FIRST™
NATIONAL
BATTERY
INDUSTRIAL (PTY) LTD
THROUGH CARING WE LEAD

STANDBY POWER BATTERIES

INSTALLATION AND MAINTENANCE INSTRUCTIONS

TÜV CERT

ISO 14001:2004
ISO 9001: 2000
ISO/TS 16949:2002

*SANS IEC 60896/1:1987

*PLANTÉ, FLAT PLATE AND TUBULAR

CAUTION!

Do not smoke, use an open flame, create an arc or sparks in the vicinity of any battery. Hydrogen gas formed while the battery is charging is highly explosive. This gas remains in the cells long after charging has stopped. Ensure that there is adequate ventilation when in an enclosed space and when charging.

Do not get electrolyte in eyes, on skin or on clothing. All batteries contain dilute sulphuric acid which may cause skin irritation or eye damage on contact. In case of contact, flush thoroughly with clean water. When eyes are affected, seek medical help immediately.

Bicarbonate of soda solution (1 kg to 10 litres water) will neutralise acid spilled on clothing or other material. Apply until bubbling stops and rinse with clear water.

It is advisable when handling batteries to wear protective clothing, a face mask, a plastic or rubber apron, gloves and boots. It is also a good idea to wear old clothing in case of accidental spillage.

ADDITIONAL PRECAUTIONS

- Do not lay any metallic object on the battery as it may cause a short circuit.

* Keep vent plugs firmly in place at all times except when adding water or taking hydrometer readings.

* Do not allow any dirt, cleaning solution or other foreign material to enter the cells.

INSTALLATION AND COMMISSIONING PROCEDURE

ERECTION OF STANDS

When stands are supplied with a battery they will consist of two or more joiner-made leg assemblies connected together by runners on which the cells stand. These parts are to be screwed or bolted together, making use of the ready-drilled holes.

The screw heads, bolt heads and nuts are set in deeply countersunk holes. These holes are to be plugged with the wood plugs provided. They can then be further sealed with bitumen compound, plastic wood or putty to prevent the collection of acid in the cavities.

Stands are braced by diagonal struts across the fronts on the runners to the inside of the stand legs or, alternatively, side rails are to be screwed onto the outside of the stand legs.

Position stands correctly by following the applicable drawings. Ensure that stands are perfectly level along both length and width.

UNPACKING

It is advisable to unpack all the cells and accessories before erection commences and not to unpack and erect cell by cell because, if any items are missing or damaged, arrangements for their replacement can be made in good time.

All items should be carefully checked against the accompanying delivery notes to ascertain if any are missing, and also inspected to see whether any are damaged or broken. Should there be any such loss, advise the carriers and First National Battery as soon as possible.

PREPARATION

Carefully clean off all dust and packing material from each of the cells and accessories. Wipe down the cells with a clean soft cloth dampened with clean water. If necessary, a small amount of mild detergent may be added to the cleaning water, to remove any greasy film.

Scouring powders or solvents should not be used for cleaning the jars or lids as scratching or damage to the surface of the container material will result.

If the battery cannot be erected immediately, store all the parts in a clean, cool, dry room.

If cells have been supplied filled with acid and fully charged, the height of electrolyte in each cell will be on the line marked “MAX” on the sides or ends of the container. Where opaque containers are used, the level indicator should be at the “MAX” mark. If the electrolyte is below this level, and there is evidence of acid having been lost in transit, contact First National Battery immediately.

Ensure that all jars and lids are thoroughly clean and dry. Clean all cell terminal pillar surfaces. Dry the pillars and cover the whole surface of the pillar with vaseline. Do not scrape the surface of any lead-plated copper pillar or connector as this could cause damage to the plating.

INSTALLATION OF BATTERY

Place cells in position on the stand, ensuring the specified distance between cells is maintained. Line up cells neatly and straight, checking alignment with a string pulled tautly between the first and last cell face of the same row.

If two stands buff against each other, commence erection at the position where these join. On a single stand begin at one end.

When positioning the cells make sure the positive terminal of one cell is always adjacent to the negative terminal of the next cell. Leave positive and negative terminals at either end of the battery free for connection to the charging source or load.

If the cells are arranged in more than one row, be particularly careful to connect the negative terminal on the cell at the end of one row to the positive on the cell at the end of the following row. The connection between the two rows is made with the length of copper busbar or cable supplied. If possible strap or saddle inter-tier cables to the stand.

Apply an even coating of vaseline to the bolts and connectors before and after assembly. Tighten connector bolts firmly, using an insulated torque spanner.

