BT Lead Acid Battery Range - Technical

Feature

1. Safety

For lead acid battery products Safety is of paramount importance at all times. The following outlines some of the safety issues that should be carefully considered. This section should be read through prior to carrying out handling, installation, operation and maintenance.

WARNING!
Never permit smoking, sparks or any flames near the battery. All batteries can give off potentially explosive gases.
Never operate a battery in a completely sealed enclosure. Adequate ventilation should be provided.
When connecting a number of batteries in series, it is important to be aware that high voltages may exist across the terminals, providing the potential for electric shock. In this situation always wear rubber gloves, stand on rubber matting and never work alone.
When working on batteries always use insulated tools and remove all metal garments such as rings, watches, belts, necklaces, etc., which may cause short circuits and personal injury. Synthetic clothing such as ‘nylon’ should not be worn.
A battery is electrically live at all times. Batteries are capable of very high short circuit currents.
Never dispose of a battery in a fire – it is liable to explode. Lead acid batteries can and should be recycled.
Do not try to dismantle; a lead acid battery contains sulphuric acid, which is highly corrosive. If the battery case is inadvertently damaged, handle with care, wearing full protective clothing such as rubber gloves, apron and glasses. Should contact be made with skin, eyes or clothes, wash immediately with copious amounts of clean water (or eye wash) and then seek medical attention.
The latest Health and Safety Act and Electricity at Work regulations, as well as the latest European Low Voltage and Safety Directives should be applied.

2. Discharge

Battery Capacity

In general, the BT lead acid battery series capacities are quoted against the 20 Hour discharge rate. Each battery is discharged at a constant current down to a predetermined end point voltage per cell at a defined temperature. Refer to individual battery data sheets for discharge curves and discharge performance information.

Discharge Characteristics

The battery capacity (Ah) is a product of the discharge current (A) and time (h) to the final discharge voltage:

Battery Capacity (Ah) = Discharge Current (A) x Discharge Time (h)

The discharge current and duration has a significant effect upon the useful capacity. Discharge durations of less than 20 hours at full current will result in an apparent reduction in capacity. For example, compare a 20 hour discharge against a 1 hour discharge:

For 20 hr discharge @ +20°C, 0.05C(A) x 20(h) = 1C(Ah)

For 1 hr discharge @ +20°C, 0.6C(A) x 1(h) = 0.6C(Ah)

(C = Battery Capacity stated at the 20 hour discharge rate @ +20°C)

This means that the capacity at the 1 hour discharge rate is 40% less that that of the nominal 20 hour rate. Evidently, increasing the discharge current causes a decrease in Ah capacity. The end of discharge voltage also has an effect on the apparent capacity.

Discharge Characteristics at Various Rates

The BT Lead acid battery curves in Figure 1 below show currents that can be drawn at different discharge capacity rates at an ambient temperature of 20°C (68°F). Using this graph, select the appropriate battery capacity. For the final discharge voltage, refer to Table 1.

