

INSTALLATION, OPERATING & MAINTENANCE INSTRUCTIONS

For Nickel–Cadmium (Ni-Cd) Batteries used in Stationary Applications

Commissioning by:

Date:

Number of cells/blocks:

Model #

SAFETY PRECAUTIONS & WARNINGS

	Familiarize personnel with battery installation, charging and maintenance procedures. Display operating instructions visibly near the battery system. Restrict access to battery area, permitting trained personnel only, to reduce the possibility of injury.
	Wear rubber apron, gloves and safety goggles (or face shield) when handling, installing, or working on batteries. This will help prevent injury due to splashing or spillage of electrolyte. Observe all accident prevention rules.
	Prohibit smoking. Keep flames and sparks of all kinds away from the vicinity of storage batteries as liberated or entrapped hydrogen gas in the cells may be exploded, causing injury to personnel and/or damage to cells.
	Wash all electrolyte splashes in eyes or on skin with plenty of clean water and seek immediate medical assistance. Electrolyte splashes on clothing should be washed out with water.
	Explosion and fire risk. Avoid short circuits. Never place metal tools on top of cells, since sparks due to shorting across cell terminals may result in an explosion of hydrogen gas in or near the cells. Insulate tool handles to protect against shorting. Prior to making contact with the cell, discharge static electricity by touching a grounded surface.
	Electrolyte is highly corrosive. Promptly neutralize and remove any electrolyte spilled when handling or installing cells. Use DI water or a weak acid (vinegar) solution to neutralize spills and to prevent possible injury to personnel.
	Batteries are extremely heavy. Exercise care when handling batteries. When lifting use appropriate mechanical equipment to safely handle batteries and avoid injury to personnel.
	Dangerous voltage. Whenever possible, when making repairs to charging equipment and/or batteries, interrupt AC & DC circuits to reduce the possibility of injury to personnel and damage to system equipment. This is particularly import with high voltage systems (50 volts and above).
	Recycle and Dispose of Used Batteries Used batteries contain valuable recyclable materials. They must NOT be disposed of with domestic waste. Modes of return and recycling shall conform to the prevailing regulations in operation at the site where the battery system is located. Call SBS for recycling options.

Version: 2014-Feb.1

QUICK REFERENCE GUIDE

Cell Type	Flooded Pocket Plate	Valve Regulated Pocket Plate	Flooded Fibre Plate
SBS Series	KPH, KPM, KPL, KBH, KBM, KBL	VRPP, KGL, KGM	KFL, KFM, KFH, KFX
Electrolyte SG	1.20 ± 0.01	1.19 ± 0.01	1.22 ± 0.01

Charging Option A*

*Note: 72hr boost charge required every 3-6 months. In addition boost system for 72hrs when any cells voltage falls below 1.36 volts.

Float Charge:	1.40-1.42 Vpc	1.40-1.42 Vpc	1.40-1.42 Vpc
Boost Charging:	1.54-1.69 Vpc	1.45 Vpc	1.52-1.57 Vpc

Charging Option B**

**Note: Boost system for 72hrs when any cells voltage falls below 1.36 volts. Use Option A Boost charging voltage data.

Float Voltage Range:	1.46-1.49 Vpc	Not Recommended	1.45 / 1.50 Vpc
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Charging Current Limit	.2C ₅ = 20% of C ₅	.1C ₅ = 10% of C ₅	.2C ₅ =20% of C ₅
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Torque Values for SBS Ni-Cd Batteries

Bolt Diameter	Recommended Torque
M5	66 in-lbs (7.5 Nm)
M8	177 in-lbs (20 Nm)
M10	265 in-lbs (30 Nm)

If you have ANY questions or concerns contact SBS Stationary Technical Support.
Early detection and corrections of problems will prevent permanent damage to your battery system!

E-mail: techsupport@sbsbattery.com
Phone: 1-800-554-2243

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SUGGESTED REFERENCES

IEEE-1106-2005

Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.

IEEE-1115-2000

Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications.

IEEE-1657-2009

Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries.

WARRANTY NOTES

Any of the following actions will invalidate the warranty:

- Non-adherence to the Installation, Operating and Maintenance Instructions
- Repairs carried out with non-approved parts or by non-approved personnel
- Unauthorized interference with the battery
- Mixing different types and/or ages of batteries without obtaining SBS's approval
- Application of additives to the electrolyte
- Operating the batteries above 130°F

Any and all problems or abnormalities must be reported to SBS within 30 days of detection. In particular this includes voltage readings that are outside the limits in this manual and are not improving when corrective action is applied. Failure to report ANY problems in a timely manner often leads to permanent damage to the battery and will void the batteries warranty.

