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Safety First

Deep cycle battery handling maintenance and test procedures

The Chemistry and plate design are totally different than that of automotive starting batteries. The grid metal used in deep cycles battery plate is specifically formulated to increase the adhesion of high –density active paste material. This provides the best available running time, cycle life and charge acceptance.

Dyno Europe batteries heavy duty plate design also protects against the stress of challenging electric vehicles, motive power and re applications witch includes vibration, heat and overcharge.

Dyno Europe deep cycles batteries employ allow maintenance design. They do require periodic maintenance and effective charging service to ensure dependable service life. The purpose of this service guide is to help you to understand the characteristics, operation and care of the batteries in your equipment so that all of their advantages may be fully realized.

A Inspection and handling

- 1 Do not allow batteries in your equipment to tip or operate at a severe angle in any direction. This would allow the battery electrolyte to push through the battery vent assembly.
- 2 Charge the battery in you equipment in a well ventilated area.
- 3 Upon receipt of your equipment, examine the batteries for signs of wetness or impact (witch my indicate damage in shipment or that the batteries were tipped beyond 45° angle during transit)
- 4 if there is evidence of damage notify the battery supplier and make a damage report.
- 5 Charge the batteries before placing the batteries in service. Simply connect the battery charger to your machine charging port and allow it to run until it automatically shuts off.



B Other factors that affect battery life and performance

- Batteries are rated in Ah are design o perform a specific workload an established period of time. Increasing either and/or both of these will over discharge the batteries and result in shortened life.
- Limit discharging the batteries beyond 1, 75 volt per cell-or 1,125 specific gravity per cell. 1,125 volt per cell corresponds to end-point voltages 5, 25 volts for 6 volts batteries, 7 volts for 6 volts batteries and 10, 5 volts for 12 volts batteries
- Batteries should always be recharged immediately following a complete discharge period. Never allow batteries to remain in a fully discharged condition? Otherwise permanent damage will result.
- If daily or routine equipment operation results in only partial discharges'(40% or less) and specific gravity are 1,125 or higher, recharging may be deferred to the next day, providing the workload is not expected to increase. Generally, user experience will determine the frequency of charging service under these circumstances.
- Under normal circumstances the temperature of the battery electrolyte must not exceed 43° Celsius. If the battery is continuou sly operated at or above this point the service life of the batteries will be severely diminished. Under normal conditions the battery electrolyte condition should range from 15°C to 38°C. After charging the battery should be allowed o cool down or rest 6-8 hours before the next charging cycle begins.
- if a battery is ever hot to touch, allow it to cool to ambient temperature before charging or discharging.
- Keep battery connectors and cabling in good condition. When disconnecting the battery connector from the equipment, pull on the connector not on the cable.
Damage to the connector and/or cables will result in poor battery performance.

C Renewable energy charging system

To maximize performance and life batteries should be recharged fully after each discharge period. To verify full recharging, regularly monitor individual battery voltage and specific gravity. As a general rule, the total input amperes from your RE charging source should be between 10% and 20% of he total ampere-hours of the battery system capacity (20 hours rating). Many RE charging controllers have an adjustable equalisation setting that ensure batteries are regularly restored to full capacity. Batteries used in RE systems should be equalised every thirty days at a minimum-with more frequent equalization occurring for the battery system routinely discharged below 50% of their rated capacity/. Please refer to the following chart for additional charge control setting information.

	System voltage				
Voltage setting	6v	12v	24v	36v	48v
Daily charge(absorption)	7,5	15	30	45	59,5
equalize	7,8	15,6	31,2	46,8	62,4
Float	6,8	13,5	27	40,5	54

D Watering Service

Deep cycle batteries begin service consuming relatively low amounts of water in electric vehicle, motive power or RE service, the real need to add water to batteries may vary from weekly service to monthly service upon the operating environment and other external factors. As batteries age they will use more water, add warmer climates batteries will require more frequent service. Equipment owners and users must be vigilant in performing regular watering service to ensure premium performance and life.

1 There are two conditions when watering can is harmful to your batteries.

Over -watering

Under- watering

Over- watering dilutes the sulphuric acid levels inside the battery- which results in poor battery performance. Under watering batteries leads to service related overcharge condition, which will shorten battery running times and life.

Maintain battery liquid level above the top of the battery plates- but not higher than the battery cover vent well. Never fill the battery to the brim of the cell or to a point where they overflow.



