POWERED BY Spark Batteries

LEAD CRYSTAL®
BATTERIES

Valve-regulated lead-crystal battery

Energy storage Cells

User Manual

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Chapter 1:

1. **Introduction**

The patented Lead crystal battery technology is based on intense research of the defects and operating characteristics of the lead acid and lead gel batteries, we developed our own trade secret SIO2 composite electrolyte to replace the traditional sulfuric acid electrolyte commonly used in acid and gel batteries. By using our own advance patented battery manufacturing technology and combining it with the new SIO2 composite electrolyte we developed a much more superior battery replacement.

By using the innovative new patented composite Lead Crystal electrolyte technology (our special formula) to completely replace the traditional sulfuric acid, gave a great change to the battery products internal and chemical structure.

During the initial charging cycles, the liquid composite electrolyte reacts with the lead plates. This reaction causes the electrolyte to crystallize. The crystallized electrolyte fixes to the active material on the plates, enhancing the channel for ion exchange, effectively overcoming loss of moisture, plate sulfation and loss of active material. A superior resistance to low temperatures, overcharging and over discharging is a result of the new chemical structure inside the Lead Crystal batteries, this effectively multiplies the products service and cycle life.

The CNFJ range is specially designed for alternative energy storage, it accepts a wide range of charging currents and don’t rely on high currents to start and maintain the chemical reaction, making it the perfect storage battery for solar and wind generators that deliver intermitted charging at variable and interrupted currents.

2. Product Features

The birth of the Lead Crystal battery is a revolutionary technological breakthrough in the battery industry, it solves most defects of the lead acid and gel batteries such as serious environmental pollution, low fast charging ability, plate sulfuric acid sulfation, short cycle life, low temperature performance ability are amongst a few. A lead crystal battery combines all the advantages of long cycle life, high efficiency, low and high temperature resistance, low internal resistance and environmental safety to make it a much more superior product.

2.1 Structure catachrestic

2.1.1 Special electrolyte composition

By using unique blending technology to combine a variety of inorganic salts and organic substances to coordinate a combined reaction to improve the react ability between the electrolyte and the active material on the lead plates, the electrolyte prevents the active material from becoming brittle and falling of the plates improving the cycle life.

After several charge and discharge cycles the liquid electrolyte transforms in to a crystallized state leaving no free liquid electrolyte in the battery, this opens a wide range of installation applications since the risk of electrolyte leakage is eliminated this reaction also improves the products safety making it less harmful to installers and users alike.

2.1.2 Special manufacturing process.

Using pressure filling technology in combination with patented gravity filling containers to fill the batteries with electrolyte and patented terminal connecting equipment these improvements ensure a much more evenly distribution of electrolyte in each cell so also enhancing the performance of the batteries and increasing the efficiency.

2.2 Performance characteristics

1. Long service life.
Twice as long as regular lead acid and gel batteries

2. Deep discharge ability.
Can be discharged to 0 volt and recover under normal charge conditions to 100% capacity within two cycles.

3. Extreme environmental temperature resistance.
Can be cycled in -40 ℃ to +65 ℃ conditions and used as normal, can be operated especially well in the low temperature ranges.

4. Environmentally friendlier.

Classified as non-dangerous, non-explosive and non-radioactive goods by various governmental institutions.

3. Working principle

The main electrochemical reaction during the charge and discharge process of the Lead-crystal battery.

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

lead dioxide	diluted sulf. acid	lead
positive plate	composite	negative plate
active material	electrolyte	active material

lead sulfate	water	lead sulfate
positive	water	negative
discharge material		discharge material

When discharging the positive and negative active material react with the acidic element of the electrolyte and become lead sulfate and water causing the acid density to decrease. When charging the acid that concentrated in the positive discharge material (during discharge cycle) is released back in to the electrolyte at this time the lead sulfate in the positive and negative plate transforms in to lead dioxide and spongy type lead, the acid density in the electrolyte increases.

