GFA AN 085
(ISSUE 4)

AIRWORTHINESS ADVICE NOTICE

SUBJECT: Pilot Harness Systems installed in sailplanes.

TYPE AFFECTED: All sailplanes and powered sailplanes.

BACKGROUND: This AN is intended to give owners and operators of sailplanes and powered sailplanes some basic information and guidance on the function and care of their harnesses.

This AN is in addition to the specific maintenance guidelines set out in Basic Sailplane Engineering September 2017 section 8.

Issue 4 was raised to include additional material.

HARNESS FUNCTION: The essential functions of the safety harness are:

1. to restrain the pilot firmly in seated position in flight so that the pilot is able to control the sailplane particularly during maneuvering including aerobatics, and in turbulence, and

2. to restrain the occupant against the deceleration forces during ground impact in an accident.

The minimum loads which the harness system is required to sustain according to EASA Certification Standard CS 22 Amendment 2 are 15.0 g forward, 7.5 g upward, 6.0 g sideward and 9.0 g downward. This means that a human body weighing 110 kg loads the webbing, seats and attachment points to 1650 kg in the high forward case, which is survivable. All components of the harness and the harness attachment points must withstand these loads. Fittings have additional factors of safety applied.

To ensure the required level of strength is achieved in service, the inspection procedures on harnesses will need to be adhered to very closely.

To ensure that the harness meets the functional requirements 1 and 2 above, the inspector must check that the adjustment of the

SIGNED: For and behalf of the Gliding Federation of Australia

harness length works without high hand forces, ie the harness is readily adjustable in flight. In one example from 2020, the SDR reported that the harness webbing was scrapped having failed to meet this requirement. The use of slightly thicker webbing for rewebbing the harness, together with the narrow slot in the webbing length adjuster clip led to the webbing surface furring up and blocking the slot. The harness adjustment was assessed as very difficult and beyond what a crew person could reasonably manage in flight.

HOW A HARNESS WORKS:

Like any woven material, harness webbing has threads running along the material and threads running across the material, these are called the warp and weft directions respectively. The warp threads provide the strength of the material and the weft threads hold the material together.
When webbing is loaded the load tends to concentrate towards the edge of the material. This is why frayed edges on the webbing are so detrimental to the strength of the webbing and webbing with frayed edges must be replaced quickly.

The harness must distribute the acceleration loads as evenly as possible on the body. To do this the harness needs the maximum area of contact with the body. To achieve this some manufacturers install large abdominal pads on the lap belts of their harnesses. Where these have been fitted they should be in good condition without losing their stiffness and any worn or soft pads should be replaced.

FACTORS AFFECTING HARNESS PERFORMANCE:

There are many factors affecting how well occupants are restrained in a sailplane. These include the way the harness is installed in the sailplane, the type of cushions used, the condition of the webbing, the manufacturing standards of the straps (including the stitching quality etc) and the condition of the fittings.

INSTALLATION:

Each safety harness is designed so that each occupant is safely retained in their original sitting or reclined position under design case accelerations in operation. Harnesses must be installed in accordance with the manufacturer's maintenance manual.

Beware of assumptions when inspecting installations. The central buckle always has one lap strap permanently installed in a specific receptacle location around the periphery. It will be supplied with that lap strap orientated for the port side anchor point as in most all cases or the starboard side as found occasionally. The buckle has an upright orientation and is <u>not</u> to be installed upside down.

The installer may falsely assume that this fixed lap strap always goes to the port side anchor. If that lap strap is actually orientated for the starboard anchor, but is fitted to the port side, then the buckle is installed upside down and then the three remaining belts will be fitted by the crew to the wrong insertion points.

CUSHIONS:

The cushions used with the harness also have a large influence on harness performance. Seats with excessively soft cushions are compressed under acceleration. As the foam is compressed the webbing comes loose and the body "submarines" under the belt. When the acceleration stops, the foam then rebounds resulting in possible injury to the abdomen and spine.

To reduce the likelihood and effects of submarining, energy absorbing, non re-bounding foams should be used. An example of this foam is ‘confor foam’ available from Aircraft Spruce and other leading suppliers. Refer to the GFA website for Australian retailers.

Tests in England have indicated that substantial reductions in spinal g loading can be achieved by the use of the correct foam while the g experienced by the spine is actually increased by the use of soft foam compared to a bare seat. The best results were found by combining 25 mm of hard grade low resilience foam with 12 mm of medium grade low resilience foam. The medium foam is placed above the hard foam and the sandwich is upholstered to prevent damage by UV light and abrasion.

It is highly recommended that the foam cushion be as thin as possible as this reduces the loosening of the harness under acceleration and therefore reduces submarining.

