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Energy Products

The unique design of the Gates Energy Cell overcomes many of the former limitations of the lead-acid system. At the same time, it retains the low cost, reliability, ruggedness and long life which have always been assets of the lead-acid battery. The cell is truly sealed—no acid, acid vapor or water loss—and incorporates recombination of gases within a starved electrolyte system. This unique maintenance-free rechargeable lead-acid cell is constructed with thin, spirally wound, pure lead plates which result in low impedance, low corrosion and long life. The self-resealing safety valve will vent under abusive overcharge conditions at an internal pressure of about 50 psi.

- Can be charged or discharged in any position.
- Use constant current or constant voltage charging.
- The same cell can be used for fast cycling or long-term float applications.

- Low internal impedance allows very high discharge currents.
- No loss of electrolyte during normal overcharging.
- Excellent mechanical and vibrational strength.
- Absolutely no "memory" effects.
- No damage due to cell reversal.
- The metal can is electrically isolated preventing accidental shorting.
- Fewer cells per battery for lower battery cost and better reliability.
- Cells can be paralleled for additional capacity.
- Can be used safely in proximity of electronic circuitries.
- Construction allows air transportation without restriction due to IATA "dry battery" classification.

TYPICAL SPECIFICATIONS ($T_A = 25^\circ\text{C}$)

Nominal Cell Voltage	2.0V	*Internal Resistance (max) (Charged Cell)	$10 \times 10^{-3} \Omega$
Capacity Rating		Storage Time	
20 hour rate (125mA)	2.7Ah	$T_A = 0^\circ\text{C}$	7,200 days
10 hour rate (250mA)	2.5Ah	$T_A = 23^\circ\text{C}$	1,200 days
1 hour rate (2.5A)	1.8Ah	$T_A = 65^\circ\text{C}$	60 days
Cell Power Rating		Atmospheric Pressure Range	0-8 atmospheres
Peak Power (at 135A)	135 W	Cell Charging	
Energy/unit volume (at C/10 rate)	1.47 W-h/in ³ 0.09 W-h/cm ³	Constant Voltage (Cyclic) (Float)	2.40-2.60V 2.30-2.40V
Energy/unit weight (at C/10 rate)	12.5 W-h/lb 27.5 W-h/kg	Constant Current (Cyclic) (max) (Float) (max)	C/3 rate C/500 rate
Cell Temperature Range		**Cycle Life	200 - 2,000 cycles
Storage	-65°C to +65°C	***Expected Float Life	8 years
Discharge	-65°C to +65°C		
Charge	-40°C to +65°C		

*Measured on Hewlett-Packard 4328A milliohm meter.

**200 cycles—100% depth of discharge, one cycle per day (Charge: 2.45V constant voltage, no current limit; Discharge: C/5 rate)

2000 cycles—25% depth of discharge (Charge: 2.45V/cell for 7.5 hrs—2.0A current limit; Discharge: C/2 rate for 30 min.)

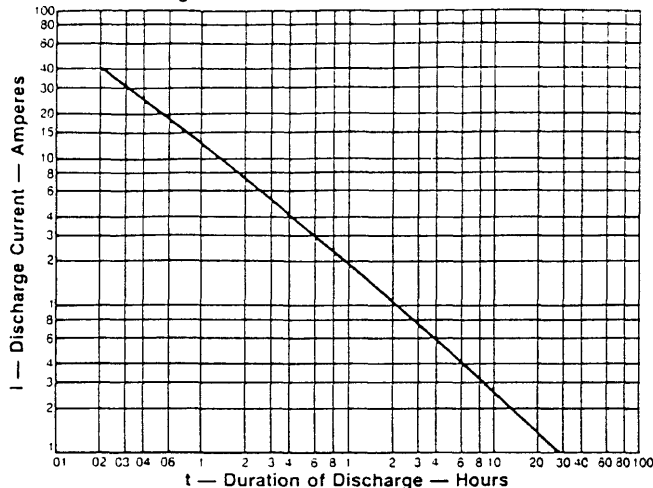
More cycles are available with shallower discharges.