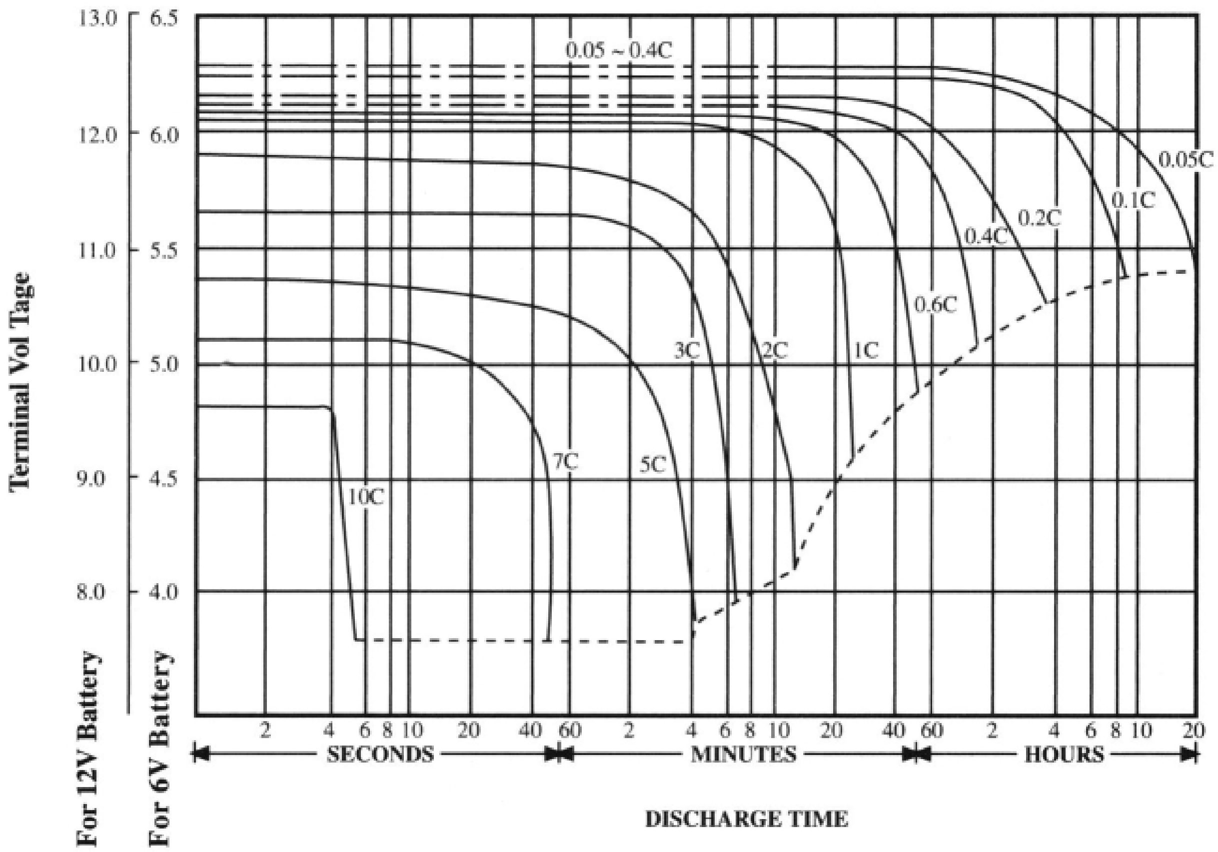


Table 1. Discharge Current and Final Discharge Voltage

Discharge Current	Final Discharge Voltage (v/cell)
0.1C or below	1.75
0.17C	1.70
0.26C	1.67
0.6C	1.60
0.6C to 3C	1.50
above 3C	1.30

Discharge Current and Final Discharge Voltage

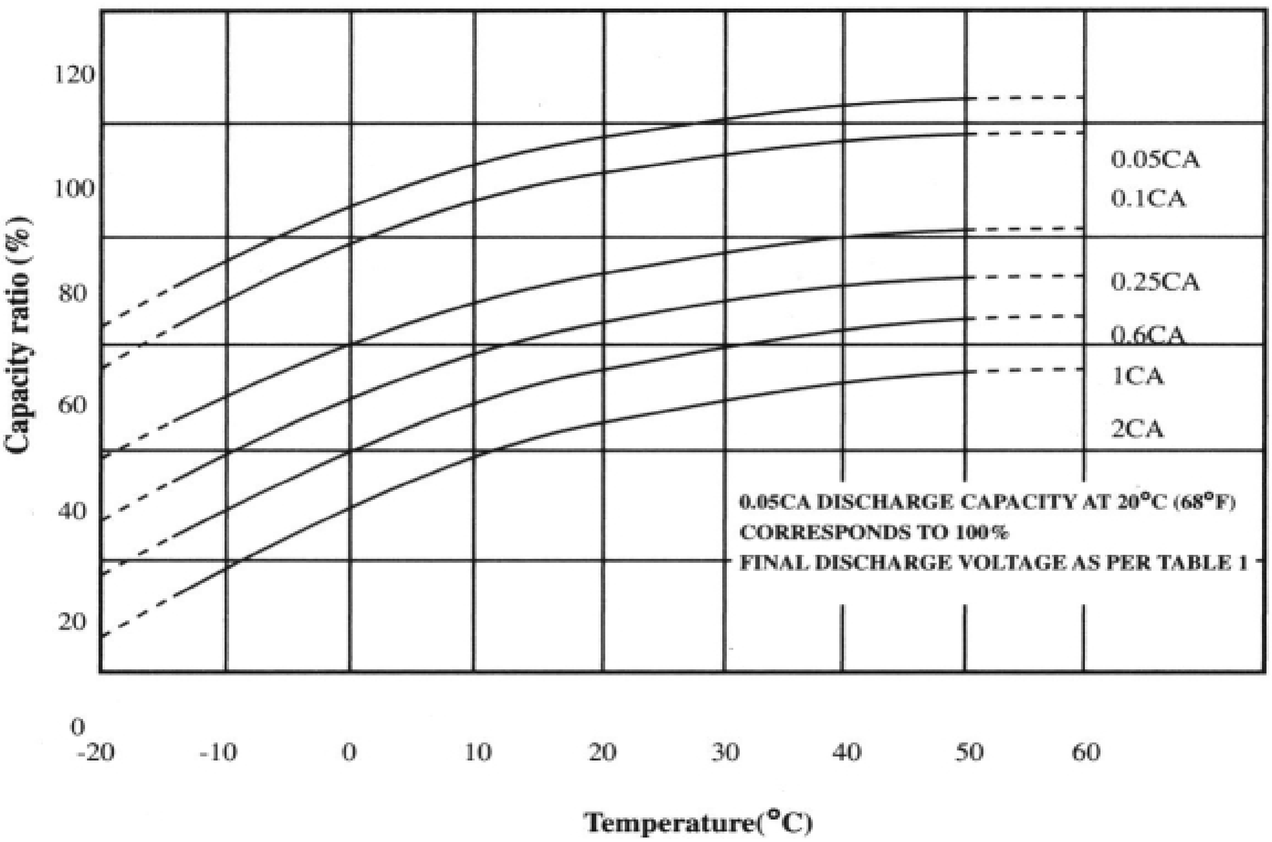
For the relation between discharge current and final discharge voltage, Table 1 is adopted. The battery should never be discharged to less than the predetermined final discharge voltage shown above; it could result in over discharging the battery. Repeated over discharging may cause permanent damage, to an extent that it may not be possible to recover the battery.

Over Discharge (Deep Discharge)

The dotted line in Figure 1 indicates the lowest recommended voltage under load, or cut-off voltage, for IBT lead acid batteries at various discharge rates. In general, lead acid batteries are damaged in terms of capacity and service life if discharged below the recommended cut-off voltages. It is widely recognised that the lead calcium alloy grid batteries are susceptible to over discharge damage. For example, if a lead acid battery was discharged to zero (0) volts, and left standing in either open circuit or on load for a long period of time, severe sulphation would occur, raising the internal resistance of the battery to an abnormally high level. In such an extreme case, the battery would not accept charge. Although over discharging IBT lead acid batteries is not recommended, they have been designed to withstand small levels of over discharge, provided that the battery is not left in a discharged state for a long period of time. It is necessary to avoid the over discharge situation as much as possible. To prevent this from happening, for some applications, it may be possible to incorporate a low voltage alarm and cut off circuit.