WEBBING CONDITION:

The condition of the webbing is critical to the performance of the harness. As stated previously the load in the webbing is concentrated at the edges and so fraying is critical to the strength of the webbing.

Webbing also wears where it chafes on the metal fittings. An example of this is given in Appendix 2 which details the correct inspection procedure for Autoflug harnesses. Webbing damage decreases the strength of the harness and should be repaired within a short time of being noticed. Where the harness chafes on the sailplane's structure, rubbing sleeves should be fitted over the straps.

CLEANING:

Clean the webbing only when there is sound reason to do so, such as to remove excessive dust/dirt, sweated salts, oils or greases, and vomit. The important protective finish on the surface of webbing fibres can be adversely impacted by excessive washing with inappropriate cleaning products and/or excessive mechanical abrasion. Carelessly conducted washing is counterproductive by

reducing strength and harness life, increasing wear, and can adversely impact the way the harness performs under load.

If washing is required, use a sponge together with mildly warm water and ordinary mild soap so that the water is neutral pH, (ie neither acidic or alkaline). Do not use a bristle brush and so avoid mechanical damage. Rinse with clean water and then air dry the webbing without heat. Reinstall only when completely dry.

Avoid exposing metal fittings to water as much as possible. The central buckle must not become wet. If the metal fittings need cleaning then use a cloth with iso-propyl alcohol and apply this ONLY to the metal fittings.

REWEBBING:

Safety harnesses may only be rewebbed by a CASA approved workshop using approved materials and methods. Webbing must be replaced with new certified webbing of the same rating or higher. Approved fittings must be used.

A release note is required when the approved organization releases the harness back to service. This release note reference number must be entered in the sailplane's log book and certified correctly fitted to the sailplane by an appropriately qualified GFA inspector. The release note is kept in the sailplane's file.

All overhauled harnesses or repaired straps must have an identification label showing the repair or overhaul company name, the job number and the date of overhaul or repair. This information should be stitched to the strap in a durable manner, for example a cloth patch with waterproof text stitched to the strap under a flexible plastic protective cover.

STITCHING:

When attaching fittings to replacement webbing, the correct approved stitching pattern and materials must be used to ensure the specified strength is maintained. This must be carried out by an approved organization in accordance with manufacturer's specifications.

FITTINGS:

In severe gliding accidents a significant proportion of harness attachment failures occur in comparison to harness webbing failures. The metal fittings must be stronger than the webbing and so the continued inspection of the fittings is important.

The fittings must be inspected for wear, corrosion, deformation and loss of surface finish such as chrome plating. Damage to the chrome plating is particularly dangerous as the flaking chrome is sharp and may cut the webbing. Also, the fittings may in time allow the webbing to slip and therefore prevent the harness from being correctly tightened.

Harness fittings which have been re-plated must be viewed with suspicion unless they have been re-plated by an approved organization and have a release note saying that the components have been re-plated to an approved procedure. The reason for this is the danger of hydrogen embrittlement. Hydrogen embrittlement cannot be detected using non-destructive techniques and can result in strength loss sufficient to cause components to shatter when dropped onto a hard floor from a large height.

QUICK RELEASE:

All sailplane harnesses must employ a central quick release buckle. Quick release buckles shall be checked for correct operation, positive locking when a webbing end lug is inserted to the correct location around the buckle perimeter, smoothness of operation, and the ability of springs to return the control knob to the closed position.

Best practice is to carry out a function test with a person actually sitting in the seat to ensure the quick release unit functions correctly in fastening and unfastening modes.

If the quick release unit will not release properly it is unserviceable and the harness must be replaced before further flight. Repair, if practical, must be carried out by an approved service outlet or the manufacturer.

If the quick release unit incorporates a separate release control for releasing just the upper shoulder straps then that operating lever must be checked for operation. It **must not** release on a 'hair trigger' but be positive in operation, and must not release the lap straps on shoulder strap disengagement or when the upper straps are refitted.

Notwithstanding the above, where the harness quick release has the facility to release the shoulder harness separately, it is highly recommended, particularly for aerobatic sailplanes, that this facility be disabled if the harness release manufacturer provides approved data by which to do so.

AGING:

In the early 70's experiments began to establish the effect of aging on harnesses. The effect of UV radiation, as well as some other environmental factors, was established. The experiments show that the main causes of the decline in the strength of synthetic webbing are UV light, temperature, humidity and the oxygen content of the atmosphere. Of these UV light is the major factor.

In Australia, harnesses in sailplanes are subjected to high levels of UV light. A case study was carried out on an 11 year old harness with the following results:

Harness type - Early model Gadringer

Glider type - ASK 13

Time in service - 11 years - 2000 hours.

