VALVE REGULATED SEALED LEAD ACID BATTERY

Castle Series

Operation and Maintenance Manual

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Content：

1. Important Safety Instructions

Please read this operation manual carefully. It offers very important safety instructions, installation and operation guide, and ensure your equipment with best performance and prolong the service life of your equipment.

When working with any battery system, be sure you have the necessary tools and safety equipment, including but not limited to:

- insulated tools
- rubber apron and gloves
- face protection/face shield
- safety goggles
- fire extinguisher
- emergency eye wash and shower, if available
- acid spill cleanup kit

- For the sake of your safety, please do not attempt to remove the components of the battery. The maintenance of the battery can only be carried out by service engineers specially trained by the principal.
- Considering the potential harm of the lead component to the health and environment, the battery can be replaced only by the service center authorized by the manufacturer. To replace the battery or maintenance equipment, please call the after-sales service hotline for information of the nearest service center.
- Please check the local regulations on the correct way of dealing with battery disposal or send the battery to the authorized service center for replacement.
- Battery replacement should be operated or supervised by engineers who are experienced and aware of the preventive measures on the potential harm of the battery.
- Avoid any possible reasons for shorting, explosions and personal injury.
- Warning - Do not smoke and refrain having fire near the battery.
- Warning - Do not use any organic solvent to clean the battery.
- Warning - Do not have fire near the battery or it may explode.

- Warning - Do not remove the components of the battery as it contains electrolyte that may cause injury to the human body.
- Warning - Battery may cause short circuit. Please remove any watches and jewelry during replacement of the battery, and operate with tools with insulated materials.

				
Electricity danger	Watch Short-circuits	Warning	Read the manual	With adults custody
				
Protecting your eye	Explosion	Do not put batteries into dustbin	Circle use	Fire forbidden

2. Battery storage and using circumstances

✧ **Storage**

- If the battery has high temperature or poor ventilation during storage and delivery, self-discharge will be increased. Therefore, keep good ventilation and keep away from fire, flame, water and heat supply etc.
- When storing the battery, disconnect charger and load, Store in dry and cool conditions.
- After storing for any certain time, please charge the batteries before use.

✧ **Using circumstances**

- No fire, flame or heat supply should be near the battery;
- Avoid operating near heat supply and in direct sunlight;
- Avoid operating in humid / damp locations;
- Do not operate in sealed enclosed or without ventilation.

3. Using conditions

- ✧ Temperature range:
  - ➢ Charging: 0 ~ +40℃
  - ➢ Discharging: -15 ~ +50℃,
  - ➢ Storage: -15 ~ +40℃;
- ✧ Optimum ambient temperature: +20℃~ +30℃.
- ✧ Parallel connection: recommended within 4 groups;
- ✧ Multilayer installation: temperature among layers should be controlled within 3℃;
- ✧ Heat dispersing: maintain 20mm inter-bloc distance between batteries.
- ✧ Ventilation: Ensure batteries are stored and used in ventilated conditions.
- ✧ Float charge (25℃) : limited current ≤0.30C_{10}, voltage 2.23~2.27V/cell
- ✧ Equalizing charge (25℃): limited current ≤0.30C_{10}, voltage 2.35~2.40V/cell
- ✧ Mixing batteries: Do not mix new and old batteries, batteries from different manufacturers, if required consult Santak technical support.

4. Installation of batteries

4.1 Unpack and check

- ✧ Delivery: Prevent any force on the terminal; do not tamper with any seals.
  Do not place upside down, Do not throw or cause any impact to the battery;
  Do not cause any metallic short circuit.
- ✧ Inspection: packaging / appearance of battery for signs of damage;
- ✧ Check parts list: battery quantity; accessories;
- ✧ Reference: catalogue; installation drawing; other notices.

4.2 Notices before Installation

- ✧ If no abnormity after check, install the batteries in the designated position;
- ✧ If installing the batteries in the battery chamber, place them starting at the bottom of chamber;
- ✧ Avoid installing the batteries near any heat supply such as transformers or heat exhaust of other equipment;
- ✧ A battery may cause flammable gas during storage, avoid enclosing with any apparatus which produce flames / sparks;
- ✧ Before connecting, clean the terminals to bright metal;
- ✧ Ensure that no conductive material can connect between positive and negative terminals;
- ✧ Before installation all tools are insulated.