2 Several other rules apply when watering

- Use only distilled or de-mineralized water
- Never add battery acid, commercial additives or other foreign material to the batteries
- Watering service should occur only after charging service is completed. Watering before charging service will result in overflow of the battery electrolyte- causing a dangerous chemical spill conditions and loss of battery capacity..
- Never charge batteries if the battery plates are uncovered/unsubmerged in electrolyte. If this condition is detected before charging service, fill the battery only until the top of the battery plates are covered with liquid.

Many DYNO Europe batteries feature a pro-eye indicator that shows users when watering service is required. Automatic waterfillingsystems are available on request

3 When colour of the Pro-eye is:

Green = No water service is required

White or clear = watering service required



The pro eye is an indicator only-and is designed to aid users with determining when individual cell inspection and/or watering service is required. Because watering service is most effective at the completion of charging service? The PRO-eye should be inspected at the completion of the charge or before the start of duty service.



E SAFETY PRECAUTIONS



- 1 **caution:** all lead acid batteries generate highly flammable hydrogen gas. If ignited the gas may explode violently. When working near batteries, always wear safety glasses, do not smoke or use open flame near the batteries; Remove watches and jewellery and avoid causing sparks with tools
- 2 Battery electrolyte is a corrosive acid and can cause blindness or severe burns. If exposed to battery electrolyte immediately flush with water and seek medical
- 3 The batteries in your equipment is electrically alive at all times. Keep the top of the batteries dry and clean to prevent ground shorts and corrosion.
- 4 Do not tip a battery beyond 45° angle in any direction. This would allow the battery electrolyte to push through the battery vent assembly



F Preventive maintenance

- Battery covers and terminals should be kept clean, dry and free of corrosion. Battery vent caps must be secured to the batteries during use and charging period. Remove vent caps only to inspect electrolyte levels or specific gravity.
- When batteries or terminals require cleaning use only biodegradable cleaner neutralizer solution can that be safely applied and disposed of through a common sanitary sewer. Other chemical based solutions are often dangerous, ineffective and cannot be disposed of in an environmentally safe manner. If Electrolyte is spilled onto the batteries or the battery compartment area, neutralize it with a cloth moistened with a solution of baking soda and water mixed in the proportion of 0.450kg of baking soda to 3.8 L of water. When electrolyte is neutralized, wipe the affected area with water moistened cloth to remove all traces of soda.
- inspect cable-to-terminal connections to ensure connections are tight and free of corrosion. Battery cables must be intact with no exposed wires.
- Preventive maintenance practices should include periodic inspection of battery specific gravity. An imbalance of specific gravity and open circuit

voltage is usually a sign of improper charging, service infrequency, or bad cell condition.

G Charging guidelines

1 EV or motive service

Original equipment systems usually include an automatic charging system for battery charging. To maximize battery life and performance, batteries should be charged as outlined in the operating instructions included with the charging equipment. In event of a charging related battery performance problem consult the OEM or Dyno Europe.



Extra care spent in proper charging will ensure battery performance. Battery charging equipment varies in terms of output and overall charging performance. For new or replacement chargers used in EV or motive power service Dyno Europe recommends electronically controlled automatic chargers that are programmed to deliver high constant current rate of 12 to 18 A per 100Ah (20 hours rating) of battery capacity. The constant voltage begins after the gassing point is achieved (2,42 volts per cell). This stage of charge will last approximately 5 hours for fully discharged battery. During the constant voltage phase the charger voltage is limited



To the gassing point level (2,42v) and the input current is allowed to gradually diminish. When the input current falls to the finish rate of 3 or 4 Amperes per 100 Ah (20 hours rating) of the battery capacity the charge phase will change from constant voltage to constant current of 3 or 4 Amperes per 100 Ah (20 hours rating)-with maximum charging voltage of 2,65 volts per cell. The charge will be

terminated approximately 3,5 hours from gassing point by an approved charge termination method such as DV/DT. Please note that fixed ferro-resonant setting are using this profile must have finish voltages set at 2,58 volts per cell or higher.

Batteries should always be recharged immediately following a complete discharge period. A weekly equalization charge-with the finish rate charge time extended 3 hours for a total of 6 hours from gassing point – will ensure reliable discharge time and battery life. The charge factor of the standard recharge cycle should be equal to or greater than 1,08 (108%) , while the charge factor of the equalization cycle should equal or greater than 1,15(115%). To ensure optimum Battery performance total recharge time should in all cases be limited to 10 hours.

Power off the charger before connection to the battery to avoid sparks. To avoid explosion never charge a frozen battery. Warming the battery to room temperature before charging begins. Charging service should be terminated if batteries become excessively hot or if violent gassing or discharge of electrolyte



occurs during charge.