***Based on accelerated test methods, 2.35 volts constant voltage charge at 23°C ambient temperature.

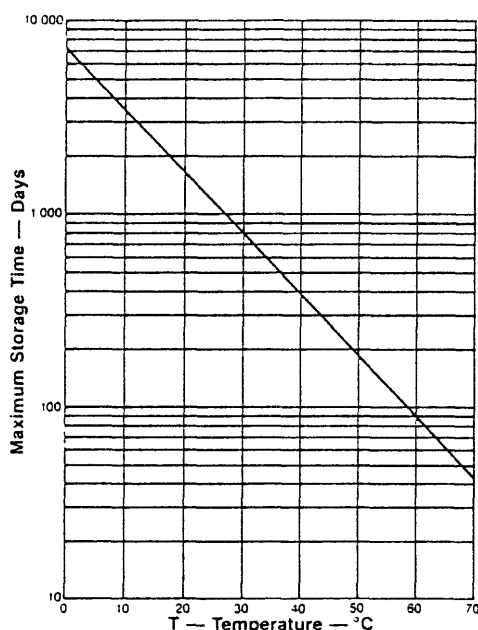


**2V, 2.5Ah
sealed
rechargeable
"D" cell**

Discharge Time of D-Cell at Various Currents at 23°C.

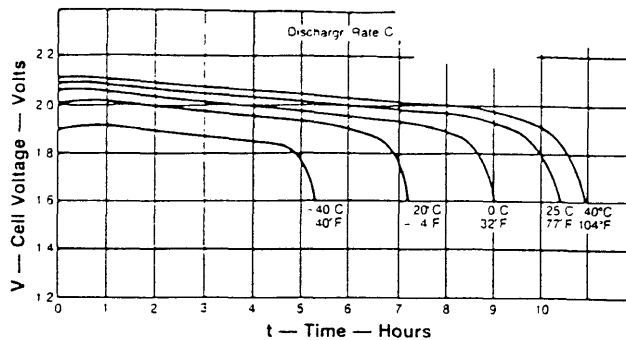


Discharge Characteristics. Based on data from standard production, 90% of all cells produced by GEP meet or exceed these discharge characteristics. New cells must be cycled or floated appropriately before full rated capacity, as shown on this curve, is reached.

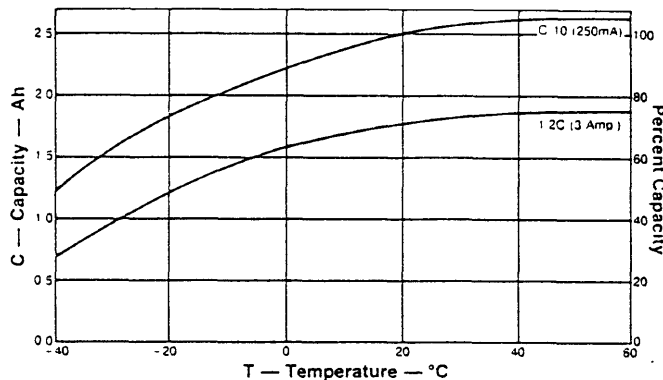


Storage Characteristics. The storage time is very dependent on the storage temperature as shown in this maximum allowable storage time versus temperature curve for a charged cell.

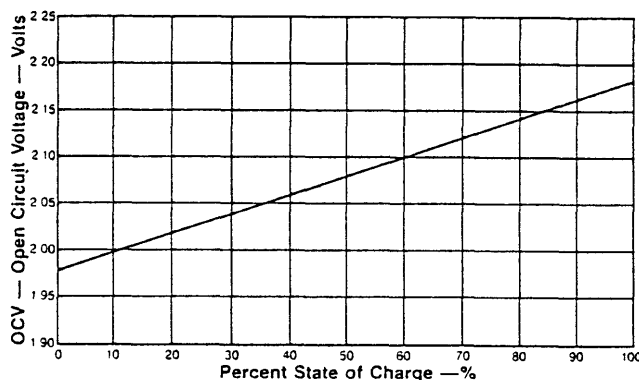
Leaving the Gates Energy Cell connected to a load for a long period of time after it has been discharged may cause difficulties in recharging and/or reduce cell life. The cell should be put on open circuit or recharged soon after the discharge is completed.