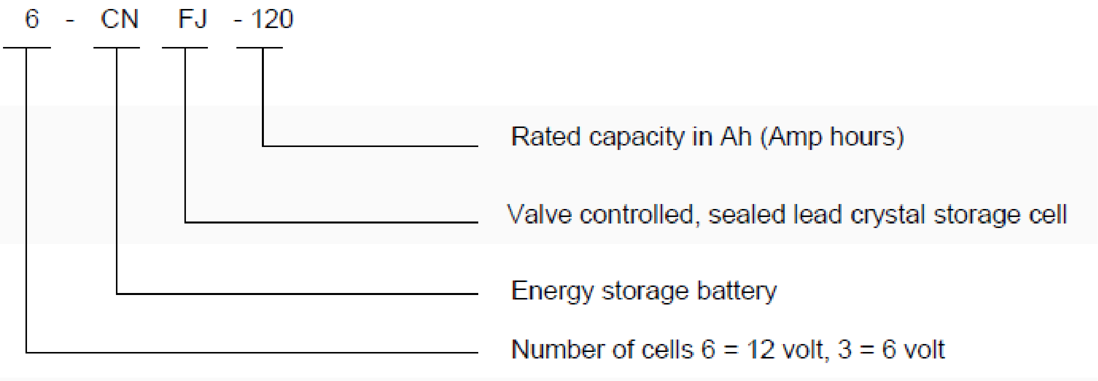
Normal lead acid batteries after charging or prior to charge completion, all the charging current is used for electrolysis of the moisture in the electrolyte, the positive plate releases oxygen and the negative plate hydrogen gas, if the gas recombination efficiency of the battery is low a large percentage of the gas will escape leaving less moisture in the battery after every charge. This action causes the electrolyte content to decrease due to water loss raising the acidity in the battery and shortening the life of the battery. This is known as late charge fluid loss phenomenon.

Lead crystal batteries besides the regular chemical reaction the composite electrolyte has various additives that participate in the electrochemical reaction, the additives inhabits the oxygen and hydrogen gas during the charging cycle increasing the batteries gas recombination rate, this in turn reduces the water loss during and after charging, when discharging the lead sulfate can be totally transformed back in to active material prolonging the batteries use life.

The Lead crystal group of batteries uses a new advanced type of AGM material as a separator, the AGM has much higher electrical conductivity, heat resistant and acid resistant abilities than standard AGM on the market. The crystallized electrolyte in combination with the AGM can effectively protect the plates and prevent the active material from falling off during use, the electrolyte is completely absorbed and stored in the AGM, since the AGM is completely saturated with electrolyte then crystallized, no free liquid electrolyte will be present in the battery. The battery can now be used in various directional positions without leaking.

4. Specifications

4.1 Product specification and model identification method



4.2 Model specification table

Model Number	Rated Voltage V	10hr Discharge rate			120hr Discharge rate			Outer dimension mm ±2mm			Weight kg
		I10/A	Rated capacity Ah	End Voltage V	I120/A	Rated Capacity Ah	End Voltage V	L	W	H	
3-CNFJ-10	6	1	10	5.4	0.12	14.4	5.55	151	50	102	2.0
6-CNFJ-10	12	1	10	10.8	0.12	14.4	11.1	151	99	105	4.2
6-CNFJ-22	12	2.2	22	10.8	0.22	26	11.1	181	76	172	6.9
6-CNFJ-24	12	2.4	24	10.8	0.24	28	11.1	185	105	135	7.7
6-CNFJ-28	12	2.8	28	10.8	0.28	34	11.1	175	166	125	9.0
6-CNFJ-40	12	4	40	10.8	0.48	48	11.1	198	166	172	14.2
6-CNFJ-55	12	5.5	55	10.8	0.55	66	11.1	229	138	220	18.4
6-CNFJ-65	12	6.5	65	10.8	0.65	78	11.1	348	167	175	22.0
6-CNFJ-90	12	9	90	10.8	0.9	108	11.1	306	169	240	28.0
6-CNFJ-100	12	10	100	10.8	1	120	11.1	408	174	235	33.0
6-CNFJ-120	12	12	120	10.8	1.2	144	11.1	408	174	235	37.0
6-CNFJ-150	12	15	150	10.8	1.5	180	11.1	486	170	241	45.0
6-CNFJ-180	12	18	180	10.8	1.8	216	11.1	522	240	244	60.0

6-CNFJ-200	12	20	200	10.8	2	240	11.1	522	240	244	62.0
CNFJ-300	2	30	300	1.8	3	360	1.85	176	154	365	22.0
CNFJ-500	2	50	500	1.8	5	600	1.85	244	175	365	32.5
CNFJ-800	2	80	800	1.8	8	960	1.85	410	175	366	55.5
CNFJ-1000	2	100	1000	1.8	10	1200	1.85	475	175	365	65
CNFJ-2000	2	200	2000	1.8	20	2400	1.85	491	351	383	130
CNFJ-3000	2	300	3000	1.8	30	3600	1.85	712	353	382	192

5. Products standards

Lead Crystal battery products are manufactured to meet the following National and International standards and are manufactured under the ISO 9001 system.