1.0 DELIVERY AND STORAGE

Delivery

Unpack the shipment as soon as it is delivered.

Verify that all of the equipment has been delivered and is in good condition. Check quantities against packing slip and accessories list. If there is any damaged or missing product, immediately notify the trucking company as well as SBS.

If necessary, clean all parts before assembling.

For all nickel-cadmium batteries shipped in filled and charged condition remove the transport seal* (red plastic film) from the vent cap prior to installation or charging. Remove the transit polarity caps (blue/red), if mounted on cell terminals as well.

The battery is then ready for installation or storing.

***Warning!** *The battery must never be charged with the transport seal in place as this can cause permanent damage.*

Storage of a NEW Battery in Filled and Charged Condition

Fully charged nickel-cadmium cells have an open circuit voltage of 1.29 +/-0.01 Volts.

Store the batteries in a dry, clean and preferably cool and frost-free location. Do not expose the cells to direct sunlight.

When the batteries are supplied wet and fully charged, storage time is limited. In order to easily charge the batteries after prolonged storage, it is advised not to store batteries for more than:

- 6 months at 50°F
- 3 months at 68°F
- 2 months at 86°F

An equalizing / refreshing charge shall be carried out according to charging section 3.0 after this time or if the average open cell voltage drops below 1.20 Vpc. Alternatively cells can be float charged during storage.

A filled and charged battery can be stored for a maximum period of one year. If in storage for more than 6 months the battery must be discharged to an average cell voltage of 1.0 Volt at 0.2 C₅ Amps, and charged per the initial / commissioning charging procedures. Failure to do this will affect the batteries capacity.

Storage of a USED Battery in Filled and Charged Condition

If the battery is going to be stored for less than one year:

- Fully charge the battery and top up with DM/DI water to the maximum level mark.
- Intercell connectors should be removed, cleaned, coated with anti-corrosion grease and stored in a separate package.
- Clean the battery thoroughly, and then coat the terminals with anti-corrosion grease.
- After removing from storage, the battery should be discharged to an average cell voltage of 1.0 Volt at 0.2 C₅ Amps and then charged per the initial / commissioning charging procedures.

Storage of a USED Battery in Dry and Discharged Condition

If the battery is going to be stored for more than one year:

- The batteries should be fully discharged at 0.2 C₅ Amps, to an end voltage of 0.6 Vpc, and the electrolyte fully drained by inverting the batteries for about 5 minutes. Use a plastic film to seal the flip top vent cap.
- Store the electrolyte in clean, air-tight plastic containers for future use.
- Intercell connectors should be removed, cleaned, coated with anti-corrosion grease and stored in a separate package.
- Clean the battery thoroughly, and then coat the terminals with anti-corrosion grease.
- After removing the battery from storage, fill cells with stored electrolyte, and perform initial / commissioning charging procedure.

2.0 INSTALLATION

The electrical protective measures, accommodation and ventilation of the battery installation must be in accordance with the applicable rules and regulations. This includes layout, safety equipment and warning signs required.

Ventilation

Nickel-cadmium batteries produce hydrogen and oxygen during operation. This is especially true during charging and discharging. These gases result from electrolysis of the water portion of the electrolyte by the charging current. Natural or artificial ventilation should be provided in the battery room, or area, to prevent hydrogen from exceeding a 1% concentration. Concentrations above 4% can result in an explosive mixture, which could be ignited by sparks from adjacent electrical equipment as well as sparks or open flame introduced by personnel. All air moved by ventilation should be exhausted into the outside atmosphere and should not be allowed to re-circulate into other confined areas.

Ventilation requirements vary. Contact your local authority for requirements. Use of a hydrogen detector is recommended.

Location

A battery system should be installed in a clean, cool and dry location. Avoid placing the battery in a warm area or in direct sunlight. Heaters, radiators and steam pipes can cause serious electrolyte temperature variation among cells within a battery system. Freezing will not cause damage to the battery.

The layout and contents of a battery room must allow easy access to the batteries and must comply with all national and local codes.

Handling

SBS Ni-Cd batteries are normally supplied in a fully charged state and must be unpacked carefully to avoid short circuit between terminals of opposite polarity. The cells can be lifted by the terminal posts with appropriate equipment.

At all times exercise caution when handling batteries to prevent damage of the plastic containers and covers. The battery containers and covers are delicate and scratches can lead to weakening of the cases.

