STRUCTURAL ANALYSIS OF THE MALFUNCTIONSOF THE GAS TURBINE ENGINE AI-25TL

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Abstract: *The article presents a structural analysis of the malfunctions of the gas turbine engine AI-25TL based on statistical materials from its maintenance in the Bulgarian Air Force. The reporting and collection of information on the malfunctions of aircraft engines makes it possible to establish the nature of their manifestation and the degree of their recurrence. Based on mass observations of the occurrence and manifestation of various malfunctions, measures are developed and implemented aimed at increasing the level of reliability of aircraft engines.*

Keywords*: maintenance, aircraft, engine.*

1. INTRODUCTION

The AI-25 TL twin-circuit turbojet engineis used on the L-39ZA trainer aircraft.

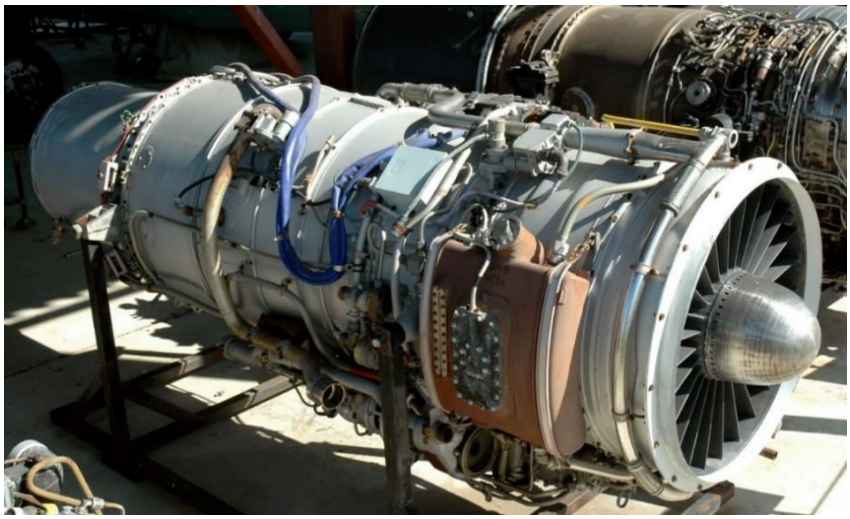

FIG.1 Gas turbine engine AI-25TL

Normal operation of the engine is ensured by the following systems:
- fuel supply system;
- oil system;
- sufflation system;
- drainage system;
- starting system;
- anti-icing system [2].

In accordance with the tactical-technical requirements for the AI-25TL gas turbine engine, the following basic modes of operation have been established: maximum, nominal, cruise (0.85 of nominal) and small throttle.

The normal and trouble-free operation in the process of operation to a considerable extent depends on the timely and qualitative performance of all types of maintenance.

The following types of maintenance shall be performed on the engine:

- engine preparation for flight;
- maintenance every 100+20 hours of flight time;
- performing storage activities;
- test the engine according to a defined programme and check the operability of the systems;
- checking the operability of the engine and aircraft systems aftertroubleshooting [3].

2. STRUCTURE OF MALFUNCTIONS OF THE AI-25TL GAS TURBINE ENGINE

Sources for gathering information on aero engine malfunctions are:

- ✓ malfunctions reporting cards [4].;
- ✓ monthly analyses;
- ✓ aircraft accident precondition reports;
- ✓ complaint reports [5].;
- ✓ lists of defects found during repairs [6].

The information gathered using the malfunctions report cards appears to be indispensable material for answering the following questions:

- which engine units and components are the least reliable under service conditions;
- which engine units and components operate reliably in service;
- what is the average life to failure of the different units and components.

The systematic data on the malfunctions of the products is in itself information on their overall technical condition. The systematisation of information is not an end in itself, but serves at all stages as a means of providing designers, production and operation with the necessary reliable data onsuccessful implementation of measures to increase the level of reliability of aircraft engines. This calls for serious attention to be paid to the issues of statistical data collection and processing. It is necessary to know that even if statistical data are processed with the most modern methods and means, the results will be unreliable if the primary information is not reliable.

In view of the particular importance of timely and accurate collection and processing of information, it is necessary:

- constant control of filling in information in malfunction reporting cards and expanding the possibilities for processing the information contained in them;
- the elimination of subjectivity in reflecting faults in malfunction reporting cards.

To obtain the necessary reliable information for the analysis, not only the statistical information on the parameters taken from the control means but also the malfunction report cards shall be used.For the analysis of the most typical malfunctions, data on AI-25TL engines operated in the Air Force for the period 1990 - 2020 are used.

The classification of the malfunctionswas performed based on the classification shown in Fig. 1.

Gradual malfunctions are accompanied by a gradual change in parameters and are mainly related to ageing and wear of materials. They are important in assessing and predicting changes in the reliability of products.

Their dependence on external loads and on the properties of the materials used is more pronounced compared to sudden malfunctions [1].