GB/T22473-2008 lead-acid energy storage battery
GB/T19638.2-2005 fixed type valve-controlled sealed battery
Q/TDZG05-2010 fixed type valve control sealed lead crystal battery.
BS 6290 part 4, Telcordia SR 4228, Eurobatt guide, UL, IEC- 60896 – 21/22

Chapter 2: Technical characteristics

1. Discharge characteristics

1.1 Battery capacity definition

Batteries under certain discharge conditions will release a certain amount of current this amount of current released is called the capacity, the symbol used to identify the capacity is “C” the commonly used unit of measure is Amp Hours (Ah). The battery capacity can be divined in to two parts Rated capacity and actual capacity under different discharge conditions. The actual capacity of the battery under certain discharge conditions is calculated by the current (A) multiplied by the discharge time (h) the unit of the result is (Ah).

1.2 Influencing factors on the battery capacity

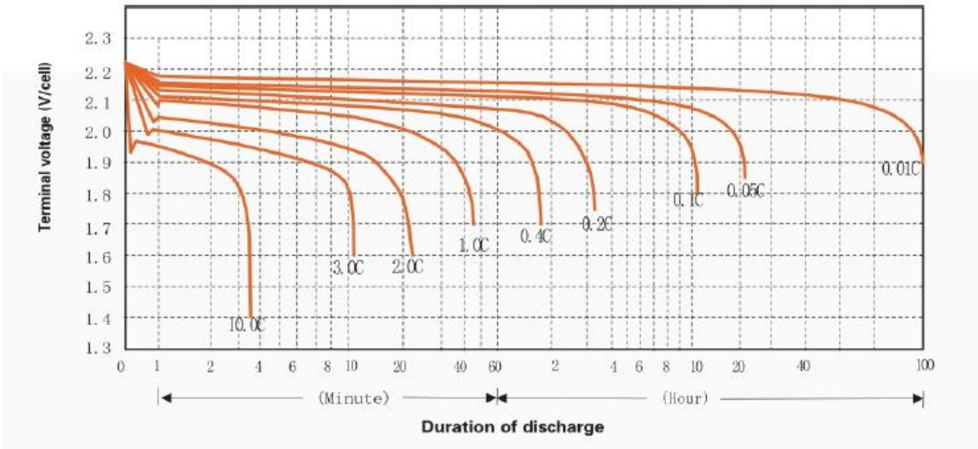
1.2.1 Discharge rate to influence the capacity

The battery discharge rate uses rated hours to determine the discharge time this time is influenced by the amount of current drawn from the battery. If the discharge current increases the discharge time will decrease and also affect the rated capacity.

Hour rated discharge: C10 =10 hour rated capacity (Ah)
C120 =120 hour rated capacity (Ah)

Rate of discharge:	1C = 1 multiplied by the 10 hour rated capacity used for the discharge current (A) 0.01C = 0.01 multiplied by the 10 hour rated capacity used for the discharge current (A)

The curve graph below indicates different constant discharge currents over time of discharge at a temperature of 25 ℃ and its effect on terminal voltage



1.2.2 The influence of temperature on the capacity

In Figure 1 you will notice the effect of temperature on the capacity of the CNFJ series lead crystal batteries. To calculate the capacity of the battery when the environmental temperature is not 25℃ the below

$$Ce=\frac{Ct}{1+K(t-25)}$$

Ct = the actual capacity at a certain temperature

t = the environmental temperature at the time of discharge (℃)

K = the temperature coefficient (10 hour rate coefficient is 0.006)

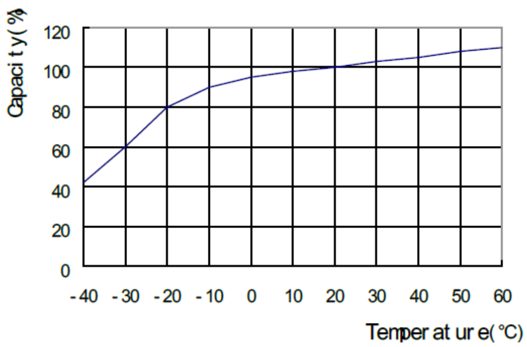


Figure 1: CNFJ series lead crystal cell relationship between discharge capacity and temperature

1.2.3 Discharge termination voltage

The termination voltage refers to the battery voltage dropping during discharge and falls to the minimum working voltage required for operation. The termination voltage and the discharge current are closely related generally during high current discharge the termination voltage of the battery should be set lower.

