VRLA AGM

Installation and

Operating Instructions

HCB TECHNOLOGIES

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Section 1- **GENERAL INFORMATION**

Synergy products are manufactured under the guidelines of the ISO 9001 quality system. Each battery undergoes a series of strict manufacturing and quality control processes before shipment.

Section 2- **SAFETY PRECAUTIONS**

2.1 Safety Alert

CAUTION

Before proceeding with the unpacking, handling, installation and operation of this sealed lead acid storage battery, please read the following recommended safety precautions.

2.2 Sulphuric Acid Burns

DANGER SULPHURIC ACID BURNS

Batteries contain sulphuric acid, which can cause burns and other serious injury.

If you or a workmate come in contact with sulphuric acid, remove contaminated clothing, irrigate thoroughly in clean water for at least 15 minutes, and seek medical assistance immediately!

When working with batteries, wear a rubber apron and rubber gloves.

Wear safety goggles or other eye protection. These will help to prevent serious eye or facial injury.

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2.3 Explosive Gases

DANGER EXPLOSIVE GASES

Batteries can generate explosive gases, which can cause blindness and other serious injury in the event of an explosion. If the safety vent opens while gases are being generated (e.g. in the event of a charger malfunction), inflammable gases will be released.

Always keep sparks, flame and lit cigarettes away from the battery storage area.

NOTE: In case of a sulphuric acid spill, an emergency spill kit should be within the battery storage area. Contain using sand, earth, inert material or vermiculite. Neutralise with soda ash or lime, and then wash down the affected area with water.

Prevent acid from entering drains, sewers, streams or other bodies of water. If contamination of sewers or waterways has occurred, advise the local emergency services.

2.4 Electrical Shocks and Burns

DANGER ELECTRIC SHOCK AND BURNS

All installation tools should be adequately insulated with vinyl electrical tape or suitable non-conducting material to minimize the possibility of shorting across connections.

Never lay tools or other metallic objects on the batteries as shorting, explosions and/or personal injury may result.

Multi-cell systems attain high voltages: extreme caution must be exercised during installation of a battery system to prevent serious electrical burns or electrical shock.

Loose or dirty connectors and connections can cause battery fires. Keep all connectors and connections clean, and torqued at proper values. Keep the exterior case of batteries clean and dry. Neutralize any acid corrosion with a cloth, moistened with a solution of baking soda and water, then wipe off all traces of soda.

Do not move or shift racks/cabinets once installed without first disconnecting the load to rack/cabinet and all inter-rack/cabinet connections. Consult wiring diagrams for location of these connections.

BEFORE working on the system:

1. Disconnect ALL loads and power sources to the battery. Use appropriate lockout/tagout procedures.

2. If working on an assembled battery system, sectionalise (interrupt the battery sections) into safe working voltage levels.

3. Check the battery system grounding. Grounding of the battery system is NOT recommended. However, grounding of the rack is recommended.

IF BATTERY SYSTEM IS GROUNDED:

(System is intentionally grounded by connecting a battery terminal to ground)

1. An increased shock hazard exists between the terminal of opposite polarity and ground, (i.e., dirt and acid on top of battery cell touching rack).

2. If an unintentional ground develops within the already grounded system, a short circuit may occur and cause explosion or fire.

IF BATTERY SYSTEM IS UNGROUNDED:

1. If an unintentional ground develops within the system, an increased shock hazard exists between the terminal of opposite polarity and ground.

2. If a second unintentional ground develops within the already unintentionally grounded system, a short circuit may occur, and cause an explosion or fire.

If you need to work on a grounded battery system, make absolutely sure you use the correct safety precautions, equipment and clothing.

2.5 Important Message

If you have ANY questions concerning safety when working with the battery system, contact your nearest **Synergy Sales/Service** representative to clarify any of the stated safety precautions.

