Trojan®
BATTERY COMPANY

USER'S GUIDE

Congratulations

on your purchase from Trojan Battery Company, the manufacturer of the world's most trusted deep-cycle batteries. The battery you purchased was engineered by Trojan to deliver superior power, performance, durability and reliability for use in a broad range of demanding applications. From the T2 Technology™ in our flooded batteries to the C-Max Technology™ in the Reliant™ AGM line, our goal is to provide clean and reliable energy storage solutions that enhance the way people live and work around the world.

This User's Guide

was created by Trojan's application engineers and contains vital information regarding proper care and maintenance of your new battery. Please read through this User's Guide carefully and completely before using your battery. It will help you achieve optimum performance and long life from your new investment.

TECHNICAL SUPPORT
800-423-6569 Ext. 3045 / +1-562-236-3045

TROJAN BATTERY
COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV
=ISO 9001:2008=

Contents

01 Safety

Since batteries deliver large amounts of power that can cause injury and even death, observing safety rules is of paramount importance. For your safety and the safety of those around you, please observe the following checklist when working on or around batteries.

Always	Never
Always wear protective clothes, gloves & safety goggles	Never smoke near batteries
Always use insulated tools when working on batteries	Never wear jewelry or other metal objects when working on or around batteries
Always check connections for proper torque	Never make direct contact with the electrolyte (sulfuric acid). If this occurs, flush with large amounts of water.
Always charge batteries in well-ventilated areas	Never place objects on top of batteries, which can cause a short circuit
Always keep sparks and flames* away from batteries	Never add acid to a battery
Always use largest cable size of shortest length to minimize voltage drop	Never charge a frozen battery
Always ensure plates are covered in water before charging	Never charge a flooded battery without securing vent caps on the cells
Always make sure charger is set for the appropriate battery type (flooded, AGM or gel)	Never charge a battery when the temperature is above 122°F (50°C)
Always charge batteries before installing	Never store batteries unless they are fully charged
Always neutralize acid spills with baking soda and water	Never leave an acid spill unattended

WARNING Risk of fire, explosion, or burns. Do not disassemble, heat above 70° C (160° F), or incinerate.
EXCEPTION This statement may be included in the instructions provided with the battery, rather than be marked on the battery.

02 Equipment Needed

Before installation or maintenance of your batteries, have the following equipment available:

- Proper personal protective equipment (eye protection and acid resistant gloves)
- Distilled or treated water (i.e. de-ionized, reverse osmosis, etc.)
- Insulated wrench
- Baking soda
- Terminal protector spray
- Voltmeter (deep-cycle flooded/wet, AGM and gel batteries)
- Hydrometer (deep-cycle flooded/wet batteries)
- Discharge tester (if available)
- Battery charger

03 Battery Installation

To ensure you install your batteries properly and safely, please use the following guidelines.

3.1 Battery Connections

Battery cables provide the link between the batteries, equipment and charging system. Faulty connections can lead to poor performance and terminal damage, meltdown or fire. To ensure proper connections, please use the following guidelines for cable size, torque values and terminal protection.

3.2 Terminal Types

Below are the various terminal types found on Trojan batteries. Refer to the appropriate terminal type when determining proper torque in *Section 3.5* below.

1 ELPT	2 EHPT	3 EAPT	4 EUT	5 LT	6 DT	7 UT
Embedded Low Profile	Embedded High Profile	Embedded Auto Post	Embedded Universal	L-Terminal	Automotive Post & Stud	Universal

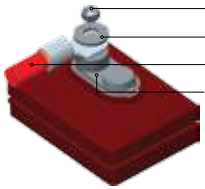
8 AP	9 WNT	10 DWNT	11 ST	14 IND	15 M6/M8
Automotive Post	Wingnut	Dual Wingnut	Stud	Industrial	6mm/8mm Insert

3.3 Correct Hardware* Installation

If using washers, it is very important to ensure the battery cable lug connection is contacting the lead surface of the terminal, and the washer is placed on top of the wire connection. Do not place washer between the terminal lead and the battery wire, which creates high resistance and can cause terminal meltdown.

Flooded

ELPT

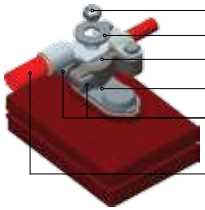


- **Nut** - Torque to 95-105 (in-lbs), 11-12 (Nm)
- Washer*
- Cable Lug
- Terminal

EUT

- Cable Lug
- **Nut** - Torque to 95-105 (in-lbs), 11-12 (Nm)
- Washer*
- Terminal
- Bolt

EHPT

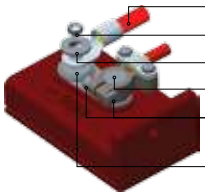


- **Nut** - Torque to 95-105 (in-lbs), 11-12 (Nm)
- Washer*
- Stud Portion
- Terminal
- AP Connector
  Torque to 50-70 (in-lbs), 6-8 (Nm)
- Cable Lug

EAPT

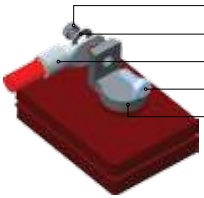
- AP Connector
  Torque to 50-70 (in-lbs), 6-8 (Nm)
- Terminal

DT



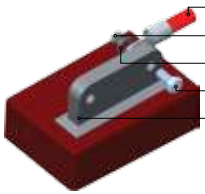
- Cable Lug
- **Nut** - Torque to 95-105 (in-lbs), 11-12 (Nm)
- Washer*
- AP Terminal
- AP Connector
  Torque to 50-70 (in-lbs), 6-8 (Nm)
- Stud Terminal

