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Foreword

Manual Description

GFM Series VRLA Battery is the product of Shuangdeng Group. “GFM Series VRLA Battery User’s Manual” is the manual accompanied with the battery. Please read the manual carefully in advance.

Introduction

“GFM Series VRLA Battery User’s Manual” introduces the technical parameter, principle, installation dimension and method, and maintenance.

Section 1 Safety introduction，containing some watchful safety proceedings during batteries’s installation、operation and maintance；.

Section 2 Summarization，containing GFM series battery model、product sampling、product conveying and using ambient requirement、parts denomination、product specification and main parameters.

Section 3 Usage and maintenance，containing maintenance watchful proceedings、charge method、relationship of temperature and capacity、relationship of temperature and cycle life、capacity checking、switch power parameters setting、using requirement under power off condition、maintenance periods and requirements.

It is promised that:

We apply four eye-catching marks to show the special noticed points in operating.

 notice 、  caution、  warning、  danger: show the special operation precautions.

Appendix

Chapter 1 Safety Instruction

1.1 Abstract

This chapter introduces about the safety signs and the precautions. Please carefully read it before operation to ensure safety.

- **Safety Signs**

The safety signs indicate the safety issues that should be conformed to in installation, operation and maintenance. The safety signs are shown as following Table1.1-1

Table1.1-1 Safety Signs and Meanings

Safety Signs	Meaning
	Safety Notice
	Electric Shock

1.2 Precautions

Before any operation of the equipment, please carefully read all the safety instructions in this manual to avoid personal injury or equipment damage.

Shuangdeng Group bears no liability to the consequences incurred by violation of the general safety operation requirement, or violation of the safety standards for designing, manufacturing and using the equipment.

1. The battery pack has high voltage, so direct contact or indirect contact through wet objects with any conducting cable may result in vital injury. The battery pack is energy-storing equipment, so never short-circuit the battery pack during operation and maintenance in any way.
2. Do not wear watch, hand chain, bracelet, ring and other conductive objects during operation.
3. Only qualified and professional personnel are allowed to install, operate and maintain the equipment.
4. Do use special tools.

Do use special tools, instead of common tools during electrical connections. In addition, keep the tools in good insulation condition (e.g. wrap insulating tape around the bare metal parts) before using them to avoid short circuit and personal injury caused by tool contact with any live objects.

5. Using the batteries of the same model

   Use batteries of the same model in the same set. Using different models in the same set will damage the equipment.

6. Fire hazard

   During battery installation, make sure to fix the connecting terminals of the conducting wire tight, and keep the output terminals of the batteries clean. Otherwise, it may lead to a high temperature of battery terminals and even to spark/fire.

7. Operation regulation

   Before battery operation, read the safety precaution/instruction, and the operation instructions, especially the battery interconnection instructions.

   Substandard operation will cause danger. Prevent battery short circuit and prevent battery electrolyte from flowing out. Overflowed electrolyte is a latent danger and it will erode the metal object and circuit board, thus damaging the equipment and causing short circuit of the circuit board.

8. The Operation Environment

   The battery should be kept far away from fire, organic solution; avoid direct sunshine and the temperature should be the same of the same set.

Chapter 2 Summary

Abstract

This chapter mainly introduce GFM series battery's model、product sampling、product conveying and using ambient requirement、parts denomination、product specification and main parameters.

2.1 Model Introduction

GFM series valve-regulated lead-acid battery(following called GFM battery for short) belong to SHUANGDENG GROUP's second battery products. GFM battery is monocase structure，rated voltage per cell is 2V. Take GFM-500 for example, its mean as fig.2.1-1 showing.

In the fig.2.1-1,"GFM"means stationary valve-regulated lead-acid battery, the figure presents battery's rated capacity.

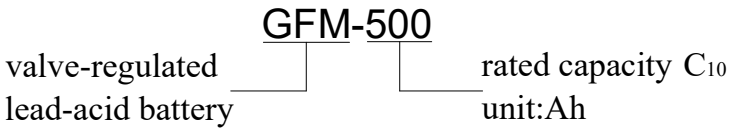


Fig.2.1-1 GFM-500 battery type and description

2.2 Sampling

Choosing batteries should consider use frequency, discharge current, discharge time and so on. The capacity should be a bit larger to prevent battery from damage caused by over-discharge or larger current discharge. Discharge current often be controlled less than $0.1C_{10}A$.