4.3 Installation and connection

- ✧ Use insulated tools only;
- ✧ Connect batteries, then connect battery group with charger or load;
- ✧ When multi-group batteries are parallel connected, connect in series first and then parallel connection;
- ✧ To ensure good ventilation, the batteries per row should keep around 10 - 20mm inter-bloc spacing;
- ✧ Before connection, clean the battery terminals to bright metal;
- ✧ Before and after connection, apply antirust compound such as petroleum gel on the surface of battery terminal;
- ✧ After batteries are installed, test the voltage of the battery group, if correct link battery to load.

✧ Use correct torque on all terminals, ensuring every connecting nut and screw is secure; see torque settings as table 1.

Table 1 Suggested torque table

S/N	Range	Torque
1	M5	2.0～3.0 N*m (20～30kgf*cm)
2	M6	3.9～5.4 N*m (40～55kgf*cm)
3	M8	11～14.7 N*m (111～150kgf*cm)

5. Use of battery

5.1 Supplementary charge

- ✧ During the delivery and storage, the battery will lose part of the capacity due to self discharge, so please supplement charge before use;
- ✧ If storage occurs before installation / connection, supplement charge regularly; Supplementary charge according table 2 below before use:

Table 2 The time interval of supplementary charge and storage temperature

Storage temperature	Time interval of supplementing charge	Supplementing charge way
20℃ or less	Every 9 months	a) Charging at a constant voltage of 2.23-2.27V/cell and initial current to be less than 0.3C (A) for 2-3days b) Charging at a constant current of 0.3C(A) and a constant voltage of 2.30-2.40V/cell for 10-16 hours c) Charging at a constant of 0.1C(A) for 8-10 hours
20℃ ~30℃	Every 6 months	
30℃ ~40℃	Every 3 months	

Note:

Current value C is rated capacity of battery. Example: rated capacity of 2V300AH battery is 300AH, 0.1C (A) = 0.1X300 = 30A;

5.2 Discharge

Ensure the maximum allowable discharge current does not exceed the value below:

- ➢ Discharge current I≤1C_{10} (A), continuous discharge;

Final discharge protective voltage as table 3 below:

Table 3 Final discharge voltage

Discharge rate	Current of discharge(A)	Final discharge voltage (V/cell)	Testing standard of capacity
10h	1.0I_{10}	1.8	≥1.00C_{10}
5h	1.7I_{10}	1.8	≥0.85C_{10}
3h	2.5I_{10}	1.75	≥0.75C_{10}
1h	5.5I_{10}	1.75	≥0.55C_{10}

Note:

Do not let terminal voltages drop below the above specified values.

Do not store after discharge, re-charge immediately.

5.3 Charge

5.3.1 Float charge

✧ **Charge parameter**

- Charge voltage: 2.25V/cell(25℃)
- The maximum charge current: $0.30C_{10}$
- Temperature compensation coefficient: -3mV/cell
- Total variation range of charge voltage: ±0.02V/cell

Note:

1. All cell/bloc voltages of a battery group have a little difference at the beginning of use, half year later they become matched.
2. Effect from too high float voltage or too low float voltage as below: Too high for a long time (overcharge): life shortened too low for a long time (not charge enough): Cannot meet load and/or make battery voltages inconsistent. The battery group capacity will drop accordingly and life is shortened.

5.3.2 Cycle use charge

✧ **Charge parameter**

- Charge voltage: 2.40 V/cell(25℃)
- The maximum charge current: $0.30C_{10}$
- Temperature compensation coefficient: -5mV/cell
- Total variation range of charge voltage: ±0.02V/cell
- Supplementary charge capacity is 110% ~ 130% of discharge capacity, ambient temperature is below 5℃, if do not know how many discharge capacity, please refer to the following table to supplementary charge:

Table 4 Supplementary charge

Ambient temperature (℃)	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

Note:

1. Charge time is the time when terminal voltage reaches value as the above table shows during charging at a constant 0.30C (A) or less.
2. If the charge time is over the time as above table, it will cause over charge, which will shorten the life of the batteries; if the charge time is less than the time as above table, the batteries cannot meet the normal capacity.