Tools

Use tools with insulated handles. Do not place or drop metal objects onto the battery. Remove rings, wristwatch, and metal articles of clothing which may come into contact with the battery terminals.

Removal

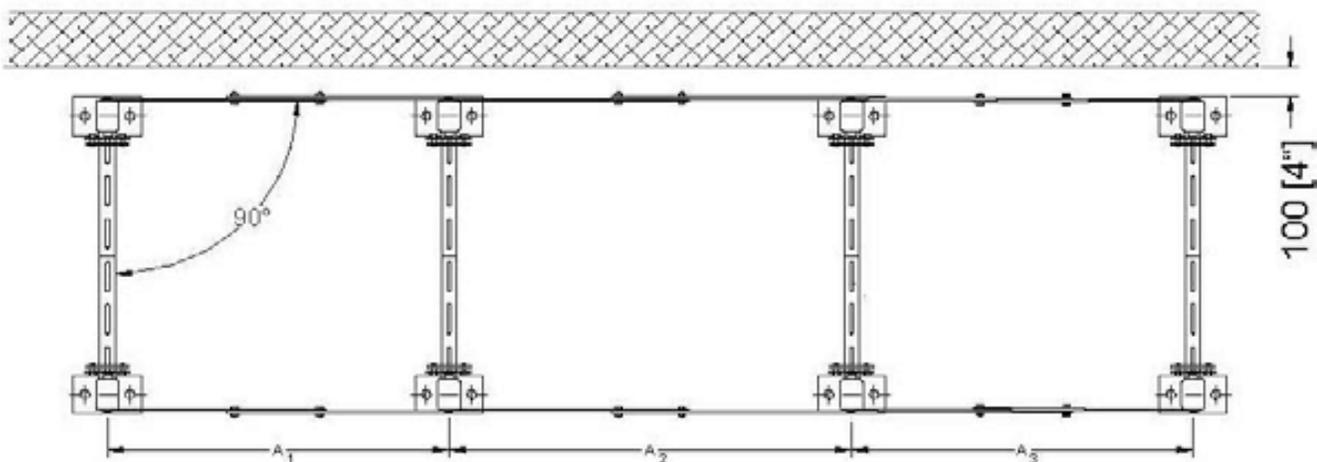
Before removing old batteries, ensure that all electric loads are switched off (breakers, fuses and switches). This must be carried out by a qualified professional. Batteries must be packaged, shipped and recycled per regulations.

Rack and Spill Containment Installation

Choose location to install rack and ensure that the area is clean and level. Make sure the rack rails supplied are insulated.

Assemble rack frame according to instructions supplied. If instructions are missing, contact rack supplier. Adjust rack rail spacing to proper width for the cells that are to be installed on the rack.

Set rack frame in final resting place. If mounting to the floor, mark and then drill anchor holes. Install contractor-supplied anchor bolts and tighten.



If an SBS **Spill Containment System** is supplied the rack will be installed inside the polypropylene spill pans. Polypropylene is acid resistant, extremely strong and can support up to 15,000 lbs. per square inch without degradation of the material. SBS supplies different size spill pans that are 'butted' together in different combinations to form different spill containment system lengths and widths. Flexible connectors are supplied to 'connect' the pans together.

If the rack and spill containment need to be anchored to the floor you will follow the previous rack installation instructions; however, you must also assemble and place the spill containment system under the rack before marking the anchor holes. After the anchor holes are marked, drill through the pans and then drill into the floor. Insert anchor bolts and tighten.

Where needed, caulk hole/bolt with silicon to provide a 100% leak proof spill containment system.

After rack and spill containment system are installed, ensure all bolts are tight and properly torqued.

Optional electrolyte absorbing/neutralizing pillows can be placed in the spill pans after the battery installation is complete.

Installation of Cells/Batteries

Batteries supplied in filled and charged condition are ready for direct installation. If not already done the transport seal (red plastic film) should be removed from inside each vent cap and the transit polarity caps should also be removed and discarded.

Begin installing the batteries on the lower step or tier for stability and safety reasons. Batteries should be placed on the rack as the intercell connectors dictate. Carefully follow the polarity sequence to avoid short circuiting cell groups.

Talcum Powder may be used on the platform surface or rails to ease movement. **DO NOT USE** any other type of lubricant such as Grease or Oil as they may contain mineral spirits which can cause crazing and cracking of the plastic jar material.

Make sure to arrange batteries plumb and level with the correct polarity – see series vs. parallel connection for explanation.