2.3 Conveying

Terminal protection is well done, the coping of the battery cannot suffer the pressure, safety valve cannot become flexible, and short circuit is prohibited when batteries are conveyed. Batteries should stand up at the time of transporting and cannot set upside down, roll, throw, bump, insolate or drench during conveying.

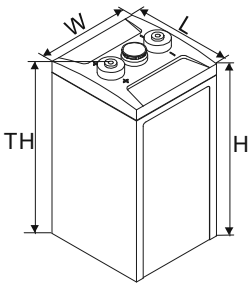
2.4 Storage

1. Batteries can be stored in the environment of 0-35°C before installation. The storage time is usually 3-6months. Batteries should be charged if the storage time exceeds 6 months.
2. Batteries should be kept in the dry, clean and ventilated environment. They cannot be kept in the environment of radiation, organic solvent and corrosive gas. They should be kept away from fire and avoid sun irradiation.
3. Batteries should stand up, safety valve cannot become flexible and batteries without package box cannot be overlapped.

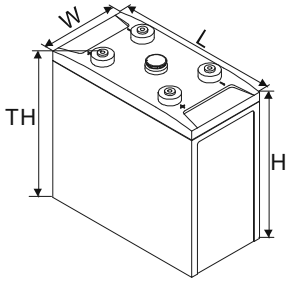
2.5 Dimension and Weight

Table2.5-1 Battery parameters

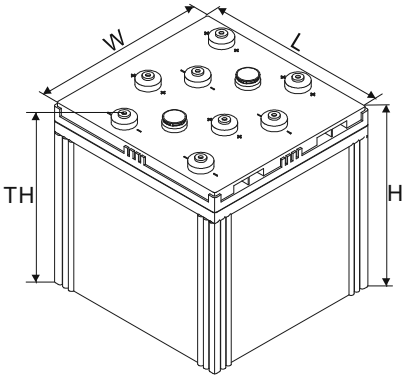
Type	Dimensions(mm)				Weight (Kg)	Internal resistance (mΩ)	Terminal
	L	W	H	TH			
GFM-200	90	181	346	365	12.5	0.90	M8
GFM-300	124	181	346	365	17.6	0.60	M8
GFM-400	158	181	346	365	23.0	0.51	M8
GFM-500	191	181	346	365	28.6	0.41	M8
GFM-600	225	181	346	365	33.2	0.39	M8
GFM-800	303	181	346	365	45.4	0.38	M8
GFM-1000	370	181	346	365	56.5	0.36	M8
GFM-1600	318	363	369	388	98.0	0.20	M8
GFM-2000	385	363	369	388	117.0	0.18	M8
GFM-3000	568	363	369	388	178.0	0.17	M8



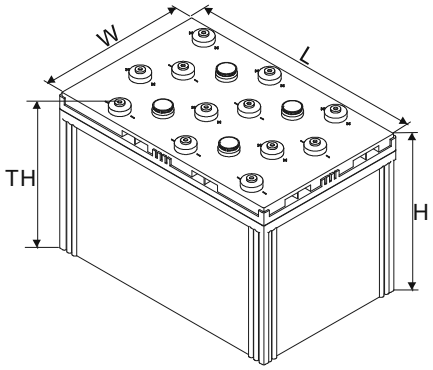
GFM-200~600



GFM-800~1000



GFM-1600~2000



GFM-3000

Fig.2.5-1 Battery figuration

2.6 Battery Appearance and Each Part Denomination

Following is the appearance and each part denomination of GFM battery（take GFM-500 for example, as fig. 2.6-1）