During assembly, be careful to avoid short circuiting posts and connectors of adjacent cells with the spanner. Bolts should be torqued as follows: YAP and RMT cells 5 Nm, YCP, YHP, FCP, FHP and RCT cells 11 Nm.

Finally, check again that all cells are connected in the correct sequence. Reverse charging a cell or the whole battery will cause permanent damage.

NUMBERING OF CELLS

Self-adhesive, numbered PVC stickers are supplied, one for each cell. These may be fitted to the cell lid or the jar. It is important that the label surface as well as the cell surface is dry and clean before fixing.

To fit numbers, remove the backing paper, place the label in position and apply pressure over the whole area of the label. Number the cells, beginning with number (1) at the positive end of the battery, unless otherwise specified.

Continue numbering consecutively in the same order as the cells are connected through to the negative end.

CELLS SUPPLIED DRY AND PREFORMED

Fill the cells to the maximum mark with diluted sulphuric acid having the specific gravity shown below:

Planté (YAP, YCP, YHP)	1,190 - 1,195 (25°C)	Tubular (RMT, RCT)	1,235 - 1,240 (25°C)
Faure (FCP, FHP)	1,230 - 1,235 (25°C)	Solar (RSO)	1,210 - 1,215 (25°C)

Temperature of the filling acid should, if possible, be less than 25°C and should never exceed 32°C.

Allow the cells to stand for not less than 4 hours, nor more than 72 hours.

Before commencing the charge, ensure that cell temperatures are no more than 30°C and as near to ambient temperature as possible. If ambient temperature exceeds 28°C, allow cells to cool to within 2°C of ambient before commencing charge.

Also confirm the polarity of the cells by checking the voltages. If polarity is incorrect to terminals identification contact First National Battery Technical Department without delay.

Commence charging at a constant current equal to 7% of the battery's 10 hour rated capacity. Charge for 24 hours.

Stop the charge and allow the cells to rest for 24 hours. If necessary resting may be extended up to a total of 72 hours.

Recommence the charge at a constant current equal to 3,5% of the cell's 10 hour rated capacity. Charge for a minimum of 24 hours.

Between 20 and 24 hours of charge, measure and record the specific gravity and voltage of individual cells to ensure that these have reached a maximum value. When fully charged the cell voltages should be between 2,60 and 2,80 volts whilst still on charge. The actual value of voltages is not as important as is the fact that the voltages and specific gravities should remain constant over three consecutive hourly readings.

Specific gravities should be within the ranges indicated below:

Planté	1,205 - 1,215 (25°C)	Tubular	1,245 - 1,255 (25°C)
Faure	1,245 - 1,255 (25°C)	Solar	1,215 - 1,225 (25°C)

<u>If voltages and specific gravities have not reached a maximum constant value, continue the charge until this condition is met.</u>

If specific gravities lie outside the range specified at completion of charge, they should be adjusted accordingly.

The temperature of the electrolyte in any one cell should not exceed 50°C at any time during the charge. Should this value be approached, the charge rate must be reduced or the charge suspended to allow the cells to cool.

If the charging rate is reduced or suspended for any reason, the charging period must be extended to achieve the required ampere-hour input, which is a minimum value of 2.52 x C_{10} in all instances.

The first portion of charge should preferably be carried out continuously, but rest periods are permissible after 50% of the capacity in ampere-hours has been put into the battery.

At completion of formation and specific gravity adjustment, where necessary, electrolyte levels should be adjusted to the maximum level marked on the containers by the addition of acid of the same specific gravity as used when filling or by the removal of excess acid.

All specific gravities are corrected values and relate to 25°C.

If significant deviations from the final gravities specified above are encountered, or unduly long charging periods are required, notify First National Battery Technical Department at once.

CELLS SUPPLIED FILLED AND CHARGED

Charge at 7% of the battery's 10 hour rated capacity. For example, if the 10 hour rated capacity is 1000 ampere hours, use a charging rate of 70 amps.

During charging, measure and record the specific gravity and voltage of individual cells every hour to determine when these reach a maximum value. When fully charged, cell S.G.'s and voltages should be as indicated for dry and preformed.

The temperature of the electrolyte in any cell should not exceed 50°C at any time during the charge. Should this value be approached, the charge rate must be reduced or the charge suspended to allow the cells to cool.

On completion of the charge and after specific gravity adjustment (where necessary), electrolyte levels should be adjusted to the maximum level marked on containers by the addition of acid of the correct specific gravity or by the removal of excess electrolyte.

If significant deviations from the gravities specified are encountered, notify First National Battery Technical Department without delay.

BATTERY OPERATION

FLOATING

Many Standby Power systems have the charger permanently connected across the battery. This method of operation is termed a 'floating system'.