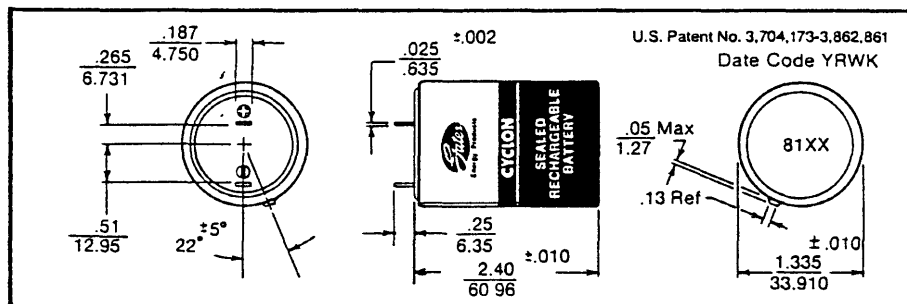
Voltage Regulation. The voltage regulation of the Gates cell is equal to or better than any other commercially available system.



Temperature Characteristics. The graph illustrates the capacity available in the cell as a function of temperature at two different discharge rates.



State of Charge. This curve of OCV vs state of charge is accurate within 20% of the rated capacity of the cell being measured if it has not been charged or discharged within the past 24 hours. The accuracy increases to 5% if the cell has not been charged or discharged within the past 5 days.



Length — 2.650 in/67.31 mm
Width (DIA) — 1.335 in/33.91 mm
Weight — 6.4 oz./182 gm
Tabs — 0.187 x .025

Tolerance (unless noted)
.XX ± .010 .XXX ± .005

All dimensions = $\frac{\text{inches}}{\text{millimeters}}$

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0602-0013 7/82

Material Safety Data Sheet

May be used to comply with
 OSHA's Hazard Communication Standard,
 29 CFR 1910.1200. Standard must be
 consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
 (Non-Mandatory Form)
 Form Approved
 OMB No. 1218-0072



IDENTITY (As Used on Label and List)
 Sealed Lead Battery closed cylindrical

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name Gates Energy Products, Inc.	Emergency Telephone Number Not Applicable
Address (Number, Street, City, State, and ZIP Code) 617 N. Ridgeview Drive Warrensburg, MO 64093	Telephone Number for Information (816) 429-2165 Date Prepared March 1, 1990 Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Lead - Lead Oxides		0.05 ug/m ³		69
Sulfuric Acid Electrolyte		1.0 mg/m ³		21
Non-Hazardous Materials		- - - - -		10

Section III — Physical/Chemical Characteristics

Boiling Point N/A	Specific Gravity (H ₂ O = 1) N/A
Vapor Pressure (mm Hg.) N/A	Melting Point N/A
Vapor Density (AIR = 1) N/A	Evaporation Rate (Butyl Acetate = 1) N/A
Solubility in Water N/A	
Appearance and Odor N/A	

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used) Non-flammable	Flammable Limits N/A	LEL	UEL
Extinguishing Media Multi-purpose dry chemical or multi-purpose CO ₂ .			
Special Fire Fighting Procedures Cool battery exterior to prevent rupture. Acid mists and vapors in a fire are toxic and corrosive.			

Unusual Fire and Explosion Hazards
 Hydrogen gas may be produced and may explode if ignited. Remove all sources of ignition. Ventilate area.

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	Avoid Shorting. Use only approved charging methods.

Incompatibility (Materials to Avoid)

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	Do not puncture battery case.

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards (Acute and Chronic)

Not applicable for finished product used in normal conditions.

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures

Battery contains acid electrolyte. If battery case is punctured,
completely flush any released material from skin or eyes with water.**Section VII — Precautions for Safe Handling and Use**

Steps to Be Taken in Case Material Is Released or Spilled

Avoid contact with acid materials. Use soda ash or
lime to neutralize. Flush with large amounts of water.

Waste Disposal Method

Place in acid resistant containers. Dispose in accordance with Federal,
State and local regulations. Do not incinerate.

Precautions to Be Taken in Handling and Storing

Other Precautions

Read manufacturers literature, which is available upon request.

Section VIII — Control Measures Not applicable for finished product.