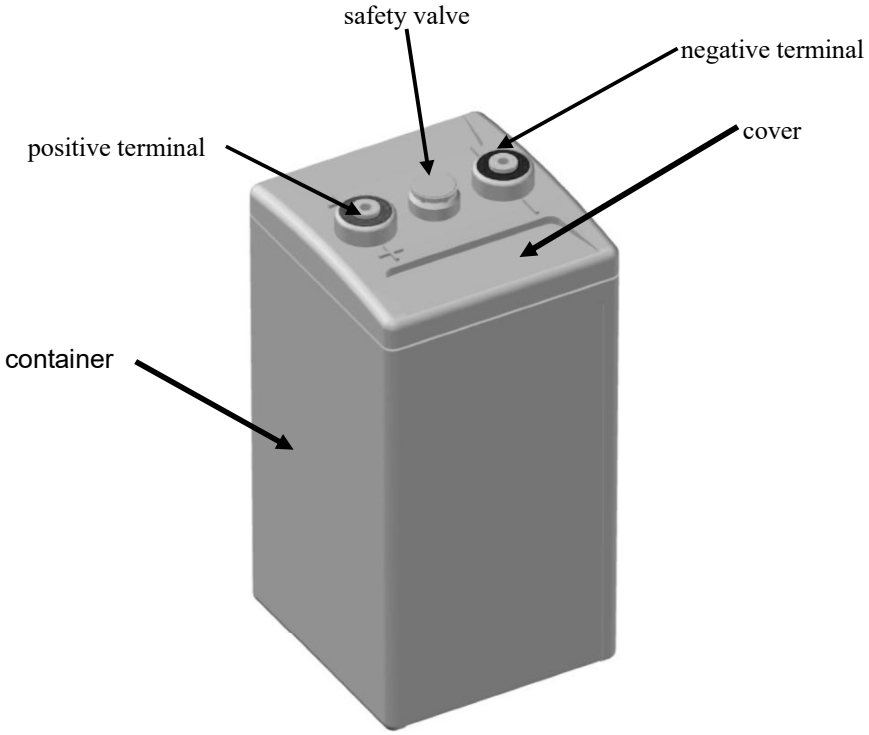


Fig.2.6-1 Battery figuration and accessories

2.7 Operation Environment and Precaution.

1. The battery servicing surroundings should be dry, clean and airy, without large quantity of irradiation, infrared ray radiation, organic solvents and corrosive gas, and avoided the direct sun shining. the temperature not exceed 35°C.
2. The ventilation hole of the heater or air-conditioner should not directly face the battery, and the temperature difference of the each part of the battery should not be higher than 3°C, and using the infrared ray thermometer to determine the each part temperature of the battery is suggested.
3. The battery can be installed with the battery cabinet or shelf provided by the manufacturer. If the battery is installed in the storied buildings, the load requirements should be inquired from the construction department. The earthquake-preventing supporting shelf which is fixed with ground foot bolt should be designed in order to diffuse the stress in the district whose anti-earthquake intensity is more than 7 degree.

4. In order to avoid increasing the circuitry voltage decrease, the battery modules should be near the load, and the cables, copper terminals and connecting wires selected should be suitable. When the batteries are used by the way of parallel-connection, the circuitry voltage decrease should be same to some extent to the best of one's best ability, and the fuses should also be equipped in every battery module.
5. The total voltage of the battery modules is comparatively higher, i.e., the danger of electric shock exists. Therefore, the insulation tools should be used and the protection gloves should be put on when installing or removing the cable, copper terminals and connection wires etc. 
6. Dirty contact or loosened connection will possibly lead to the temperature increase in the part of the battery terminal, then spark will be produced, which will probably result in fire. Thus, the cable, copper terminals, connection wires, and the battery terminals should be kept clean and the connection should be fastened during the installation of the battery. Single battery should be serially connected with stainless steel bolt, copper terminals (connection wires and cables) electrodeposited with tin, and flat gasket. And the bolt must be fastened (Wring moment is no less than 15N·m).
7. After the installation, carefully examine the total voltage, open circuit voltage per cell, the polarity. Check to see if the supervising parameters in the switch power monitor unit consist with the operation and maintenance manual (float charge voltage, equalization charge voltage, equalization charging time and period, charge current limit, equalization charge current turned to float charge, float charge current turned to equalization charge current, temperature compensation value, the recovery voltage of the battery and so on.).
8. Check to see if the switch power has equipped with the temperature sensor, which should be installed in the center of the big side of the battery.
9. The resistance between the output terminal and the cabinet (shelf) should be carefully checked in order to confirm the correctness of the installation and settings after the battery system is installed.

10. The circuit switch should be disconnected, and the correctness mentioned in item has been confirmed (it should be empathized that the positive terminals of the battery should be connected with the positive counterpart of the charger, and negative to negative) before the battery system is connected with the charger or load. 
11. Never try to open the safety valve during operation 

2.8 Check After Installation

After installation, check carefully and keep record, see Table 2.8-1 for the main items.