Series Connection – batteries are usually installed in series.

Place the batteries on the rack making sure that the positive terminal of one battery is connected to the negative terminal of the next battery and continue in the same fashion. Make sure batteries are aligned properly.

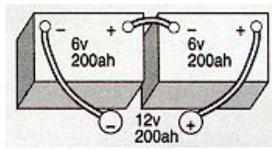


Figure 1: These are two 6 Volt batteries in series to produce 12 Volts. You can add more batteries for a higher voltage, i.e. 24, 48, 130 Vdc.

Parallel Connection – Batteries may be connected in parallel to give higher current capability. In the case of parallel connected strings, use only batteries of the same capacity, design, and age, with a maximum of four parallel strings.

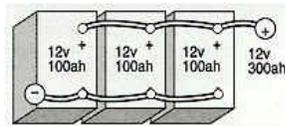


Figure 2: These are three 12 Volt 100 Ah batteries in parallel. They produce 12 Volts with 3X the capacity (300 Ah) of a single battery.

After cells are positioned on rack install intercell connectors and jumper cables. Use the correct torque to tighten the terminal bolts as indicated below. After connections are torqued the connectors and terminal screws should be coated with a thin layer of anti-corrosion grease or petroleum jelly.

Bolt Diameter	Recommended Torque
M6	66 in-lbs (7.5 Nm)
M8	177 in-lbs (20 Nm)
M10	265 in-lbs (30 Nm)

Charger Connection

Before the charger is connected, make sure the cells are clean and double check all connections for correct torque and polarity. Ensure all connections have appropriate internal resistance values.

With the charger switched off, the battery fuse removed, and the load disconnected, connect the battery to the DC power supply. Ensure that the polarity is correct – positive terminal of the battery to the positive terminal of the charger.

Switch on the charger (per charger instructions) and adjust the float and equalize voltages as needed.

3.0 CHARGING

Charging incorrectly leads to the majority of battery problems so it is very important that these charging instructions be followed. Contact SBS should you have any questions related to battery charging.

Over/Under Charging

Over charging within reasonable limits will not damage a nickel-cadmium battery, but water consumption will be increased. A Ni-Cd battery can be left standing for short periods at any state of charge without damage.

Charging Current

Limitation of the charging current is not required under floating condition.

During the initial or an equalize charge, the current should be limited to:

- Flooded Ni-Cd batteries: $.2C_5 = 20\%$ of the 5hr Ah rating of the battery
- Valve Regulated Ni-Cd batteries: $.1C_5 = 10\%$ of the 5hr Ah rating of the battery*

Example: *KPM100P = 100 Ah flooded Ni-Cd battery. The maximum charge current is (20%) $0.2 \times 100Ah = 20$ Amps. If there is a constant load of 2.5 Amps on the system, add 2.5 to the maximum charger current limit: $20 + 2.5 = 22.5$ Amp current limit setting.*

***VRPP Charging Current Warning!** *Using a current higher than 10% of the batteries 5 hour Ah rating will make the VRPP batteries gas more than the recombination vent cap can handle. This will cause increased electro-chemical activity in the cell, which may lead to electrolyte ooze out or 'boil over'.*

Initial / Commissioning Charge

Before initial charge, all batteries must be inspected for physical and/or mechanical damage. Make sure that the batteries electrolyte levels are above the <Min> line. Do not adjust the VRPP electrolyte levels at any time however.

Equalize charge the system for 72hours at a voltage of:

- Flooded Pocket Plate Ni-Cd batteries: 1.54-1.69 Vpc
- Valve Regulated Pocket Plate Ni-Cd batteries: 1.45 Vpc
- Flooded Fibre Plate Ni-Cd batteries: 1.52-1.57 Vpc

If after 72 hours any cells have a voltage of 1.36 Volts or less the system may need to be charged for longer or at a higher voltage. Upon completion of the initial charge place the batteries on float charge and record the following initial reference values. This data should be kept and stored with future test data for warranty purposes.

- Date and time of the completion of the initial charge on the battery system
- All individual cell voltages
- Float voltage of the DC output of the charger as measured on the main (+) and (-) terminals of the battery.
- Float current of the DC output of the charger measured on the cable(s) to the positive post of the battery.
- Float AC ripple voltage and current as measured on the main (+) and (-) terminals of the battery.
- Electrolyte temperature of every 10th cell

Top off all electrolyte levels after battery has been on float charge for a minimum of 24 hours.

Float Charge

When in service batteries should be maintained on float charge and should be fully recharged within 24 hours of any discharge.

