BGA Airworthiness and Maintenance Procedure	AMP 1-11
BATTERY MAINTENANCE	

Version 2	5th January 2024

General

Most gliders have batteries installed to provide power for radios, GPS navigation systems and some flight instrumentation such as electric variometers. The batteries used are normally of the Gel type although lighter and more power Lithium based batteries have in recent years become available.

On IFR aircraft, it is a requirement to have a battery of at least 80% capacity. In gliders with no starter motor and therefore with lower demand on the battery, a lower figure can be acceptable. It is also worth bearing in mind that temperature affects the capacity of the battery, eg, the colder it is the lower the capacity. See section on ‘Capacity testing’.

Battery retention requirements

Historically, gliders designed before CS 22 requirements were often delivered without any battery installation fitted. The owners were expected to design, make and fit their own. This sometimes meant very little design consideration was given to battery installations. Even some factory fitted installations (SZD perhaps) were of low quality, only requiring a weak bungee to hold the battery in place. These legacy installations need reviewing at every annual maintenance to ensure that they are airworthy.

CS 22 indicates that all equipment must have (see below) retention limits. The highest of which is 15G.

Upward	7·5 g
Forward	15·0 g
Sideward	6·0 g
Downward	9·0 g

A further summary of CS 22 requirements below

(d) Except as provided in CS 22.787, the supporting structure must be designed to restrain, under loads up to those specified in sub-paragraph (b)(1) of this paragraph each item of mass that could injure an occupant if it came loose in a crash landing.

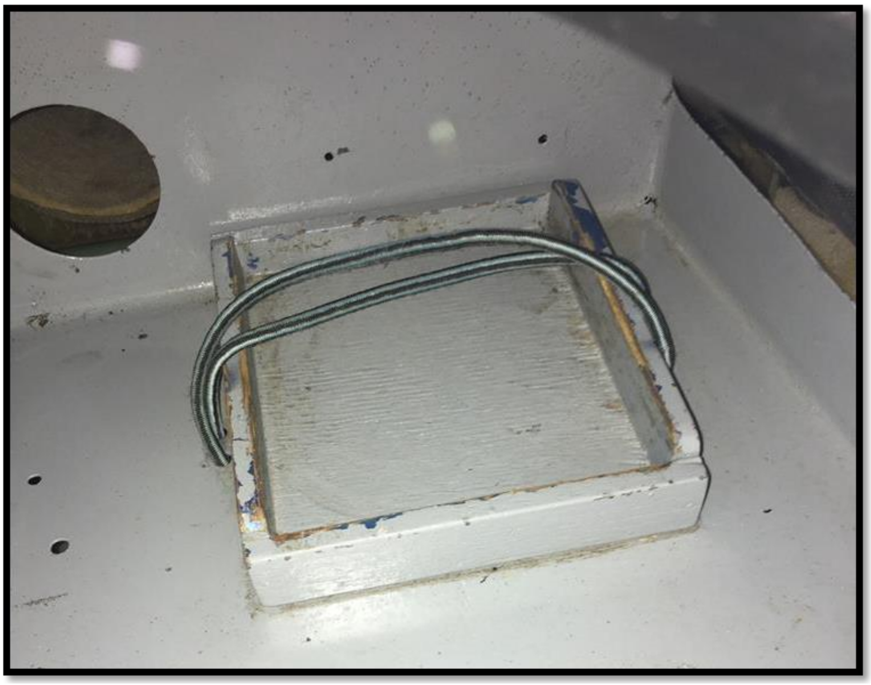
(b) Means must be provided to protect occupants from injuries by movement of the contents of baggage compartments under an ultimate forward acceleration of 15·0 g.

Is 15G forward load adequate?

In formula 1 car accidents, drivers have walked away from 46G crashes and survived crashes of 90G. Put in context the requirements of 15G should be an absolute minimum.
Historically the BGA required all modifications to fittings of equipment to have 25G retention requirement in all directions.

