DYNO

BATTERY, INC. | MADE IN THE USA SINCE 1933

USER GUIDE

CONTENTS

1| SAFETY

Batteries can cause severe harm or injury and in some cases death. There is a risk of fire, burns, explosion and electrical shock.

Please observe the points before working on batteries:

- Wear appropriate clothing, protective gloves and safety eyewear
- Remove all jewellery or conductive accessories
- Use insulated tools to avoid risk of electric shock
- Do not have open flames or sparks near the battery
- Ensure the battery connections are sound
- Have baking soda and water on-hand as a neutralising agent in case of electrolyte spillage
- Ensure there is adequate ventilation

2| EQUIPMENT

It is important to wear the correct safety gear when working with batteries. Proper equipment will combat any unwanted contact with electrolyte or debris.

Before maintaining or installing your batteries, have the below equipment available:

- Safety glasses
- Apron
- Hydrometer
- Voltmeter
- Acid resistant gloves
- Eye-wash kit
- Insulated tools
- Baking soda

3| BATTERY INSTALLATION

To guarantee you install your batteries properly and safely, please see the below recommendation.

3.1 Battery Cables

Battery cables are used to connect multiple batteries into a series/parallel/series-parallel format. If the quality of the cable or connection to the terminal is poor, it can lead to high resistance, generating extreme heat and potentially causing the battery terminal and/or surrounding casing to melt. This can be very dangerous if left unattended and is a high fire risk.

3.2 Terminal and Connection Types

There are many different types of terminals in batteries, some of which are multi-purpose. It is important to use the correct cable type to avoid bad connections. If the battery has an 8mm stud, an eyelet cable should be used to ensure a solid connection. If using flat washers, place the washer on top of the lug and not between the lug and the lead terminal.

3.3 Cable Size

Cables size should be sized to handle the expected load. Refer to the below table for the maximum amperage per cable gauge size.

CABLE GAUGE SIZE, AWG (MM^2)	AMPACITY (AMPS)
14 (2.08)	20
12 (3.31)	25
10 (5.26)	35
8 (8.36)	50
6 (13.3)	65
4 (21.1)	85
2 (33.6)	115
1 (42.4)	130
1/0 (53.5)	150
2/0 (67.4)	175
4/0 (107)	230

Table values are from NEC Table 310.15(B)16 for copper cables rated at 167°F (75°C), operating at an ambient temperature of no more than 86°F (30°C). Lengths in excess of 6 feet (1829 mm) may require heavier gauge wire to avoid unacceptable voltage drop. 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 Electrical Code for correct cable/wire size, which can be located at www.nfpa.org.

3.4 Torque Values

Make sure your cable connections are tightened to the proper specification, using a suitable torque wrench, so there is a good contact with the terminals. Be sure not to over-tighten the connections to avoid any terminal breakage or loose connections which can lead to terminal melting or fire. refer to the below table for proper torque values based on the terminal type you are connecting to (terminal key below).

Note: Do not use a drill to tighten the terminal nuts, as it is very easy to over-tighten and damage the battery terminal.

TERMINAL TYPE	DRY TORQUE (IN-LB)	DRY TORQUE (NM)
Automotive Post	50 – 70	6 – 8
Dual Purpose (S)	95 – 105	11 – 12
LPT	95 – 105	11 – 12
Marine (AP Portion)	50 – 70	6 – 8
Marine (Stud Portion)	95 – 105	11 – 12

Terminal Key

3.5 Terminal Protection

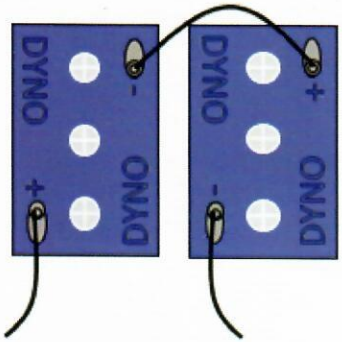
If battery terminals are not kept clean and dry, corrosion can occur. To prevent corrosion, after tightening the terminal connections, apply a thin coat of terminal protector spray, or Vaseline.

3.6 Connecting Batteries in Banks

By following the techniques below, you can increase the capacity, voltage or both, of your battery bank.

3.6.1 Series Connection

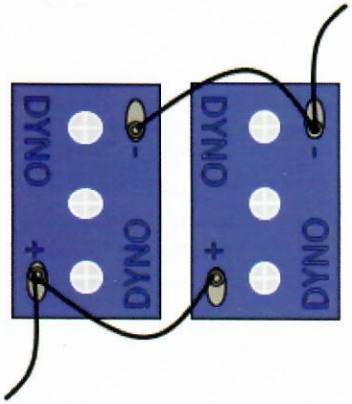
To increase system voltage, connect the batteries in series. This will not increase the capacity of your battery system.