Section 3- **BATTERY SHIPMENT**

3.1 Delivery Inspection

Immediately upon delivery, examine for any damage caused in transit. Damaged packing material could indicate rough handling. Make a descriptive notation on the delivery receipt before signing.

If cell or unit damage is found, request an inspection by the carrier and file a damage claim immediately. Any battery with post or seal damage should be replaced.

3.2 Visible External

Immediately upon delivery (while the carrier representative is still on-site), inventory all materials against the Bill of Lading and inspect for visible external damage.

Check material quantities received against the Bill of Lading, including the number of battery pallets and the number of accessory boxes.

Note any:

Damage to packing material

Wetness or stains, indicating electrolyte leakage

If damage is noted:

1. Make a descriptive notation on the delivery receipt before signing.

2. Request an inspection by the carrier.

3. File a damage report.

3.3 Concealed Damage

Within 15 days of receipt, unpack the cells/batteries and check for concealed damage. Remember, you are handling a LIVE battery.

Take precaution against a shock hazard. Follow all safety precautions as noted in Section 2.0.

Note any:

Damage to packing material

Wetness or stains, indicating electrolyte leakage

Section 4- **STORAGE PRIOR TO INSTALLATION**

1. Store batteries indoors in a clean, dry and cool location. Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and life.

2. Do NOT stack pallets directly on top of batteries. Damage may occur and the warranty may be voided.

3. The maximum storage time from shipment to initial charge is six months for batteries stored at ambient temperatures no warmer than 25°C. For storage temperatures greater than 25°C, the battery must be recharged one month sooner for every 3°C increase above 25°C. *See Table 4.1.*

TABLE 3.1

STORAGE TEMPERATURE	STORAGE TIME
0°C to 10°C	9 months
11°C to 25°C	6 months
26°C to 33°C	3 months

If storage time exceeds the storage time recommended in Table 3.1, give the battery a freshening charge before the end of the recommended storage interval. *See Section 7 for charging information.* Synergy VRLA AGM batteries must be charged in the horizontal position. Charging in the vertical position may void the battery warranty.

4. Repeat the freshening charge for each additional storage interval, until the battery is installed. Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and life. Storage times exceeding the above may result in plate sulphation, which may adversely affect electrical performance and expected life.

5. Maximum total storage time prior to installation is two years from date of shipment from the factory to the customer. Freshening charges are required before the end of the storage time period, or more frequently, as noted in Table 3.1.

6. Failure to charge as noted may void the battery warranty.

Section 5- **INSTALLATION**

5.1 Usage Guidelines

- Temperature range: Charge 0~40°C
- Discharging: -20~55°C
- Storage: -20~50°C
- Avoid sparks, flame and sources of heat near the battery
- Avoid installing in direct sunlight or very hot environments
- Avoid installation in wet or high humidity environments
- After a long storage period, charge the batteries before use

5.2 Usage Conditions

A maximum of 4 strings is recommended for parallel connection installations

Multi-layer assembly temperature between layers should be controlled to within 3°C

Allow approx. 10mm between battery casings to disperse heat

Adequate ventilation must be available to ensure the concentration of released hydrogen is less than 0.8% by volume

Optimum ambient temperature is 5~35°C

Float use: limited current=0.3C10A, voltage 2.23~2.27V/Cell, at 25°C

DO NOT install a mixture of new and old batteries, or batteries from different manufacturers. If this is required, please contact us for a safety assessment

5.3 Battery Handling Procedure

Avoid any impact or force to the battery terminal, and to the sealed casing

Do not place or store the battery upside down

Avoid handling or securing the battery with metal or wire (e.g. steel rope) to prevent short circuits

Inspect outer packaging of battery for damage before use

5.4 Notice before Installation

If installing a battery in an enclosed housing, try to place it in the base of the housing, leaving some “headspace”

Avoid enclosing the battery near a transformer or other heat-producing components

Avoid installing the battery in an enclosed space with spark-producing componentry, such as fuses

Before connecting, clean the battery terminals to expose bright metal

Be careful not to short-circuit the positive and negative terminals with any type of conductive material or tools

When multiple batteries are used together, first connect the batteries correctly, before connecting to a charger or load

When connecting a charger, the battery positive terminal should be connected to the positive terminal of the charger or load, and the battery negative connected to the negative load terminal. Incorrect connection may damage your battery charger

Don't use extreme force on the terminals when connecting

Ensure every connecting nut and screw is correctly tightened - please refer to the torque values in Table 1.