There are two options for float charging SBS ni-cd batteries:

Float Option A: System will require a boost charge every 3-6 months

- Flooded Ni-Cd batteries: 1.40-1.42 Vpc
- Valve Regulated Ni-Cd batteries: 1.40-1.42 Vpc

Float Option B: Periodic boost charge NOT required however user may have to add water to the system more frequently

- Flooded Ni-Cd batteries: 1.46-1.50 Vpc
- Valve Regulated Ni-Cd batteries: Not Advisable

Float voltage should not vary by more than +/-1%.

Should the float voltage of any cell drop below 1.36 Volts apply a 72 hour boost charge to the system or the individual cell.

Equalizing / Refreshing / Boost Charge

At times a ni-cd battery system may benefit from a high rate charge. By increasing the chargers voltage output the charger will deliver more current to the batteries. This is beneficial:

- After a deep discharge, or after an inadequate recharging, an equalizing charge can help reduce the charging time.
- Every 3-6 months – this will help keep cell voltages in line and will assure 100% capacity.
- When individual cells fall below 1.36 Vpc.

Equalize charge the system for 72 hours at a voltage of:

- Flooded Pocket Plate Ni-Cd batteries: 1.54-1.69 Vpc
- Valve Regulated Pocket Plate Ni-Cd batteries: 1.45 Vpc
- Flooded Fibre Plate Ni-Cd batteries: 1.52-1.57 Vpc

Recharging times vary depending on the charging procedure and on the charging current available. Higher voltages will typically recharge a system faster however many systems have a high voltage limit so suitable measures should be taken to protect the load circuits (e.g. charging off-line or limiting the equalize voltage).

Recharge 1.2 times the discharged capacity.

Upon completion of the equalize charge place the batteries back on float charge.

Warning! Leaving batteries on an equalization charge for long periods of time may result in: voided warranty, seriously overcharging the battery causing loss of electrolyte (dry out) and shortened system life.

Voltage Spread Correction

Voltage spread is when the voltages of individual cells in a system vary significantly (typically by 0.08 Volts or more). Voltage spread occurs due to a short or long term undercharge and it also can occur over time naturally if a system is not periodically equalize charged.

An equalize charge applied to the system every 3-6 months will typically prevent voltage spread from occurring.

Make the following corrective actions if any individual cell drops below 1.36 Volts:

First, make sure that the chargers float and equalize voltage settings are at the correct levels (as measured at the battery terminals).

A. Minor Voltage Spread.

If individual cell voltages are above 1.32 Volts a 72 hour equalize charge to the system will typically remedy the situation.

When equalize charging a full system to correct voltage spread the charger should be set to the highest possible voltage (without exceeding the voltage sensitivity of your connected load). Disconnecting the load and using the highest equalize voltage setting possible will produce the best results. When a charger is in equalize mode, the cells that are accepting a charge readily will consume the majority of the extra voltage, leaving very little increase in voltage on the low voltage cells. So the higher the equalize voltage setting the less time it will take to raise the voltage of the lowest cells.

Equalize charge the system for 72 hours and monitor the low voltage cells periodically to see when their voltage stops rising. Continue equalizing these low voltage cells to until no further increase in voltage over a two hour period.

B. Major Voltage Spread

If minor voltage spread is not corrected in a timely manner individual cell voltages can fall as low as 0.00 Volts. If any cells drop below 1.31 Volts the procedures to fix 'major voltage spread' are as follows:

1. Discharge entire system at 0.2C5 (20 Amp per 100 Ah of rated capacity) to 1.0 Vpc
2. Recharge system with a constant-current charge at 0.2C5 for 8 hours. If a constant current charge is not available equalize the system at as high of a voltage and with as much current as possible for 72 hours.
3. Discharge entire system again at 0.2C5 (20 Amp per 100 Ah of rated capacity) to 1.0 Vpc
4. Recharge the system for 72 hours per equalize charging instructions and monitor the cells periodically to see when their voltage stops rising. Adjust the equalize time until there is no further increase in voltage over a two hour period.
5. Put system back on float charge

C. Use of a Single Cell Charger

If only a few cells have a low voltage applying a high-rate charge to an individual cell via a single cell charger is ideal.

Applying a high rate charge to an individual cell is generally more effective than equalize charging the entire system. While the main charger remains in float mode and the system is still online, a single cell charger can be connected to the cell with a low voltage. Once the voltage of that cell stops increasing for a period of 2 hours the charger can be moved to the next cell with a low voltage. To order a single cell charger, contact SBS.