As a guide, the battery voltages under float conditions should be held at an average voltage of 2.25 ± 0.02 volts per cell. The actual optimum float voltage is that which just maintains the battery in a fully charged state with the minimum amount of water loss. This voltage can be affected by temperature, humidity and system characteristics. The optimum float voltage for a particular system ensures:

- the battery is maintained fully charged and healthy.
- water usage is minimal (typically period for electrolyte level to drop from maximum to minimum will exceed 12 months). If water usage is in excess of this, the float voltage is too high
- service life is optimised

- maintenance is minimised
- the frequency of freshening charges is minimal.

It should be noted that low overall float/trickle charge voltages result in:

- a loss of capacity
- increased frequency of freshening charges
- stratification of electrolyte
- reduced battery service life.

Whereas high overall float/trickle charge voltages result in:

- overcharging
- increased water usage
- higher operating temperature
- reduced battery service life.

Individual cell voltages can vary considerably within the new battery. Generally they will be within the range - 0.05V to + 0,10V around the average float voltages but variations beyond this are not unknown. The range will normally close-up within the first few months of service.

BOOST CHARGE

A boost charge in standby applications is normally applied after a battery has supplied back-up power due to a loss in AC power, to restore the batteries to full capacity in the shortest possible time.

EQUALISING

It is commonly believed that whilst a battery is being ‘float charged’, it will remain in a fully charged condition. This belief, however, is incorrect as stratification (the separation of electrolyte into distinct layers of differing densities) can occur, resulting in uneven current distribution between the plates of the cell.

This uneven current distribution and the varying ‘acid strength’ can cause the gradual discharge of portions in the plates located in the low current density areas. Initially the overall cell voltage remains at the correct float level because portions of each plate, which are galvanically continuous, remain fully charged and still in acid of a high specific gravity.

The partial discharge in areas of the cell plates will eventually cause sulphation, which worsens with time. The battery internal resistance is then affected, causing considerable variations in individual cell voltages and, more importantly, specific gravity. This is commonly known as ‘out of step’ condition. The only corrective action possible to rectify any ‘out of step’ condition is an equalising charge.

The battery should be charged at a rate which is five to seven percent of the ampere hour capacity at the 10 hour rate.

This charge should continue until such time as the specific gravity and voltage readings of individual cells have reached a maximum value and have ceased to rise for a period of three consecutive hourly readings.

At this point the cells should be gassing vigorously with voltages being in the region of 2,5 to 2,75. The actual value of voltage is not so important as the fact that the voltages and specific gravities cease to rise.

It is recommended that equalising charge be carried out when a cell's specific gravity drops by more than 0,015 (15 points) from its original level.

SERVICING

THE BATTERY ROOM

The room in which the battery is housed should be well ventilated and its temperature kept as close to 20°C as circumstances will allow.

The design life is based on an electrolyte operating temperature of 20 to 25°C. It is generally accepted that, even if temperature compensation is applied to the float voltage, an increase in average temperature of 10°C will result in a 50% decrease in life expectancy.

As hydrogen gas liberated from the battery is lighter than air, it will accumulate in pockets on the ceiling. It is therefore advisable to install ventilation ducts at the highest points.

Maximum permissible hydrogen gas, at any one point, is 2% of the free air volume in the room.

Install 'no smoking/naked flame' signs.

GENERAL MAINTENANCE

Keep the battery and surroundings clean and dry and all connections tight. Connections should also be protected by a thin film of vaseline or equivalent to prevent corrosion.

Take every precaution to avoid risk of explosion of gases, particularly during charge. Never smoke or use a naked flame in the battery room, or take any action which could cause an electric spark.

Any cells having a specific gravity noticeably lower than the other cells should be regarded as suspect. Where possible, such cells should be carefully examined for internal shorts such as may be caused by small pieces of scale bridging across the plates. These short circuits should be removed or the cell may be permanently damaged.

A period of charging will normally restore the suspect cells to the condition of the remainder of the battery but if it does not, contact First National Battery Technical Services Department without delay.

TOPPING UP

Due to evaporation and gassing on charge, water is lost from the electrolyte and the level gradually falls. Water must be added to bring the electrolyte to the correct level. The electrolyte level must never be allowed to fall so low as to expose group bars, the tops of plates or separators.

Top up cells regularly with approved water, i.e. deionized or distilled. Should any level adjustments be made on a fully charged battery, a charging period of 3 to 4 hours after 2,35 volts per cell has been reached is advisable to mix the electrolyte.

If the system permits an unrestricted voltage, a charge at a constant current of 3 to 7% of the 10 hour capacity is recommended to accelerate mixing the electrolyte.