Example:
Two D105, 6V batteries rated at 225Ah, connected in series.
System Voltage = 6V + 6V = 12V
System Capacity = 225Ah

3.6.2 Parallel Connection

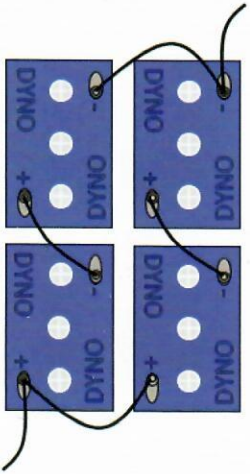
To increase system capacity, connect the batteries in parallel. This will not increase the voltage of your battery system.



Example:
Two D105, 6V batteries rated at 225Ah, connected in parallel.
System Voltage = 6V
System Capacity = 225Ah + 225Ah = 450Ah

3.6.3 Series/Parallel Connection

To increase both voltage and capacity of your system, connect additional batteries in series and parallel. Note: Maximum of three parallel strings.



Example:
Four D105, 6V batteries rated at 225Ah, connected in series/parallel.
System Voltage = 6V + 6V = 12V
System Capacity = 225Ah + 225Ah = 450Ah

3.7 Ventilation

Deep Cycle flooded/ wet lead acid batteries release small amounts of gas during usage and a larger amount during the charging process. It is critical to charge the batteries in a well ventilated area to avoid buildup of hydrogen gases which are very dangerous if inhaled or ignited.

3.8 Watering

Deep Cycle flooded/wet lead acid batteries need to be watered regularly. Depending on the usage, charging and operating temperature, the frequency will differ. You should check the batteries every 2-3 weeks to identify how much water needs to be replaced. It is common that as the batteries age, the amount of watering required will increase. In heavy deep cycle applications, watering may be required every 5-7 days.

- Only use deionized or distilled water. Tap water can contain contaminants that will damage the battery
- Check electrolyte levels by removing the ventilation caps on the top of the battery. A flashlight may be needed if there is not adequate lighting at the install location
- Electrolyte levels should be just below the bottom of the vent well, approximately ½ – ¾"
- Watering should only occur when the battery is in a fully charged state. The only exception is if the plates are not fully covered by the electrolyte levels. If this occurs, only add enough water to cover the plates before charging and fully water the batteries once they are in a fully charged state
- Once your electrolyte levels are correct, replace the vent caps and ensure they are fitted firmly

4| CHARGING

Correctly charging your batteries is crucial and is a huge contributing factor to maximising battery performance and life. Both under-charging or over-charging can significantly reduce a batteries life. There are different charger technologies including automatic chargers, pre-programmed chargers and manual chargers which allow the user to set the voltage and current parameters.

Please read the below advice before charging a batery system:

- Only initiate charge if there is adequate ventilation
- Before charging, make sure the charger is set to the appropriate program for the battery type
- Charging time will vary depending on battery size, charger output and depth of discharge
- Lead-acid batteries do not have a memory effect and should not be fully discharged prior to charging
- Never charge a frozen battery
- Avoid charging if battery temperature exceeds 50°C
- Prior to charging, check electrolyte levels to confirm that the plates are fully submerged
- Make sure vent caps are in place and sound
- Batteries should be fully charged after each use
- Charging should not be interrupted until complete

4.1 Charging Flooded/Wet Batteries

Dyno recommends a 3-stage IUI charging profile for deep cycle, flooded/wet lead-acid batteries. The three stages each have unique voltage and current outputs suitable for the batteries state of charge.

First Stage – Constant Current/Bulk Charge

Applies a constant current equal to 10-13% of the C20 as the voltage slowly increases. The bulk phase ends when the voltage climbs to the absorption voltage. Most of the batteries capacity is restored during this stage of charging.

Second Stage – Constant Voltage/Absorption Charge

A constant voltage equal to 2.35 - 2.44 VPC (volts per cell) is applied as the current slowly declines. The absorption phase ends when the current falls to the finish current, The reduced current going into the battery safety brings up the battery's state of charge without over heating it.