LT



- **Nut** - Torque to 95-105 (in-lbs), 11-12 (Nm)
- Washer*
- Cable Lug
- Bolt
- Terminal

IND

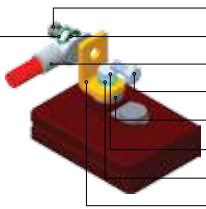


- Cable Lug
- **Nut** - Torque to 100-120 (in-lbs), 11-14 (Nm)
- Washer*
- Bolt
- Terminal

*Images shown reflect correct hardware placement. *Hardware not supplied by Trojan Battery Company.*

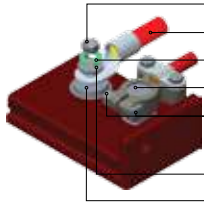
AGM

LT



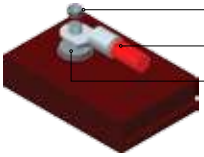
- Lock Washer
- **Nut** – Torque to 70 (in-lbs), 8 (Nm)
- **Washer**
- **Cable Lug**
- **Bolt** - 20 mm
- **M8 Terminal**
- **Bolt** - 16mm - Torque to 85-95 (in-lbs), 10-11 (Nm)
- **Lock Washer**
- **LT Adapter**

DT



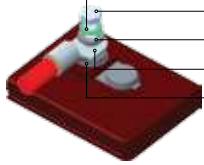
- **Nut** – Torque to 95-105 (in-lbs), 11-12 (Nm)
- **Cable Lug**
- **Lock Washer**
- **APTerminal**
- **AP Connector** Torque to 50-70 (in-lbs), 6-8 (Nm)
- **Washer**
- **Stud Terminal**

ST



- **Nut** – Torque to 120-180 (in-lbs), 14-20 (Nm)
- **Cable Lug**
- **Terminal**

M8

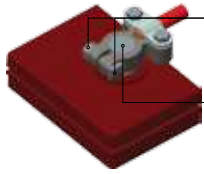


- **Lock Washer**
- **Bolt** – Torque to 85-95 (in-lbs), 10-11 (Nm)
- **Washer**
- **Cable Lug**
- **Terminal**

AP (RELIANT)

- **AP Connector** Torque to 50-70 (in-lbs), 6-8 (Nm)
- **AP Adapter** Torque to 85-95 (in-lbs), 10-11 (Nm)
- **M8 Terminal**

AP

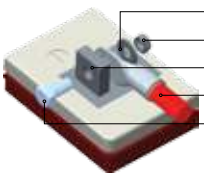


- **AP Connector** Torque to 44-62 (in-lbs), 5-7 (Nm)
- **Terminal**

Images shown reflect correct hardware placement. All hardware supplied for Reliant AGM. Hardware for non Reliant AGM is optional.

Gel

LT



- Washer*
- Nut – Torque to 95-105 (in-lbs), 11-12 (Nm)
- Terminal
- Cable Lug
- Bolt

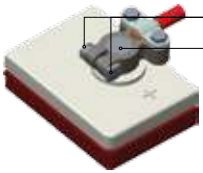
UT

- Nut – Torque to 95-105 (in-lbs), 11-12 (Nm)
- Cable Lug
- Washer*
- Terminal
- Bolt

DT

- Nut – Torque to 95-105 (in-lbs), 11-12 (Nm)
- Cable Lug
- Washer*
- AP Terminal
- AP Connector
  Torque to 50-70 (in-lbs), 6-8 (Nm)
- Stud Terminal

AP



- AP Connector – Torque to 50-70 (in-lbs), 6-8 (Nm)
- Terminal

*Images shown reflect correct hardware placement. *Hardware not supplied by Trojan Battery Company.*

3.4 Cable Size

Battery cables should be sized to handle the expected load. Refer to *Table 1* for the maximum amps based on the cable/wire gauge size.

Table 1

Cable/Wire Gauge Size *(AWG)*	Ampacity *(amps)*
14	25
12	30
10	40
8	55
6	75
4	95
2	130
1	150
1/0	170
2/0	265
4/0	360

Table values are for cable lengths less than 6 feet (1829 mm). In series/parallel battery banks, it is preferable for all series cables to be the same length, and all parallel cables to be the same length.

For more information refer to the National Electric Code for correct cable/wire size, which can be located at www.nfpa.org.

3.5 Torque Values

Tighten all cable connections to the proper specification to make sure there is good contact with the terminals. Over-tightening terminal connections can cause terminal breakage and loose connections can result in terminal meltdown or fire. Refer to *Table 2* for the proper torque values based on the type of terminal on your battery.

Table 2

Terminal Type	Torque (in-lb)	Torque (Nm)
Flooded		
DWNT, ELPT, EUT, LT, UT, WNT	95 - 105	11 - 12
EAPT, AP	50 - 70	6 - 8
DT, EHPT	50 - 70 (AP Connector) 95 - 105 (Stud Portion)	6 - 8 (AP Connector) 11-12 (Stud Portion)
IND	100 - 120	11 - 14
AGM		
M8	85 - 95	10 - 11
AP (Adapter) Reliant	50 - 70 (AP Connector) 95 - 105 (AP Adapter)	6 - 7 (AP Connector) 11 - 12 (AP Adapter)
AP	44 - 62	5 - 7
DT	50 - 70 (AP Connector) 95 - 105 (Stud Portion)	6 - 8 (AP Connector) 11-12 (Stud Portion)
LT (Adapter)	70 (Nut) 85 - 95 (Bolt)	6 - 8 (Nut) 10 - 11 (Bolt)
M6	30	3 - 4
ST	120 - 180	14 - 20
Gel		
AP	50 - 70	6 - 8
LT, UT	95 - 105	11 - 12
DT	50 - 70 (AP Connector) 95 - 105 (Stud Portion)	6 - 8 (AP Connector) 11-12 (Stud Portion)