Never use metal vessels for storing or dispensing the topping up water.

Ensure that only distilled or approved water is used for topping up. Casual indiscriminate use of any available water may cause premature battery collapse and may nullify any guarantee.

If there is any doubt as to the suitability of the water supply, a sample in a clean stoppered bottle may be sent to First National Battery. The sample will be analysed and a report submitted.

Under no circumstances should acid be added to cells except where it has been spilt accidentally and needs to be replaced. Under normal operating conditions only water is lost from the cells through the natural evaporation and electrolysis caused by gassing during charge.

PILOT CELLS

For ease of measurement and to save time select one cell of the battery as a pilot cell. For batteries containing more than 60 cells, select one pilot cell per 60 cells or part thereof.

Any variations in specific gravity of the electrolyte in the pilot cells will be indicative of the state of charge of the whole battery.

CELL READINGS AND RECORDS

Daily

Check the overall voltage of the battery, with normal load and charger connected and operational, to ensure that the battery voltage is correct.

Weekly

Check and record the total voltage across the battery, as well as the specific gravity and temperature of the electrolyte in the pilot cell.

Three monthly

Check and record the voltage and specific gravity of the electrolyte in each cell together with the temperature of the pilot cell. Specific gravities of all cells should be reasonably constant. Should any cells' specific gravity be more than 0,015 below that obtained on putting into service, the battery should be given an equalising charge.

Yearly

Check intercell connector bolts and torque to the correct level.

General

Record the details of any emergency or accidental discharge.

BATTERIES TEMPORARILY OUT OF SERVICE

Before taking the battery out of service, ensure that all cells are fully charged. If it is not possible to maintain the cells on trickle charge or under float conditions, the battery will require a freshening charge at least once every six weeks.

DETERMINING THE STATE OF CHARGE OF THE BATTERY

Dilution of the electrolyte during discharge is a useful guide to the state of charge of a lead acid cell. The more water there is in the electrolyte, the less dense it is, and the lower its specific gravity.

One cubic centimetre of water has a mass of approximately 1 gram, in other words, its density is 1 gram per cm^3. The specific gravity of any liquid is the density of that liquid divided by the density of water!

Specific gravities are usually measured with a hydrometer. This works on the principle that a float will sink further into a liquid of low specific gravity than into one of high specific gravity, because the latter is denser and provides greater support.

Using the hydrometer

From one of the cells, draw acid into the barrel until the hydrometer float moves freely. Now read the specific gravity at the point where the scale emerges from the acid. Afterwards, make sure the acid is returned to the cell from which is was drawn, or the specific gravity and acid level of that cell will be different.

When taking a reading

- make sure that there are no air bubbles under the float
- bring your eye level with the acid surface
- read off against the lower point of the meniscus
- ensure that the hydrometer is in a vertical position
- if necessary, shake the hydrometer gently to enable the float to move freely
- if the ambient temperature differs from the battery temperature, draw in electrolyte to warm the hydrometer first.

The change in specific gravity of the acid is directly proportional to the ampere hours taken out of the cell on discharge.

Temperature correction

All specific gravities quoted relate to temperature at 25°C and have to be corrected if read at other temperatures.

Specific gravities decrease as the temperature increases. To provide a standard, the specific gravity can be corrected to 25°C in the following manner:

Take the temperature of the electrolyte and

- add 7 points (0,007) to the specific gravity reading for every ten degrees above 25°C

or

- subtract 7 points (0,007) from the specific gravity reading for every ten degrees below 25°C

For example:

A reading of 1,240 at 35°C corrected to 25°C gives 1,240 + 0,007 = 1,247

or A reading of 1,260 at 15°C corrected to 25°C gives 1,260 - 0,007 = 1,253.

