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CONCEPT OF PROVIDING SAFE AIRCRAFT MAINTENANCE*Tamargazin A.*, Doctor of Science, prof., *Linnik I.*, Candidate of Science, associate prof.

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У статті розглянуто основні питання підтримання льотної придатності повітряних суден у цивільній авіації, різні підходи, використовувані сьогодні найбільшими виробниками авіаційної техніки у світі. Розглянуто комплекс заходів, які гарантують, що в будь-який момент свого ресурсу повітряне судно відповідає дійсним вимогам до льотної придатності та його технічний стан забезпечує безпечну експлуатацію.

Ключові слова: летная годность, воздушное судно, ресурс, срок службы.

The article deals with basic problems of continued airworthiness, various approaches to them. Used nowadays by the world's largest aircraft manufactures. The complex of measures is considered which guarantee that at any moment of its service life the aircraft is in compliance with existing requirements of airworthiness and its technical condition provides safe operation.

Keywords: airworthiness, aircraft, resource, service life.

Problem setting

According to ICAO regulations and air law of Ukraine and Russian Federation for providing flight safety efficient work which provides safe operation of civil aircraft is necessary, including:

- the system of state control of airworthiness;
- the system of continued airworthiness.

Table 1 [1] shows main components of control system from the side of public authorities of the state

designing an aircraft and the state registration it for providing aircraft safe operation and the specific features of national approaches (FAA is American approach, IASA is a European approach).

It is a common knowledge that there are no insignificant things in providing aviation safety, that is why the stated above components do not complete the list and some new ones may be added to it.

Table 1

Main components of airworthiness control system

Main components		National approach		
		FAA	IASA	Russia, Ukraine
State monitoring of airworthiness		Immediate and continuous technical and flight inspection		Controlling of evidential documentation for continued prolonging of resource and life-service
Step-by-step prolonging of resource and life service		Applied only after reaching designing value of resource and life service by the sample aircraft		Applied continuously
Type of aircraft certification of the typical structure has a high level of harmonization				
Certification	Sample of aircraft	Airworthiness certificate is not limited in time	Inspection of aircraft by a representative (commission) of civil aviation administration	Through procedure of step-by-step prolongation of resource and life service
	Organizing of maintenance and repair	Resolution of aircraft designer is obligatory	Resolution of designer is not obligatory	
Subject of customer service		Designer and manufacture are integrated as one judicial person having common commercial goals		Designer and manufacturer are separate judicial persons with their own corporative goals
Authenticity of the supplied aircraft components		High		Low

As it is evident from table 1 domestic system of control of providing safe aircraft operation bases on step-by-step setting (prolongation) of resource and life service, and that is the fundamental difference between the domestic and American/European approach to this problem.

Step-by-step setting (prolongation) of resource and service life means that the aircraft operation is divided into two stages in the process of their operation and ageing. Duration of the stage usually corresponds to time between overhauls. During putting aircraft park into operation this resource constituted 4.000...5.000 flight hours, which corresponded to 3...4 years of service life. The stage of setting resource and service life corresponds to 3...4 years of operation as well for aircraft without major repairs and overhauls.

The value of resource and service life as well as conditions of operation in which flight safety is guaranteed, is set for each stage on basis of operational experience, the results of laboratory tests of natural structure and forecasts of expected conditions of aircraft operation. In the process of operation of aircraft park on each stage the new information is accumulated about the conditions of operation, defects detected repeatedly, additional tests of natural structure are done and technical measures are worked out as additional measures are worked out as additional conditions (or confirmation of existing conditions), for prolonging resource and service life for the next stage of operation. Within the limits of the next stage of setting the resource and service life practically all the defects of designing, manufacturing, maintenance and repair are detected.

Further continuance of operation is possible only after the detected defects are rectified.

Practice has shown that on each stage some new defects may be detected, it being known that during short operating time (at the beginning of aircraft park operation) it is the result of miscalculation during designing or manufacturing. On later stages appearing of structural — manufacturing defects becomes rare, they are mainly defects connected with the load of functioning, corrosion and specific conditions of operation.

An important specific feature of domestic step-by-step setting of resource and service life is the fact that the results of each stage were used for carrying out state control of airworthiness. In the USA and European Union state airworthiness control is an independent procedure.

A staff of work participants for setting resource and service life in Ukraine and Russia practically has not changed since the times of the USSR:

Designing bureaus of various aircraft types;

Central Aerohydrodynamic Institute (TsAGI) — airworthiness codes and testing's;

Federal state unitary enterprise "Siberian aeronautical research institute named after S. A. Cahplygin" (SibNIA) — central of testing in aviation industry;

State research institute of civil aviation (SRICA), State research institute (SRI) "Aeronavigation" — summary of operational experience and technical conditions of aircraft.

All the participants of works, first of all and principally, carry out scientific expertise of evidential documentation on setting the resource and service life of aircraft in the interests of the corresponding state authorities.

In Ukraine and Russian federation air laws specify that the designer is responsible for compliance of typical aircraft construction with airworthiness standards on all the stages of designing and maintenance of aircraft created by them. Aircraft resource and service life are principal performance features of its typical structure.

Besides, only a designer as the author of the structure possesses all the information about potential possibilities of the structure in the conditions of its creation.