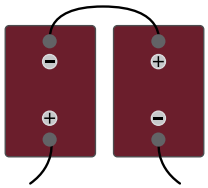
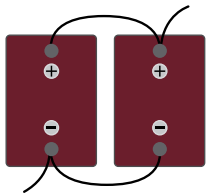
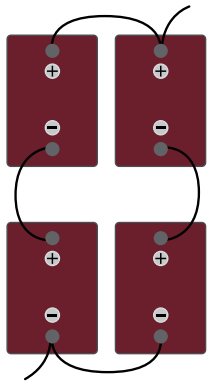
WARNING **Use an insulated wrench when making battery connections.**

3.6 Terminal Protection

Corrosion can build up on terminals if they are not kept clean and dry. To prevent corrosion, apply a thin coat of terminal protector spray that can be purchased through your local battery dealer.

3.7 Connecting Batteries to Increase System Power

You can increase capacity and voltage, or both, by configuring your batteries as follows:

	Series Connect	Parallel Connect	Series/Parallel Connect
			
	To increase voltage, connect batteries in series. This will not increase the system capacity.	To increase capacity, connect batteries in parallel. This will not increase the system voltage.	To increase both voltage and capacity, connect additional batteries in series and parallel.
EXAMPLE	Two T-105, 6V Batteries rated at 225AH Connected in Series	Two T-105, 6V Batteries rated at 225AH Connected in Parallel	Four T-105, 6V Batteries rated at 225A Connected in Series/Parallel
	Voltage 6V + 6V = 12V System Capacity = 225AH	Voltage 6V System Capacity = 225AH + 225AH = 450AH	Voltage 6V + 6V = 12V System Capacity = 225AH + 225AH = 450AH
	Call Tech Support for Additional Configurations		

3.8 Ventilation

Deep-cycle flooded/wet lead acid batteries release small amounts of gas during usage, particularly during the charging process. Deep-cycle AGM and gel batteries do release gas, but at a much lower rate than the flooded types. It is critical to charge batteries in a properly ventilated area. For more assistance in determining ventilation needs, please contact Trojan Battery Company's technical support engineers.

3.9 Battery Orientation

Deep-cycle flooded/wet batteries must be placed upright at all times. Fluid in the battery will spill if the battery is placed on its side or at an angle. Deep-cycle AGM or gel batteries are non-spillable and can be placed either upright or on their side.

3.10 Battery Environment

Batteries should be stored and installed in a clean, cool and dry place, keeping water, oil, and dirt away from the batteries. If any of these materials are allowed to accumulate on the batteries, tracking and voltage leakage can occur, resulting in self-discharge and possible short-circuits. Battery chargers should also be installed in well-ventilated, clean areas that are easily accessible.

3.11 Temperature

The recommended operating temperature range is between -4°F to 122°F (-20°C to +50°C) with a humidity of <90%. Elevated battery electrolyte temperatures of >80°F (27°C) will reduce operating life, while lower battery electrolyte temperatures of <80°F (27°C) will reduce battery performance.

It is important to minimize temperature variations between the cells, therefore, do not arrange the batteries where they are too tightly packed together which restricts airflow. The batteries should have a minimum of 0.50" (12.7 mm) of space between them to allow for adequate airflow.

04 Preventative Maintenance

4.1 Inspection

- Examine the outside appearance of the battery. The tops of the batteries and terminal connections should be clean and dry, as well as free of dirt and corrosion. Refer to *Cleaning Section 4.3*.
- If fluids are present on the top of a deep-cycle flooded/wet battery, it may mean that the battery is being over-watered or overcharged. Refer to *Watering Section 4.2* for the proper watering procedure.
- If fluid is present on the top of a deep-cycle AGM or gel battery, it may mean that the battery is being overcharged, which can reduce battery performance and life.
- Check battery cables and connections. Replace any damaged cables and tighten any loose connections. Refer to *Torque Values Section 3.5*.

4.2 Watering (flooded/wet batteries only)

Deep-cycle flooded/wet batteries need to be watered periodically. The frequency depends on battery usage, charging and operating temperature. Check new batteries every few weeks to determine the watering frequency for your application. It is normal for batteries to need more watering as they age.

Standard Batteries

Water should NEVER be added to deep-cycle AGM or gel batteries.

Plus Series™ batteries

- Fully charge the batteries prior to adding water. Only add water to discharged or partially charged batteries if the plates are exposed. In this case, add just enough water to cover the plates and then charge the batteries. Once completed, continue with the watering procedure below.
- Check the electrolyte levels by removing the vent caps and placing them upside down so that dirt does not accumulate on the underside of the cap. For Plus Series™ batteries, simply flip open the cap.
- If the electrolyte level is well above the plates, then it is not necessary to add more water.
- If the electrolyte level is barely covering the plates, add distilled or de-ionized water to a level of 1/8" (3 mm) below the vent well. See right.
- After adding water, secure vent caps back onto batteries.
- Tap water may be used if the levels of impurities are within acceptable limits. Refer to *Table 3* for Water Impurity Limits.

