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Aircraft maintenance and repair using "Mobile complex of unified aircraft repair facilities"

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Abstract. This paper presents a projected model of aircraft Maintenance Repair and Overhaul (MRO) using "Mobile Complex of Unified Aircraft Repair Facilities" (MCARF). MRO using MCARF is part of the "Before Failure Detection" and "As Conditioned" MRO strategies. The MRO project with MCSM allows building a concept of control of the aircraft life cycle stage - operation in conditions of rapid response to current aircraft repair needs, in the presence of limitations in the required maintenance and repair facilities and the possibility of their rapid delivery.

1 Introduction

The Fixed Service Centres (FSCs) or Aircraft Repair Facilities (ARFs) used in today's reality for AC aircraft repair do not meet the current nature of some AC types of operation. With the increasing number of raids and the need to ensure continuous AC availability with specified safety and reliability characteristics, at a great distance from the FSCs and ARFs, dictates the need to optimize the AC maintenance system during the period of enhanced operation [1]

Realizing that FSCs are not able to timely and fully meet the needs of highly mobile aviation formations, under the above conditions in the necessary means of maintenance and current repair - there is a need to use in the MRO system " Mobile complex of unified aircraft repair facilities".

Existing solutions for aircraft repair at the base locations, such as mobile aircraft repair workshops on a transport base (mobile vehicle repair workshops) MVRW, consisting of either railroad cars or vehicles in which equipment is mounted, are neither sufficient nor effective for the problem described above. The limited range of transported equipment and tools allows the workshop to perform only minor and routine AC repairs. In addition, the mobile aircraft repair complexes developed in the last century are obsolete and do not meet the needs for providing aviation units with modern means of repairing the latest aircraft.

Maintaining the specified characteristics of safety, reliability and availability, aircraft (AC) with long service life when integrated into the MRO AC system MCARF with modern tools as content (automated/robotic lines, additive technologies, modern information

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monitoring and control systems, independent power supply sources, etc.) today is the absolute reality and is not difficult to implement [2,3].

2 Model and method

The overall operational structure of the aviation industry is consolidated in the form of the flow chart shown in Figure 1, identifying the process participants and typical interactions between them.

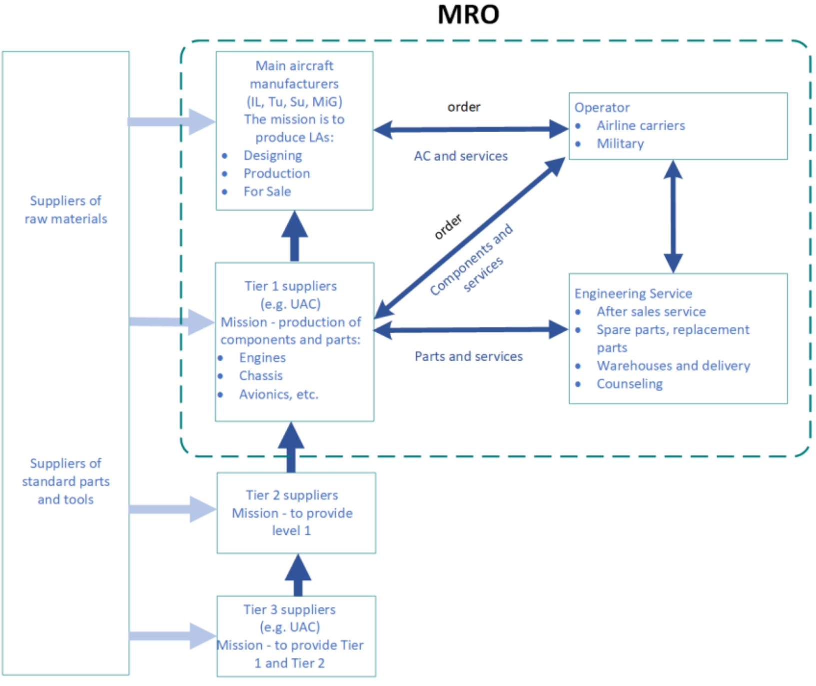

Fig. 1. AC production and maintenance model.