Table 1 Suggested Torque Table

Range	M5	M6	M 8
Torque	3.1~4.2N*m	3.9~5.4N*m	11~14.7N*m

5.5 Installation

Ensure that the racks, cabinets, or shelves are stable before installing the cells/batteries, do not use grease on the racks and ensure that the batteries are installed in the approved orientation

Avoid open flames, electrostatic discharges, sparks and short circuits with clothing, jewellery, wristwatches and tools when installing and operating the batteries (Remove jewellery and wristwatches)

Never lay tools or other metallic objects on batteries

Do not reach or lean across batteries on step racks

Remember, hazardous voltages are present

Be aware of what you are touching at all times

If the units need cleaning only use a water damp cloth, do not use chemicals, solvents or sprays

Maintain a gap of 10mm between individual units

DO NOT try to remove the vents and add water to PG batteries, this is very hazardous and will void the warranty

Check unit polarity and voltage before making inter-unit connections and use specified cables and accessories only

Install the inter-tier cabling, again checking unit polarity. Attach the inter-tier cabling to the wall or the rack so that the weight of the cable is not on the battery terminal. If using a stiff cable, pre-bend the cable so no 'spring' force is placed on the battery terminals

Failure to support the cable weight could result in a premature battery failure and loss of battery integrity

Within a string, check that all connections are properly made (positive to negative) and measure the total string voltage. Tighten the interconnections onto the terminals to the recommended torque values above

For parallel strings, connect batteries in parallel with cables of similar resistance and only at the end terminals of the strings

Affix number stickers to each unit, starting with no.1 at the positive end of the battery

Make sure the settings of the charger or rectifier are set to the correct float voltage

Power down the charger/rectifier

Finally, connect the main positive terminal of the battery with the positive terminal of the charger/ rectifier

Monitor the battery to ensure the operation is proceeding normally i.e. the charge acceptance of the battery is reducing, the batteries are not overheating and are within 3°C of each other and the ambient temperature

Section 6- **INITIAL and/or FRESHENING CHARGE**

During delivery and storage, the battery capacity will decrease due to self-discharge, so a supplementary charge before use may be required

If the battery has periods of inactivity during normal use, it will require supplementary charging at regular intervals

Refer to the table below for Supplementary charge intervals, and charge before use

Storage Temperature	Charge Time Interval	Supplementary Charge Methods (Optional)
20°C or less	Every 9 months	Charging at a constant voltage of 2.23-2.27V/cell and an initial current less than 0.3C (A) for 2- 3 days
20°C ~ 30°C	Every 6 months	Charging at a constant current of 0.3C(A) and a constant voltage of 2.35-2.45V/cell for 10-16 hours
30°C ~ 40°C	Every 3 months	Charging at a constant of 0.1C(A) for 8-10 hours

Note Current value C is rated capacity of battery.

For example rated capacity of 12V100AH battery is 100AH,

0.1C10A=0.1*100=10A;

Charge Voltage 12V battery is 2.25*6=13.50V,

6V battery is 2.25*3=6.75V

Section 7- **OPERATION**

7.1 General

The sealed design of the VRLA batteries makes it impossible to measure specific gravity as a state-of-charge indicator. The state-of-charge can be identified to some degree by the amount of charging current going to the battery.

7.2 Determining the State-Of-Charge

The following method can be used to determine the state-of-charge of the battery.

