UNDERSTANDING BATTERY CHEMISTRY AND ITS IMPLICATIONS WHEN USED IN GLIDERS.

There appears to be a lot of confusing information regarding various battery chemistries so I thought it would be helpful if I publish a paper on our findings with regard to battery behaviour between the Lead Gel Acid, Nickel Metal Hydride and Lithium ion batteries.

My name is Richard Morgan and I own a Design and Development Company called A.T.S.I. Ltd which specialises in advanced battery management systems, charging regimes and safety related circuitry specifically for the following:

British Ministry of Defence Air Land Technology Group, DE&S Special Projects Abbey Wood, DSTL Fort Halstead, QuinetiQ Malvern, QinetiQ Farnborough ,Canadian Department of Defence, US DOD, Metropolitan Police, SOCA, Met Special Branch, Manchester , Hertfordshire, Lancashire, Nottinghamshire, Derbyshire, North Yorkshire, Cumberland, RAF Police, HM Customs and Excise, NPIA. All of which have sought our advice and continue to use our services regarding power management issues be they batteries, chargers, DC to DC or stabilized power supplies..

A.T.S.I. Ltd has both environmental and temperature testing chambers capable of reproducing any climate profile worldwide combined with a humidity and temperature chamber capable of 0 to 100% humidity and temperatures ranging from -50C to +150C.

We have been designing, developing, testing and manufacturing batteries, chargers and power delivery devices for the past 10 years, culminating in my company owning several world patents in advanced battery management systems.

We hold UKAS ISO9001:2000 in conjunction with URN 98/887 in both Design, Manufacture and Supply of Specialised Power Management Systems as well as MOD Design Status with DE&S Abbey Wood.

A.T.S.I. employs avionics technicians from both the Military and Civilian market who specialise in light aircraft.

Many of our batteries have NATO codification and have been through full MOD Safety Case Procedures which include full vibration to destruction, environmental and temperature profiles, and are approved to be carried on both transport or passenger aircraft, be they Military or Civilian..

We are currently in the process of applying for the EASA Part 21 subpart G Manufacture with Lees Avionics who will hold the design section of Part 21.

I am extremely passionate about aviation especially when it comes to safety and hold a current PPL(Aero plane), IMC, Multi, Single, TMG, SLMG, PPL(Helicopter) with jet conversion, (Jet-Ranger and Long-Ranger) together with various Glider Ratings.

I am currently testing various back-up batteries in DG808C and DG1001M based at Lasham Gliding Club.

Through our sister company A.T.S.I. Aviation, we have just launched our latest development Ni-MH Lynx battery which is **CONSIDERABLY SAFER** than the current Lead Gel Acid Batteries available on the market today.

Let us consider the 3 main batteries which concern the light aircraft market at present:-

1/ Lead Gel Acid

2/ Nickel Metal Hydride

3/ Lithium

All three batteries have a role to play within the glider market but it must be clearly understood how their applications, charging and handling, are to be conducted.

Both Lead Gel Acid and Nickel Metal Hydride batteries can be used as "stand alone" but Lithium predominantly is used within a controlled environment.

To explain this further, neither Lead Gel Acid nor Ni-MH require complex safety circuitry in order to prevent catastrophic failure be it safety or performance.

The glider fraternity was forced to adopt a battery for its electrical requirements several years ago. As technology moves forward combined with the possibility of air recognition systems, FLARM, TCAD and transponders, more power will inevitably be required.

Lithium batteries are normally encapsulated within equipment where the battery has a specific function to perform. Furthermore, it is governed by that equipment to the exact level of current and voltage required to operate it. Usually, no external connections or leads exist from the battery, which prevents it from being removed from the environment it was designed for.

"Stand alone" batteries are designed to accommodate various levels of current demand as well as maintaining stability in deep discharge situations. This is not necessarily the case with Lithium where deep discharge can present a problem of either safety, and/or performance.

When dealing with large lithium batteries (large Ah), caution must be exercised when handling and charging these units. This will always be stated by the manufacturer. These problems do not present themselves when in a controlled environment such as PDA's, laptops and designer made items.

Under no circumstances must lithium batteries be modified to be used for other than its intended use.

Lithium technology is improving all the time and eventually large Ah batteries will become available as stand alone with most of the safety issues resolved.

All three battery chemistries have their own charging methods, unfortunately very few battery manufacturers supply their own battery chargers, consequently confusion can arise with the "end user" (glider pilot) to such an extent that if not totally understood, the wrong charger could be used on the wrong type of battery.

This has particular relevance if a Lead Gel Acid charger is used on a Lithium battery. Potentially this could lead to a catastrophic failure with the high possibility of fire and/or explosion. Only use battery chargers recommended by the manufacturers and if no recommendation is available seek further advice from the supplier, thus avoiding a potential safety hazard.

No battery is completely bullet proof and a certain amount of common sense should be used when handling any form of battery.

Lead Gel Acid

The most common battery used in the glider world is the 7Ah brick.

This battery was adopted from the alarm world as a suitable battery to be used within a glider for basic power requirements such as artificial horizon, flight computer and radio.