If there are still voltage discrepancies contact SBS.

4.0 TEMPERATURE

Higher temperatures reduce the operational life of any battery. Lower temperatures will reduce the available capacity. Compared to lead-acid batteries nickel-cadmium batteries are not as greatly affected by high and low temperatures but they are still affected. The typical operating temperature range is -4°F to 113°F. The recommended operating temperature range is 68°F to 77°F. This will maximize life and minimize maintenance. All technical data relates to a rated temperature of 77°F.

5.0 ELECTROLYTE

Nickel cadmium batteries electrolyte is a solution of potassium hydroxide (KOH) with a small amount of lithium hydroxide. This alkaline electrolyte acts as an ionic conductor and consequently the specific gravity does not change significantly with the state of charge of the cell. The specific gravity will increase slightly when the electrolyte level is low due to water loss.

The nominal S.G. of the electrolyte at 77°F is 1.19-1.22. The maximum deviation is +/- .01g/cm³. Electrolyte specific gravity should not be measured immediately after water has been added.

Filling bottles, hydrometers etc., used with lead acid batteries must never be used with alkaline batteries in order to prevent acid contamination. NEVER USE SULPHURIC ACID in an alkaline battery.

6.0 SPECIAL APPLICATIONS

Whenever the batteries are to be used for special applications (non floating type applications) such as repeated cycling or under extreme ambient conditions, please contact your sales office. Different instructions may apply. In addition, the battery may have a shorter operational life.

7.0 MAINTENANCE AND TESTING

Water Topping: Use *ONLY de-mineralized or distilled water (purity grade: maximum conductivity 10 µS/cm) to top off cells.*

Under ideal operating conditions, flooded Ni-Cad batteries should require watering every 6-24 months. Watering intervals are influenced by temperature, charging rates and the number and depth of discharges.

VRPP batteries require watering every 7-15 years depending on the same factors as listed above.

Top up the electrolyte level to the < Max > line. Topping over < Max > line when combined with an equalize charge can lead to boil over.

Never let the electrolyte level fall below the <Min> line or the top of the plates.

Do not add water during equalize charge since accurate level readings are not possible when the battery is gassing.

Avoid splashing water when topping up. A wet battery can result in earth faults and /or erratic operation.

Always keep the flame-arresting vents closed except for when topping up electrolyte levels.

On float charge, the homogenization will eventually occur and an equalize charge is not necessary. If preferred after topping off the water level, an equalize charge up to 72 hours can be applied to help reduce the time for homogenization of the electrolyte density.

Cleaning

Keep containers and lids dry and free from dust. Clean with a damp cotton cloth without man-made fibers or addition of cleaning agents. Do not use feather dusters or dry cloths. This could cause static discharge which can lead to an explosion hazard

If potassium carbonate crystals (grey white deposits) form on top of the battery, clean them off with a soft brush and wipe with a damp cloth followed by a clean dry cloth.

Do not use a wire brush or solvents of any kind, such as gasoline, thinner, acetone, kerosene etc.

Intercell Connectors

Check connections for proper torque at least once a year. This is especially important if the battery is subjected to vibration.

The connectors and terminal screws should be coated with a thin layer of anti-corrosion grease or petroleum jelly.

Vent Caps

Ensure that the transport seal film used for preventing electrolyte spillage during transportation has been removed from the vent caps before charging.

The cell vent caps should be closed during charging.

Vent caps should be kept clean to allow venting of gases produced during charging. Wash ceramic plugs, if soiled, in clean water and dry them thoroughly before putting them back on the battery.

Check Charger Settings

The chargers float and equalize voltage settings should be checked at least once a year. The proper float and equalize settings should be verified at the battery terminals.

High water consumption is usually caused by a high float voltage setting of the charger. A high float voltage setting will force more current into the battery than required and the extra heat generated will cause excessive water loss.

Seeing batteries or cells with low voltages is typical of a system that is being undercharged. If the leads from the charger to the battery are long or undersized voltage drop will occur and the system will be undercharged. To compensate for voltage drop the charger settings may need to be increased and checked against the battery terminals.

Capacity/Discharge Testing

Capacity testing (acceptance and performance tests) is used to trend battery aging. The result of a capacity test is a calculation of the capacity of the battery. The calculated capacity is used to determine whether the battery requires replacement.

Capacity tests should be carried out in accordance with IEEE1106-2005.