FAULT	RESULT OF FAULT	CORRECTIVE ACTION
Voltage level too high for floating operation.	Increased water consumption, in-crease in temperature, 3 Ah overcharge decomposes 1 gm of H_20 to $2H_2$ and 0_2.	Adjust charger voltage control. If unsuccessful exchange or repair defective control unit.
Voltage control too high for boost charge.	Similar results as above .	
Voltage level too low for floating operation	Sulphation. Drop in specific gravities.	Adjust voltage control. Carry out equalising charge.
Failure of voltage control unit.	Incorrect charging.	Exchange or repair voltage control
Average ambient temperature too high (above 25°C).	Increased water losses by evaporation. Increased floating current. Higher plate corrosion rate and reduced service life.	Improve the ventilation. Air con-ditioning might be necessary in some cases. Where temperature cannot be reduced, lower float voltage
Manually operated boost charge not switched off.	High water consumption and in-creased temperature; battery might be destroyed after long duration.	Ensure operator training. Consider automatic switch-over to float charge.
Interruption of charge for long (unknown) period of time.	Self discharge (for calc. use 0,1% / day) battery will be discharged slower or faster according to load. Danger of deep discharge and sulphation.	Recharge immediately, followed by a manual equalising charge.
Battery filled with electrolyte remains on open circuit (not yet in service).	Self discharge and sulphation.	Charge including equalising charge, then put on float.
Fully charged battery taken out of service.	Self discharge and sulphation.	Charge every 6 weeks or connect permanently on float.
Deep discharge.	Sulphation, reduced capacity.	Equalising charge may be necessary.
Discharged battery put on open circuit without recharging.	Sulphation.	Discharged batteries are to be charged immediately followed by an equalising charge.
Topping up with water not done in time or incorrectly.	Partial sulphation, sludging, re-duced capacity, eventually total collapse.	Train operator, top up immediately and equalise charge.
Contaminated water used for topping up.	May cause severe damage, corrosion, total collapse, sulphation, poisoning of neg, plates, etc.	Only purified (deionized) water to be used; confirm by analysis; no metal containers.

FAULT	RESULT OF FAULT	CORRECTIVE ACTION
Purified water stored for too long in open or in improper jars.	Contamination of the water, result as above.	Use clean jars made of glass or plastic with proper seal. Confirm water quality by analysis.
‘Capacity’ or ‘life improving’ agent used.	Only short-term benefit if any. Loss of guarantee by manufacturer.	To be avoided.
Topping up with acid because low S.G. was measured.	Danger of sulphation increased, effect as above (corrosion if SG exceeds 1,30 g/ml)	Equalise charge and reduce SG to standard value. Check again later to ensure within limits.
External short circuit of either the whole battery or of single cells.	Cable faults. Over long periods result in deep discharge and destruction of battery or cell(s).	Determine cause and rectify immediately.
Drop in SG of the whole battery (esp. in float charge service).	Reduced capacity, sulphation, heavy plate corrosion.	Increase voltage of the charger.
Connectors and/or bolts not greased (excl. bolt-on connectors).	Corrosion.	Damaged parts to be cleaned and greased or replaced.
Battery dirty and/or wet (e.g. because of overtopping)	Leakage currents. Increased self-discharge and loss of SG in single cells.	Clean battery properly and ensure the correct acid level is maintained by training the operator.
Hydrometer for NiCd-batteries is being used.	Contamination of cells.	Never use the same equipment for NiCd and lead-acid batteries
NiCd-battery operated in same room with lead-acid battery.	Corrosion of NiCd possible, inter-change of maintenance equipment and electrolyte possible.	Avoid if at all possible; if not, keep batteries far apart to avoid con-tamination.
Cell installed onto stand with polarity reversed.	Reverse charging destroys the cell(s).	Cell(s) to be replaced.
Battery connected in reverse.	Dangerous for rectifier, same effect as short circuit.	Disconnect, and reconnect after thoroughly checking all com-ponents’ polarities.
Loose bolts, e.g. at final terminal connection.	Spark erosion, corrosion, danger of explosion.	Repair and/or replace parts and retighten all bolts.
Commissioning not done in accordance with instructions.	Reduced capacity, and ultimately loss of service life.	Perform additional regular equalising charges.
Any copper, brass or iron parts fallen into a cell.	Plates will be destroyed by chemical reaction.	Replace the electrolyte, and if necessary, the complete cell.
Use of open fire, sparks from electrostatic charge.	Explosion of hydrogen gas might occur, hazardous to operator and battery.	Instruction to the operator.

BATTERY WATER

Water used for topping up batteries must comply with the following specifications:

- It shall be clear, colourless and odourless.
- The pH shall be between 5 and 7.
- Impurities shall not exceed the limits in the table below.
- It shall, wherever possible, be stored in a glass or plastic container.
- Conductivity shall be less than 30 μS/cm

Impurities	Milligrams per litre
Dissolved solids	25
Arsenic (As)	1
Chloride (Cl)	5
Copper (Cu)	0,1
Iron (Fe)	0,2
Manganese (Mn)	0,1
Nitrogen (as NH_4)	5
Nitrogen (as NO_3)	5
Heavy metals (as Pb)	5
$KMnO_4$ reducing substances *	10

*As determined by FNB test method LTM - 01 - 01 (25.09.2003)

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THROUGH CARING WE LEAD

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In the interests of continuing advancement we reserve the right to modify specifications without notice.

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