STRAP	BREAKING LOAD
Shoulder strap - right	550 kg
Shoulder strap - left	500 kg
Lap strap - right	1122 kg
Lap strap - left	1428 kg

Original webbing strength - 2000 kg

The shoulder straps have a larger reduction in strength due to the higher exposure to sunlight compared with the lap straps.

USAGE: For effective restraint the following method of using a harness should be followed:-

(a) Pull up the lap straps firmly while locating the lap straps low over the hips.

(b) If fitted, pull the crotch strap up firmly to hold buckle in place and prevent the shoulder straps from lifting the buckle.

(c) Tighten each shoulder strap to a comfortable level that allows the controls to be reached.

(d) Periodically in flight, and before landing, ensure that all of the straps are correctly tightened, keeping up with body/cushion settling.

Note: the crotch strap is intended to retain the body in place under negative g and to hold the buckle in place. It is highly recommended that 5 point harnesses are fitted to sailplanes which will undergo extensive aerobatics.

THE POCKET KNIFE EFFECT: This occurs if the shoulder straps are not used properly. The upper body experiences forward acceleration and the body folds at the hips like a pocket knife. When the body reaches the limits of the shoulder straps a whiplash effect can occur and if the straps are sufficiently loose the head or upper body may come into contact with the surrounding structure or the instrument panel.

LIFE OF A HARNESS: It is <u>STRONGLY</u> recommended that the harness webbing be replaced after 10 years of service if (a) there is no other life limitation from the manufacturer or (b) the inspector is in any doubt

about the continuing airworthiness of the harness. Service life for all materials used in harnesses has been established by experience and testing to recognized standards and specifications.

Most manufacturers now limit the life of their harnesses to 12 years on condition. If an airworthiness directive applies to a particular harness type or model then a reduced life may be specified therein. If the manufacturer advises of 12 year life then MOSP 3 provides that beyond 10 years the inspector is to certify annually in the logbook that the harnesses and buckles have been checked IAW BSE and are being extended on-condition for 12 months. Refer to BSE for guidance on acceptable webbing condition and operation before you approve further use.

ACCIDENTS:

It is not permitted to re-use any occupant harness that has been recovered from a serious accident where it is likely that it has been loaded over the rated strength or the residual strength following years of use. The occupant harness is a fundamental piece of safety equipment and it must be treated as such. All seat belts recovered from an accident should be destroyed unless it can be established without doubt that the harness is serviceable, such as the inspector is completely satisfied that the harness or seat belt was not subject to any abnormal loads. If the sailplane is being rebuilt from an accident, it is strongly recommended that new harnesses be fitted.

DOCUMENTATION:

In preparing this AN reference has been made to:

GFA MOSP 3

The Crash Survival Design Guide.

Flying Safety Information. Harness - Safety through Knowledge. Braunschweig, 27-3-87.

British Gliding Association, AMP Part 4, Leaflet 4-8.

British Gliding Association, “Why you should fly with an energy-absorbing safety cushion” 12 pages published around 2016.

CAA UK Safety Notice SN-2019/003 re Harness Integrity

GFA “Safety In The Cockpit, Cushions and Harnesses” by Len Diekman for GFA.

APPENDIX 1.

CAA UK Safety Notice SN-2019/003 re Harness Integrity

Key points:

A review of a number of recent Non-EASA GA aircraft accidents identified that the ground impact had been survivable due, in part, to the good condition of safety harness systems used in each instance. However, the AAIB report of the accident involving Yak 52 G-YAKB in 2016 identified that the failure of the aircraft's lap and shoulder harnesses could have contributed to the severity of injuries incurred by both occupants during the unsuccessful forced landing. In this case, the lap and shoulder harnesses had been in service longer than originally intended by the aircraft manufacturer. The harnesses exhibited significant ultraviolet fading and discolouration, and the analysis showed that the harness strength had degraded by as much as 50%, and possibly more.

2.2 When undertaking scheduled maintenance, the expectation is that consideration is given to the utilization of the aircraft and therefore wear to the harness, visible or not:
(a) An aircraft that is used for training or is regularly operated by different pilots will see considerably higher 'working' of the harness through adjustment. This will have an adverse effect on the degradation rate.
(b) The age of the harness should be considered, regardless of the environment. Anecdotal evidence has shown that even in good storage conditions without even being installed on an aircraft, there can be a degradation in strength over time:

(b) (1) A set of good quality Nylon harnesses that had been stored in good conditions (dry and appropriately packaged and not exposed to sunlight) showed an approximate 12% reduction in total breaking strength over 12 years, despite not ever having been installed.
(b) (2) A harness of the same construction and material installed on an aircraft with low annual hours, very limited UV exposure and stored in a hangar had degraded in strength by 30% over 14.5 years. The external condition appeared to be 'as new'. The percentage of strength deterioration that is acceptable has generally not been defined, partly because strength data is not available, and partly because the decision depends to an extent on the magnitude of the reserves of strength of the harness, particularly when compared to the strength of the attachments.