Respiratory Protection (Specify Type)

Ventilation	Local Exhaust	Special
	Mechanical (General)	Other

Protective Gloves

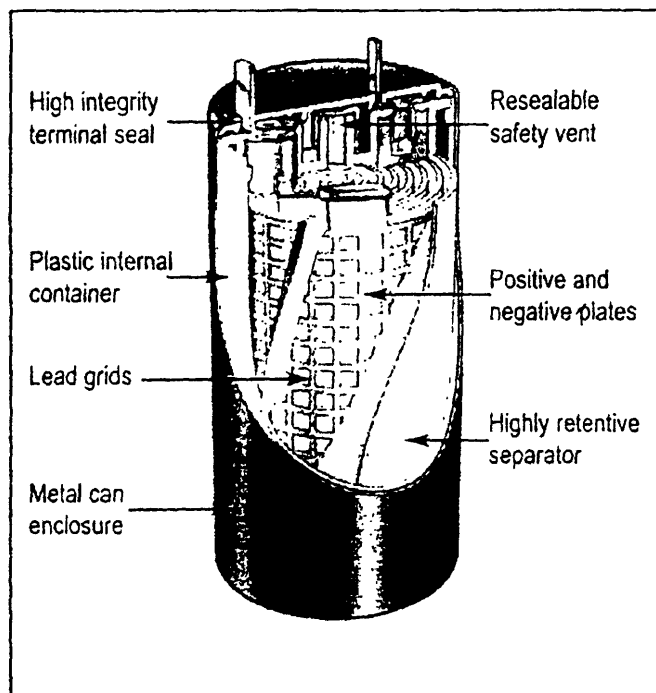
Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

Introduction to Cyclon Cells and Monoblocs

Cyclon Valve Regulated Lead Acid (VRLA) Cells and Monoblocs are a unique technology using wound electrodes made of pure lead (99.004%) alloyed with 0.65% of tin.



Gasses produced in normal overcharge are recombined within the cell. A re-sealable bunsen valve is incorporated to permit gas venting in the case of abusive overcharge.

Both Cyclon Cells and Cyclon Monoblocs can be charged and discharged in any attitude.

Both Cells and Monoblocs can be assembled into many different configurations providing maximum design flexibility.

Product can be transported by land, sea and air as non-hazardous cargo. Cyclon Cells are a recognised component meeting UL924 and UL1778. Cyclon Monoblocs meet UL924.

Performance Characteristics

Cyclon Cells and Monoblocs have outstanding performance in the following areas.

- Long float life - Cyclon Cells: 15 years at 20°C.
- Cyclon Monoblocs: 10 years at 20°C
- Long storage life (greater than 2 years at 25°C before recharge is necessary).
- Exceptional high rate discharge (Up to 26C).
- Wide operating temperature range
- Cyclon Cells -65°C to +80°C
- Cyclon Monoblocs -40°C to +40°C
- Very high shock and vibration resistance in all planes.
- Cycle life up to 2500 cycles at 30% DOD.

Discharge Characteristics

Maximum current capabilities

Cyclon Type	Pulse Amps	Continuous Amps
D Single Cell (2.5 Ah)	200	65
D Monobloc (2.5 Ah)	200	50
TD Single Cell (4.5 Ah)	200	65
X Single Cell (5.0 Ah)	285	65
X Monobloc (5.0 Ah)	285	50
E Single Cell (8.0 Ah)	330	65
E Monobloc (8.0 Ah)	330	50
J Single Cell (12.5 Ah)	400	65
BC Single Cell (25.0 Ah)	665	250

Table 1

The extremely low internal resistance of Cyclon cells gives excellent voltage regulation on discharge which is equal to or better than other VRLA systems.

As with all lead battery systems discharge energy available is reduced as temperature decreases.

Variation of discharge capacity with temperature.

% of rated C/10 Capacity Available

Temp °C	C/10	C
80	105	75
60	105	75
40	105	75
20	100	72
0	85	65
-20	70	50
-40	50	30

These values should be taken as a guide only.

Table 2

If the application fully discharges the battery it is recommended that a low voltage cut out is employed to protect the battery against overdischarge. The end of discharge voltage varies according to the rate of discharge (See Table 3). Overdischarging the battery can lead to recharging difficulties and also damage the battery. For design details of low voltages cut out circuits please contact our Customer Support Staff on +44 (0) 1794 830111.

Recommended minimum End of Discharge Voltage (EODV).