The Effects of Temperature on Capacity

Figure 2 shows the relation between temperature and discharge capacity. The figure shows the result of charge at 20°C (68°F) and discharge at various temperatures. An increase in temperature will provide an increase in the battery performance and, conversely, a decrease in temperature will reduce battery performance. Avoid operating the battery below –15°C (5°F) or beyond 50°C (122°F), since damage may occur even though the battery may still operate.



3. Charge

Correct charging is one of the most important factors to consider when using valve regulated, gas recombination, lead acid batteries. Battery performance and service life will be directly affected by the charge efficiency. The four main charging methods are:

- Constant Voltage Charging
- Constant Current Charging
- Taper Current Charging
- Two-Step Constant Voltage Charging

Constant Voltage Charging

Of the four methods above, the constant voltage charging method is the most suitable and commonly used to charge IBT lead acid batteries. (Please refer to the Sales Office for details on the other charging methods.) As charging commences, the lead sulphate of the positive plate becomes lead dioxide. Further on in the charge cycle, the positive plate begins to generate oxygen, causing a sudden rise in battery voltage. A constant voltage charge, therefore, gives rise to direction of the voltage increase and controls the amount of charge. This type of charging also requires current limitation to prevent initial high charge currents experienced whilst the battery voltage is low.

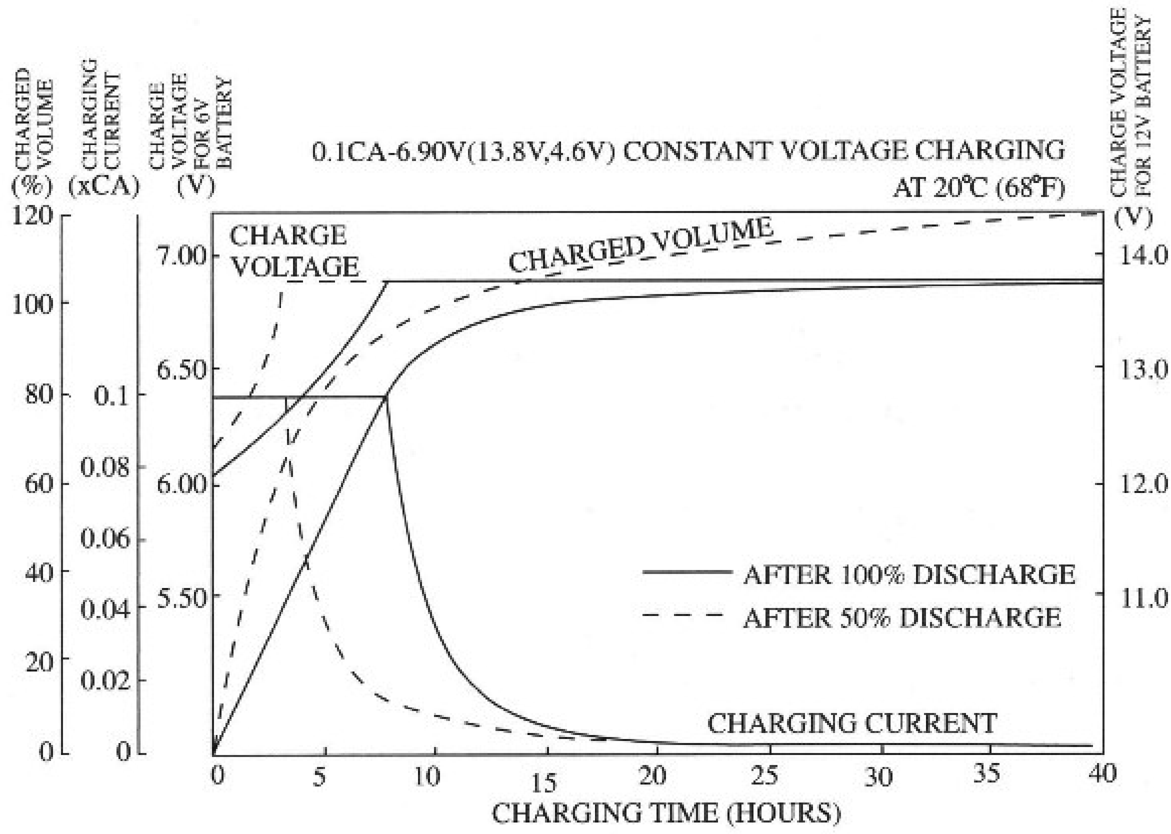
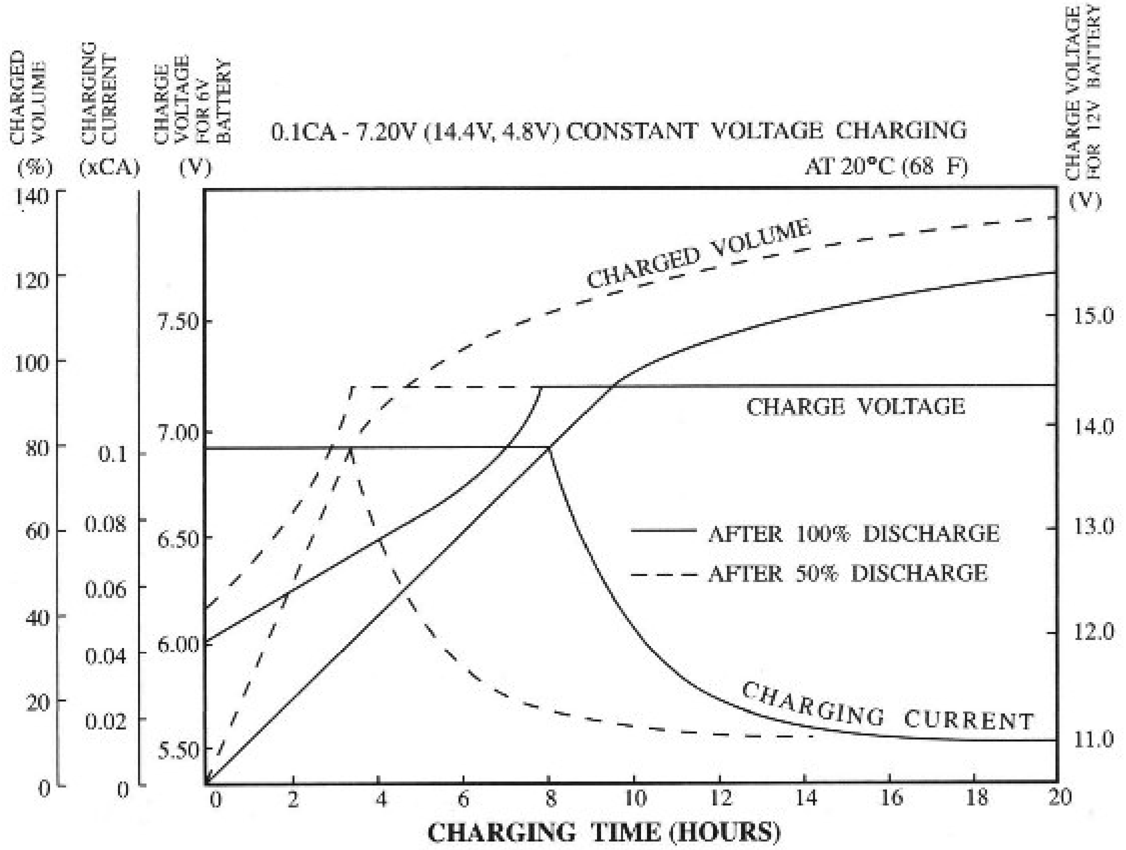