Result of an inadequate battery installation
A Vega landed in crop. The momentary deceleration of approx 10G caused the battery to come out of its holder and smash through the canopy. The glider had very little other damage. See image below:

Below is a picture of Vega battery tray. It is a converted barograph holder, relying on bungees for retention. Bungees have a very limited life due to perishing and can stretch too far in accidents. As was the case in this accident.



A review of the BGA accident database for trend history shows 16 reports of battery retention related incidents. 11 of the reports were in the last 7 years. Below is a brief report of those accidents.

Libelle	On aerotow in turbulent conditions heard something moving about. 1 hour later at 9,000ft found aileron movement restricted to left. Vigorous movements failed to dislodge obstruction. Attempted X-wind landing on runway but unable to line tip correctly so retracted U/C and landed across rough ground. Cause - battery secured by bungee in poor condition had broken loose.
Pegase	After completing 5 hours of soaring the pilot discovered that the airbrakes were jammed closed so returned to the hill to soar while contacting his club by radio. A tug led him to a nearby uphill open common and a wheel up landing was made. The airbrake controls had been jammed by the battery retaining bar which had been missed by at least one DI.
Twin astir	After a period of negative g, the ailerons were found to be very stiff. P2 continued the flight, finding that the ailerons were practically jammed when the airbrakes were deployed. After a safe landing the ailerons freed themselves. The loose battery leads had dropped through an open inspection hatch behind the rear seat and jammed the controls.
Astir CS77	The supervised trainee winch driver apparently drove a slow launch and, at about 50ft, the pilot abandoned the launch and mistakenly opened full airbrake as he lowered the nose. This resulted in a high sink rate and he was unable to prevent a very heavy landing despite closing the brakes. During the landing the battery fell out and hit the pilot's head.
K8	After 30 minutes soaring the pilot found he had difficulty rolling to the right. As he had sufficient control to he decided to land . Later inspection showed a second battery had lodged in the lower fuselage limiting the right aileron control. It is not known if this had fallen from the battery holder after a previous flight or fallen off the seat.
Ventus b	Loose battery opened & jammed an airbrake. A post flight inspection showed that the battery had not been properly secured before flight.
K13	Loose battery came out of its container during a simulated winch launch failure. One end of the retaining strap was not easily visible during the DI & had been left unfastened.
K21	Restriction in control movement during ground checks found to be caused by dislodged batteries.
Grob Acro	At the end of the day's flying it was found that the glider battery was completely unsecured and the securing bolt was missing. The glider had been busy with soaring and aerobatic flights all day.
K13	Battery installer distracted, not secured, not detected during DI, batteries came loose and tumbled in fuselage while spinning)
K21	Loose batteries discovered during DI. A slightly smaller battery had been inserted with soft cloth packing on top to fill out the space under the clamp and as the packing compressed the wing nut holding down the clamp securing both batteries was able to work loose.
Discus	Battery came loose during flight. The pilot who did the DI reports putting both securing bungees over the battery, the pilot who put the glider away reported only finding one battery in the

	compartment. The second battery was later found dangling within the rear fuselage attached to the battery cable.
K8	Aileron control obstruction. The glider entered cloud at about 800' agl during the winch launch. The pilot released, lowered the nose and opened the airbrakes after which he heard a loud bang from behind him. Once clear of cloud the pilot tested the controls and was unable to apply any right aileron. The pilot flew a cautious left hand circuit using the rudder to level the wings on final approach. After landing it was found that the battery had not been secured in the battery holder and had fallen onto the floor of the fuselage next to the aileron control rod.
Puchacz	Battery came loose during aerobatics. A bungee cord retaining hook had straightened slightly, allowing the bungee to slip off.
K21	Insecure battery found after DI
Vega T65	Landed in crop, battery flew past pilot and smashed through canopy

The database shows that the issues of battery retention mostly affect legacy gliders that have not been produced for many years. The issues have been both operational (forgetting to secure battery before flight) and technical (bungees not doing their job).