1. Place the battery on charge/recharge following a discharge. Read the ammeter.

The charging current will be a combination of the load current plus the current necessary to charge the battery.

2. The battery becomes fully charged when the current to the battery starts to decrease and stabilize.

3. When the current level remains constant for three consecutive hours, the state-of-charge is approximately 95 to 98%. Full charge can be assumed.

For most requirements, the battery is ready for use.

7.3 Float Operation

7.3.1 Float Charge Parameters

Charge voltage 2.23~2.27V/Cell (25°C, recommend 2.25V/Cell

The maximum charge current 0.3C10A

Temperature compensation coefficient -3mV/°C • Cell (taking 25°C as base point)

Total variation range of charge voltage ±0.02V/Cell

Recommended Charge Voltages for Different Temperatures

Temperature	Float Use (V)
-40°C	2.38-2.43
-20°C	2.34-2.39
-10°C	2.32-2.37
-0°C	2.30-2.35
10°C	2.28-2.33
20°C	2.26-2.31
25°C	2.25-2.30
30°C	2.24-2.29
40°C	2.22-2.27
50°C	2.20-2.25

Notes:

- The voltages of individual batteries in a battery group will show some variance at the beginning of use, after approx. 6 months they become consistent.
- Excessive float voltage or overcharging will shorten battery life
- Inadequate float voltage or undercharging causes inconsistent battery voltages, inability to deliver full load capacity, and will shorten the life of the battery group

7.3.2 Equalization Charging

Due to their sealed maintenance free designs, Synergy batteries do not normally require equalization charges. However, environmental conditions or charger variations may cause voltage imbalances in battery systems. This imbalance can be resolved by a short term equalization charge. An equalization charge is accomplished by raising the charging voltage for a certain amount of time. For Synergy batteries, the following data should be used for equalization charging. (25°C)

Charge Parameters

Charge voltage 2.35~2.40V/Cell (25°C, recommend 2.35V/Cell)

The maximum charge current 0.3C10A

Temperature compensation coefficient -4mV/°C • Cell (taking 25°C as base point)

Total variation range of charge voltage ±0.02V/Cell

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The level of dropping out of the equalizing charge is usually set as 0.01C10A, multiplied by the number of the batteries in a string, when connected in parallel.

Notes:

This step may be omitted during normal float charging, but in the situations outlined below, an equalization charge can be considered. DO NOT exceed 2.37 volts per cell (VPC), or the safety valve may release excess gas into the atmosphere. It is not recommended to use an equalizing charge on a regular basis.

- Capacity loss exceeds 20% of the rated capacity
- Storage period is more than 3 months
- There is a single cell with float voltage less than 2.18V
- Has been float charging for 3-6 months with a laggard (weak) battery
- Battery has operated for more than 1 year under float charging
- Supplementary charge the battery after installation and before use
- Equalization charge the battery *after* doing a capacity test

7.3.3 Cycle Use Charge

Charge parameters
Charge voltage 2.40V/Cell (25°C)
Maximum charge current 0.25C20
Temperature compensation coefficient -5mV/°C • Cell (taking 25°C as base point) Total variation range of charge voltage ±0.02V/Cell
Supplementary charge capacity is 110%~130% of discharge capacity, ambient temperature is below 5°C, if discharge capacity is unknown, please refer to the following table for supplementary charge data:

Table 4 Supplementary Charge

Ambient temperature (°C)	Charge Voltage (V/cell)	Charge time (h)
5	2.31	7
	2.46	4
20	2.25	7
	2.40	4
35	2.21	7
	2.34	4

Notes:

- Charge time is complete when terminal voltage reaches the value specified in Table 4 above, charging at a constant 0.3C10A or less
- If the charge time is longer than the time specified in Table 4, over-charging will result, which will shorten the life of the batteries. If the charge time is shorter than the specified time in the table, the batteries will not deliver the rated capacity