Table 2 shows the charge voltages and max. charge current.

Application	Charge Voltage (v/cell)			Max. Charge Current (A)
	Temp	Set Point	Min / Max	
Standby	20°C	2.275	2.25 – 2.30	0.25C
Cyclic	20°C	2.450	2.40 – 2.50	0.25C

Figures 3 and 4 show a typical constant voltage charge characteristic of an IBT lead acid battery with the charge voltages set at 2.30 volts/cell and 2.40 volts/cell respectively. In both cases the current limit was set to 0.1CA. (0.1CA = 10% of the battery capacity @ the 20 hr discharge rate.)



Two curves are shown on each graph: the first for a 100% discharged battery and the second in a 50% discharged state.

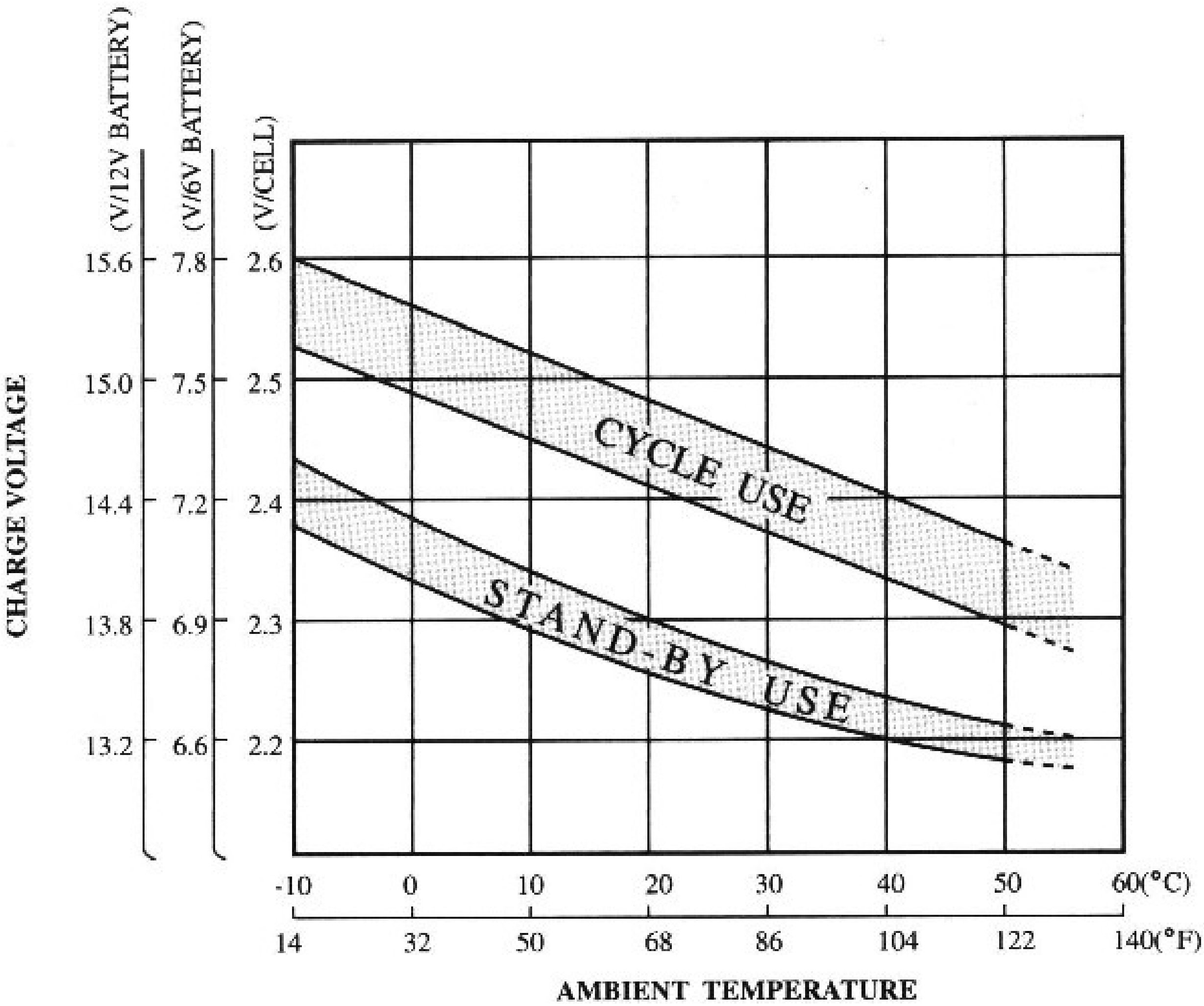
Temperature Compensation

To obtain optimum life from the battery, it is recommended that, if the battery is to be operated continuously above or below +20°C, the charger