In situ testing of a battery installation strength is best as this also tests the shelf the battery is mounted on. On some older gliders this might be a thin layer of plywood or a few layers of GRP.

Using a spring balance or a very well calibrated strong persons arm (as suggest by CS STAN 3 that approves FAA Advisory Circular AC 43-13-2B), ensure that as a the minimum it passes the stated requirements.

A standard Yuasa 12v 7Ah Lead Acid Battery that weighs 2.65 kg x 15G must be able to take a minimum of 39.75kg load forward to meet the requirements. But ideally 2,65kg x 25G gives a minimum load 66.25kg

The use of lighter weight batteries substantially improves the G tolerance of battery holders. Ideally battery installations will not be directly behind the pilot/passenger head.

What if my existing battery installation is inadequate?

The legacy battery system can be exchanged for an installation that is approved in CS STAN (link below). CS STAN approves various exchanges of equipment and how to do it legally.

Go to page 21 to see the standard exchange of battery requirements. Please remember every time CS stan is used to also use the Form 123 with the owner's signature.
https://www.easa.europa.eu/sites/default/files/dfu/Change%20Information%20%E2%80%94%20CS-STAN%20Issue%203.pdf

Page 21 of CS Stan 3 refers to a FAA Advisory Circular AC 43-13-2B, Chapters 1, 2 and 10. (free download link below) for advice on the installation. However, the FAA document only calls for 9 G of forward loading (found on page 119 paragraph 3) when the EASA absolute minimum is 15G. Design and install all replacements installations to at least 15G forward load (ideally more)
https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2043.13-2B.pdf

This part of the leaflet only deals with Lead Acid Batteries but a lot of the principles of wiring, etc, apply to all batteries. (For Ni-cad batteries please refer to the aircraft or battery manufacturer) commonly used in motor glider or tugs engines.

Maintenance

(a) **Case**:
The battery should be inspected for condition, cracks or excessive wear in the outer casing, if fill plugs are fitted these should be secure and free from signs of leaks.

(b) **Terminals**:
The terminals should be checked for security or looseness, cracks or corrosion. Check that the connectors or disconnect plug (s) are in good condition and a good fit. If the plating is worn and corrosion evident either; replace the terminals, or remove the deposits using hot water and reprotect with petroleum jelly. Do not use grease.

(c) **Fuse**:
All glider wiring should be protected by a fuse situated as close to the battery terminal as possible. By convention the fuse is usually in the Positive + line. Motor gliders are not normally fused at the battery due to the high starter motor load but rely on individual system fuses or circuit breakers. The majority of glider applications use a 5A fuse, refer to manufacturer's information if available.

(d) **Mounting:**
Check the security of the battery mounting and the means of retaining the battery. As most glider batteries are located in the centre section behind the pilot's head it is imperative that the battery is retained in the event of any accident. Some mechanical means of securing the battery is required. The practice of using an elastic band is not acceptable.

(e) **Fit of Battery:**
The battery must fit the battery stowage correctly. If a smaller battery is used than initially designed for, then suitable packing must be used to prevent the battery moving. The packing must be secured in place and also not be capable of absorbing any spilt battery fluid.

(f) **Battery Stowage**:
Glider batteries are normally housed in either wooden or GRP battery stowage and gel batteries pose no significant corrosion problem. If a 'wet' battery is used then precautions against corrosion should be taken especially if a metal battery stowage is used. A metal stowage other than Stainless Steel, should be protected with acid proof paint. Acid proof paints are available through normal consumable suppliers. Some installations are fitted with vent and drain tubes. Ensure that these are clear and correctly fitted. Some have clamps in the drain line – these should be drained each annual inspection.