In nickel-cadmium batteries, approximately 12 weeks is needed after a previous discharge for the “float effect” to reach its full extent (see Annex D of IEEE1106 for details). Results of capacity tests that are carried out after less than 12 weeks have elapsed will not be characteristic of normal operation and the results should not be compared with future performance test results.

Note: *SBS does not recommend an acceptance or performance test until the system has been in float service for a minimum of 12 weeks. Results of a test carried out before the system has been on float for 12 weeks will not be considered for warranty purposes.*

Test length

SBS recommends discharge times of 1 to 8 hours to an end cell voltage of 1.00- 1.14 Vpc.

For comparison purposes, having the performance test be similar in duration to the battery duty cycle and to the end voltage originally used for sizing is desirable.

Discharge Rate

Correct discharge rates (in amps) must be chosen from discharge rate tables based on long term float charging ratings.

Performance data is available at www.sbsbattery.com or can be supplied by contacting SBS. For trending purposes, the same test length and rate should be used for each test during the batteries service life.

Temperatures effect on a Capacity/Discharge Test

Discharge tests should be performed between 65°F and 90°F.

For tests of a duration of 1 hour or more, do not adjust the rate of the discharge. The time adjusted capacity calculation allows you to factor in the temperature correction factor (Kc) after the test is completed.

Acceptance Testing

Acceptance tests may be carried out after the battery has been on float charge for at least 12 weeks without discharging. Although an acceptance test carried out after less than 12 weeks on float charge will confirm that a battery has adequate capacity, the acceptance test results cannot be compared with future performance test results because of the “float effect” (see Annex D in IEEE1106-2005 for details). This condition makes performing an acceptance test that accurately reflects operation in float charging mode impractical.

Performance Testing

Per IEEE a performance test should be made within the first two years of service and at five-year intervals until the battery shows signs of excessive capacity loss. Annual performance tests of battery capacity should be made on any battery that shows signs of excessive capacity loss. SBS recommends using the time adjusted method for calculating system capacity as outlined on page 11.

CAPACITY TESTING PROCEDURES

Pretest Requirements

- For accurate test results the battery should be on float charge for at least 12 weeks since its last discharge.
- All battery voltages should be within tolerances noted in charging section of this manual. No cell should be less than 1.36 Volts prior to the discharge test. Take any required corrective actions to correct voltages that are out of tolerance.
- Verify the battery has had a high-rate charge completed more than 1 day and not more than 30 days prior to the test.
- Record the float voltage of each cell just prior to the test (with charger on).
- Record the float voltage at the battery terminals (with charger on) just before the start of the test.
- Record the electrolyte temperature of 10% or more cells to establish an average temperature.
- Determine proper discharge current and time. Contact SBS if assistance is needed.

Information to Record during Test

- At regular time intervals during the test, measure total Vdc, Amps DC and individual cell voltages of all batteries / cells.
- As the test nears its end, take readings more frequently to monitor cells that are approaching low voltage limits.

Test Procedures:

- A. Set up the load and the necessary instrumentation to maintain and record the determined discharge rate.
- B. Disconnect the charging source, turn on load, start the timing and continue to maintain the selected discharge rate.
- C. Read and record the individual cell voltages and the system voltage. The readings should be taken while the load is applied at the beginning and at the completion of the test and at specified intervals. As the test nears its end it will be necessary to take readings more frequently to monitor cells that are approaching low voltage limits.
- D. Maintain the discharge rate, and record the elapsed time at the point when the system voltage decreases to a value equal to the minimum average voltage per cell (e.g., 1.10 Volts) times the number of cells per string.
If the battery does not pass, additional data will be beneficial for evaluation or for determining corrective action. If possible, the testing should be continued to the original test time or a lower final voltage to acquire this information. Nickel-cadmium cells are not damaged as a result of cell reversal, so no provisions are required for bypassing weak cells. Reversing the polarity of NiCad cells should not be a basis for terminating a discharge test before the over all terminal voltage is reached.
- E. If one or more cells are approaching reversal of their polarity (0.5 Volts or less), and the test is at 90–95% of the expected completion time, continue the test until the specified terminal voltage is reached.
- F. If earlier in the test one or more cells are approaching reversal of their polarity, the test may be continued so as to determine the capacity of the remainder of the battery. Bypassing of cells is not recommended. Because the reversed cell(s) will be making a negative contribution to the overall battery voltage, adjust the minimum terminal voltage to compensate. The new minimum terminal voltage will be the minimum cell voltage multiplied by the number of non-reversed cells, plus the negative voltage of the reversed cell(s). **For example**, a 95 cell battery is being tested to a minimum terminal voltage of 105 Vdc (1.10 Vpc). During the discharge, two weak cells go into reversal and stabilize at –0.30 Volts. The new minimum terminal voltage is $93 \text{ cells} \times 1.10 \text{ Vpc} - (2 \times 0.3) = 101.7 \text{ Vdc}$.
- G. At the conclusion of the test, determine the battery capacity according to the Time Adjusted Method for Calculating System capacity procedure outlined below.