Discharge Rate Amps	Min. EODV per cell
0.05C (C/20)	1.75V
0.10C (C/10)	1.70V
0.20C (C/5)	1.65V
0.40C (C/2.5)	1.65V
1.00C	1.60V
2.00C	1.55V
>5.00C	1.50V

Discharging the Cyclon cell below these voltage levels or leaving the cell connected to a load in a discharged state may impair the cell's ability to accept a charge.

Table 3

Temperature Compensation

If operating temperatures are above 30°C or below 0°C temperature compensation should be applied to the charging voltage as shown below.

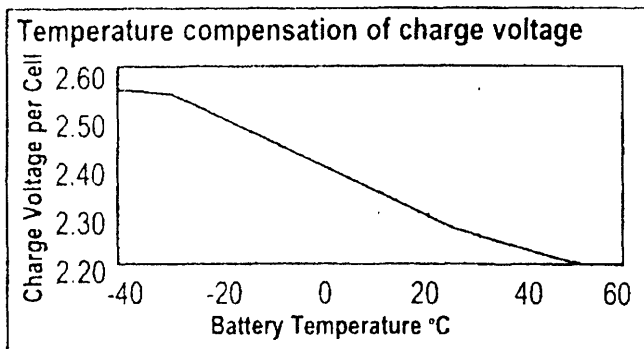


Table 8

Two State Constant Voltage Charging

To allow fast recharge but maximise standby life, two level voltage charging can be used. Charging should commence at the cyclic rate and switch down to the float charge voltage after a preset time has elapsed. The time is established with reference to the charge current limit (See Table 7 page 5).

Constant Current Charging

This technique can be used with Cyclon cells and Monoblocs providing charging is terminated before excessive overcharge occurs. Charge can be terminated by time or voltage sensing but long term overcharge must be limited to C/500. Please contact our Customer Support Staff for further assistance.

Taper Charging

Although taper current chargers are the least expensive type of chargers, their lack of voltage regulation can be detrimental to the life of any cell type. Half wave rectification should be avoided because the high peak-to-average voltage ratio will reduce the service life of the cell. It is recommended that charge rate at 2.50 volts/cell be between C/50 and C/100 to prevent serious overcharge if the charger is left connected for extended periods.

The normal recharge time for a taper charger can be assessed by reference to the charge current available at charge voltage of 2.2VPC allowing for the return of 120% of discharged capacity.

Other Charging Methods

For application engineering support on solar, vehicle systems or other charging methods please refer to our Customer Support Staff.

Service Life

End of service life of Cyclon products is defined as the point when the battery delivers less than 80% of its rated capacity.

Float Life

Cyclon cells have a design life of 15 years at 20°C for floating applications.

Cyclon Monoblocs have a design life of 10 years at 20°C for floating applications.

Cyclon cell float life at 2.30VPC to 80% capacity

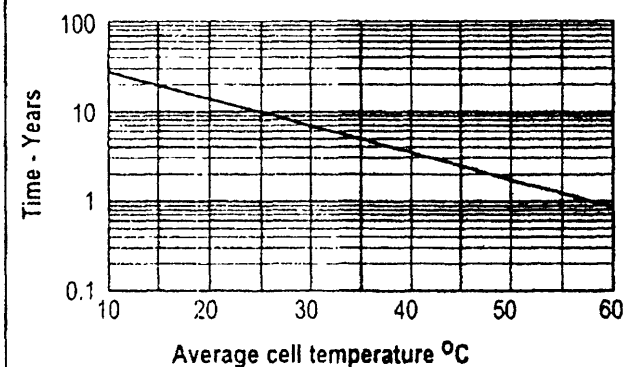


Table 9

Cycle Life

Cycle Life varies with depth of discharge (D.O.D.)

DOD %	Cycle Life
100	300
80	450
60	700
25	1,600
10	3,000
5	10,000

Table 10

NB Service life is dependent on correct charging of the product and operating temperature.

Storage

The state of charge of the Cyclon cell can be estimated by using the graph below.