(g) **Servicing:**
Gel batteries require no servicing and are filled for life. 'Wet' batteries require servicing (unless sealed & maintenance free) due to evaporation of battery fluid. Only use clean distilled water to top up the battery and do not overfill. **Do not add acid**. If a battery

requires constant topping up the charging system may be at fault and overcharging or the battery may be leaking.

1. **CHARGING**

Two level charging is recommended, the initial charge must not exceed the manufacturers recommended current and when the battery is charged the charge rate should automatically fall to a float charge rate. This prevents damage to the battery plates and minimises the loss of electrolyte due to evaporation. Fast chargers are not recomended, as permanent damage to the battery will most likely be caused.

2. **CAPACITY TESTING**

The capacity of a battery needs to be established from time to time, this is usually once a year, to ascertain if the battery will reliably last for the intended flight. Most electric varios and GPS units will work satisfactorily at a voltage down to 11 volts (on 12-volt nominal systems) but radios often do not transmit satisfactorily at this voltage. All electronic equipment on stand-by will use some current, so there is a constant drain on the battery. A battery with a low capacity may work satisfactorily at the launch, but quickly becomes exhausted and may not work when needed during the flight or landing.

Batteries are rated in Voltage and Amp hours. Some may have maximum amperage stated.

The most common glider battery is a 12 volt 7 amp hour (Ahr) battery. This means for example; a 12v/7Ahr battery will at 100% capacity, nominally supply 1 amp for 7 hours or 7 amps for 1 hour. The Max. Amperage really only comes into play if you have a starter motor to operate as the battery will have larger terminals and internal components to supply the heavier load. For Motor Gliders and Self Sustainer Sailplanes the Parts Catalogue should be consulted for the correct battery to ensure that the battery is capable of delivering sufficient amperage for starter loads.

Quick Check
If a battery is suspect, a quick check of the open circuit terminal voltage will show if the battery needs to be recharged or if a cell has failed. Assuming the battery is not just off charge, a voltage of about 12½v or more should indicate a good battery. If this check can be done under load e.g. by momentarily pressing the transmit button on the radio the voltage should not fall below 12v.

Capacity test
By convention the rated capacity of a lead acid type battery is stated for the current which will fully discharge the battery in 20 hours. For practical purposes this means when the terminal voltage, under load, falls to 10½v for a nominal 12v battery. One can arrange to discharge at a faster rate but the apparent capacity (amp hours) will be slightly less. For a practical approach it is convenient to discharge at a rate such that the battery is fully discharged in 5 hours (i.e. down to 10.5v), in which case the nominal 20 hour capacity will be about 10% more than measured.

Note: Two 12v/21w car stop light bulbs wired in series provides a convenient 1.1 to 1.2A load which draws almost a constant current at 12v as the battery discharges. Two 12v/21w bulbs wired in parallel will draw a load of 3.5A at 12v.

If the glider is only equipped with an electric vario or vario plus GPS then a capacity of about 3½ amp hours will be sufficient for a typical days flying, however if a radio is fitted in addition then there should be a minimum of 4½ amp hours available. (Approximately 50% and 65% of a 7Ahr battery respectively)

Temperature effect
The available capacity of the battery will fall with a drop in temperature. At 0°c only 80% is available and at -15°c only 65% is available compared with room temperature.