should be fitted with temperature compensation to prevent over and under charging. With an increase of temperature the charge voltage should be reduced and, conversely, with a decrease of temperature the charge voltage should be increased. The temperature coefficient is:

(1) For cycle use – 5m V / °C / cell

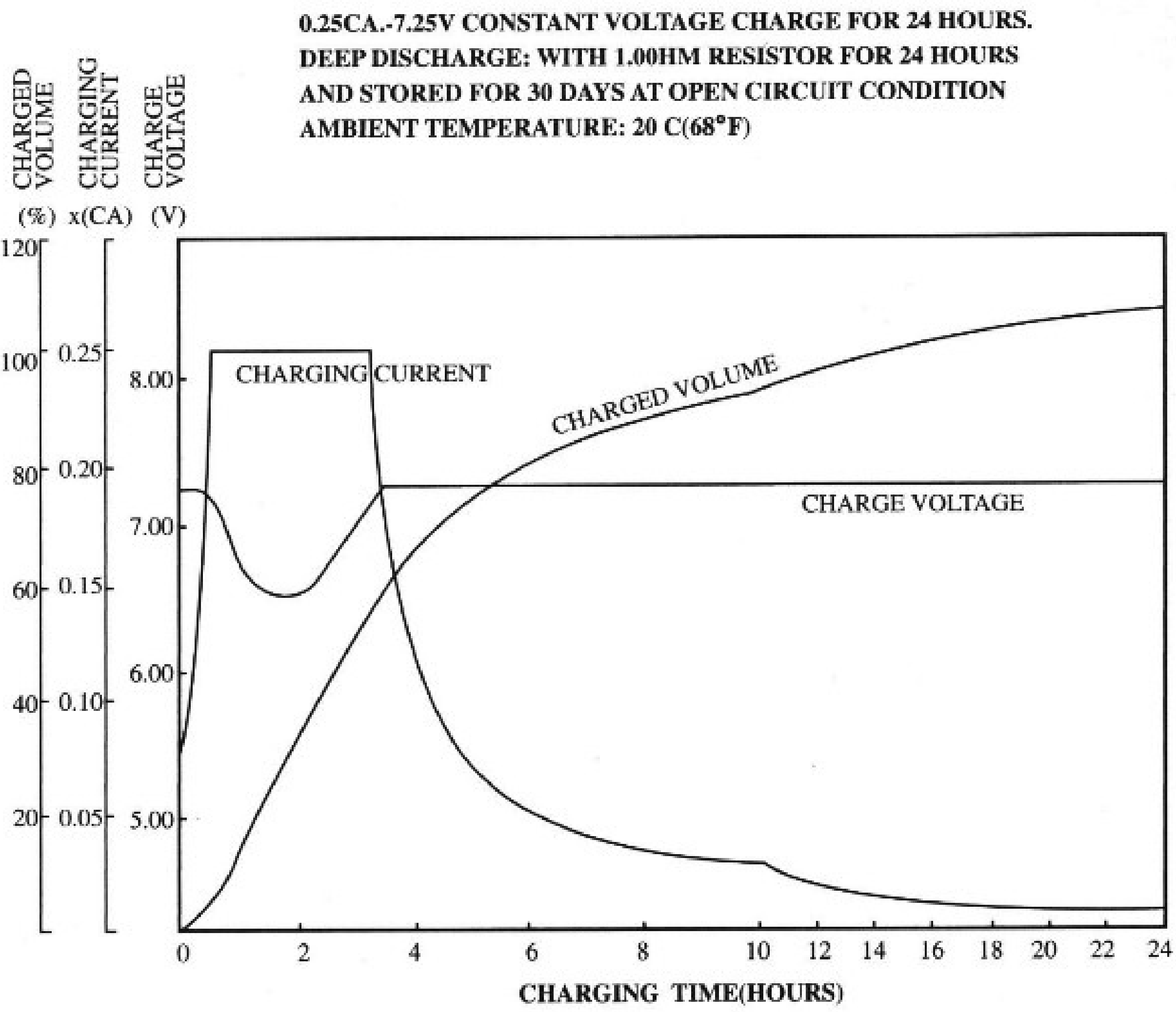
(2) For standby use (trickle charge of float charge) – 3.3m V / °C / cell

For short-term temperature changes of between 5°C and 35°C it is not essential to apply temperature compensation, although it is recommended. For temperature fluctuations below 5°C or above 35°C, temperature compensation is necessary. Refer to Figure 5 for further details with regard to charge voltage set points in relation to temperature. Two curves are shown: one for cyclic applications and the other for stand-by use.



