Non-destructive testing and diagnostics of manufacturing gliders and motor-gliders

K. Juočas[1], K. Gečas[1], V. Valavičius[2]

[1] AB "Sportinė aviacija" –Pociūnai, LT - 59327 Prienai, Lithuanian Republic
Phone: +370 319 60567, Fax: +370 319 60568
E-mail: info@lak.lt
[2]Vilnius Gediminas Technical University –
Gelvonu 16-6 Str, LT10223 Vilnius, Lithuania, Phone: (+370 5) 2466388
vinval@fm.vtu.lt

Abstract
Prospects of development of manufacturing gliders in AB „ Sportinė aviacija " are presented. Characteristic malfunctions of gliders, methods of definition of malfunctions and methods of non-destructive testing and diagnostics in manufacture of gliders and motor gliders are investigated.
Key words: glider , non-destructive testing, diagnostics.

Introduction

Now for improvement of quality of new methods of manufacturing and maintenance of gliders new methods of non-destructive testing and diagnostics are used. For this purpose analysis of achievements of this problem have been carried out.
Directions of the investigation were the following:

- research of fatigue defects of gliders and motor-gliders;
- development of new methods of non-destructive testing of gliders for quality assurance.

Objects of diagnostics were gliders and motor gliders (Fig. 1).

Fig. 1

1. The historical information on development and manufacture of gliders and motor gliders

The Company **AB Sportinė Aviacija** was founded in 1969. For over 35 years the Company has designed and manufactured highest quality gliders. In the course of its history the Company designed, tested and produced 20 different types and modifications of gliders and motor-gliders. More than 400 company's products–different types of LAK (LAK- Lithuanian aviation construction) gliders – successfully fly in 30 countries.

During period of 35 years in our company has grown a generation of highly skilled specialists.

The first high performance glider BK-7 "Lietuva" took-off in 1972. Since then many other aviation projects were developed and manufactured, best known of which are: open class glider LAK-12; 15-18m class glider LAK-17a; standard class gliders Genesis 2 and LAK-19; self-sustaining gliders LAK-17AT and LAK-19T; primary training glider LAK-16.

Thanks to hard work we have developed and started the serial production of the best world's glider LAK-17a FAI 15-18 meter class and the FAI standard class glider LAK-19.

In 2002, we launched a new record open class glider, LAK-20 (two-seater version) and at the same time we are preparing a turbo version of this glider as well. We hold the Certificate issued by the Lithuanian Civil Aviation Authority, which grants the right to perform production of sailplanes, self-launching sailplanes as well as related products and parts. We are producing trailers for glider transportation, and our designing department enables us to design any kind of gliders, motorized gliders or even general aviation aeroplanes. LAK gliders are worldwide type certified, not only in Lithuania, today we have type certificates for our gliders in EASA, CAR, and other countries.

Apart from building gliders, the factory has capacities to develop a large variety of aviation or non-aviation composite structures and constructions. Our own testing facility can be employed for comprehensive analysis of our projects and as a complimentary service for our customers as well. For these purposes the factory has its own strength test laboratory.

The LAK-17AT is a single seat high performance self-sustaining powered sailplane of FAI 15m – 18m class designed according to JAR-22, category "U" specifications. It is a mid-wing motor-glider with flaps, T-tail, retractable main landing gear. Sailplane is equipped with retractable power-plant powered by 19,6 kW (26,28 hp) two stroke two cylinder air cooled SOLO 2350 engine. The LAK - 19 is a standard class sailplane designed and certified to the JAR - 22 category "U" specifications. It is a

mildewing glider with flaps, T - tail, retractable main landing gear with the shock absorber, pneumatic tail wheel and is capable of carrying 180ltr water ballast.

LAK-19 sailplane is made of hybrid composite materials such as Kevlar, carbon, glass fiber. The wing spar is made of modern carbon rods GRAPHLITE SM315 and has a double T section. The weight of each wing panel is about 55 kg. The airbrakes are situated in upper surfaces only. The wing airfoil is LAP 92 - 130/15 and it passes into the LAP 92 - 150/15 in the tip.

The sailplane is made of composite materials. The wing spar is made of pultruded carbon rods GRAPHLITE SM315 and has a double T section. The wing water ballast of 180 ltr. (47.55 US gal.) is filled in and poured out through the holes at the bottom of the wings. The airbrakes are located on the upper wing surface only. The wing airfoil is LAP 92-130/15 at the root transiting into LAP 92-150/15 at the tip. LAK-20 is the newest JSC "Sportinė Aviacija" project currently under development.

LAK-20 is an open class two-seat glider designed to meet the latest standards of the gliding industry. Glider is of normal aerodynamic configuration with “T” tail and wings slightly swept forward. Due to changeable wingtips, glider can have 23 m or 26m wingspan. Our latest achievements in engineering and aerodynamics allowed us to design wing with very high aspect ratio, which made possible to improve glider performance to the new levels. Wing is four piece - two centre section panels and two outer wing panels. Glider is made of modern composite materials using already known LAK brand technologies such as use of pastured carbon rods for the wing spar construction and others. Glider construction allows installation of the engine. Both self-launching and self-sustaining versions are planed, powering glider with SOLO 2625 02 or SOLO 2350C (k=1:1,56) engine respectively [7].