Third Stage – Constant Current/Equalization Charge

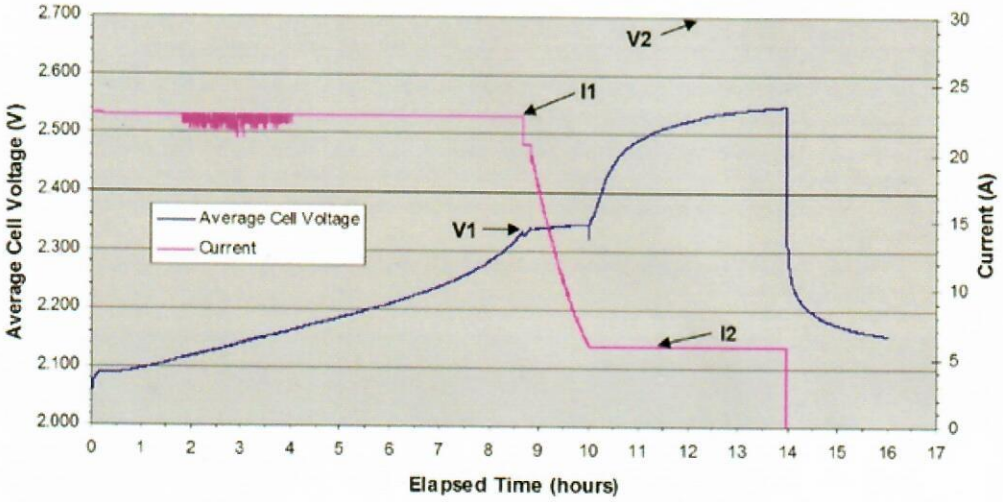
A constant current equal to 3% of C20 is applied as the voltage increases to 2.6 – 2.8VPC. The finish phase ends when the battery is fully charged. This stage causes the batteries to gas, mixing the electrolyte, eliminating acid stratification.

PLEASE NOTE: It is normal for flooded/wet batteries to gas (bubble) during this phase.

BATTERY BRAND	MAXIMUM CHARGE CURRENT (% OF C20)	ABSORPTION VOLTAGE (VPC)	FINISHING CURRENT (% OF C20)	EQUALIZATION VOLTAGE (VPC)	FLOAT VOLTAGE (VPC)
Dyno	13%	2.45	1-3%	2.70	2.25

4.2 IUI Charging Profile for Deep-Cycle Flooded/Wet Batteries

The below chart shows the charging curve for an IUI charging profile.



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

5| TESTING

Below explains how to properly check a battery's state of charge or health using a hydrometer and voltmeter.

5.1 Specific Gravity/Relative Density

Specific Gravity or Relative Density is the ratio of the density of a substance to the density of a reference substance of the same mass/weight. Here are some tips on how to properly test your battery's specific gravity.

- Use a high-quality hydrometer to ensure the results are accurate. Glass hydrometers are preferable
- Always fill and drain the hydrometer 2 – 3 times before drawing a sample from the battery
- Make sure to measure all battery cells to identify any faults or weak cells. Measuring one cell will not give an accurate result
- If any battery has a specific gravity variation of more than 1.130 between cells, it is recommended the set be equalized
- Correct specific gravity reading for temperature by adding 0.004 for every 5°C above 27°C, and subtract 0.004 for every 5°C below 27°C

5.2 Open Circuit Voltage

Open-circuit voltage is the difference of electrical potential between two terminals of a device, when disconnected from any circuit. OCV can be measured with a voltmeter by connecting the positive probe to the positive battery terminal and the negative probe to the negative battery terminal.

- For accurate voltage readings, batteries should remain idle (not charging or discharging) for at least 6 hours, and preferably 24 hours before testing
- It is important to record all data for the batteries being tested
- If any recorded voltages have a difference of 0.3V or more, it is recommended the set be equalized
- After an equalization charge, if any recorded voltages have a difference of 0.3V or more, your battery may be faulty or have a damaged cell

Voltmeter

Hydrometer

6| STORAGE

The following tips will help guarantee your batteries emerge from storage in good condition:

- Always charge batteries before placing them in storage
- Store the batteries in a cool and dry location, protected from the elements
- Disconnect the batteries from any equipment to eliminate any loads that may cause the battery to discharge
- Batteries gradually discharge during storage, it is advised that you should monitor the specific gravity and open-circuit voltage every 4 weeks
- Batteries discharge more quickly in higher temperatures, if your storage area has a higher than average ambient temperature, it is suggested to check the battery's charge state as frequently as every 2 weeks
- Batteries should be charged when they decline to a state of charge equal to or less than 70%
- When batteries are taken out of storage, they should be placed on a full charge cycle

Below is a table displaying the relationship between state of charge, specific gravity and open-circuit voltage:

Flooded/Wet Battery State of Charge					
STATE OF 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	2.108	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