Recovery Charge After Deep Discharge

When a lead acid battery has been subjected to deep discharge (commonly known as over discharge), the amount of electrical energy that has been discharged can be 1.5 to 2.0 times greater than the rated battery capacity. Consequently, a battery that has been over discharged requires a longer charging period than normal. Please note from Figure 6 below, as a result of increased internal resistance, the charging current accepted by an over discharged battery during the initial stage of charging will be quite small. It will increase rapidly over the initial 30 minutes (approx.) until the high internal resistance has been overcome, after which normal charging characteristics will resume. In view of the above, when an over discharged battery is charged and current sensing is employed to provide charge indication or a reduction of charge voltage (in the case of two stage charging), it is important to note that during the initial stages of charging the current will fall, thus providing a false indication that the battery is fully charged.



4. Storage

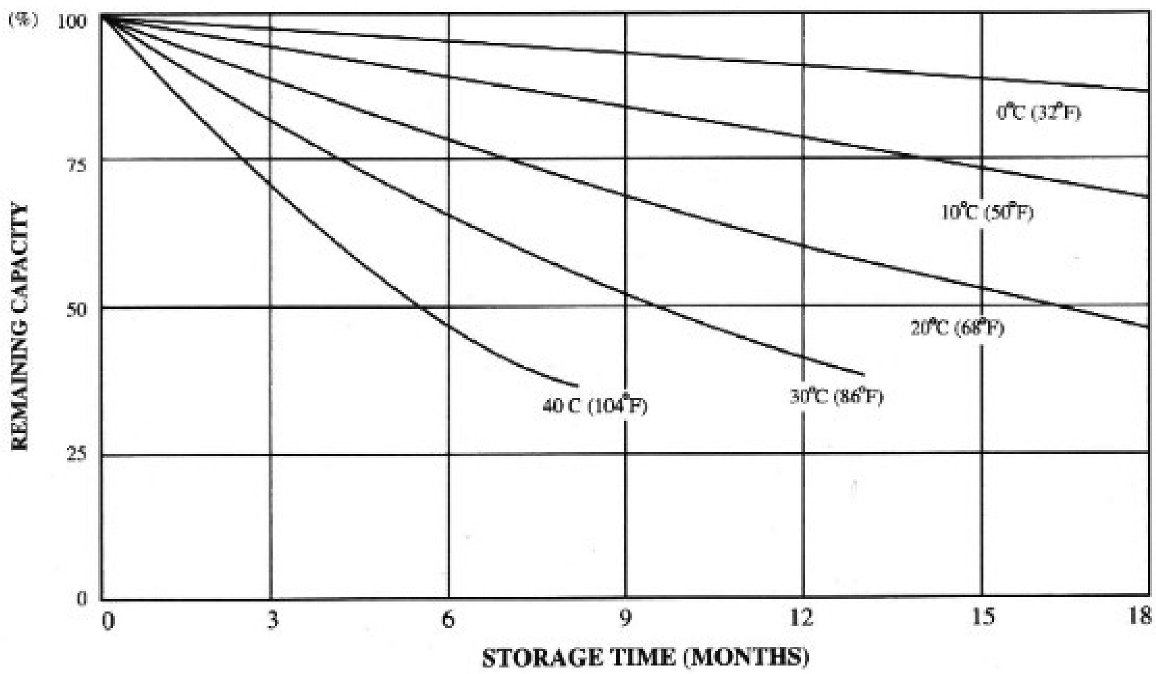
It is recognised that IBT valve regulated batteries have excellent charge retention characteristics. That is, their self-discharge rate is low and is typically less than 3% per month at 20°C. The self-discharge rate will vary as a function of ambient storage temperature. Figure 7 shows the relationship between storage times at various temperatures versus remaining capacity.

During storage carry out supplementary charging, refer to Table 3.

For supplementary charging after long storage, either the constant voltage charge with 2.45V/cell, or the constant current charge with 0.05CA, is recommended. For extended storage periods, one supplementary charge may not completely recover the battery capacity to 100%. Such being the case, it should be repeated until the capacity is recovered before storage.

Table 3 Storage Temperature and Charge Interval

Storage Temperature	Recommended Charge Interval	Supplementary Charge Method
Below 20°C	Every 6 months	Greater then 24 hours at constant voltage of 2.275 v/cell
20°C to 30°C	Every 3 months	6 to 12 hours with a constant voltage of 2.45 v/cell
Over 30°C	Every 3 months	6 to 12 hours with a constant current of 0.05C(A)



Although whilst standing open circuit, the self-discharge rate is relatively low, specific precautions must be taken against self-discharge to prevent the battery from over discharging. In general, to optimise performance and service life, it is recommended that IBT batteries that are to be stored for extended periods, be given a periodic supplementary charge, commonly referred to as 'top charging'.