Table 2.8-1 The main items needed to be checked after installation

No.	Items	Results
1	The polarities are in right connection, the voltage of the battery group between positive and negative output terminals are higher than 48V	□Y □N
2	The voltage of each cell in the same battery group is between 2.1 and 2.2V.	□Y □N
3	If several battery groups are parallel connection, each output positive terminals should be connected together and negative terminals together.	□Y □N
4	The positive and negative output terminals of the battery group should be connected with the counterparts of the charge device.	□Y □N
5	All of the bolts, nuts and screws are fastened tightly.	□Y □N
6	The rack has no deformation after installation, and its vertical obliquity should be less than 5°.	□Y □N
7	No unnecessary connecting wires or tools etc. are left on the batteries or racks.	□Y □N
8	The appearances of the batteries have no cracks or damages.	□Y □N
9	The safety valve has been twisted tightly and has no looseness or damage.	□Y □N
10	The ambient site of the batteries and rack is clean.	□Y □N
11	All of the parameters of the battery group, such as the equalization charge and float charge currents, have been set correctly.	□Y □N
12	The resistances between output terminals and the rack are normal.	□Y □N
13	Other items need to be checked.	□Y □N
14		□Y □N
15		□Y □N

16		□Y □N
17		□Y □N
18		□Y □N

Chapter 3 Operation and Maintenance

Abstract

Operation and maintenance，containing battery maintenance and precaution、charge method、relationship of temperature and capacity、relationship of temperature and cycle life、capacity checking、switch power parameters setting、usage requirement under power-off condition、maintenance periods and requirement.

This chapter introduces bout the operation and maintenance of GFM battery.

3.1 Operations

3.1.1 Precaution

1. Never short circuit the battery.
2. Charge before operation after long period storage.
3. No open of the safety valve.
4. Keep the battery clean.
5. Equalized charge the battery for long storage.
6. After emergency discharge, no continuous power supply without in time equalized charge.
7. Never parallel the battery of different capacity.
8. No burning feel when touch the battery terminal or the connecting part.

3.1.2 Battery Charging

3.1.2.1 Float Charging

The float charging voltage of the battery is set as 2.23V/cell (the mean value calculated from all of the battery voltages at 25°C), the maximum charging current is set as $0.20C_{10}$A.The float and balancing charging voltages should be correspondingly modified if the battery working environment temperature exceeds the range of 25°C, and the modification voltage is Vmodification $=$ $V_{25°C}$—0.003/°C×(T_{actual}—25°C), i.e., if the

temperature increases by 1°C, then the float charging voltage should decrease by 3mV/cell; and if the temperature decreases by 1°C, then the float charging voltage should increase by 3mV/cell.

3.1.2.2 Balancing Charging

Balancing charging voltage is usually set as 2.35V/cell (the mean value calculated from all of the battery voltages at 25°C), and the maximum charging current is set as $0.2C_{10}A$, according to setting table to set Balancing charging time.

Table3.1-1 Balancing charging parameters

Balancing charging condition		Balancing charging time.	Conditions to exit the balancing charging
1	Before operation and after installation and debug of the battery	1~10h，The idiographic time according to the condition of exiting Balancing charge	When the pile's equalize charge current lower than 10mA/Ah, it switches to float charge automatically(for parallel ≤10mA/Ah×pieces)
2	The charge current after power off≥50mA/Ah （for parallel≥50mA/Ah×pieces）		
3	Balancing charge starts after battery capacity checking		
4	Balancing charge should start when the float voltage lower than 2.18V/cell during the using process	10h	When the balancing charge time arrive 10h, it switches to float charge
5	For net battery, it should execute periodic balancing charge one time six months commonly		

3.1.3 Temperature Effects the Battery Capacity

Temperature effects the battery capacity. Usually, the higher the temperature, the larger the discharge capacity . During discharging time, if the temperature isn't 25°C, it needs to convert the measured capacity C_t to 25°C benchmark capacity C_{25} according to the following formula.

$$C_{25} = \frac{C_t}{1+K(t-25)}$$

In the formula: t is the discharging ambient temperature, K is temperature coefficient. In the 10hr capacity experiment, K=0.006/°C and 10hr capacity experiment, K=0.008/°C, 1hr capacity experiment, K=0.01/°C.