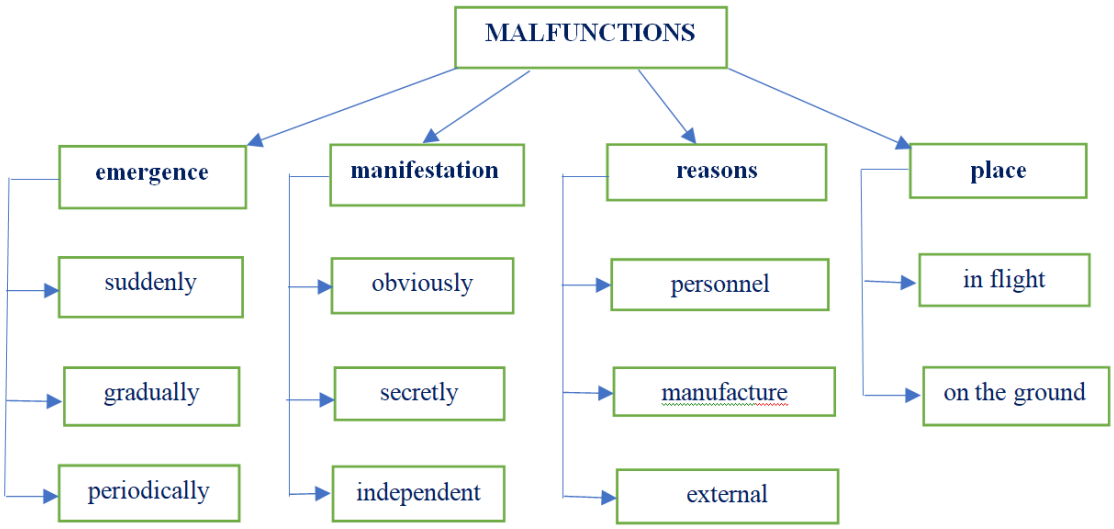

FIG.2 Classification of the malfunctions of AI-25TL gas turbine engine

Sudden malfunctions are accompanied by an accidental change in the functional parameters and technical condition of the engine assemblies. They are usually quite obvious and accompanied by pronounced signs of disruption of normal engine operation.

The main reasons for the occurrence of sudden malfunctions may be:

- manufacturing defects, the detection of which is difficult even with the most modern control methods;
- foreign objects entering the engine;;
- gross violation of flight and technical operation standards.

After processing the statistical data from the mentioned sources for collecting information about the aviation enginesmalfunctions, the results are obtained and presented in graphical form. The pie chart in Fig. 3 depict the distribution of malfunctions by the cause of their occurrence.

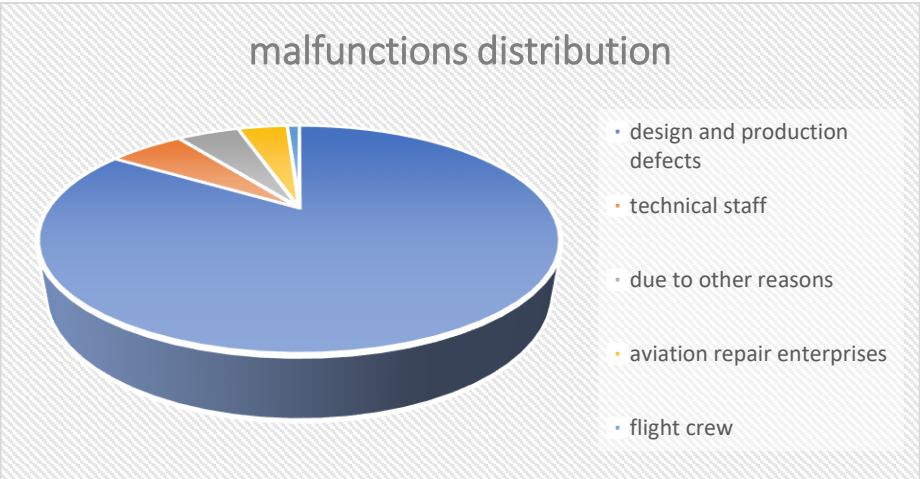

FIG. 3 Distribution of malfunctions according to their cause.

As can be seen from the figure, the largest percentage - 84%, of design and production defects. The second largest group of defects is caused by the technical staff - 6%; due to the fault of the aviation repair enterprises— 4%; for other reasons - 5%. The smallest percentage of defects - 1%, are caused by the flight crew.In order to be able to properly plan measures to increase the operational reliability of the AI-25TL gas turbine engine, it is particularly important to know the distribution of malfunctions among the individual engine units and systems.

The pie chart in Fig. 4 shows the distribution of malfunctions among the individual engine systems.