7.4 Notes during Charging

- If charging current during the final period of charging is higher than 0.05C10A, permanent damage to the battery may occur
- Chargers should be constant voltage (CV) type.
- If the ambient temperature is less than 25°C, temperature supplementary should be applied on the voltage, formula is U U25 -K*(T -25)
- Where T = ambient temperature, and K = temperature supplementary modulus

Charging is completed if the battery meets any one of the criteria listed below:

- Charged value is not less than 1.2 times of the released value
- The current is less than 0.005C10A (C10 rated capacity of the battery) during the final period of charging

Section 8- BATTERY CAPACITY TESTING

Since discharge or load testing gives the only real measure of battery capacity, it is recommended that capacity checks are carried out on an annual basis. There are two discharge tests that can be carried out:
1) A ratings test discharge - the intention here is to determine the percentage of battery capacity as compared to the rated capacity. This is typically an 8 hour discharge test.
2) A service test discharge - this test is to determine the battery standby time under the actual load conditions of intended battery usage.

8.1 Test Procedure
The battery test procedure for either test is:

- Ensure the battery is fully charged before capacity testing and that all connections are clean and tight
- Prepare the load bank or test load system. Ensure all temporary cable connections are secure and connected to the proper polarity, and have sufficient current carrying capacity
- Determine the battery temperature by measuring and recording the temperature of each block. Average the readings to determine average battery temperature. Measure the battery temperature in the middle of the side (preferably) or the end wall of the container
- If a ratings test is being performed, the load current or power must be temperature corrected if the battery temperature is significantly different from 25°C. Use the following formula for calculating temperature corrected load
- Just prior to starting the discharge test, measure and record the individual bloc voltages, the string voltage and float current (if available)
- Remove or disconnect the charger from the battery string
- Connect the load to the battery and start a timer. Monitor the string voltage and record the lowest voltage reached and the time reached (this is called the “coup de fouet” and indicates a fully charged battery)
- Record the load current, string and individual cell voltages on a regular basis. A minimum of three sets of readings should be taken

The time interval between sets of readings will vary based on the expected test time. For example, take readings every hour for the first 4 hours of an 8 hour rating test. For the following 3 hours take readings every 1/2 hour. For the last hour, take readings every 15 minutes. For a 15 minute UPS discharge, readings every 5 minutes would be desirable.

- Continue the discharge until the string voltage drops below the endpoint voltage per cell times the number of cells in the string
- Stop the timer and remove the load from the battery
- Recharge the battery using the existing charger or an external charger
- An equalize voltage may be used to reduce charge time
- Record the discharge time and calculate % capacity if a ratings test was performed
- Keep a copy of all the test data with the battery records

Discharge Test Notes:

- The PG series batteries /cells full capacity will be obtained after several cycles
- String voltage should be measured at the battery terminals, not at the load connections
- Accurate meters are essential for correct test results. Ensure all meters, shunts, etc., are properly calibrated before usage

8.2 Discharge

To maximize life it is preferable not to discharge a battery past a certain point called a final discharge voltage. The acceptable final discharge voltage varies with the rate of discharge during the cycle. As a rule of thumb, at high discharge rate and short run time each tolerate a lower final discharge rate. This is because less total capacity is taken from the battery than a lower amp discharge over a longer period.

Final discharge protective voltage as below:

Final Discharge Voltage

Discharge current	Final discharge voltage (V/cell)	Remarks
0.2C(A) or less	1.80	1. Current value C is rated capacity 2. Current discharge rate should be not less than 0.05C(A)
0.2 ~ 0.5 (A)	1.75	
0.5C ~ 1C(A)	1.70	
Above 1C(A)	1.60	

The maximum allowable discharge current does not exceed the value below
Discharge current I 1C10A, continuous discharge;
Discharge current I 3C10A, discharge time T 2min;
Discharge current I 6C10A, discharge time T 10s.
Noted: a) Do not let terminal voltage drop past the above specified value; b) Do not store after discharge, please supplementary charge immediately