During long term operation at small discharge currents the battery will form a thin layer of sulfation on the plates increasing their size this could cause deformation of the active material and cause it to fall off the plates. To prevent this and also to protect the battery during small current operations the termination voltage should be set higher.

Over discharging below the termination voltage should be avoided since the over discharging could only gain a small amount of additional capacity but drastically reduce the batteries service life

Discharge current (A)	Discharge termination voltage (V/Cell)
Below 0.05C or non constant discharge	1.9
Equal/close to 0.05C	1.85
Equal/close to 0.1C	1.8
Equal/close to 0.2C	1.75
0.2C ~ 0.5C	1.7
0.5C ~ 1C	1.6
1C ~ 3C	1.5
Above 3C	1.3

1.2.4 Self-discharging of the lead crystal batteries

Lead crystal battery with the use of our unique crystal composite electrolyte and alloy grid plate technology, efficiently reduces the battery self-discharge consumption, at a constant 25℃ environment can be kept on a shelf for more than one year without constant top up charging and the battery will maintain over 85% of its rated capacity.

The self-discharge characteristics of the battery changes with environmental temperatures, the higher the temperature the higher the self-discharge, so the batteries should not be stored in an environment that is subjected to extremely high temperature conditions for long durations of time.

The following table shows the lead crystal batteries self-discharge characteristics, remaining capacity over time:

Storage Capacity (25 °C)	3 months	95%
	6 months	90%
	1 year	85%

2. Charging characteristics

2.1 Charging conditions are the key factors that affect battery life and functionality

The CNFJ range of Lead crystal batteries should be charged using constant voltage for both floating and cyclic charge applications.

2.2 The relationship between charge voltage and environment temperature

The battery benchmark temperature setting should be assumed to be 25℃, under different environmental temperature conditions a temperature compensation coefficient of -3mV/℃/Cell should be applied to the charging equipment this equipment voltage stability factor should be ±1% or higher.

2.3 Equipment setting

During the initial charge and discharge cycles the depth of discharge, discharge current, operating temperature and time of discharge should be recorded, equipment must then be recalibrated to the recorded parameters so to ensure longer life of both the batteries and the equipment. After complete discharge the battery should periodically be fully charged and discharged for at least two complete cycles to ensure full recovery of the batteries capacity, the abovementioned results should be recorded and again adjustment should be made to equipment if necessary.

2.4 Float charging applications

For applications that is constantly connected to the electrical grid and where the batteries are in constant charging state and only discharged when there is a break in or loss of grid supply. The charge equipment should be set to the float charging mode, the equipment should be set and monitored so that strict control can be maintained over charging to ensure a constant charging voltage and current.

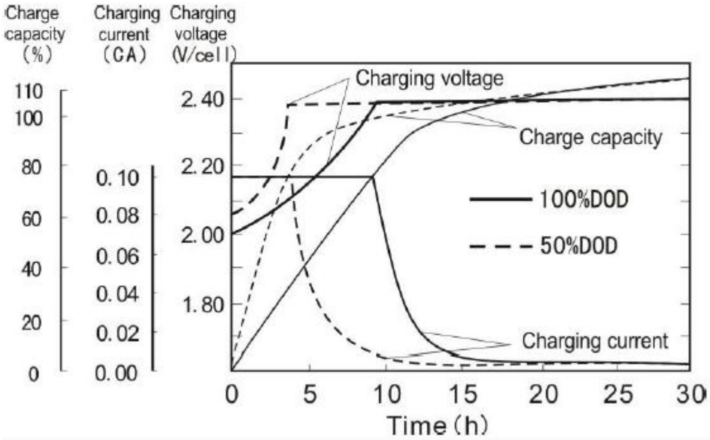
Recommended floating charge voltage should be between 2.25～ 2.3v/Cell and the floating current should be between 0.005 ～ 0.01CA, in long term float charging applications a six monthly balanced charge and discharge should be performed as part of battery maintenance where the balanced cycles should be no more than 8 ～ 12 hours in duration. During the initial charge and discharge cycles on new installations the charge current should be limited to 0.1C ～ 0.25CA (not to exceed 0.3CA) and the temperature not more than 35℃ during this stage of operation an increase of temperature is noticed the charge current should be reduced.