2. Condition of use of non-destructive testing over quality assurance of gliders and motor gliders

Quality of non-destructive testing of gliders and motor gliders essentially depends on correctness of a choice of means and methods of non-destructive control. The solution of this problem probably with research of fatigue places of objects, means of not destroying control and qualification of the experts who are carrying out(are spending) the control.

The most important means of not destroying control:

- Eddy currents;
- Ultrasonic;
- Acoustic issue;
- Optical.

In joint-stock company the Sports Aircraft is widely used eddy currents defect scope, designed in the State scientific research institute of civil aircraft.

Of defect scope TBD defects of power (force) elements of a glider in manufacture and operation are supervised at occurrence of fatigue cracks. For last 10 years there were some incidents from breakage of units of fastening of the stabilizer of gliders "Jantar-standart".

It in the Kiev aero club, in two gliders of Poland, in Šiauliai and the Klaipėda Aeroclubs of the Lithuanian Republic. The technical resource of a glider "Jantar-standart" is 6000 летных hours. Despite of it the strike of gliders which have suffered failures, was 1000 - 1140 летных hours, but there were fatigue cracks and not in due time defects have been found out. Therefore also there were these incidents.

Now in aero clubs of the Lithuanian Republic constantly non-destructive testing of units of fastening of stabilizers of gliders is carried out. Carrying out вихретоковый not destroying control, are established in 4 gliders LAK-12 of a crack of arms of the handle of management.

Used methods of non-destructive testing: method NDT finds cracks of rings of external bearings of units of fastening of wings and fuselages of gliders. These defects arise after rough planting gliders.

During major overhaul of glider LAK-12 it is used ultrasonic flaw detector, created by scientists in Kaunas University of Technology by which it is carried out defect scope the basic units of a longeron of a wing.

For modern again created gliders and motor gliders experts of the enterprise and faculty of mathematical modeling of the Vilnius technical university carry out research works on use in the future modern ultrasonic, eddy current and acoustic flaw detectors for carrying out non-destructive and fatigue tests of gliders.

Now, with development of computer mathematics in Mathematical Modeling Department Vilnius Technical University and use of the information at the automated registration during flight the new methodology of non-destructive testing and diagnosing of gliders and motor gliders is actually started and demands development at designing, tests and in operation of gliders [1, 2, 3, 4, 5, 6].

3. Maintenance service of gliders on a condition

For all listed systems of maintenance service and repairs typically, that the operating time to the next repair is set beforehand and not connected to a condition of a concrete glider. Thus it appears, that for a part of gliders which were in favorable conditions of operation, repair could be executed much later, than it is dictated by sizes of established resource Tp(i). it is economically expedient to repair a glider during the moment when its(her) technical condition demands repair. Here there is a full analogy to advantages and lacks of a resource on a limiting condition and the appointed resource.

If repair is carried out at an operating time adequate(answering) to some limiting condition of the plane at which it(he) demands elimination of malfunctions speak that the system of repairs on an actual technical condition is used.

Performance of requirements of maintenance of high safety of flights at system of repairs on an actual technical condition is a complex (difficult) technical problem(task) and demands means for additional experiments. The opportunity of use of this system of repairs should be incorporated during designing and manufacturing of a glider, i.e. high survivability of parts of the plane, high

control suitability, easy shooting and interchangeability of parts should be provided.

High survivability means that defects and malfunctions caused by them rather slowly develop, and consequently there is sufficient time for their revealing before there will come (step) refusal.

High control suitability of gliders means, that all his(its) parts can be subjected without the general(common) dismantle of a glider to diagnosing for revealing their technical condition. For these purpose diagnostic gauges, devices for the control of a condition of parts of a glider should be built - in. For a modern glider it complicates his (its) design and consequently is not applied. The engine of a motor glider should have windows for the control of inwardness and gauges for the control of a condition of bearings, etc.

Easy shooting of parts allows to carry out(spend) their replacement without the general(common) dismantle from a glider.

Mutual replacement of parts provides their replacement without selection and adjustment.

Complexity of a design, thus, a glider and his(its) units leads to to necessity of restriction of a set of units and their parts subject to repair on a technical condition.

Basis for performance of repair on a technical condition is not only revealing of a condition of a glider and his (its) parts without essential volume of disassembly, but also forecasting of technical condition ЛА for long term of operation. It especially concerns to parts of a glider which elimination of malfunctions is under operating conditions too labors-consuming. It also has for an object the further research.

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Neardomieji bandymai ir diagnostika gaminant sklandytuvus ir sklandytuvus su varikliais

Reziumė

Pateikta sklandytuvų gamybos AB „Sportinė aviacija“ raida. Tiriami sklandytuvų būdingieji gedimai, gedimų nustatymo metodai, neardomųjų bandymų ir diagnozavimo metodai sklandytuvų ir sklandytuvų su varikliais gamybos metu.

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