8.3 Off-System Test Method

a) Isolate the battery group for 1 hour from the system after a full charge, connect to a simulated load and proceed with a discharge test at 10hours discharging rate at an ambient temperature of 25°C ± 5°C.
b) Terminal voltage, ambient temperature, time should be tested before discharging
c) Terminal voltage, discharging current, room temperature should be tested and recorded during the discharging period. Testing interval is 1 hour, discharging current must not exceed 1% of the stipulated data. Terminal voltage of the battery and room temperature should be tested and recorded during the discharging period. Test interval is 1 hour. Be ready to record results at the 1 hour point when target voltage is almost reached, so the discharging time is recorded correctly.
d) Discharging current multiplied by discharging time equals the capacity of the battery. When the battery is discharged at the 10hour rate, but the temperature is not 25°C, then it should be calculated according to the formula below, using the capacity obtained in the test.

Ce=Cr/ 1+K(t-25) ----------(A)
In this formula, t refers to the temperature; K-refers to the temperature modulus (K=0.006/°C when discharging at 10H discharging rate,
K=0.008/°C when discharging rate is 3H. K=0.01/°C when discharging rate is 1H.
Temperature corrected load = load at 25°C x CF, where CF is the capacity correction factor for temperature.

Test Temperature (°C)	Correction Factor(CF)
0	0.78
5	0.84
10	0.89
15	0.94
20	0.97
25	1.00
30	1.03
35	1.05

If the service test is being performed, no temperature correction is necessary.
E) Battery should be recharged by 1.2 times of the original after finishing discharge.

8.4 On-System Test Method
a) In the direct current power system, adjust the output voltage of the inverter to protection voltage (e.g. 46V), supply load to the batteries, then find and test the battery with the lowest voltage, and worst capacity.
b) Power on the inverter and charge the battery, then wait 1hour after full charge.
c) Proceed with testing at 10hour discharging rate on the worst battery (see a)). Terminal voltage, temperature, discharging time, and room temperature should be tested and recorded before and after the test.
Be ready to record results at the 1 hour point when target voltage is almost reached, so the discharging time is recorded correctly.
d) Discharging current * discharging time= capacity of the battery group. If the room temperature is not 25°C, the capacity should be calculated according to the formula outlined in section 8.3.
e) After finishing the test, supplementary charge the battery to recover its capacity.
f) Draw the discharge curve according to the test data.

8.5 Check-Aimed Discharge Test Method
To confirm the capacity of the battery group at any time, it is necessary to proceed on the check-aimed discharge test.
a) In a DC power supply system, adjust the output voltage of the rectifier to protection voltage (for example 46V), and the battery supply electricity to communication load. Terminal voltage, temperature, room temperature and discharge time of the single battery should be tested and recorded before and after the battery discharging, until 30-40% of the rated capacity is discharged.
b) Supplementary charge the battery (after discharging) - the charged value should be 1.2 times the discharged value.
C) Draw the discharge curve according to the notes, and keep a record for comparison with future tests.

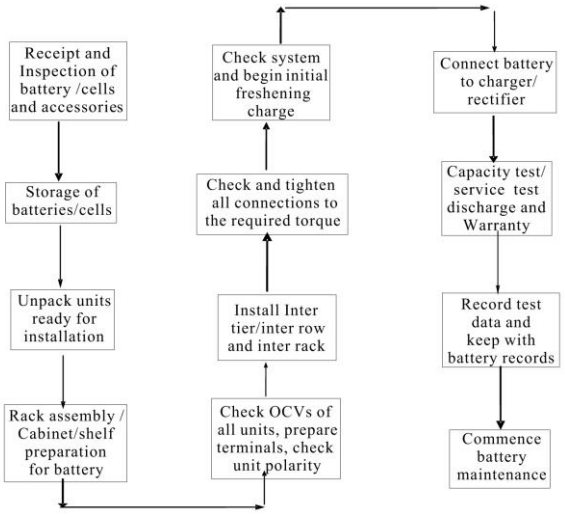
Remarks:
1) The Off-System test method is not recommended for UPS system battery groups.
2) When operating the On-System test method and Check-Aimed capacity test, if the tested UPS equipment is equipped with discharge test capability, it should be the preferred option. If it is without discharge test capability, its AC input should be disabled before beginning the discharge test.