2.5 Cycling charge applications

For applications that is connected to the grid and where the load is transferred to the batteries once they reach state of full charge, the cycling charge mode should be selected on the charging equipment. Recommended cycling charge voltage should be 2.4 ~ 2.5 V/Cell and the initial charge current between 0.1 ~ 0.25 CA

2.6 Charging characteristic curve

The below curve graph shows typical charge characteristics of the lead crystal batteries



Chapter 3： Battery installation

1. Installation method and sequence

1.1 After the batteries is unpacked check for any visible damage to the product.

1.2 Please read this manual before installation to ensure correct installation according to required application and equipment settings.

1.3 Ensure that the batteries remain in the shipping packaging until it arrives on the installation site when the batteries are handled please take care not to lift the batteries by means of the terminals to avoid damage to the internal seals, always lift the batteries by the supplied handles or from the bottom of the batteries in the event that the battery is not designed with or supplied with the required lifting handles.

1.4 Before connecting the equipment to the batteries, use a piece of fine grid sandpaper to sand the contact area of the terminal and the connection lug, this will ensure a good contact between battery and lug and reduce the risk of oxidation.

1.5 When there are multiple batteries connected together in a group (series or parallel) ensure that the voltage of the batteries in the group mach prior to connecting. Ensure the connections on the batteries are secure and the configuration is according to the voltage required to operate the equipment. Before connecting the load charge the batteries to a state of full charge to ensure all the batteries are on the same level, at this point it is save to connect the load.

2. Matters that need attention during installation

2.1 Ensure that all heating and cooling ducts are directed away from the batteries, the installation site should be kept clean, dry and well ventilated at all times. Avoid installing the batteries in direct sunlight, away from a heat source, organic solvents and corrosive gas to ensure longer battery life and to prevent accidents.

2.2 All the lead crystal batteries are fully charged prior to shipping to activate the crystallization of the electrolyte in the batteries, because of this please take care when handling the batteries with great care during transport and prior or during installation to prevent short circuit and reverse connection so not to damage equipment and cause harm to people.

2.3 Because of high voltage and the risk of electrical shock the batteries should be handled with great care during transportation and when being installed. Electrically Insulated equipment and clothing should be used/worn when working on or connecting the batteries.

2.4 Smudgy, oily and loosely connected connections could cause contact problems and lead to faults on the equipment. So please ensure all contacts are clean from oil and grease and that all connections are securely fastened. Terminals should be torque to individual battery specification but not exceed 15 N.m. excessive tightening will cause damage to the thread on or inside the battery terminal. Terminal connections should be check periodically during the life of the battery to ensure that there are no loose connections

2.5 Ensure that the batteries are connected in the correct way, ensure that reverse polarity are eliminated by connecting positive to positive and negative to negative on the equipment, also ensure that the correct size of wire diameter are used according to current drawn requirement if the incorrect wires are used it will heat rapidly and cause damage to both the battery and the equipment that it is connected to.

3. Correct use and maintenance

3.1 Use environment, the batteries are designed to be able to operate in extreme environmental temperatures ranging from -40 ℃ ~ + 65 ℃ yet most installations and best recommended environmental temperatures for use are -5 ℃ ~ + 35 ℃ and a relative humidity of 95%.

3.2 The CNFJ range of batteries can be used in both floating and cyclic charge applications.

4. Charge and discharge regulations

4.1 The CNFJ range of batteries should be charged according to the specified voltages and currents indicated in Chapter 2.

4.2 The CNFJ range of batteries should be discharged according to the termination voltage specified in Chapter 2 and in accordance with the equipment requirements. This will ensure long life of both the battery and the equipment.

5. Battery maintenance

5.1 Perform an inspection of the batteries prior to installation

5.1.1 Check for damage to ABS plastic shell

5.1.2 Check batteries open circuit voltage and calculate the per cell voltage if the voltage is less than 2.1 volt/Cell the batteries should be individually charged to correct the balance

5.1.3 Make a battery maintenance and operation file and record all relevant information during the life of the battery.

5.2 Operating maintenance

5.2.1 Monthly inspection and maintenance

Content	Method	Inspection standard	Solution
The total voltage when the Battery is charging and discharging	Equipment should be calibrated with an deviation of no more than 0.5 volt before testing batteries in a group	Total voltage = charging and discharging voltage x quantity of batteries in the group	Adjust voltage = charging and discharging voltage × quantity of batteries in the group, replace defective battery/ies if individual charging does not bring the voltage back to required level
Controller Charge and discharge voltage	Use the voltmeter to measurement the controllers output voltage, highest charge voltage and over discharge protection voltage	Check if the results meet the required specifications	Adjust the controller voltage parameters
Controller Charge and discharge current	Use the ammeter to measurement the controllers output current, highest charge current and over discharge protection	Check if the results meet the required specifications	Adjust the controller current parameters