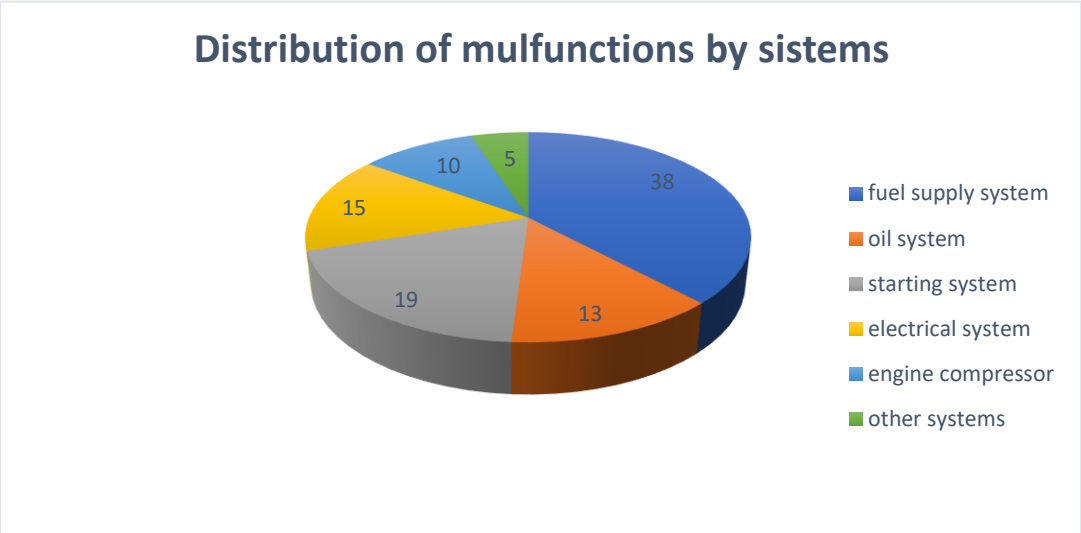

FIG.4 Distribution of malfunctionsby systems.

From Fig.4 it can be seen that the largest share is occupied by fuel supply system malfunctions- 38% . In it, the largest number of malfunctions were registered on the fuel regulator- unit 4000.

Fig.5 shows the distribution of malfunctions depending on the location of their occurrence. It can be seen that the malfunctions manifested on the ground many times exceed those in the air.

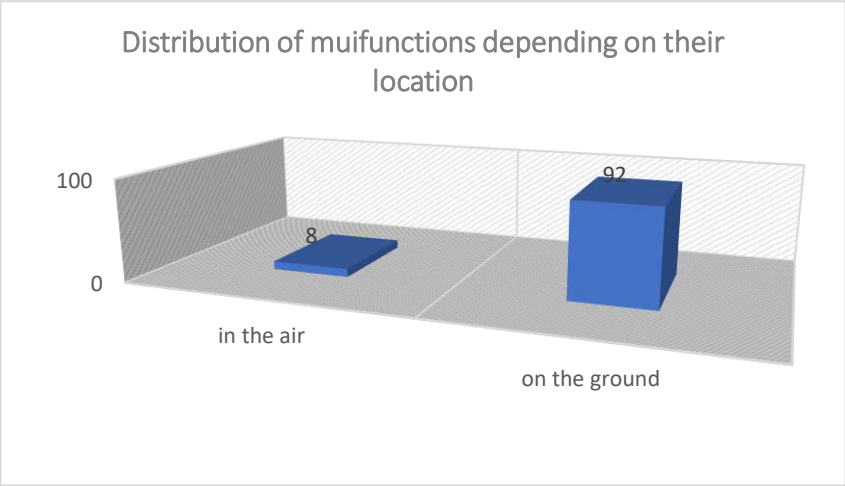

FIG. 5 Distribution of malfunctions depending on their location.

The information on the quantity and nature of the malfunctions of the aviation gas turbine engines obtained during their operation, is of great importance for the development of measures to increase their operational reliability, determination of the technical resource and improvement of the methods of technical operation. On the basis of the analysis of the malfunctions of the gas turbine engines the following main tasks are solved:

- the main directions of experimental and theoretical research on reliability improvement are determined;
- the operational reliability of the existing and commissioned aviation equipment is assessed;
- establish the regularity of change of the operational reliability of gas turbine engines, depending on the service life and storage time;
- develop measures to increase the in-service reliability of existing and entering into service aviation equipment;
- reveal the most unreliable assemblies and parts, design and manufacturing deficiencies;
- development of additions and amendments to the existing technical documentation.

Therefore, on the basis of the results of the statistical malfunctions analysis, it is concluded that the gas turbine engine AI-25TL (and its systems, respectively), like any other technical object in the process of operation, goes beyond the set norms of parameter variation. Taking into account the high requirements in terms offlight safety, it is necessary to continuously monitor the trend of the controlled parameters and not to allow them to exceed their pre-test value. The latter requirement is implemented by timely adjustment actions on the relevant units.

3. CONCLUSION

From the analysis of the malfunctions of the gas turbine engine AI-25TL, it can be seen that most of themalfunctionsoccur on the elements and aggregates of the fuel control apparatus.

For this reason, it is necessary to pay particular attention to the control of the technical condition of the elements and assemblies of the fuel automation of the gas turbine engineAI-25TL,as they are the least reliable.

It is imperative to observe the rules for the use of tools and ground support equipment and the technological frequency when carrying out maintenance and repairs in order to prevent foreign objects from entering the engine.

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