Table 3

Recommended Maximum Allowable Impurities in Water for Battery Use		
Impurity	Parts Per Million	Effects of Impurity
Color	Clear and "White"	-
Suspended Matter	Trace	-
Total Solids	100.00	-
Organic and Volatile Matter	50.0	Corrosion of positive plate
Ammonia	8.0	Slight self-discharge of both plates
Antimony	5.0	Increased self-discharge, reduces life, lower on-charge voltage
Arsenic	0.5	Self-discharge, can form poisonous gas at negative plate
Calcium	40.0	Increase of positive plate shedding
Chloride	5.0	Loss of capacity in both plates, greater loss on the positive plate
Copper	5.0	Increased self-discharge, lower on-charge voltage
Iron	3.0	Increased self-discharge at both plates, lower on-charge voltage
Magnesium	40.0	Reduced life
Nickel	None Allowed	Intense lowering of on-charge voltage
Nitrates	10.0	Increased sulfation on the negative plate
Nitrites	5.0	Corrosion of both plates, loss of capacity, reduced life
Platinum	None Allowed	Increased self-discharge, lower on-charge voltage
Selenium	2.0	Positive plate shedding
Zinc	4.0	Slight self-discharge of negative plate

4.3 Cleaning

Check the battery for cleanliness at regular intervals and keep terminals and connectors free of corrosion. Terminal corrosion may adversely affect the performance of the battery and present a safety hazard.

- Check that all vent caps are secured properly on the battery.
- Clean the top of the battery, terminals and connections with a cloth or brush, and a solution of baking soda and water (1 cup of baking soda to 1 gallon of water).
  Do not allow cleaning solution to get inside the battery.
- Rinse with water and dry with a clean cloth.
- Apply a thin coat of terminal protector spray that can be purchased through your local battery dealer.
- Keep the area around batteries clean and dry.

4.4 Charging & Equalizing

4.4.1 Boost Charging

The term boost charging refers to fully charging your batteries before they are used or when they are in storage.

Flooded Batteries

Two methods can be used to boost charge flooded batteries, either automatically or manually. If using the automatic method (charger is preprogrammed), simply allow the charger to go through the complete charge cycle.

If you use the manual method (charger has adjustable settings) follow the steps below:

- Boost charge at CONSTANT CURRENT, without voltage limit, at 3% of C_{20} until the voltage stops increasing for three consecutive hourly readings. If using CONSTANT VOLTAGE, the recommended boost charge voltage is 2.58Vpc with the charger output current limited to 3 – 5% of C_{20}. The minimum recommended value is 2.45Vpc; however, this will result in an extended boost time.
- The boost charge is not complete until the specific gravity readings of each cell remain constant over three successive hourly readings and all cells are gassing freely. If you have questions concerning boost charging, contact Trojan Battery Company Technical Support.

AGM / Gel Batteries

Similarly, two methods can be used to boost your AGM/gel product, automatically or manually. If using the automatic method (charger is preprogrammed), just allow the charger to go through the complete charge cycle. Make sure the proper battery type, AGM or gel, is selected on the charger.

If you use the manual method (charger has adjustable settings) follow the steps below:

- Boost charge at a CONSTANT VOLTAGE of (2.40 VPC) with the current limited to 20% of C_{20}. Example: 20 amps for a battery with a C_{20} of 100Ah.
- The time needed to boost charge the cells can be determined using the equation below.

$$\text{Boost Charge Time in Hours} = \left(\frac{\text{DOD X Capacity at 20Hr Rate}}{\text{Maximum Charge Current}} + 5 \text{ Hours} \right)$$

For example, a 100Ah battery taken down to a 25% depth of discharge (DOD) or 75% state of charge (SOC) will need to be boost charged for 7½ hours with a 10A charger, or for 6¼ hours with a 20A charger.

4.4.2 Charging

Proper charging is imperative to maximize battery performance. Both under- or over-charging batteries can significantly reduce the life of the battery. Most chargers are automatic and pre-programmed, while others are manual and allow the user to set the voltage and current values.

AGM and gel batteries should always have temperature compensated charging.

- **Batteries should be fully charged after each use. "Use" is defined of at least 30 minutes of runtime.**
- **Deep-cycle flooded/wet charging guidelines:** Refer to *Table 4* and *Diagram 4*.
- **Deep-cycle AGM charging guidelines:** There are various ways to charge AGM batteries. For optimum performance and life, Trojan recommends a 3-step profile as shown in *Diagram 5* and following the guidelines in *Table 5*.
- **Deep-cycle gel charging guidelines:** Refer to *Table 6* and *Diagram 6*.
- Before charging, make sure the charger is set to the appropriate program for deep-cycle flooded/wet, AGM or gel, depending on the type of battery you are charging.
- Lead acid batteries (deep-cycle flooded/wet, AGM or gel) do not have a memory effect and therefore and do not need to be fully discharged before recharging.
- Charge only in well-ventilated areas.
- Check electrolyte levels in deep-cycle flooded/wet batteries to make sure plates are covered with water before charging. Refer to *Section 4.2*.
- Check that all vent caps are secured properly on the battery before charging.
- Deep-cycle flooded/wet batteries will gas (bubble) towards the end of charge to ensure proper mixing of the electrolyte.
- Never charge a frozen battery.
- Avoid charging at temperatures above 122°F (50°C).