That is why finally only he has the right for continuing resource and service life of the structure and is responsible for the results of their continuing. Since the domestic aircraft designers do not have a fully-featured laboratory base for conducting fatigue tests, they involve various scientific centers and organizations into them (TsAGI, SibNIA, SRICA, SRI "Aeronavigation") which become immediate participants of works and share responsibility of a designer during step-by-step continuance of resource within the limits of their competence. Civil aviation administration, carrying out state monitoring of airworthiness on all the stages of designing, manufacturing and maintenance, is responsible within the limits of its power.

Main works during setting (continuing) of resource and service life include:

1. Analysis of technical condition of aircraft park.
2. Working out the program for investigation of aircraft technical condition.
3. Investigation of aircraft technical condition.
4. Evaluation of actual operational lead, including analysis of repeated loads on actual routes and determining their impact on the main elements of airframe.
5. Analysis of individual critical points of airframe structure.
6. Accurate specification of operating conditions (evaluation of parameters of actual typical flight according to Technical task during designing and to the "flight" on resource benches).
7. Analysis of the results of bench tests on the basis of operational loads (actual conditions of operation) and works in tasks 1 and 5.

8. Continuation of bench tests on the basis of more exact actual operation load and actual conditions of operation.

9. Analysis of fail-safe features and consequences of possible failures of units and systems.

As practice shows, for a lot of aircraft user states these works are like a certain iceberg. A small part (a visible top of an iceberg) is the works in tasks 2 and 3. Is carried out with aircraft user states participating, so evident for everybody. All the rest works are carried out actually without them participating, are not understood by them, so the latter have a false idea that such works are unnecessary.

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Existing monitoring system for providing aircraft safe operation was founded nearly 70 years ago in Ukraine and Russia, and the history of domestic civil aviation has proved the level. Nevertheless, the problem of canceling step-by-step setting (continuing) resource and regularly raised. Considering table 1 it is not difficult to represent that it cannot to purely administrative decision, so as state monitoring of sample aircraft airworthiness ICAO Contention. It is permissible not to cancel step-by-step system of setting (continuing) resource and service life, but to replace it with the equivalent system providing the state monitoring which is as effective as step-by-step one. It is an extremely complicated problem in view of political situation in Ukraine and Russia nowadays.

Solving the problem

Let's consider the principles underlying the system of continued airworthiness.

According to ICAO document [2] continued airworthiness suggests carrying out a complex of measures, which guarantee that at any moment of its resource an aircraft conforms to current regulations of airworthiness and its technical condition provides safe operation. These measures monitored by the respective civil aviation administrative bodies of the aircraft designer and aircraft registration states must make provisions for:

1. Designing such aircraft structures which:

a) provide safe operation of structure (including the demand of structure strength throughout its service life);

b) provide necessary operational adaptability for inspections with high effectively of detecting defects;

c) allow to use established methods of maintenance.

2. Preparation of necessary operational documents by aircraft designer.

3. Working out maintenance manual by the aircraft user on the basis of the information resented by aircraft designer.

4. According to the demands of aircraft registration state presenting to aircraft designer the data of defects and other essential information concerning aircraft maintenance and operation by aircraft user state.

5. Analysis of defects, accidents and data concerning maintenance and operation by the designer and designer state as well as working out and presenting information (as airworthiness directives or bulletins) about recommended as obligatory actions taken as a result of such analysis.

6. Studying the information by aircraft user and registration states presented by the designer or designer a state and carrying out necessary actions in connection with this information, paying particular attention to the actions advised as the obligatory ones.

7. Fulfilling by aircraft user state of all obligatory requirements concerning aircraft and in particular observing conditions of resource execution connected with strength (fatigue, corrosion etc.) as well as doing any special tests or inspections provided in the process of certification or acknowledged necessary after wards for providing structure integrity.

8. Development and carrying out the program of additional inspections of ageing aircraft structure.

ICAO conception on continued airworthiness of civil aircraft, presented above, as a rule has national specifics of its implementation. For example, in Ukraine and Russia the conception of single maintenance schedule is accepted, according to which task 3 of ICAO conception is practically not carried out by aircraft user state, but in view of step-by-step system of continuing resource and service life, existing in these states, task 7 is exclusively important.

It is known that all the aircraft properties and performances are laid while designing, carried out during manufacturing and kept on during operation. That is why particular attention should be paid to measures of designing and manufacturing of aircraft, the structure of which provides safe operation on established methods and ways of maintenance. In other words, the structure should be designed in such a way that the high level of its safety of operation was provided during aircraft operation.

Summary

Continued airworthiness conception as far as the structure is concerned may be legalized as structure

safety on condition of its strength within the limits of the set resource (service life) in the expected conditions of its operation (environment, typical spectrum of loads, etc.), emergency and catastrophic situations due to structure fatigue, damage with corrosion and because of accidental factors, must be practically improbable.

Structure safety due to strength ("structure safety" for short) is provided with:

- a) respective aircraft structure;
- b) technological process of aircraft manufacturing;
- c) maintenance and repair;
- d) following with set regulations and operating conditions and is confirmed with:
 - e) the results of the respective calculations;
 - f) investigation of actual operating conditions including characteristic of environment and effecting loads;

- g) the results of flight-stress tests;
- f) the results of laboratory and bench tests of natural structures, their units, constructive elements and materials;

- h) experience of aircraft operation of the given type and (or) similar aircraft.

Moreover, it is necessary to take into account, that when one speaks about structure maintenance, first of all one means a complex of works monitor works during different types and forms of maintenance and repair of such structure.

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