5.2.2 Six monthly maintenance and inspection

Content	Method	Inspection standard	Solution
The total voltage when the Battery is charging and discharging	Equipment should be calibrated with an deviation of no more than 0.5 volt before testing batteries in a group	Total voltage = charging and discharging voltage x quantity of batteries in the group	Adjust voltage = charging and discharging voltage × quantity of batteries in the group, replace defective battery/ies if

			individual charging does not bring the voltage back to required level
Controller Charge and discharge voltage	Use the voltmeter to measurement the controllers output voltage, highest charge voltage and over discharge protection voltage	Check if the results meet the required specifications	Adjust the controller voltage parameters
Controller Charge and discharge current	Use the ammeter to measurement the controllers output current, highest charge current and over discharge protection	Check if the results meet the required specifications	Adjust the controller current parameters
Visual inspection of the batteries appearance	Check if there are visible leaking of electrolyte	-	If there is: the battery should be replaced
	Check if the battery is free from dust and pollutants	-	If there is pollutant or dust clean with a moist cloth
	Check if there is water present in the battery container/enclosure and if the terminals and cables are dusty or corroded	-	Find the source of water and repair clean or repair corroded cables if possible replace.

5.2.3 Annual maintenance and inspection

Annual inspection should include six monthly maintenance check and also perform the following procedures and inspections:

Content	Method	Inspection standard	Solution
Terminal connections and cables	Ensure good connection of the nuts and bolts on the battery terminals and connections on equipment	See installation requirements and tighten to individual battery specification	According to the battery specification tighten and torque nuts and bolts

5.3 Maintenance while inspecting the battery

5.3.1 Check for damage, leakage and deformation

5.3.2 Check if there are any loose connections and tighten according to specification if any found to be loose

5.3.3 Check if the voltage over the group is balanced

6. Remarks

6.1 Battery maintenance should be performed by professionals

6.2 Avoid constant over discharging of the batteries

6.3 When batteries are discharged the termination voltage should be set according to the discharging current requirement. The over discharge protection should be set to be +-0.05V lower than the termination voltage to ensure good operation and long life of the batteries and equipment. After the battery is discharged it should immediately be charged again.

6.4 When abnormalities or damage is noticed the problem should be investigated immediately, if the battery was the cause, it should immediately be replaced to prevent further damage.

6.5 When charging the battery the controllers charge voltage accuracy should be less ±1% to prolong battery service life.

6.6 All display instrumentation should be regularly checked and calibrated to ensure accurate reading of measurements. If the equipment can't read an error the equipment could cause damage to the batteries.

Chapter 4: Transportation and storage

1. During transportation please perform save handling of batteries, due to the weight of the batteries it should be handled with care not to drop and throw while loading and unloading.
2. Use appropriate lifting technique while handling the batteries, never lift the batteries by means of the terminals or ventilation valves
3. Note that the batteries are charged and could cause electrical shock to personnel and damaged to the battery and equipment if the terminals are short circuited.
4. The batteries should be stored in a clean, dry and well ventilated place where the ambient temperature is between 5 ~ 30 ℃ batteries should be rotated to ensure on shelf storage is approximately 6 months, longer storage up to 24 months is possible and

would not cause damage to the batteries but it would need to be charged prior to installation.

5. Avoid contact with organic solvents and corrosive liquids. Also prevent metal impurities from falling in to the battery.
6. Keep batteries free from mechanical shock and heave pressures
7. Half used batteries can be stored for future use, it should be charged prior to storage then stored according to save storage practice.

Appendix:

When selecting the appropriate battery for a project the following parameters should be considered and the below formula used to calculate the quantity and size of batteries needed. System output and maximum power, continuous rainy day storage, quantity of solar panels, wind generators or both and the total system current.

To determine the battery capacity use the following formula:

$$C=K1\times W/V\times T\times(d+1)/0.8$$

C = Battery capacity in Ah, K1 = safety coefficient normally set as 1.2, W = the system output power in watt (W), V = the system operating voltage in volt (v), T = daily operating time in hours (h), d = continuous rainy days.