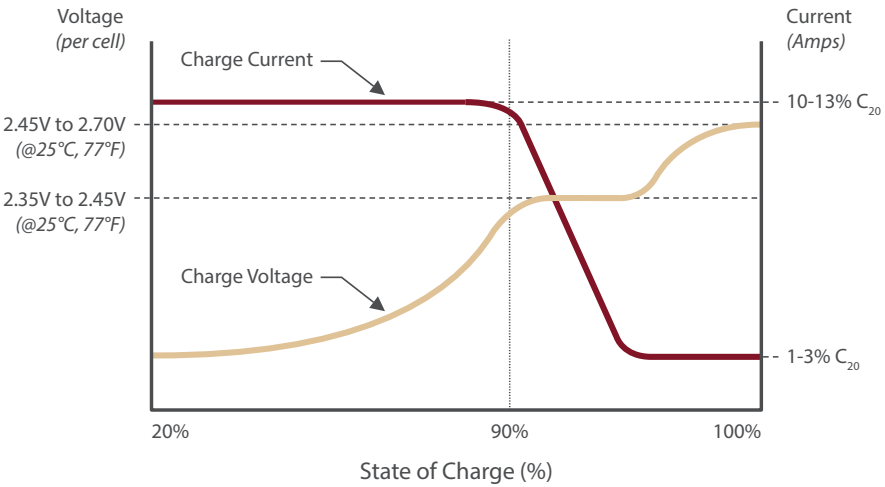
Table 4

Deep-Cycle Flooded/Wet Batteries - Charger Voltage Settings (@25°C, 77°F)						
System Voltage	6 Volt	8 Volt	12 Volt	24 Volt	36 Volt	48 Volt
Bulk Charge (2.47 VPC)	7.4	9.9	14.8	29.6	44.5	59.3
Absorption Charge (2.35 – 2.45 VPC)	7.05 – 7.35	9.4 – 9.8	14.1 – 14.7	28.2 – 29.4	42.3 – 44.1	56.4 – 58.8
Finish Charge (2.70 VPC)	8.1	10.8	16.2	32.4	48.6	64.8
Equalize Charge (2.70 VPC)	8.1	10.8	16.2	32.4	48.6	64.8
Float Charge (if desired 2.25 VPC)	6.75	9.0	13.5	27	40.5	54

The chart below illustrates a **typical** recharge profile:

Diagram 4

Recommended Deep-Cycle Flooded/Wet Charging Profile



Note: Charging time will vary depending on battery size, charger output, and depth of discharge.

Table 5

Deep-Cycle AGM Batteries - Charger Voltage Settings**						
System Voltage	6 Volt	8 Volt	12 Volt	24 Volt	36 Volt	48 Volt
Bulk Charge (2.40 VPC)	7.2	9.6	14.4	28.8	43.2	57.6
Absorption Charge(2.35 – 2.45 VPC)	6.75 – 6.9	9.4 – 9.8	14.1 – 14.7	28.2 – 29.4	42.3 – 44.1	56.4 – 58.8
Finish Charge (2.45 VPC)	7.35	9.8	14.7	29.4	44.1	58.8
Float Charge (2.25 – 2.3 VPC)	6.75	9.0	13.5	27	40.5	54

*** AGM batteries should always use temperature compensated charging per the following rule:*

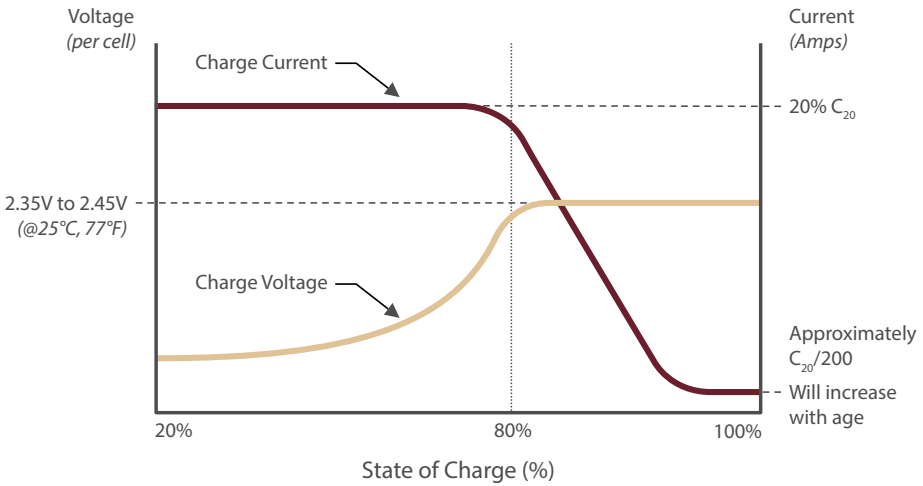
5.0 mV per cell / °C or 2.8 mV per cell / °F

Subtract 0.005 volt per cell from the voltage reading for every 1°C above 25°C, or add 0.005 volt per cell for every 1°C below 25°C. Subtract 0.0028 volt per cell for every 1°F above 77°F, or add 0.0028 volt per cell for every 1°F below 77°F.

The chart below illustrates a **typical** recharge profile:

Diagram 5

Recommended Trojan Deep-Cycle AGM Charging Profile



Note: Charging time will vary depending on battery size, charger output, and depth of discharge.

