Lithium battery packs - quick fix attempts

PROPOSAL ONLY

NOTICE – The paper is a theoretical discussion of repair choices. The author strongly does not recommend that people attempt to do any of this, unless they have experience in good safety procedures and adequate equipment to protect themselves and others. Under no circumstances will the author accept liability for the action of others or harm that they might cause to themselves or anyone else by methods mentioned herein. THIS IS A HYPOTHETICAL PROPOSAL for purposes of intellectual debate about an often ignored topic.

Essentially, the proposed actions are to attempt to resolve a multiple cell lithium pack that refuses to charge and is indicating that you must purchase a whole new battery pack.

This essay starts out with solution [A], the easiest and lowest risk solution first; then solution [B], a bit harder and higher risk solution; and [C], the final solution which may be VERY DANGEROUS and desperate.

Above all, there are some very good reasons that the industry does NOT endorse repair of Lithium battery packs. The situation might easily get out of control, people might get hurt, property may be damaged.

For just about everyone, I would recommend to **never** even consider [C] as a possibility, but there are a few bright and skilled engineers that might make it work in a proper safety environment.

A. Try to correct a lock out condition with a remedial charge to problem cells.

- Locate dead or lowest cells by voltage.
  - These cells may present a State of Charge that is lower than the minimum voltage required by the controller board and result is a charger lock out.
- Attempt to individually bring up their State of Charge to levels that the controller board will engage and accept.
  - To do so, provide the individual cells with a DC voltage that is NOT more than the peak voltage specified by the controller board or the battery specification. For 3.6-3.7 cells, that is generally 4.25volts. It would not hurt to limit the voltage to a lesser amount, say 4.10 volts as the goal to get the dead or low cell to charge to something over 3.00 volts and not to bring it to full charge. For 3.2-3 volt cells, the limit is generally recognized as lower, at about 3.9volts.
- Because the battery pack is often a series of batteries that are soldered or welded in series, an independent supply is required to inject the 4.10 to 4.25 volt charge.
  - Conventional wisdom is that this does NOT have to be a large charge current and a small limited current over a longer time might even be better for an initial charge of an extremely low cell. 50 Millamps or less may be quite adequate.
  - At the very least, the sense wires must be removed to protect the controller board and to eliminate complexities and the hazard of damaging the control board. Complete removal of the controller board is likely wisest.

- If the 'dead' or low cells will hold a charge, reconnect the controller board and attempt to charge in the usual manner. Do this is a fire safe environment and in the open air.
- If the battery pack behaves properly, the situation is tentatively resolved. Observation over time will indicate if the battery pack is reliable or not.

B. If individual cells will not hold a charge, it may be possible to remove the cells and replace them with others of the exact same specifications.

- This requires cutting the defective welded or soldered cells out of the series and inserting replacements.
  - Remove the battery pack and disconnect the controller board.
    - Care needs to be taken as all cells do have some charge in them and shorting might damage other good cells.
  - Replace the defective cells and make sure the connections will be good enough to handle full current in a safe fashion.
    - ***Consider ONLY using mechanical wiring for reassembly.***
      Please note that soldering or welding Lithium cells may actually cause them to ignite and explode. Tempertures in excess of 50 degrees Celcius are very dangerous and fully charged cells at lower tempertures may still be quite hazardous and unpredictable.
- Check voltage levels and charge individual low cells if required – in a safe and sane manner.
  - After the dead cells are replaced, a check of each cell's voltage needs to be made and if any are below minimum threshold - those cells need to be individually charged as in Procedure A.
- Reassemble the battery pack and attempt to recharge conventionally.
- If successful, observe battery pack in actual use to determine whether the repair is successful.

C. If no individual replacement cells are available, it may be possible to remove a damaged cell and to modify both the charger and the control board configuration to operate with less cells.

- This procedure is the **HIGHEST RISK of failure and catastrophe**.
  - Reverse engineering the control board to fully understand if it will accept a lower charge voltage and less cells would greatly reduce the risks.
  - Modifying the charger may force you to not only purchase a replacement battery pack and new control board, but also a new charger.
  - This is a very drastic remedy as it renders the battery pack less functional than it was originally and presumes that the lower voltage output will be acceptable to motor.
  - In most cases, there is significant risk that the charger, the battery pack, and/or the controller board may be damaged beyond repair and NO solution becomes the final outcome.

- Remove the low cells.
  - If only one or two cells are bad, after disconnecting the controller board, remove the dead cells and reconstruct the remaining ones into a series that will output a lower voltage.
  - Before reconnecting the control board, relocate the sense wires for the missing cells to

the adjacent cell.
    - It may be best to go closer to negative and to not go towards positive. But this is purely speculative as boards vary in how they are constructed and will respond.
- Reassemble the battery pack and measure the overall voltage.
- If individual cell voltages are high enough to do a test run, attempt to operate the motor.
- Calculate the total voltage that the remaining series should tolerate.
    - If the original charger was for 10 cells at 4.25V maximum, the series of batteries had 42.5 volts applied. If the charger provided 44volts, there was some voltage drop on the overall control mechanism. So for each removed cell, deduct 4.25volts from what the charger should supply and modify downward the charger's output voltage.
    - Investigate how the controller board might attempt to control peak total charge voltage.
- Attempt to recharge the battery pack at the reduced charger voltage outside in a safe area.
    - Stand back as ANYTHING might happen, but with luck the battery pack and the controller board might find the new configuration acceptable.
- Once fully charged, check for overheating, and observe in actual use.

Safety First – It is not worth doing if you might end up hurting yourself or others.