(c) Evidence suggests that while harnesses with straps made from natural fibres are likely to be worst affected, harness strap fibres constructed of any material can degrade with exposure to temperature and light (particularly UV light). With Nylon for example, continued exposure to temperatures exceeding 20 degrees Celsius will result in a degradation in strength over the long term. Above 40 degrees, this can be accelerated considerably further. Thus, a harness in a type with a bubble canopy consistently left uncovered on an apron in the summer will likely be notably affected.

2.3 When undertaking scheduled maintenance, it is recommended that the following advice is considered as an aid to the inspection process. Gain access to the aircraft seat harness (shoulder harness, lap belt etc.) attachments and using a suitable light source, mirrors, magnifying glasses or other visual aids, examine:
(a) each attachment bracket, its securing means and where appropriate, whether it's free to swivel;

(b) each harness adjuster and buckle for evidence of cracking, corrosion, wear or deterioration of the surface finish, and for correct operation, freedom from jamming, slippage and broken springs, ability to release under tension etc.;
(c) the related aircraft structure in the vicinity for evidence of cracking, corrosion, distortion, wear or deterioration of the surface finish;
(d) the webbing, ensuring it is looped through buckles and other hardware in the correct sense, has not been pulled significantly to one side of any adjustment/attachment device and is not twisted.

2.5 Gain access to the full length of each safety harness (in some cases, this may involve removing the harness from the aircraft). Each individual strap of each cockpit safety harness should be examined in detail, including assessing for signs of:
(a) broken or frayed stitches and threads;
(b) nicks, cuts and tears,
(c) chafing (e.g. scratching and scuffs on webbing exterior);
(d) warping (usually apparent by curvature in the webbing pattern);
(e) contamination due to mould growth or from exposure to contaminants such as acid, oil, grease, water, grit/dirt etc. (Dirt or grit contamination could lead to chafing/fraying of stitches/webbing as the harness is in normal use, and may be partially or fully hidden from view unless care is taken);
(f) deterioration due to exposure to sunlight (UV degradation, often evident by discoloration 'bleaching');
(g) lack of security of end fittings; and
(h) elongation or wear of the attachment holes.

2.7 Care should be taken when cleaning safety harnesses to ensure that the cleaning agent used does not itself degrade the harness strength or any protective finishes.

(a) Nylon materials respond adversely to any acidic substances, whereas for polyester, alkalis have an adverse effect. The original equipment manufacturer's maintenance practices should be followed where possible.

(b) Generally, clean luke-warm or cold water with a mild (non-detergent, pH neutral) soap may be used, but even soap residue remaining present can accelerate degradation, so after rinsing, the harness should be allowed to dry naturally. Accelerated drying by heating could induce temperature-related degradation.

(c) When cleaning, care should be taken to keep foreign matter and any cleaning media (water/soap) away from the hardware components i.e. buckles, adjusters etc.
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APPENDIX 2.

INSPECTION FOR AUTOFLUG HARNESS

COMPONENT AFFECTED: Autoflug 4 point harness using the Gl-2 buckle.

SUBJECT: Inspection and possible repair/replacement of both harness webbing loose lugs and fixed lugs.

BACKGROUND: Service experience in Australia shows that the loose lugs used to plug 3 of the straps into the Gl-2 Buckle may not have been manufactured properly, having sharp edges which can cut the harness webbing. Also sweat and moisture may cause rusting of the edges of the slot, the rust in turn cutting the webbing. Similarly the 4th strap attaching to the buckle by the fixed lug may also be defective.

RECOMMENDED ACTION: As soon as possible inspect the harness as shown on page 8 for damaged webbing.
If damaged webbing or excessive lug corrosion is found, that constitutes a defect which must be rectified. "Damaged" meaning strands in the outer layer of the webbing worn through.

RECTIFICATION: Autoflug have made replacement lugs Pt No AFG0314259, available from Autoflug agents. These lugs are stainless steel, un-plated with smooth edges. Stainless steel fixed lugs are also available. Replacement of lugs will require re-ending of the existing straps if they have sufficient excess length, or completely replace the webbing with webbing of the same type.

Any Autoflug harness repair must be done by an approved harness manufacture or repair organisation.

COMPLIANCE: This inspection is strongly recommended.