5.3.3 Equalization charge

✧ **Charging parameter**

- Charging voltage : 2.35V/cell (25℃)
- Maximal charging current : $0.30C_{10}$
- Temperature equalization parameter: -3mV/cell
- Variation scope of charging voltage: ±0.02V/cell

Note:

Do not carry this operation under standard float charging. Adopt equalization charging under below situations:

- Discharging capacity is above 20% of rated capacity.
- Lay aside the battery without using it for more than 3 months.
- Float voltage of battery unit is less than 2.18V/cell
- Continuously float charging battery for 3 ~ 6 months or low voltage batteries appears in battery group.
- More than 1 year fully under float operation
- Supplementary charge the battery after installation and before using.
- Equalizing charge the battery after the capacity test.

5.3.4 Notes during charging

✧ Charge current at the end of charge is over 0.05 C_{10}A, which may result in permanent damage on battery appearance and battery life; pay more attention to charging voltage.

✧ The used charger should have digressive automatic constant voltage device, please contact us if use other kind of charger.

✧ If the ambient temperature is not 25℃ , temperature compensation should be applied on the voltage, using the formula is U=U25℃ - K×(T -25)

✧ T—ambient temperature; K—temperature compensation coefficient

✧ Judgment on charge end point, usually, if the battery charge can meet any

one of the below listed condition, it can be regarded as the charge end point.

a) Charged value is not less than 1.2 times of the released value.

b) The current is less than $0.005C_{10}A$ (C_{10} = rated capacity of the battery) during the final period of charging.

c) The current is steady for 5 hours during the final period of charging.

6. Battery maintenance

6.1 Cleanness

- ✧ Keep the battery surface and its working circumstance clean and dry.
- ✧ Keep battery clean and avoid static condition.
- ✧ Clean battery with damp cloth avoiding contact with terminals, no organic solvent such as gasoline, alcohol etc. or clothes with such substance should be used to clean battery.

6.2 Inspection and maintenance

To better understand the operation of battery and equipment and also to prevent battery damage during maintenance inspection, please periodically inspect the battery and record it.

6.2.1 Inspection items per month:

Items	Contents	Standards	Maintenance
Total float charging voltage of battery group	Measure output end voltage of positive and negative end of battery group with voltage meter.	1. tested data comply with the data displayed on the meter and meet the voltage standard under the temperature conditions 2. The error of float charge voltage after temperature compensation Is ≤±50mV	1. If data attained by testing is varies from the standard, the tested data should prevail. 2. For those adjusted by monitor module and still can't reach the allowed error range after module adjustment, repair is to be applied or send them back to factory.
Battery appearance	Inspect battery case and cover for bulge, leakage or damage.	Normal	Find out the reasons if abnormal appearance exist, please change battery if it effects the normal use of battery group
	Inspect for dust or stains	Clean	Clean the dust and stain with damp cloth.
	Inspect the harness and terminal for rust or corrosion.	No rust	Clean the rust, change the harness and paste with antirust coating/paste.

Temperature of the battery	Test the temperature of the terminal and battery surface by infrared thermometer	Under 35℃	Determine reason for temperature being above standard value and proceed on relevant course of action.
Connection Parts	Check the tightness of terminal bolt/screw with torque spanner	Fastness please refer to the table of torque）	Tighten the loosen bolt/screw in time
	Check the connection cable and terminals for dirt and corrosion	Without appearance of corrosion or dirt	Take out the connection cable and clear it in water if it is light corrosion, for serious corrosion please replace the cable and clear the connection point with a steel brush before attaching new connectors
Switch DC power supply	Cut off AC power supply and change to UPS or DC power supply	AC power supply switch to UPS or DC power supply smoothly	Correct the potential difference

6.2.2 Inspection items per quarter

Apart from the maintenance per month, additional articles added as below:

Items	**Contents**	**Standards**	**Maintenance**
Float voltage of each battery	Measure the end voltage of each battery in battery group.	Float voltage value after temperature equalization ±50mV	If float voltage is over standard value, please apply Equalization charge the battery group after discharging them and then float charge them for 1～2 month, please contact us if still have any deviation from standard.