Notes:
1) The above mentioned capacity tests are the most frequently used methods, but whichever test is used, it is very important to keep monitoring the system during the test period. Before starting the test, you should ensure there is a contingency plan for electricity cut-off and have a standby generator ready to go.

2) Apply a multi-meter, or ammeter to record a baseline result before the capacity discharge test. 3) To ensure accuracy of the capacity test, professional test instruments and simulated load methods should be used.

8.6 Assessment of Laggard (weak) Battery
Terminal voltage of a laggard battery is lower than standard, so it should be tested under discharge conditions. If the terminal voltages of a particular battery are lower on average during a three cycle discharge test, it is most likely to be the laggard battery of the group. An equalizing charge should be carried out when a laggard battery is diagnosed.

Section 9- BATTERY SYSTEM INSTALLATION FLOW CHART



Section 10- **BATTERY MAINTENANCE**

10.1 Cleaning

Keep the battery surface and its installation environment clean and dry.
Keep battery clean and avoid static condition.
Clean the battery with a wet cloth, do not use organic solvents e.g. gasoline, alcohol etc. or cleaning cloths contaminated with these substances to clean the battery.

10.2 Inspection and Maintenance

To maintain optimum operation of battery and equipment, please periodically inspect the battery and record inspection dates and data.

10.2.1 Monthly Inspection items:

Items	Content	Standard	Maintenance
1. Float charging voltage of battery string	Measure output end voltage of positive and negative end of battery string with a voltage meter.	1. Tested data complies with the data displayed on the meter and meets the voltage standard at the correct temperature 2.The error of float charge voltage after temperature supplementary is 50mV	1. If data obtained by testing is out of specification, treat the tested data as correct. 2. If checked by monitor module and battery is still out of acceptable range after module adjustment, send battery for repair or warranty
	Inspect battery case and cover for bulging, leakage or damage.	Normal	Investigate if appearance is abnormal

Items	Content	Standard	Maintenance
2. Appearance of the battery	Inspect for dust or marks	Clear	Clean the dust or marks with wet cloth.
	Inspect the harness and terminal etc. for corrosion or buildup.	No corrosion or buildup	Clean the corrosion, change the harness and use an anti-rust agent.
3. Temperature of the battery	Test the Temperature of the terminal and battery surface by infrared thermometer.	Under 35°C	Check the temperature is not higher than standard value
4. Connection	Check for loose bolts/screws	Must be tight (please refer to the torque table)	Tighten loose bolts/screws promptly
	Check terminals are clear of the connection rack/table	No corrosion or buildup	Remove the connection cable and clean it in water for light corrosion. For serious corrosion or buildup, please replace the cable, and clean the connection point with a wire brush before tightening.
5. Check the backup power supply	Cut off the AC power supply to initiate UPS or DC supply	Backup power supply should initiate correctly	Resolve any problems immediately

10.2.2 Quarterly Inspection Items:

Items	Content	Standard	Maintenance
Float voltage of each battery	Measure the end voltage of each battery in the battery group.	Float voltage value after temperature equalization 50mV	If float voltage is higher than standard, please equalization charge the battery group, after discharging them and then float charging for 1~2 months.
Repair batteries with laggard (weak) single cell	1) Equalization charge of the battery group: charge the group at upper limit voltage for at least 10H, 3 discharge cycles are necessary in serious cases. 2) On-line repair of single cell: Connect the charger to the laggard battery and charge the single cell.	The difference in float charge voltage between single cells in a group of batteries should meet the these limits: 2V series 90mV 6 V series 240mV 12 V series 480mV	Single cell should be replaced if the repair process fails.
Activation charge and discharge	Charge and discharge the battery for one cycle, then charge the battery by the lower limit of the equalization voltage.	About 30% of the rated capacity is released.	Do this procedure on batteries which have been float charged more than 6 months, without a discharge.