Ideally as with the house backup alarm applications, this type of battery should be kept under constant float charge conditions.

Extensive tests over a wide temperature range combined with various levels of discharge, including deep discharge, using draw pulls of 300mA, 500mA, 1 Amp, 2 Amp and 3 Amp, displayed the following averaged results:-

The battery from new on its first set of tests displayed a good output of 6.8 Ah.

Second set of tests showed a variation between the low draw pull of 300mA giving 6 Ah and the high draw pull of 3 Amps giving 5 Ah.

This trend continued to decline on each subsequent test to the point that on the 30th test the results were as follows:-

Variation between draw pull of 300mA giving 4.8 Ah and the high draw pull of 3 Amps giving 2.6 Ah.

Note. These test performance figures varied considerably and in most cases were much worse when extreme temperatures were applied, hence the averaged figures have been presented as a guide line.

Ten batteries were used over a period of 6 months with temperatures from -20C to + 55C.

The overall conclusion was this particular chemistry did not lend itself to deep discharge, large temperature swings, and could not deliver more than moderate current loads without rapid deterioration over a short period of time.

With regard to safety, the Lead Gel Acid battery has no internal fuse and relies totally on an external fuse to be fitted for protection.

There are no guide lines as to the value of the fuse to be fitted and should this be a 40 amp car fuse, for example, the battery would act as if the fuse did not exist.

Should the battery develop an internal short circuit, it would become hot followed by internal pressure build-up causing the vent valves to blow, potentially showering the surrounding area with Acid Gel.

There have been several reports of this type of battery catching fire under certain conditions within the glider world.

Transportation Classification:- Class 8 under the Dangerous Goods Act.

A lead gel acid battery charger should only be used on a lead gel acid battery.

Provided that the chargers are not mixed up it is perfectly safe to charge a Lead Gel Acid Battery in the same room as Ni-MH.

A.T.S.I. Lynx batteries have a 4 pin plug that prevents the use of other chargers being connected to it and subsequently will only accept its own dedicated charger.

LITHIUM-ION.

Transportation Classification :- Class 9 of the Dangerous Goods Regulations

Air Transportation of Lithium –Ion batteries.

IATA Dangerous Goods Regulations.

Section A-45
Lithium cells or batteries that do not satisfy the following conditions will not be in compliance with these guidelines:

2/ The concentrated lithium content of a lithium alloy battery with a liquid positive pole must not exceed 1 gram. The concentrated lithium content of a lithium or lithium alloy battery with a solid positive pole must not exceed 2 grams. The concentrated lithium content of a lithium-ion battery must not exceed 8 grams.

Some Lithium batteries can become unstable if deep discharge is permitted especially if the voltage value falls below the internal safety circuitry.

Even when the safety circuitry has prevented an unstable condition it is highly possible that the lithium battery could become unusable due to the failsafe not allowing the battery to be re-charged.

Small Lithium batteries used in PDA's do not present a problem, but caution should be exercised when replacing the batteries as they can still be dangerous if handled incorrectly.

Several issues have recently been in the headlines with regard to laptop computers and their lithium batteries where fires had occurred.

Lithium batteries are voltage charging devices where Lead Gel Acid and Ni-MH are current charging devices.

A lithium battery charger should not be used on a Lead Gel Acid nor a Ni-MH battery

Nickel Metal Hydride

Nickel Metal Hydride Batteries when applied to the aviation world have a far better safety record than either Lead Gel Acid or Lithium.

The same tests as applied to the 7Ah Lead Gel Acid were applied to the LYNX 9Ah Ni-MH rechargeable battery with the following results:-

Extensive tests over a wide temperature range, combined with various levels of discharge including deep discharge using constant current draw pulls of 300mA, 500mA, 1 Amp and 3Amps, displayed the following average results:-

The battery from new on its first set of tests displayed a good output of 8.6 Ah.

Second set of tests showed an improvement in overall output of 9.2 Ah there were no significant variations between 300mA and 3 Amps

After 30 tests were conducted no deterioration in performance was detected.

Ten batteries were used over a period of 6 months with temperatures from -20C to +60C.

The overall conclusion was that although more expensive, the LYNX Ni-MH battery preformed in a vastly superior way to that of the Lead Gel Acid, and furthermore, could deliver a higher current output over a longer period of time in a much wider temperature band.

Safety

There are no reported safety issues with the Lynx battery or the Lynx charger.

Ni-MH batteries fall under the same category (dangerous goods) as alkaline manganese products (e.g. the domestic Duracell etc)

The Lynx battery is possibly the safest 9Ah "Aviation Battery" on the market today with both an internal re-settable fuse, thermal control device and a 10.5 volt cut-out circuit with built-in output terminal short circuit protection.

The battery will accept an indefinite total short circuit with no damage to the battery.

A shrouded 4 pin XLR socket delivers up to 6 amps of output at a constant 12 volts, unlike the lead gel acid which would rapidly decay in voltage.

Charging is achieved by a specially designed battery charger which has 3 levels of charge safety built-in.

1/ Change of temperature over change of time (improves the end of charge heat coefficient)

2/ Temperature auto cut-out

3/ Timer to prevent over charging if temp charging fails

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