Given the wide geography of aircraft operations and current operational (aftermarket) realities, a more efficient MRO can be achieved by integrating into this system an MCARF that can, for repair and maintenance, produce parts locally, in a timely manner and in small quantities, needed suddenly or planned for the changing operational conditions of the product. By forming a faster yet no less reliable supply chain than the one shown in Figure 1, sitting next to the "operator" block in the diagram - and deploying rapid manufacturing next to the AC operator as a production platform in a literal sense.

The undeniable subsequent benefits from the implementation of these platforms will be reduced warehousing, simplified inventory management of parts and components, elimination of long-distance transportation and overall time costs of the supply chain, savings in financial costs for a large number of specialists accompanying these processes due to the rapid deployment of production of low-volume and unlimited nomenclature products.

To solve the problem of using MCARF in the aircraft operation and maintenance system, it is necessary to design MRO AC, using MCARF as a tool.

3 Study and results

According to GOST 18322-2016 technical condition; TC (technical state): A set of properties of the object, subject to change in the process of its production, operation, transportation and storage, characterized by the values of parameters and/or qualitative attributes established in the documentation [4].

Types of TC are: serviceable condition, operable condition, faulty condition, inoperable condition and limit state.

Schematically, the main states are presented in Figure 2.

In the diagram of the figure - data for MRO forecasting should be processed and controlled in blocks 1,2,3 maintenance and repair is carried out in blocks 5 and 4.

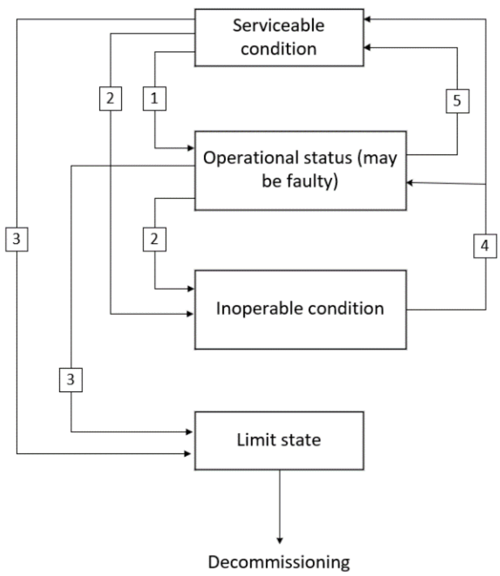

Fig. 2. Scheme of the main states of the operation object:

1-Damage, 2 - Failure, 3 - Transition to the limit state of unrecoverable destruction, 4 - Repair, 5 – Recovery

Thus, MCARF exists in blocks 4, 5 of the circuit of Fig. 2

Let's highlight the repair and maintenance tasks to be solved

Among the repair and maintenance tasks addressed by MCARF are:

- inspection of technical condition and defection of parts, assemblies and structural elements of aircraft and aircraft engines;
- repair of airframe cladding and power components;
- repair of glazing of military aircraft cabins;
- repair and replacement of gas turbine engine compressor blades;
- repair of thin-walled parts of gas turbine engines;
- repair of pipelines of liquid-gas systems of military aircraft, etc.
- repair of replacement elements and components of digital and analog, low-frequency and ultra-high-frequency radio equipment,
- antenna-feeder path repair,
- power unit repair,
- repair of cable connections, harnesses, etc.,
- repair of aviation fuel system ("AFS") devices, including fuel pumps, filters, replacement of pipe fittings, etc.,

- repair of cylinder and caisson fuel tanks,
- repair of the main elements of the chassis and the harvesting system, including replacement of pneumatics, repair of locks, shock absorber struts, brake actuators, etc.,
- repair and replacement of mechanization drives and steering surfaces, linkage brackets,
- repair of armament suspension assemblies and their systems,
- repair of the complex of life support system devices,
- repair of de-icing system components,
- etc.

On the basis of repair and maintenance tasks from the total number of types of maintenance (repair) (Qualification category of maintenance (repair), allocated by one of the distinctive features) GOST 18322-2016. we will single out as the main [4]:

2.2.4 on-site maintenance: Maintenance performed at the site where the facility is used.

2.2.20 preventive maintenance: Scheduled technical maintenance, performed at certain intervals and aimed at maintaining the operable state of the object, early detection of malfunctions and reducing the probability of failures.