Top Charging

Since a lead acid battery loses capacity through self-discharge, it is recommended that a 'top charging' be applied to any battery which has been stored for a long period of time, prior to putting the battery into service, as follows:

1. Ensure the open circuit voltage of the battery is greater than 2 volts per cell (v/c). If the voltage is lower than 2 v/c, then please refer the problem to IBT before attempting to recharge.

2. Excepting conditions in which storage temperatures have been abnormally high, top charging is recommended as per Table 4.

Table 4 Top Charging Recommendations

Storage Time	Top Charging Recommendations
Less than 6 months from manufacture or previous top charge.	Maximum of 20 hours at a constant voltage of 2.40 v/cell
Up to 12 months after manufacture or previous top charging	Maximum of 24 hours at a constant voltage of 2.40 v/cell
Note: A faster recharge may be obtained by using the constant method of charging. This requires close supervision.	
Less than 6 months	Maximum of 6 hours at a constant current of 0.1C (A)
Up to 12 months	Maximum of 10 hours at a constant current of 0.1C (A)

Storage Recommendations

a) The batteries should be stored in a cool, dry place.

b) The batteries should not be stored in direct sunlight.

c) The batteries should not be subjected to an external heat source.

d) The voltage of batteries in stock should be regularly checked.

e) Ensure top charges are carried out in accordance with Table 3.

5. Sevice Life

As with similar products, IBT valve regulated, gas recombination, lead acid batteries experience electrode deterioration in relation to use. There comes a point during the service life when the capacity cannot be recovered by charging. There are a number of factors that will have an effect on the expected service life, such as: number of discharge cycles, depth of discharge, ambient temperature and charge voltage.

Depth of Discharge

Repetitive deep discharges, for example in cyclic applications, will directly reduce the service life.

Discharge Current

Repetitive light discharges followed by much higher discharges will reduce the expected cycle life.

Charge Current

An excessively high charge current generates a gas in a quantity exceeding the absorption rate of the battery. This causes internal pressure to rise, and gas is expelled via the valve. If this high current continues, the electrolyte eventually decreases and the battery becomes dry, effectively making the lead acid battery useless. Particular attention should be paid to float / standby applications.

Over Charging

When a battery is overcharged, some of the components (plates, separators, etc.) will suffer from deterioration due to electrolyte oxidisation. In the case of float charging, the overcharge quantity is an important factor in determining battery life.

Influence of Ambient Temperature

High ambient temperature accelerates the deterioration of some of the battery components. With constant voltage charging, a high ambient temperature allows an unnecessarily large quantity of charge current to flow, which results in a shorter service life. Charging at low temperature, however, causes generation of H_2 gas. This gas causes the internal pressure to increase or the electrolyte to decrease and thereby shorten service life.

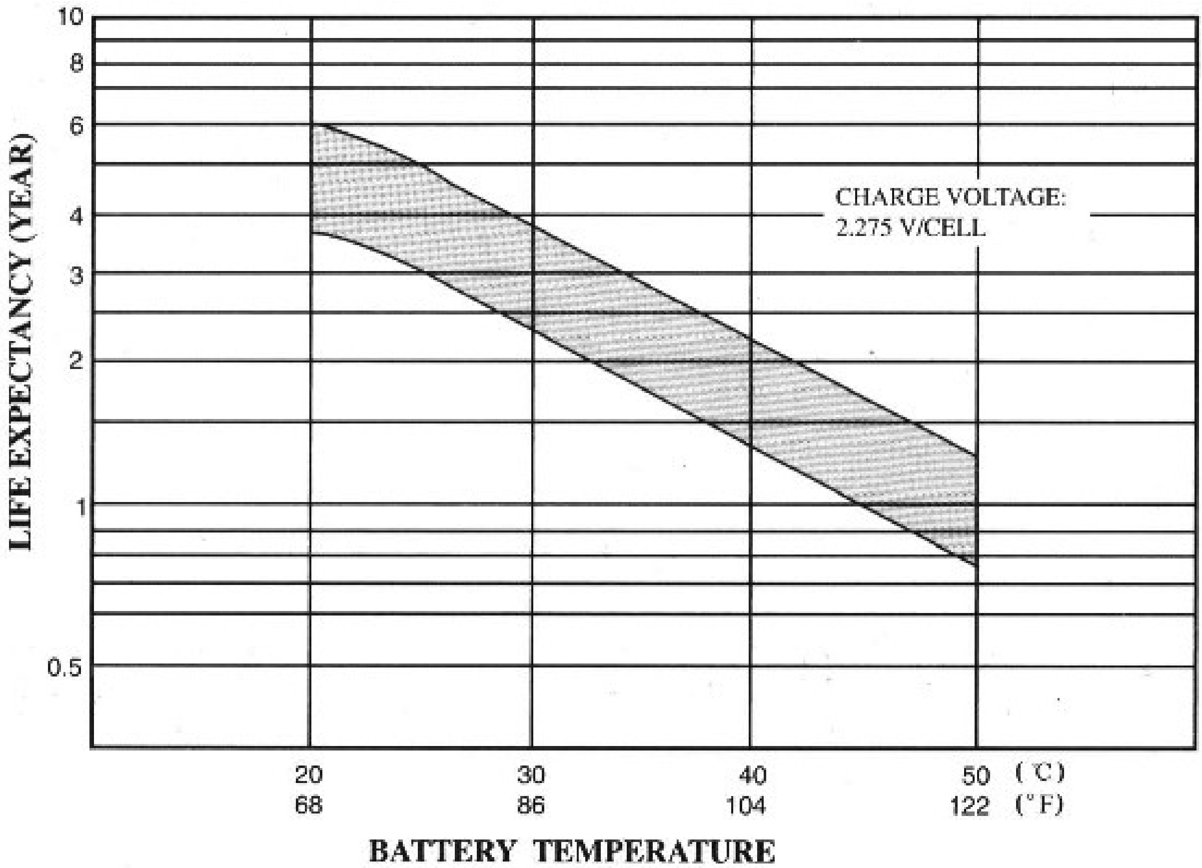
Cycle Service Life

The deeper the depth of discharge, the service life decreases. In short, the larger the battery capacity is in relation to the depth of discharge, the greater the expected cycles.