10.2.3 Annual Inspection Items:

Items	Content	Standard	Maintenance
Checking discharge test	Cut off AC power supply, discharge battery with load, and discharging 30%~40% rated capacity.	Battery voltage should be over 1.90V/Cell after discharging.	If battery voltage is lower than standard, please equalization charge the battery group after discharging and then float charging it for 1~2 months.
Capacity test	Use an on-system capacity test instrument or simulated load discharge battery and discharge 60-80% of the rated capacity.	More than 80% of the capacity is reserved	Record the parameters during the discharging test, if a laggard (weak) battery is found, please see relevant procedure.

10.3 Basic maintenance requirements

10.3.1 Always wear insulated gloves when handling batteries to avoid electric shock. Make sure metal tools are insulated.

10.3.2 Only use instruments and meters that are correctly calibrated, and give reliable results.

10.3.3 Physical Checks

a) Check that the terminals and connections are clear of corrosion or build-up. If corrosion is evident, please clean/remove it to help reduce resistance.

b) Check for loose connections, and tighten if required.

c) Check for visible acid climbing, leakage of liquid, and if there is liquid overflow around the safety valve.

d) Check the battery case and terminals for damage, leakage or visible distortion.

e) Check for abnormally high temperature of the battery and connections.

10.3.4 Check and adjust parameters.
a) Check that the float voltage, equalization voltage, and float charging current are within specifications, for the battery environment onsite. If not, please take prompt action.
b) Check whether the limited charge current set for the battery is correct, if not, please take prompt action.
c) Check the alarm voltage (low voltage and high voltage alarm) set for the battery is correct. If not, please take prompt action.
D) If there is an off-load set, please check the off-load voltage is correct, if not, please take prompt action.

Section 11- BATTERY REPLACEMENT

11.1 Replacement Criteria:
If the battery is discharged to 80% (refer to the corresponding discharge rates, such as C20, C3 etc.) of rated capacity, OR the voltage is below 1.80V/cell (the discharge rate for 1 hour is 1.75V/cell), the battery should be replaced.
11.2 Service Life
The VRLA battery has a finite service life. It is best practise to replace the old battery before the expected lifetime expires, so that the application can run safely and within specifications.

Section 12- SAFETY WARNINGS

- Make certain batteries are inaccessible to children
- Do not use batteries for applications other than those specified by the manufacturer
- DO NOT attempt to disassemble, repair, or modify discarded batteries! This is very hazardous, and may cause acid leaks, explosion, and/or serious injury
- DO NOT dispose of batteries in waterways, or by fire, and do not apply heat to batteries
- DO NOT short-circuit batteries
- If the known voltage of a battery is above 45V, wear insulated gloves for handling, to avoid electric shock
- DO NOT bring your face or eyes close to a battery, and wear eye protection when working with batteries
- Batteries contain sulphuric acid! DO NOT allow sulphuric acid to contact skin, clothing, and especially eyes. If you or a workmate come in contact with sulphuric acid, remove contaminated clothing, wash thoroughly in clean water for at least 15 minutes, and seek medical assistance immediately!

Section 13- **BATTERY MAINTENANCE RECORD**

Battery/Cell Type_____
Installation Date_____
Battery Location_____
No. Of Strings per Battery_____
No of Cells per String_____

Battery on Float
Date: _____
Time: _____
Battery Overall Voltage (Volts) _____

Battery Discharged
Date: _____
Capacity Achieved (Ah) _____
Charge Current (Amps) _____

Battery Equalised
Date:_____
Duration: _____
Ambient Temp (°C) _____

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