Repair batteries which with laggard single cell	1. Equalization charge of the battery group: charge the battery at upper limit voltage and last more than 10H, 3 times of discharge cycle is necessary when case is serious. 2. On-line repair of single cell: connect the cell the activation meter or charger with the laggard battery and charge the single cell.	The difference of float charge voltage between single cell in a group of battery should meet the below standard: 12Vseries 480mv	Single cell should be replaced if it fails in repair.
Activation charge and discharge	Charge and discharge the battery by one cycle, then charge the battery by the lower limit of the equalization voltage	About 30% of the rated capacity is released.	Produced this text on the batteries which float charge more than 6moths but without discharge.

6.2.3 Inspection item per year

Apart from the maintenance per quarter, additional articles added as below:

Items	**Contents**	**Standards**	**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 value, please equalization charge the battery group after discharging and then float charging

			it for 1～2 month, please contact us if still have any departure.
Capacity test	Adopt the on-system capacity test instrument or fake load discharge battery and discharge 60~80%of the rated capacity	More than 80% of the capacity is reserved.	Take down the parameters during the discharging test, if any laggard battery is found, please proceed to relevant operation.

Requirements:

1) Principle “find out the hidden trouble and insure the safety” Should be complied when make test on the battery.
2) Daily maintenance and performance analysis should be carried out strictly according the processing plan.
3) Battery parameter setting operation should be strictly complied with the maintenance rules and related requirement.
4) Always wear insulated gloves when handling the batteries to avoid electric shock. Make sure the metal instrument is insulated.
5) Use instrument and meters which meet the test requirement.
6) Physical articles:
   a) Check whether the post and connection is clean or not, whether there is any appearance of oxidation or corrosion. In case it is serious, please clear it and reduce the resistance.
   b) Check for any loose connection, if any, please tighten them up.
   c) Check if there is any appearance of acid climbing, leakage of liquid, and whether there is liquid overflow around the safety valve.
   d) Check if there is any damage, leakage and distortion on the battery case and the post; it should be without any damage and distortion.
   e) Check there is any abnormal temperature increase on the battery and its connection.

7) Check and adjust the set of related parameters.

a) Check the float voltage, equalization voltage, float charging current is normal or not on the base of technical parameters and site environment. Please handle it in time.

b) Check the limited charge current set is correct, please adjust immediately.

c) Check the alarm voltage (below voltage and over voltage alarm) of the battery set is correct, if not, please adjust promptly.

d) If there is off-load set, please check the off-load voltage is correct, if not, please adjust promptly.

7. Exchange of Batteries

7.1 Exchange judgments

The batteries are discharged 80% (refer the corresponding discharge rates, such as C_{10}, C_1 etc.) of rated capacity, at the same time, the voltage is below 1.8V/cell (the discharge rate for 1 hour is 1.75V/cell). It should be exchanged.

7.2 Exchange time

The VRLA GEL battery has the certain service life; please replace the old battery with the new one before the end of service life so that the application can run safely and normally.

7.3 Exchange steps

- ✧ **Step 1:** Disconnect the battery's inter-cell connectors and inter-tier connectors.
- ✧ **Step 2:** The batteries remove should be operated from the top to down, such as disassembly one of the top lateral frame to remove the top layer batteries. And then the second top layer. Until all batteries are removed from the rack.
- ✧ **Step 3:** For installing the new batteries and, please refer to the section 6.5;

Note:

Sometimes, the cables need to be reused according to the requirement. Don't hurt the cables during disconnect.

8. Cautions

- ✧ Keep batteries out of reach of children.
- ✧ Do not use batteries for application other than those specified in its specification.
- ✧ Do not attempt to dis-assemble revised, damaged, impacted, disposed batteries, otherwise the battery would leak, get hot, or explode.
- ✧ Do not dispose of the batteries in water, fire, and do not heat the batteries.
- ✧ Do not cause any short circuit
- ✧ If the voltage of battery pack is above 45V, please be sure to wear insulated gloves when working; otherwise, there is a risk of severe electrical shock.
- ✧ Do not bring face close to the top of batteries, please keep a sensible distance when you are measuring and repairing, you must wear safety goggles.
- ✧ There is sulphuric acid in the battery, do not allow contact of sulphuric acid with skin, cloths, especially eyes. If eyes come in contact with sulphuric acid, please wash with a lot of clean water, and consult a physician immediately.
- ✧ Longer service life will be attained when the battery is operated within an ambient temperature range of 20~30℃.

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