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**Subject: Technical Service Bulletin – Battery Pack and Charging System Problem Diagnosis and Corrective Actions**

### **Technical Service Bulletin**

**Equipment Affected:** Golf cars, electric vehicles, and other types of electric powered equipment powered by battery packs in the range of 12, 24, 36, 48, 72 volts and higher.

**Battery Type:** All types of deep cycle battery packs assembled using 6, 8, and 12 volt batteries.

**Battery Date Codes:** All batteries at any age or stage of life.

**Condition Description:** Battery packs installed in golf cars, EV's, and other types of equipment have been found to be continuously undercharged in many applications. Since the on-board and/or off-board charger controls the charging process, it is important that the charging system is functioning properly to maintain a full charge on the battery pack. It has been found that some charging systems can fail to charge properly often resulting in undercharge of the battery pack and subsequent poor battery performance, decreasing runtime, and customer dissatisfaction with the battery pack. Testing has shown that the batteries are simply undercharged and usually recover capacity when charged properly.

**Cause of Condition:** Performance of some charging systems has been found to be deficient, possibly due to deterioration with use. With exposure to temperature extremes and corrosive environments over time, the electronic components used in these charging systems can become incapable of delivering a full charge. Even though they may appear to be charging properly to the user (they appear to start charging and terminate charging as expected), more detailed testing shows that they may not function as designed and/or may not fully charge the battery pack.

**Problem Resolution:** Follow the attached diagnostic procedure developed by US Battery to determine whether the charging system is functioning properly and is capable of fully charging the battery pack. If found to be defective or incapable of delivering a full charge, the charging system must be repaired or replaced. Refer to Battery Council International testing procedures BCIS-05 and BCIS-06 for general battery charging guidelines and US Battery charging recommendations for charging battery packs supplied by US Battery.

**Note:** US Battery warranty policy does not cover batteries and/or battery packs that are simply undercharged. It is important to assure that batteries and/or battery packs are fully charged before testing and/or submitting for warranty coverage.

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## Battery Pack – Charging System Diagnostic Procedure

1. If charger is connected and charging, begin checking on-charge voltage at battery pack positive and negative terminals. On-charge voltage will normally continue to increase until the charger terminates charge automatically. It is important to determine the maximum on-charge voltage and charge current (on the charge meter if available) observed near the end of charge (just before charge termination).
2. If charger has completed a charge cycle and has already terminated charge automatically; unplug power to the charger, wait 1-2 minutes, then reconnect. Charger should resume charging normally. Note charge current and time at the beginning of charge. This is usually described as an 'equalization charge' and should continue for ~30 minutes before checking charger performance.
3. Begin checking on-charge voltage at battery pack positive and negative terminals. On-charge voltage will normally continue to increase until the charge terminates automatically. If the voltage does not increase or initially increases and then decreases, note maximum and final voltages observed. Record on-charge voltage, charge current, and charge time from beginning of charge until the charge is terminated automatically.
4. If on-charge voltage does not reach the equivalent of 2.5 volts per cell times the number of cells connected in series (see Table I attached for pack voltage data) when charge terminates or if voltage increases and then decreases, check on-charge voltage of each battery. If on-charge voltage of each battery varies by more than the values shown in Table II for 6, 8, or 12 volt batteries (either variation from pack average or variation from highest to lowest), replace the lowest voltage battery and repeat the diagnostic test. (Test the failed battery separately to determine mode of failure.)

<b>Table I - Battery Pack On-Charge Voltage</b>			
<b>Battery Pack Nominal Voltage</b>	<b>Number of Cells per Pack</b>	<b>Minimum On-Charge Pack Voltage</b>	<b>Maximum On-Charge Pack Voltage</b>
12	6	15.0	15.6
24	12	30.0	31.2
36	18	45.0	46.8
48	24	60.0	62.4
72	36	90.0	93.6

<b>Table II - Battery On-Charge Voltage (CHV) Variation</b>			
<b>Battery Nominal Voltage</b>	<b>Number of Cells per Battery</b>	<b>CHV Variation from Pack Average</b>	<b>CHV Variation - Highest to Lowest</b>
6	3	0.75	1.50
8	4	1.00	2.00
12	6	1.50	3.00

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5. If on-charge voltage still does not reach the equivalent of 2.5 volts per cell times the number of cells connected in series (Table I) when charge terminates or if voltage increases and then decreases and if on-charge voltage of each battery does not vary by more than the values shown in Table II for 6, 8, or 12 volt batteries (either variation from pack average or variation from highest to lowest), the charger is not charging properly and will not fully charge the battery pack – it must be repaired or replaced.

Note: If battery pack on-charge voltage reaches equivalent of 2.60 volts per cell (Maximum On-Charge Pack Voltage in Table I) and charger does not terminate charge after 1-3 hours, charger is not functioning properly and will overcharge the battery pack - it must be repaired or replaced.

6. Repair or replace charger or charge controller as required.
7. Record open circuit voltage of each battery and specific gravity of each cell in each battery.
8. Restart charging and repeat diagnostic procedure with new charger. On-charge voltage should increase gradually into the range of 2.50-2.60 volts per cell as the batteries begin to approach full charge.
9. Record on-charge voltage, charge current, and charge time from beginning of charge until the charge is terminated automatically. Wait 1-2 hours after charge is terminated and record open circuit voltage of each battery and specific gravity of each cell in each battery and compare to previous readings taken in Step #7.
10. If any specific gravity reading is less than 1.260, perform equalization charging by disconnecting power, waiting 1-2 minutes, then reconnecting power. If charger terminates charge in less than 45 minutes, disconnect one battery interconnect cable from a battery terminal, reconnect and restart charger. Charger should continue charging for 1-3 hours or until batteries are fully charged. Several cycles of charging and discharging with the new charger may be required to return the battery pack to peak capacity.

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