Float / Standby Service Life

Figure 8 shows the battery capacity versus the float charge service life. The dark shaded portion indicates the expected service life range.

The graph shows an IBT battery floated at a charge voltage of 2.275V/cell.



6. App. Notes

IBT batteries are efficient, maintenance-free, electrochemical systems designed to provide years of trouble-free electrical energy. The performance and service life of these batteries can be maximised by observing the following guidelines.

• Heat kills batteries. Avoid placing batteries in close proximity to heat sources of any kind. The longest service life will be attained when the battery is operated over an ambient temperature range of 20°C to 25°C.

• Since a battery may generate ignitable gases, do not install close to any item that produces sparks or flames.

• It is important that the battery is not operated in a completely sealed enclosure; ventilation must be provided. A cubicle containing the battery should be provided with sufficient ventilation allowing for airflow.

• The battery is manufactured from high impact ABS plastic resin; placing it is an atmosphere of, or in contact with, organic solvents or adhesive materials should be avoided.

• Correct terminals should be used to connect cables to the battery. Soldering is not recommended, however, if unavoidable, the solder connection should be carried out as quickly as possible within three seconds using a 100 Watt soldering iron.

• Permissible operation temperature range is –15°C to +50°C for float / standby use and 5°C to 35°C for cyclic applications.

• For applications where the battery may be subjected to shock and vibration, it is recommended to limit these forces as much as possible by using shock absorbing materials and fastening the battery tightly.

• When connecting the batteries, free air space must be provided between each battery. The recommended minimum space between batteries is 5mm (0.02 inches) to 10mm (0.04 inches).

• When the batteries are to be assembled in series to provide more than 60V, it is essential to ensure that adequate measures are taken to prevent inadvertent contact and electrical shock. This may be implemented by using insulated cables and terminal shrouds or restricting access to the battery. Please refer to the latest low voltage European directives.

• If two or more groups of batteries are to be used in parallel, they must be connected to the load through equal cable lengths having equal cross sectional area and resistance.

• When the batteries are used on a metal stand or rack:

a. Where the DC input exceeds 60 Volts, each battery should be insulated from the battery stand by using suitable polypropylene or polyethylene material.

b. In high voltage systems, the resistance between battery and stand should always be greater than 1 Mega ohm. An appropriate alarm circuit could be incorporated to monitor any current flow.

• Clean the lead acid battery with a wet cloth. Never have the battery splashed or deposited with oils or organic solvents such as gasoline and paint thinner, nor have it cleaned with cloths impregnated with these materials.

• Touching electrically conductive parts might result in electric shock. It is recommended when connecting a number of batteries in series, which will result in a total voltage exceeding 60 Volts, that the battery be assembled in blocks of lower voltages. Once this is complete, carefully make the connections between the lower voltage blocks.

• Mixed use of batteries with different capacities, different histories and of different manufacture is liable to cause damage to the battery or the equipment. If this is unavoidable please consult us beforehand.

• A lead acid battery should never be stored in a discharged condition; this may result in permanent damage or complete failure.

• Batteries are capable of producing very high short circuit currents. It is worth considering some form of protection in the way of a fuse or circuit breaker.

• Given that deep discharging can have a detrimental effect on the battery, a low voltage cut off circuit is recommended.

• Additional information is available on request.

• It is important to ensure that the charging circuit does not have excess ripple content on its output. If it does, it will invariably reduce the battery's service life. Ideally the ripple content should be as low as possible.

7. Installation

• Carefully read the Technical Information and Safety Instructions.

• Carry out a visual examination of the batteries, checking for damage.

• The BT lead acid battery range is suitable for operation in office and industrial environments, when used in normal circumstances.

• The environment in which the battery is to operate should have adequate ventilation to allow airflow.

• The ideal operating temperature for these batteries is between +20°C and +25°C.

• When a number of batteries is connected in series to result in a total battery voltage of 60 Volts or more, it is essential that the latest European Low Voltage and Safety Directives are implemented.

• If a battery is to be installed on a metal stand or rack, and its total voltage exceeds 60 Volts, then it should be isolated from the metal by using a polypropylene or polyethylene material.

• Where two or more battery strings are to be paralleled, it is important to use the same cable lengths having the same cross section to make the connection. Where large cables are involved, it is recommended that parallel connections be made using a junction box.

• Prior to installing the battery, check the voltage of each block with a digital multi-meter to ensure that it is around the nominal. For example, that a BT12-6 has an approximate terminal voltage of 6VDC (±10%).

• When making connections, it is essential to ensure that the polarities are correct.

• Prior to making final connections to the charger, check the total battery voltage.

• When using the battery take off cables, it is important to support them to prevent damage to the terminal seal.

• Consideration should be given to having some form of fused protection and / or isolation. This is for two reasons: the first, to enable safe isolation for high voltage batteries and the second, to allow the battery to be removed from circuit for maintenance.

• Once the battery is in situ and the necessary checks have been made, check that the charger voltage is set up correctly and commence with charging. Measure the battery voltage with a DVM to check that the voltage is rising.