Table 6

Deep-Cycle Gel Batteries - Charger Voltage Settings**						
System Voltage	6 Volt	8 Volt	12 Volt	24 Volt	36 Volt	48 Volt
Bulk Charge (2.40 VPC)	7.2	9.6	14.4	28.8	43.2	57.6
Float Charge (if desired 2.25 VPC)	6.75	9.0	13.5	27	40.5	54

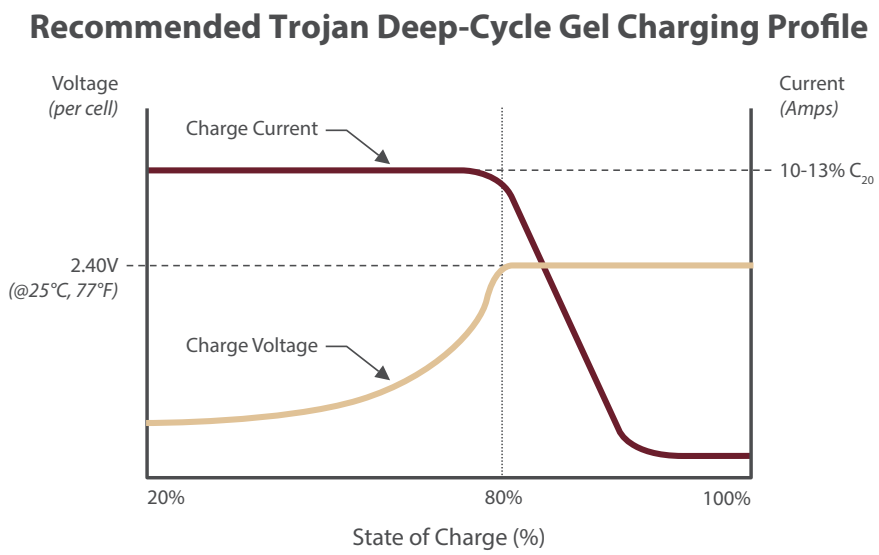
*** Gel batteries should always use temperature compensated charging per the following rule:*

5.0 mV per cell / °C or 2.8 mV per cell / °F

Subtract 0.005 volt per cell from the voltage reading for every 1°C above 25°C, or add 0.005 volt per cell for every 1°C below 25°C. Subtract 0.0028 volt per cell for every 1°F above 77°F, or add 0.0028 volt per cell for every 1°F below 77°F.

The chart below illustrates a **typical** recharge profile:

Diagram 6



Note: Charging time will vary depending on battery size, charger output, and depth of discharge.

4.4.3 Equalizing (deep-cycle flooded/wet batteries only)

Equalizing is an overcharge performed after fully charging deep-cycle flooded/wet batteries. An equalizing charge prevents battery stratification and reduces sulfation which are leading causes of battery failure. Trojan recommends equalizing every 30 days or when batteries have a low specific gravity reading after fully charging, below 1.235, or have a wide ranging specific gravity of >0.030 points between cells.

Deep-cycle AGM or gel batteries should NEVER be equalized.

Equalization can be performed either automatically (as programmed on the charger) or by following the procedure below:

- Check the battery's electrolyte level in each cell to make sure the plates are covered before charging.
- Check that all vent caps are secured properly on the battery before charging.
- Set charger to equalizing mode.
- The batteries will gas (bubble) during the equalization process.
- Measure the specific gravity every hour. Refer to *Table 7* for specific gravity and voltage measurements. Discontinue the equalization charge when the specific gravity no longer rises.

WARNING **Do not equalize deep-cycle AGM or gel batteries.**

Table 7

Flooded/Wet State of Charge as a Measure of Specific Gravity and Open-Circuit Voltage					
Percentage Charge	Specific Gravity	Cell	6 Volt	8 Volt	12 Volt
100	1.277	2.122	6.37	8.49	12.73
90	1.258	2.103	6.31	8.41	12.62
80	1.238	2.083	6.25	8.33	12.50
70	1.217	2.062	6.19	8.25	12.37
60	1.195	2.04	6.12	8.16	12.24
50	1.172	2.017	6.05	8.07	12.10
40	1.148	1.993	5.98	7.97	11.96
30	1.124	1.969	5.91	7.88	11.81
20	1.098	1.943	5.83	7.77	11.66
10	1.073	1.918	5.75	7.67	11.51
AGM State of Charge as a Measure of Open-Circuit Voltage					
Percentage Charge	Specific Gravity	Cell	6 Volt	8 Volt	12 Volt
100	NA	2.14	6.42	8.56	12.84
75	NA	2.09	6.27	8.36	12.54
50	NA	2.04	6.12	8.16	12.24
25	NA	1.99	5.97	7.96	11.94
0	NA	1.94	5.82	7.76	11.64
Gel State of Charge as a Measure of Open-Circuit Voltage					
Percentage Charge	Specific Gravity	Cell	6 Volt	8 Volt	12 Volt
100	NA	2.14	6.42	8.56	12.84
75	NA	2.11	6.33	8.44	12.66
50	NA	2.06	6.18	8.24	12.36
25	NA	2.00	6.00	8.00	12.00
0	NA	1.97	5.91	7.88	11.82

05 Storage

- Charge batteries before placing in storage.
- Store in a cool, dry location, protected from the elements.
- Disconnect from equipment to eliminate potential parasitic loads that may discharge the battery.
- Batteries gradually self-discharge during transit and storage, so monitor the specific gravity or voltage in flooded batteries every 4 - 6 weeks. Monitor the open circuit voltage for AGM or gel batteries every 2 - 3 months.
- Batteries in storage should be given a boost charge when they are at 70% SOC for flooded and 75% for AGM or gel. Refer to *Table 7* for specific gravity (flooded only) and voltage measurements for flooded batteries and AGM or gel batteries. If boosting is needed, refer to *Section 4.4.1* for boosting instructions.
- When batteries are taken out of storage, recharge before use.

5.1 Storage in Hot Environments (greater than 90°F or 32°C)

Avoid direct exposure to heat sources, if possible, during storage. Batteries self-discharge faster in high temperatures. If batteries are stored during hot summer months, monitor the specific gravity or voltage more frequently (approximately every 2 - 4 weeks).