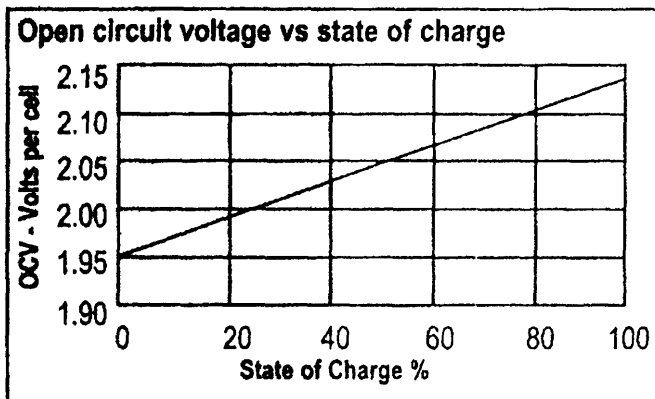


Table 4

Note: - This curve is accurate to within 20% of the cell's rated capacity, if it has not been charged or discharged within the past 24 hours. The curve is accurate to within 5% if the cell has not seen any activity, charge or discharge, for the past 5 days.

Storage

Most batteries lose their stored energy when allowed to stand open circuit. The self discharge rate is dependent both on the system's chemistry and on the temperature at which the battery is stored. Lead-tin technology gives the lowest self discharge and the longest shelf life of any VRLA battery system. Storage life is shown in Table 5 and is dependent on temperature.

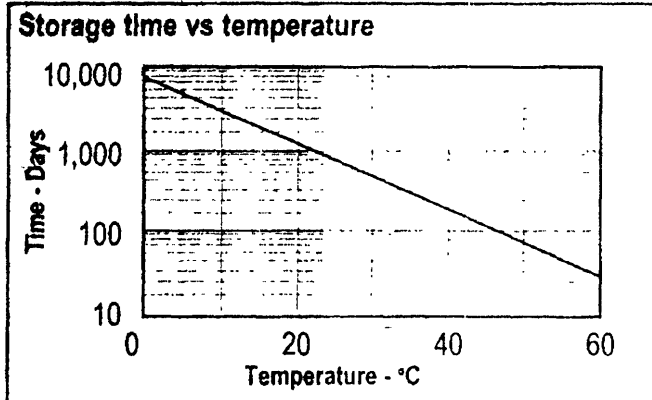


Table 5

Cyclon's self discharge rate is non linear. Table 6 indicates capacity remaining against time.

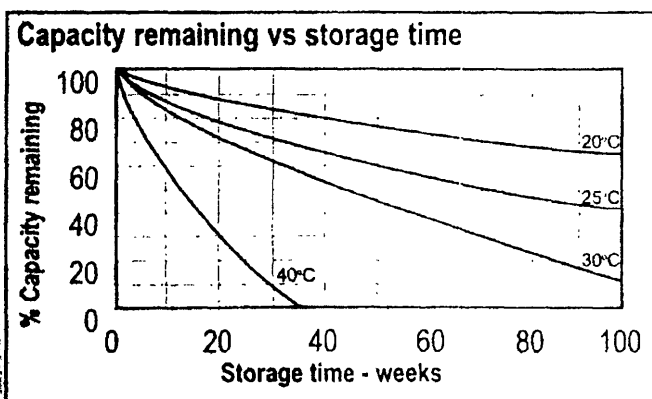


Table 6

Charging

Constant Voltage Charging is the most efficient method of charging Cyclon VRLA products.

To obtain full recharge and maintain the capacity of the cell it is necessary to return a minimum of 110% of the energy that has been removed during the last discharge. Correct voltage setting and good voltage regulation of the charger are essential to maintain an acceptable battery life. Fast recharge is possible with Cyclon products although for economic reasons batteries are usually recharged at the C/10 or C/5 rate.

Voltage levels differ for float and cyclic applications.

The table below shows the correct charger voltage setting for both cyclic and float applications.

Charge Voltages

Float charge = 2.27-2.35V per cell at 25°C

Cyclic charge = 2.45-2.5V per cell at 25°C

Recharge Time

Cyclon products can be recharged to 95% capacity in under one hour. No current limit is necessary at either float or cyclic voltages. If a fast charge regime is used it is necessary to allow a longer period of recharge (typically 7 to 10 hours) every 7-10 cycles. This permits cells to fully recharge and ensures a maximum cycle life.

Typical recharge time in hours for different current rating chargers at 25°C

Charger Rating	Charge Voltage			
	2.3VPC (Float)		2.45VPC (Cyclic)	
	90% Rech.	100% Rech.	90% Rech.	100% Rech.
5C	-	-	0.5	7
C	-	-	1.5	8
C/5	7	45	6	16
C/10	12	50	11	24

Table 7