Float charge characteristic: Float charge voltage should choose the manufactory recommendatory voltage value. And the float charge voltage value should make correspond adjustment according to the ambient temperature. When the switch power have temperature equalization function, but have no sensor or no temperature auto-equalization function, VRLA battery float charge voltage with different temperature should make correspond adjustment according to the following table.

Table3.1-2 Float charge voltage under different ambient temperature

Ambient temperature（°C）	Float charge voltage(about V±0.01V/cell)
0～10	2.28
11～15	2.26
16～25	2.23
26～30	2.22
31～40	2.19

3.1.4 Temperature Impact on the Battery Life

The battery has the longest service life and the best performance if the environment temperature is kept at 24~25°C. When the temperature is lower than 25°C, the charging efficiency and performance of the batteries will decrease. Vice versa, if the temperature is higher than 25°C, the service life of the batteries will be shortened. The reference data are listed below:

Table3.1-3 Effect of temperature on the battery service life

Battery mean temperature	Service life decreasing rate (%)
25°C	0
30°C	30
35°C	50
40°C	66
45°C	75
50°C	83

The expected floating charging service life is around 15years. But if the actual mean

temperature of the batteries is around 35°C, then the expected floating charging service life is only 7.5 years.

3.1.5 Capacity Determination

Balancing charging should be done before capacity determination. After balancing charging changes into float charging, float charging current will be between 1~2 mA/Ah, and if the float charging current is stable for about 2~3 hours, it shows that the battery system has been fully charged. The capacity determination can be carried out only after confirming that float charging has been continued for about 24h, then charging has been stopped for 1h.

Table3.1-4 Capacity examination method

Discharge rate	Discharge current, A	Discharge single battery final voltage，V	Capacity determination standard
10h	$1.0I_{10}$	1.80	$\geq 1.00C_{10}$
5h	$1.6I_{10}$	1.80	$\geq 0.80C_{10}$
3h	$2.5I_{10}$	1.80	$\geq 0.75C_{10}$
1h	$5.5\ I_{10}$	1.75	$\geq 0.55C_{10}$

3.1.6 The Parameter Set of the Switch Power Supply

The control parameters of the switch power supply to the batteries should be set according to the value of the load current. The parameters normally set are listed in Table.

Table3.1-5

The ratio of load current and I_{10}	Stop the work of programmed exchange machine, the final discharge voltage of the single battery，（V）(the first discharge-stopping)	Stop the work of signal exchange transition，the final discharge voltage of the single battery,（V）（the second discharge-stopping）
6/6	1.90（45.6V/48V system）	1.88（45.0V/48V system）
5/6	1.95（46.8V/48V system）	1.93（46.3V/48V system）
2/3	1.96（47.0V/48V system）	1.94（46.5V/48V system）
1/2	1.97（47.3V/48V system）	1.95（46.8V/48V system）
1/3	1.98（47.5V/48V system）	1.96（47.0V/48V system）
1/6	1.98（47.5V/48V system）	1.96（47.0V/48V system）

Note:

1. I_{10} means 10-hour rate discharge current in Table 6, its value is one-tenth of C_{10}

which is the rated capacity of the battery. If the batteries are parallel connected, then C_{10}, the rated capacity is the sum of the rated capacity of all of the individual battery paralleled (Batteries which have different rated capacities cannot be parallel-connected).

2. If bad battery whose final discharge voltage is below 1.80V/cell when discharging it with I_{10} after 5 hours occurs in the battery system, the very bad battery should be displaced with a good one or restore its capacity as soon as possible.
3. The parameters listed in Table 6 and 7 are only suitable for the situation that the discharge current is less than $0.1C_{10}$.