2 What is happening with a battery that is not fully charged?

1. Lead sulphate is going to begin building up and the customer will lose capacity. After a period of time this material will not be usable and it is going to get worse and worse.
2. Stratification will take place since the electrolyte is not getting mixed. The customer will end up with batteries with very low SG on the top of the cell and very high SG on the bottom of the cell. These causes lead to be soluble at the top of the cell and will short between the separators. The bottom of the cell with the high SG will cause extensive grid corrosion and the active material will end up becoming very soft.

Batteries need to get to at least 2.58 VPC to operate correctly

H Trouble shooting

When properly maintained and charged Dyno Europe deep cycle batteries will provide many years of trouble free services. However, failure to follow operating and maintenance guidelines above may result in poor performance or premature failure. The following addresses some of the typical errors in operation and maintenance

Condition	
Poor battery performance	<ul style="list-style-type: none"> - Undercharged Battery Supplies - Sulphated Battery Supplies - Cold Operating temperature less than 0°C - Defective cables or connectors - Low electrolyte - Old batteries - Defective charge level gauge
Unequal/ low specific gravity	<ul style="list-style-type: none"> - over filling - undercharging
Excessive water service	<ul style="list-style-type: none"> - overcharging - Container leak - Old batteries
Odor during charging	<ul style="list-style-type: none"> - Low electrolyte - Over charging
High temperature	<ul style="list-style-type: none"> - Over charging - battery overworked - Opportunity charging

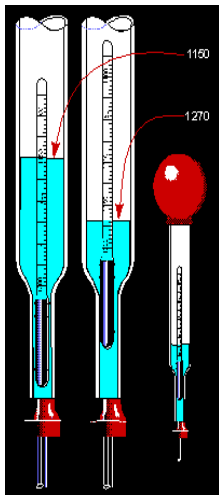
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A common procedure for troubleshooting battery involves a three-point procedure

1 Visual inspection

Check battery age and length of service if available. Inspect the battery for damage, when physical damage to the battery container or terminals is present, replace the battery. If none, check the battery cells electrolyte levels. Fluid levels should be above the top of plates in all cells, and not higher than the top of the fluid level indicator. If the battery is sufficiently filled with electrolyte, proceed to step 2. If the top of the battery’s plates are not covered with liquid, add demineralised water, replace vent caps and place the battery on charge. Be sure no open flame or spark is near while the battery vent caps are removed from the battery.

2 Specific gravity inspection



Hydrometer reading of all cells should be at least 1,235” and show less than 50 points difference between high and low. More than 50 points difference replaces the battery. Less than 50 points difference but some cells read less than 1,235 recharge the battery. Replace the vent caps during recharge. Charge the battery using a properly matched automatic charger until all cells measure a specific gravity of 1,275 to 1,280. If charging won’t bring up the specific gravity, replace the battery.

<u>State of charge level</u>	<u>Specific gravity</u>
100%	1,28 - or greater
75%	1,235 - 1,240
50%	1,190 - 1,195
25%	1,150 - 1,175
Discharged	1,125 or lower

3 Open circuit voltage and electric load test



Battery open circuit voltage is an effective indication of battery state of charge. Determine the approximate state of from the following chart

Electrical load testing is a effective troubleshooting technique for identifying batteries with internal defects. But it is not an approved method for measuring deep cycle battery capacity.

For this reason load test results are useful only to identifying batteries having bad cell conditions. Batteries with less than 75% state of charge should be charged before an effective load test is applied to the battery.



When load-testing batteries remove all battery cables, disconnecting the negative cables first. Make sure the battery terminals are free of corrosion and dirt. For batteries having stainless steel stud terminals attach a lead charging post to the threaded stud before testing. Using a carbon pile load tester apply 50 to 75 amperes load for 15 seconds remove load. Refer to the chart below to determine the minimum passing voltage.

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<u>State of charge</u>	<u>12 volt open circuit</u>	<u>6 volts open circuit</u>
100 %	12,6	6,3 or greater
75%-100%	12,4-12,6	6,2 - 6,3
50%-75%	12,2-12,4	6,1 - 6,2
25%-50%	12,0-12,2	6,0 - 6,1
0-25%	11,7-12,0	5,95 -6,0
0%	11,7 or less	5,95 or less

Chart assumes a fully charged gravity of 1,280

<u>Battery voltage under 15 seconds load test</u>			
<u>State of charge</u>	<u>12 volts</u>	<u>6 volts</u>	<u>Spec. gravity</u>
100%	12,66	6,33	1,280
75%	12,00	6,00	1,235

If the load tests voltage shows above the minimum return the battery to service. If the test voltage is below the minimum replace the battery.