Time Adjusted Method for Calculating System Capacity – Recommended by IEEE and SBS

When using this method, a discharge rate correction is not required prior to the performance of the test. The systems capacity is calculated after the completion of the test using the published performance data at 77°F.

To calculate the % capacity of your system
$$C = \frac{T_a \times K_c}{T_s} \times 100$$

- C = % capacity at 77°F
 Ta = the actual time (in minutes) of the test to specified end cell voltage
 Kc = the time correction factor in the below table
 Ts = the rated time (in minutes) of the test to specified end cell voltage

Recommended temperature-correction factor (Kc)

°F	65	67	69	70	71	73	75	77	79	80	81	83	85	87	89	90
Kc	1.087	1.069	1.055	1.047	1.041	1.026	1.015	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Example: KPM50 battery rated to deliver 10 Amps for 5 hours (300 minutes) to 1.00 Vpc at 77F. If the battery was 65°F, discharged at 10 Amps and the end cell voltage was reached at 4 hours and 25 minutes (265 minutes) the capacity would be calculated as follows:

$$C = \frac{265 \times 1.087}{300} \times 100 = \text{System has 96\% Capacity}$$

REQUIRED PERIODIC INSPECTION AND MAINTENANCE ACTIVITIES

Note: Keep a logbook in which the measured values can be noted. Also note any power cuts, discharge tests, equalize charges, water topping up dates, storage times and general conditions.

To obtain the full capacity and service life from your SBS stationary battery system, the performance of complete and timely periodic maintenance is essential. Temperature extremes, improper electrolyte levels, and charging voltage imbalance are a few of the items which can have a negative effect on the system.

Routine visual inspection, charger/rectifier checks, and pilot cell checks should be performed monthly. More detailed inspection of the battery is required on a quarterly and annual schedule.

BATTERY ROOM AND EQUIPMENT - GENERAL INSPECTION

Perform the following checks whenever in the battery room

- The battery room is clean, dry, and clear of debris and within a 68-77°F temperature range.
- The battery room ventilation system is operating.
- Battery room and personal safety equipment is available and operational.
- Battery cleaning and neutralization supplies are available on site.
- Battery maintenance equipment and tools are available and operational.

MONTHLY CHARGER/RECTIFIER OUTPUT CHECKS – *record in a log book the following:*

- Charger rectifier output voltmeter reading: It should be the same value as that read with a calibrated voltmeter. If a deviation in voltage greater than +/- 1% occurs, the charger must be adjusted or checked for proper operation (measure voltage at battery terminals).

MONTHLY BATTERY SYSTEM CHECKS – *record in a log book the following:*

- Record the battery system float charging voltage. It should be equal to the number of cells multiplied by the recommended charging voltage per cell.
- Record each individual pilot cell charging voltage.
- Record the pilot cell electrolyte temperatures: The normal range is usually between 68-77°F, and should have a variance no greater than 5°F between individual cells.
- Electrolyte levels of all cells must be between the high and low level marks on the cells: If water is added record this event.
- All cells have clean vent caps installed.
- Visually inspect each cell noting any changes or abnormalities. If anything odd is noticed, record and call sales office immediately to determine proper action. Changes you should look for may be, but are not limited to the following: discoloration, cracks, corrosion and growth inside or outside of container. Any noticeable sign may be a sign of trouble.
- All cells and racks are clean, dry and free of any spilled electrolyte and corrosion.
- Record room temperature.

QUARTERLY BATTERY SYSTEM CHECKS – *record in a log book the following:*

In addition to the monthly inspection the following checks should be completed quarterly.

- Record the charging voltage of each cell or multi-cell block in the battery system.
- Review the general condition or change in condition of the cells, racks, cables and connectors.
- Record temperature of electrolyte in pilot cells on each rack.

ANNUAL BATTERY SYSTEM CHECKS – *record in a log book the following:*

In addition to the quarterly inspection checks, perform the following checks annually.

- Check torque of all connections, batteries and racks.
- (Suggested) Record the Internal Resistance of each cell and intercell connection.
- Check to ensure ventilation is okay.