reference-installation drawing and operation manual.

2 Installation Precautions

2.1 Fix the battery to avoid vibration and shock;

2.2 Combustible gas(hydrogen) will be generated during charge and storage, so keep the battery away from spark source (like switch and fuse);

2.3 Do not use sealed container or container within which combustible gases easily accumulate;

2.4 When internal installation is required, place battery at the bottom of the equipment to avoid overheating. Beside, contact with the inner wall of the equipment and other batteries should be avoided;

2.5 Keep the battery away from heating things (such as a transformer).

3 Installation and Wiring

3.1 Wrap the metal mounting tool(such as spanner) with insulating tape;

3.2 First carry through the connections between the batteries, and then connect the battery string to charger or load;

3.3 When multi-battery strings are used in parallel, it should conduct series connections then the parallel connections. Keep the space of more then 10mm between each battery to assure better heat dissipation;

3.4 A quantity of antirust is spread on the terminal surface of the battery before or after the installation;

3.5 After battery installation and there is no problem about the total voltage of the battery string, the battery string can be powered on.

Chapter Five　Service

Quality policy of Narada: Strictly selected material, accurate manufacturing, high technology, sincere service. With a complete service net, an excellent service group and a quick and effective service mode, we promise you with below before, in and after sales services:

－ Assist the design and offer type selection service.

－ We will offer a service guarantee due to manufacturing, design and material defects if the batteries are operated in a correct way.

－ Answer the complain within 24 hours and deal with them in time.

－ Give training for installation and commission of the battery according to users requirements.

－ Hold regular training classes about the operation and maintenance of the VRLA.

－ Establish an excellent files on each customer.

If you have any problem, please contact us:

Service Department:

－ TEL：0571-28827007

－ TAX：0571-28827038

－ E-mail：xsglb@narada.biz

－ Http：www.naradabattery.com.cn

Annex 1

VRLA Battery Regular Maintenance Record

Type		Place	
Status		Number of battery	
Total Voltage（V）	Current (A)	Temperature	

No.	Voltage（V）	No.	Voltage（V）
1		13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	
Check by sight			

Result：

Tester:		Date:	