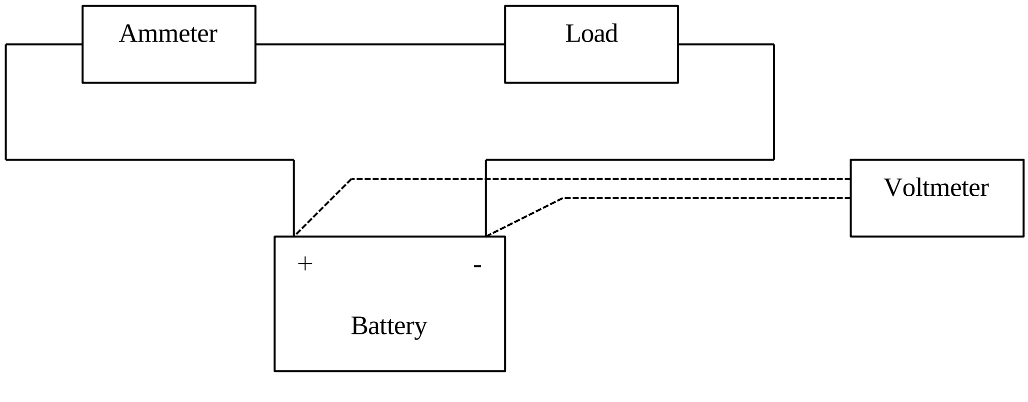
Method
Note: this is a simplified method of capacity testing applicable to smaller batteries used in gliders and motor gliders and using equipment readily available to most BGA inspectors. For Tugs and larger batteries, 20Ahr and above, it is recommended that specialist equipment (CAA approved if necessary) be used.

Equipment required: Battery charger, Known load, Accurate Voltmeter & Ammeter, Clock, Calculator and label or marking paint.

Note: Two meters are required, digital if possible. If only one multimeter is available then use the voltmeter function, but you will need to periodically check the current during the discharge procedure.

a) Fully charge the battery and leave to stand off charge or allow to float charge overnight.
b) Measure the terminal no load voltage. You should have approximately 13.6v.
c) Connect known load (2 x 12v/21w bulbs in series = 1.2A approx.) (2 x 12v/21w bulbs in parallel = 3.5A approx.) and ammeter across the battery as per diagram below.
d) Record time it takes the battery to discharge to 10½v. Monitor battery voltage & record current against time at 15 minute intervals for first hour, then half hour intervals until the voltage drops to about 11 volts, then every 10 minutes until the voltage falls to 10½ volts. Record the time taken in minutes.
e) To Calculate capacity –
   Take the mean current between two readings and multiply by the time interval and record amp minutes. Summate all the amp minutes and divide by 60 to convert to amp hours. The capacity at the 20 hour rate is then (measured Amp hours ÷ nominal Amp hours) x 110%.
f) Recharge battery
g) Record capacity and date on battery. (Use label or paint).
h) Establish that battery capacity is suitable for the particular application taking into account the low temperature effect if applicable.

Capacity test set up:



Example: 12v / 7Ahr battery

Elapsed time	Battery Voltage	Current draw	Amp/minutes (to nearest .5)
0 min	13.6v	0 A	-
15 min	13v	1.2 A	18 A min
30 min	13v	1.2 A	18 A min
45 min	12.8v	1.2 A	18 A min
60 min	12.6v	1.1 A	17.5 A min
90 min	12.2v	1.1 A	33 A min
120 min	12.0v	1.1 A	33 A min
150 min	11.8v	1.0 A	31.5 A min
180 min	11.6v	1.0 A	30 A min
210 min	11.4v	1.0 A	30 A min
240 min	11.2v	1.0 A	30 A min
270 min	11.0v	1.0 A	30 A min
280 min	11.0v	1.0 A	10 A min
290 min	10.8v	1.0 A	10 A min
300 min	10.7v	0.9 A	9.5 A min
310 min	10.6v	0.8 A	8.5 A min
320 min	10.5v	0.7 A	7.5 A min
			334.5 A min

334.5 ÷ 60 = 5.6 Ahr ÷ 7 Ahr = 0.8 x 110 = 88% @ 20 hr rate

≈ 7 Ahr x 88% = 6.1 Amp hours available @ 20 hr rate

If in the above example an assumed current of 1.1A was used without the use of an ammeter then a result of 352 A min would have been recorded. This would have given an artificially high value of 91.6% battery capacity. This may be of no concern in the majority of applications but may give problems if battery capacity is tight for longer flights or in cold conditions.

Thanks to F J (Jim) Tucker, Southdown GC for assistance in compiling this part of the leaflet.