Table3.1-6 Switch power parameters setting

Item	**Parameter**
Float charging voltage	2.23V/cell
Equalized charging voltage	2.35V/cell
Charge current limiting	$0.20C_{10}$A
Upper voltage alarm threshold	57V（2.375V/ cell）
Lower voltage alarm threshold	45V（1.875V/ cell）
Temperature compensation coefficient of battery	-3mV/cell·℃
Battery over temperature	35℃
LVDS Deviation Voltage	44V
LVDS Reposition Voltage	47V
48V series pile replacement working voltage	48V(avoiding battery deep discharge resulted by the voltage rebound time after time and continue work after arriving the working voltage)
Equalized charge period	6 months usually for batteries in equipment room
Periodical equalized charge time	10h
Precondition of float charge switching to equalized charge	≥50mA/Ah
Equalized charge time with power cut	1～10h
Precondition to exit equalized charge	≤10mA/Ah
Capacity setting for battery diffluence	According to battery capacity
Batteries connection	Serial first, parallel next
Voltage difference between individual batteries	50 mV for working mode 20 mV for open circuit mode

3.1.7 The Application Requirements for Power Supply Interruption Time

1、Under the situation that the battery system has not been recharged after accident discharge, and just at the very time, the power supply of the communication station stops, often the battery system cannot be used to supply the power further. If continue working, it could lead the battery life shorter because of the battery deep discharge

2、If the accumulative discharge capacity reaches 50%~80% of the battery rated capacity for one power supply interruption, the float charging time cannot be less than 48h after balancing charging changes into float charging. If the accumulative discharge capacity is less than 50% of the battery rated capacity for several power supply interruption in one day, the float charging time cannot be less than 24h after balancing charging changes into float charging.

3、As far as the communication station, which has very good power supply conditions, is concerned, protective C_{10} capacity discharge should be done every 6 months (depth of discharge is 50%), and the battery system should be recharged in time.

4、Auxiliary power supply equipment, such as Oil Power Generator etc., should be equipped for those communication stations in which frequent power interruption exists and the power interruption time is very long. If discharge depth of the battery system is above 80%, and the public power supply has not restore yet, Oil Power Generator should be used to supply power to the communication station equipments and recharge the battery at the same time.

3.2 Maintenance Period and Requirements

1、The newly installed battery system should be checked in the following aspects when it is put into use --- whether or not the terminal voltage of every battery is normal, charging and discharging current are stable, fastening parts are loose, connecting parts and the battery terminals are being heated up by touch during charge and discharge.

2、Individual battery terminal voltage should be determined every 3 months to judge their evenness, good record should be done at the same time.

3、The maintenance person should periodically check that whether or not connection bars are loose or move, vent valve is loose, single battery is damaged and leaks, vent valve normally vents gas, battery is dry etc. And in site maintenance should be done if problem occurs, and manufacturer should be contacted to settle the problem if in site maintenance is very difficult.

4、The maintenance person should periodically determine the battery float charging voltage, and check that whether or not there is individual battery which has very high or low float charging voltage.

5、Check that whether or not there is difference between the total system voltage and the voltage display of the Switch Power Supply. If difference exists, it should be rectified.

6、Check that whether or not there is difference between the total system voltage and the sum of all of the individual battery. If difference exists, the reason should be checked out and then the difference should be corrected.

7、Record the relative electricity interruption and charging parameters in the Switch Power Supply internal memory, and if necessary, it is strongly suggested that the battery system be fully recharged.