5.2 Storage in Cold Environments (less than 32°F or 0°C)

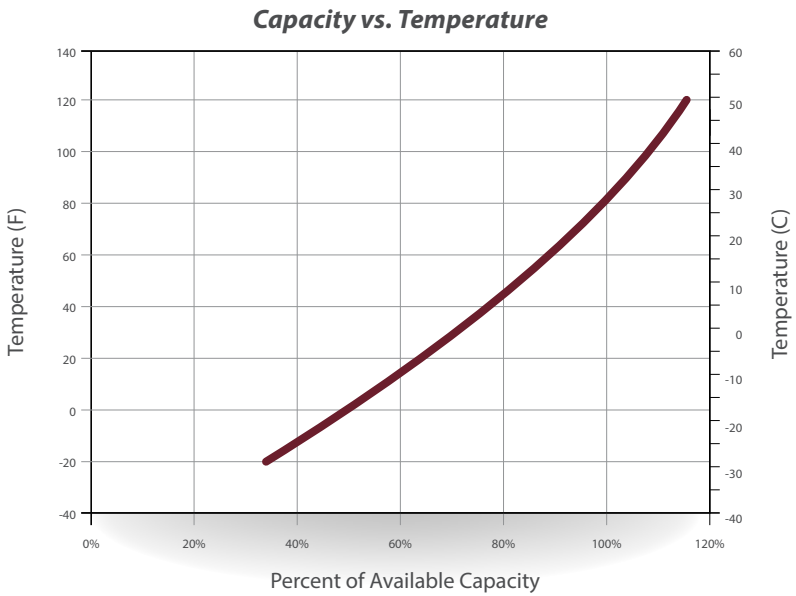
Avoid locations where freezing temperatures are expected, if possible, during storage. Batteries can freeze in cold temperatures if they are not fully charged. If batteries are stored during cold winter months, it is critical that they are kept fully charged at all times.

06 How to Maximize the Performance of your Trojan Battery

- Follow all the procedures in this User's Guide for proper installation, maintenance and storage.
- Do not discharge your battery more than 80%. This safety factor will eliminate the chance of over-discharging and damaging your battery.
- If you have any questions or concerns about battery care, please contact Trojan Battery Company's technical support engineers at 800-423-6569 Ext. 3045 or +1-562-236-3045 before a problem develops.

07 What to Expect from your Trojan Battery

- A new deep-cycle battery will not immediately deliver its full rated capacity. This is normal and should be expected since it takes time for a deep-cycle battery to reach maximum performance or peak capacity.
- Trojan's deep-cycle AGM and gel batteries will reach rated capacity in less than 10 cycles.
- Trojan's deep-cycle flooded batteries take between 50 – 100 cycles to achieve full, peak capacity.
- When operating batteries at temperatures below 80°F (27°C), they will deliver less than the rated capacity. For example at 0°F (-18°C) the battery will deliver 50% of its capacity and at 80°F (27°C) it will deliver 100% of its capacity.
- When operating batteries at temperatures above 80°F (27°C), they will deliver more than the rated capacity but will reduce battery life.
- The life of a battery is difficult to predict and will vary by application, frequency of usage and level of maintenance.



08 Trouble-Shooting

These battery testing procedures are guidelines only for identifying a deep-cycle battery that may need to be replaced. Unique situations may be observed that are not identified within this procedure. Please contact Trojan Battery Company's technical support engineers at 800-423-6569 Ext. 3045 or +1-562-236-3045 for help interpreting the test data.

8.1 Preparation for Testing

- Check that all vent caps are secured properly on the battery.
- Clean the top of the battery, terminals and connections with a cloth or brush and a solution of baking soda and water (1 cup of baking soda to 1 gallon of water). Do not allow cleaning solution to get inside the battery. Rinse with water and dry with a clean cloth.
- Check battery cables and connections. Replace any damaged cables. Tighten any loose connections with an insulated wrench. Refer to *Torque Values Section 3.5*.
- For deep-cycle flooded/wet batteries, check the electrolyte level and add water if necessary. Refer to *Watering Section 4.2*.
- Ensure batteries are fully charged before discharge testing to obtain accurate results.

8.2 On-Charge Voltage Testing

- Disconnect and reconnect DC plug to restart charger.
- While the batteries are on-charge, record the current in the last ½ hour of charge cycle (if possible), and measure the battery set voltage.
- If the current at the end of the charge is below 5 amps, and the battery set voltage is above the following readings, proceed to the next step:
  - 56V for a 48V system
  - 42V for a 36V system
  - 28V for a 24V system
  - 14V for a 12V battery
  - 9.3V for a 8V battery or 7V for a 6V battery
- If the current at the end of the charge does not match these readings, check the charger for proper output and recharge the batteries. If the set voltages are still low, you may have a failed battery.
- While the batteries are on-charge, measure the individual battery voltages.
- If any battery voltage is below 7V for 6V battery, 9.3V for 8V battery and 14V for 12V battery, and a voltage variation is greater than 0.5V for 6V battery or 1.0V for a 12V battery, from any other battery in set, it may be a failed battery.

8.3 Specific Gravity (flooded/wet batteries only)

- Fill and drain the hydrometer 2 - 3 times before drawing a sample from the battery.
- Measure specific gravity readings for all battery cells.
    - Correct specific gravity readings for temperature by adding 0.004 for every 10°F (5°C) above 80°F (27°C), and subtract 0.004 for every 10°F (5°C) below 80°F (27°C).
    - If every cell in the battery set is below 1.235, the batteries may be undercharged and require recharging.
    - If any battery has a specific gravity variation of more than 0.030 between cells, equalize the set.
    - If there is still a variation there may be a failed battery.

8.4 Open Circuit Voltage Testing

This is the least preferred method of evaluating the condition of a deep-cycle flooded/wet battery, but is the only method for AGM and gel batteries.

- For accurate voltage readings, batteries must remain idle at least 6 hours, preferably up to 24 hours.
- Measure the individual battery voltages.
- If any battery voltage is greater than 0.3V compared to other batteries in set, equalize the set (deep-cycle flooded/wet batteries ONLY). Refer to *Equalizing Section 4.4.3*.
- Measure the individual battery voltages again.
- If any battery voltage is still greater than 0.3V compared to any other battery in the set, you may have a failed battery.

8.5 Discharge Testing

- Follow the procedure below to determine battery capacity.
- Connect and start discharger.
- Record the runtime (minutes) when discharge is complete.
- Correct runtime minutes for temperature using the following formula (valid between 75°F (24°C) and 90°F (32°C):

  $M_c = M_r [1 - 0.005^* (T_1 - 80^*)]$ *(For Celsius, use 0.009 & 27°C)

  Where M_c = Discharge time corrected to 80°F (or 27°C)
  M_r = Actual discharge time
  T_1 = Battery temperature at end of discharge (°F or °C)

- If the discharge runtime is greater than 50% of the batteries' rated capacity at that discharge rate, then all the batteries are operational.
- Restart the discharger to record the individual battery voltage while still under load (current being drawn).
- If the discharge runtime is less than 50% of the batteries' rated capacity, the battery with a voltage that is 0.5V lower than the highest voltage may be a failed battery.

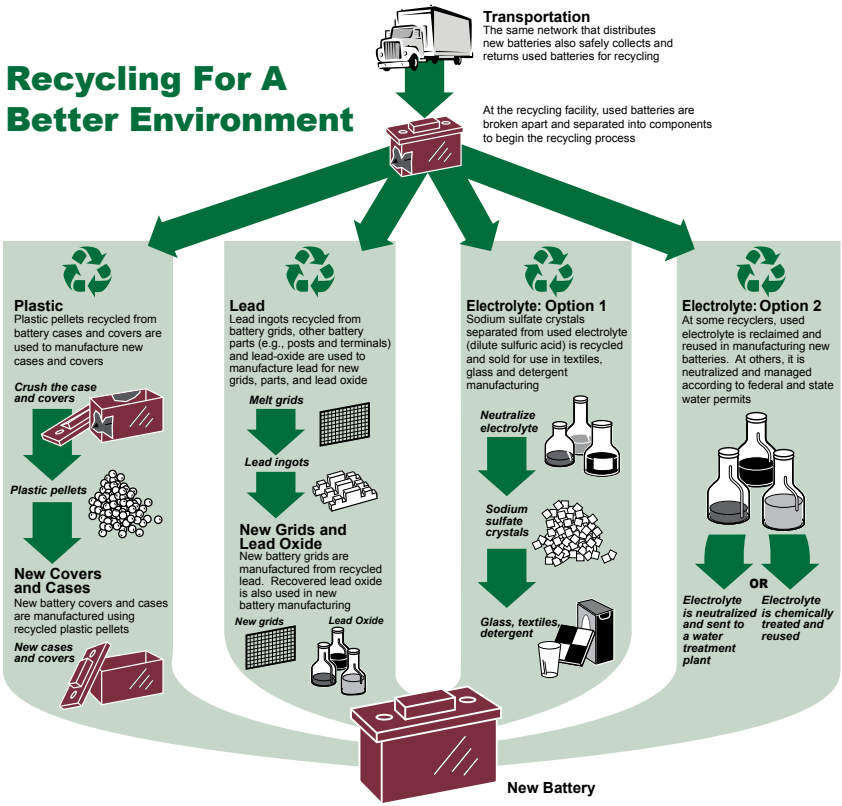
There are other methods of testing batteries including internal resistance (i.e. C.C.A. testers) and carbon-pile discharge testers. However these are not suitable testing methods for deep-cycle batteries.

09 Battery Recycling

Lead acid batteries are the environmental success story of our time since more than 97% of all battery lead is recycled. In fact, lead acid batteries top the list as one of the most highly recycled consumer products. Trojan Battery supports proper recycling of your battery to keep the environment clean.

Please contact your nearest Trojan Distributor, at www.trojanbattery.com, to learn how to properly recycle your batteries.

Below is the process in which your Trojan battery will be recycled:



Graphics provided by Battery Council International

10 Battery Acronyms

AGM	Absorbed Glass Mat
AMP	Amperage
AH	Amp-Hours
AWG	American Wire Gauge
AP	Automotive Post Terminal
°C	Celsius
C.C.A.	Cold Cranking Amps
DT	Automotive Post & Stud Terminal
DWNT	Dual Wingnut Terminal
EAPT	Embedded Automotive Post Terminal
EHPT	Embedded High Profile Terminal
ELPT	Embedded Low Profile Terminal
EUT	Embedded Universal Terminal
°F	Fahrenheit
IND	Industrial Terminal
LT	L-Terminal
M6/M8	6mm - 8mm Teminal
Mc	Corrected Minutes
Mr	Minutes Recorded
SOC	State of Charge
ST	Stud Terminal
T	Temperature
UT	Universal Terminal
V	Volt
WNT	Wingnut Terminal

Notes

Trojan Battery Company

would like to thank you for selecting our battery. With over 85 years of experience, Trojan Battery is the world's most trusted name in deep-cycle battery technology backed by our outstanding technical support. We look forward to serving your battery needs.

TROJAN BATTERY COMPANY
12380 Clark Street, Santa Fe Springs, CA 90670 USA

Call **800-423-6569 Ext. 3045** or **+1-562-236-3045**

or Visit www.trojanbattery.com

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