Operation Instruction of Battery Recharging

Shuangdeng Group Co.,Ltd

Appendix

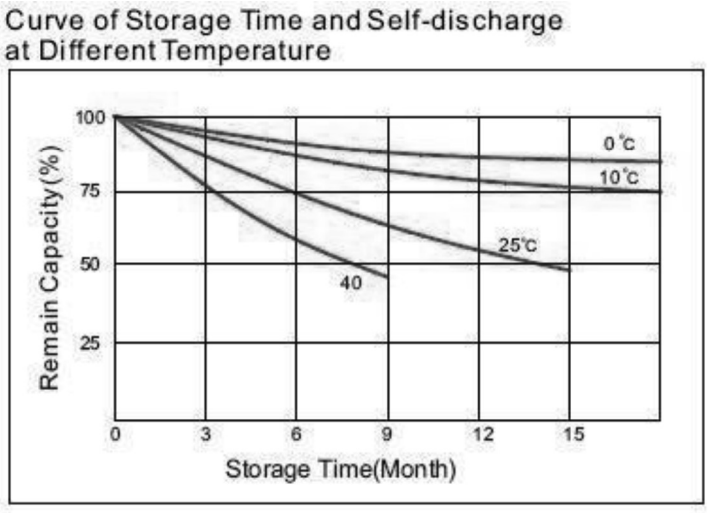
1 Application Range

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

2 Battery Recharging Requirement

VRLA (Valve Regulated Lead Acid battery) is widely used in telecommunication. The battery is full charged While shipped as its self-character, automatic Self-discharge will occur because of chemical reaction when delivery, this cause battery capacity decreasing, OCV (open circuit voltage) dropping In a certain period, the voltage and capacity have to be renewed by proper methods. Requirements of self-discharge describe in the domestic and overseas battery standards. For example, YD/T 799-2010 prescribes: battery capacity should be not less than 96% of its rated capacity after 28 days storage under the normal temperature; IEC60896-2 prescribes: capacity for fully charged battery should be not less than 70% of its rated capacity after 6 months storage under the temperature 20°C ~ 30°C. From the above, we can see that long time storage will much influence the battery capacity.

The external effects on battery are temperature and storage time. The temperature is higher, the self-discharge rate is more; the storage time is longer, the self-discharge rate is more. See the figure below, it shows the self-discharge rate under different temperature and storage time.



Therefore, long time storage batteries need recharge in order to recuperate the discharged capacity. The requirement of interval is below for recharging battery under different temperature.

Storage temperature	Longest interval
over 30° C	once 4 months
under 30° C	once 6 months

The recharging interval is shorter, battery capacity is more renewed, the recharging time is shorter, and there is less effects on battery life. If the recharging interval exceeds the prescriptive time, the batteries should be cycled with charge and discharge for at least once time.

3 Battery Recharging Method

3.1 Recharging Parameter

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

a) Charging mode: equalizing charge;

b) Charging voltage: (2.35±0.02)V/cell, for -48V system, charging voltage is 56.4V;
Charging voltage (made up with 12V monobloc) = 2.35 × 6 × battery quantity
Charging voltage (made up with 2V monobloc) = 2.35 × battery quantity

c) Current limited: $0.05C_{10}$ (A);

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

3.2 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 reach the cut-off condition. At the last one hour before finish, test the battery voltage one by one, the battery which voltage is below 2.16V/cell should be delt with the method in chapter 3.3, if that battery still can not accord with the requirement, it should be rejected.

3.3 Cycle Procedure

We can use the method as below to recharge the batteries with 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. If the capacity still can not be renewed by this method, this means the batteries fail because of long time storage.

3.4 Battery Capacity Test Method

If we cannot 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 when the voltage reaches 1.80V/cell. The time is very important for capacity calculation.
3. Stop discharging when all the battery voltages are below 1.80V/cell. Immediately recharge the batteries for 24 hours with constant voltage of (2.35±0.02)V/cell and current limited of $0.15C_{10}$ (A);
4. 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 again; If it is less than 80% of rated capacity, the fully charged battery be discharged for another time to test capacity, if it is still less than 80% of rated capacity, then the battery already fails and cannot be used.

Remark:

1. C_{10} means 10 hour rate capacity, generally it is the same with rated capacity, for example, for 2V300Ah battery, its rated capacity C_{10}＝300, for 12V100Ah battery, its capacity C_{10}＝100;
2. Usually there is only 1 cell in 2V monobloc and 6 cells in 12V monobloc;
3. The total charging voltage must be less than the maximum voltage of the charger, if there are many batteries, please charge time after time;
4. Current limited means maximum current during the process of charging, $0.05C_{10}$ means 0.05 times rated capacity. For example, the current limited of 2V300Ah battery is 0.05 × 300＝15A;
5. The precision of current during charge and discharge should be less than 1%;
6. Especially: for battery, storage should be not more than 6 months, because it is harmful to battery capacity and life, though the capacity can be partly renewed, service life cannot be renewed, this will affect the performance of warranty. Therefore, the battery should be used within 6 months after delivery as best as you can.

4 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	ampere meter	Precision: less than 3%	Test charge and discharge current
4	monkey spanner		Tightening the screws
5	screwdriver		Prize up battery top cover

5 Attention Proceedings

1. Use battery testing equipment to recharge batteries, if there is not, the power system can be used. Pay attention to the parameter of charge and discharge.
2. In order to prevent exceptional condition, person 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 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 2.35V/cell and current limited of $0.15C_{10}$ (A) should be not more than 24 hours.

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GFM 系列阀控式密封铅酸蓄电池用户手册

GFM Series Valve-Regulated Lead-Acid Battery User's Manual

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