2.2.21 corrective maintenance: Maintenance performed after a malfunction is detected in order to return an object to a serviceable condition.

4 From GOST R 57329-2016/EN 13306:2010, Maintenance and overhaul systems. Terms and definitions

To form a complete picture of the design and as a basis we will use the general scheme of maintenance and repair (Fig.3)

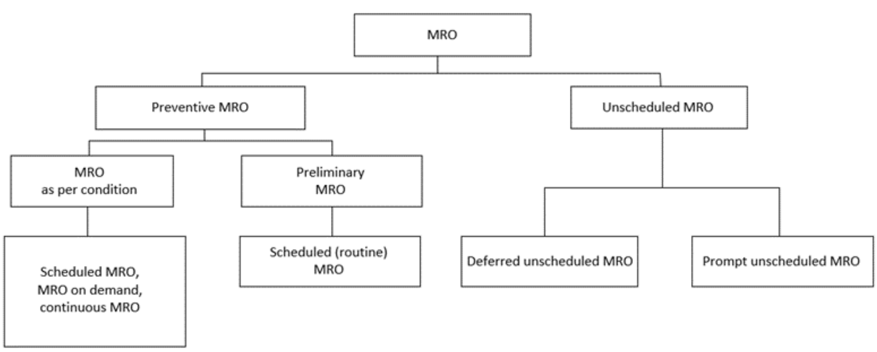

Fig. 3. Maintenance and Overhaul. General view.

From the same standard [5] description of the relative duration of maintenance and repair (Fig. 4). (Similar to the table "Operational time of maintenance (repair)" GOST 21623-76 repairability assessment indicators [6]).

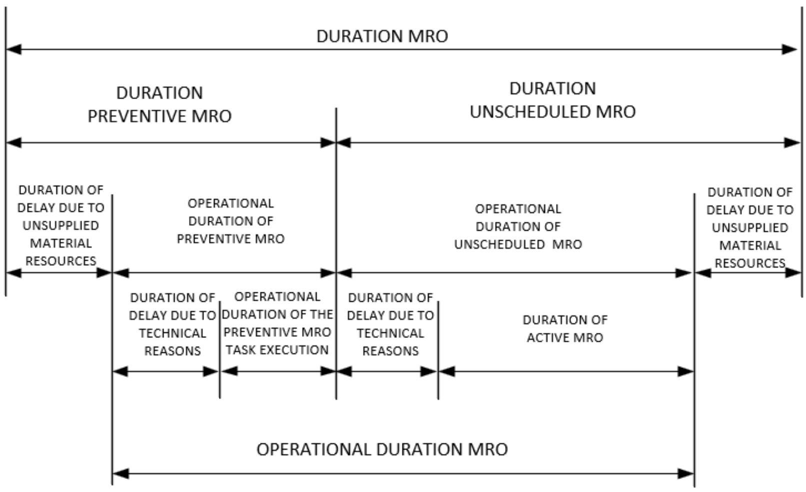

Fig. 4. Maintenance and overhaul durations.

Taking as a rule that MCARF is considered to be optimal in terms of cost and efficiency at MRO we exclude from the table - "Duration of delay due to lack of material resources" reducing the intervals "duration of preventive maintenance and overhaul", "duration of unscheduled maintenance and overhaul" and in general "duration of maintenance and overhaul" to "operational duration of maintenance and overhaul", in fact, practically equalizing their values get:

$$p\left(t_{\text{MRO.O}\gamma}\right) = \int_0^{t_{\text{T.O}\gamma}} \varphi\,(t_{\text{T.O}})dt_{MRO.\text{O}} = \frac{\gamma}{100} \qquad (1)$$

where $p\left(t_{MRO.\text{O}\gamma}\right)$ – the probability that the operational duration of maintenance of a given type will not exceed γ ;

$\varphi(t_{MRO.\text{O}})$ – probability density function of the distribution of operational duration of maintenance of a given type.

"gamma percentage of the operational duration of maintenance of a given type"[7].

for the whole interval "Duration of maintenance and overhaul".

By analogy with the previously discussed scheme (Fig.3) "Maintenance and Overhaul. General representation" let's design MRO using MCARF as a tool (Fig.5)

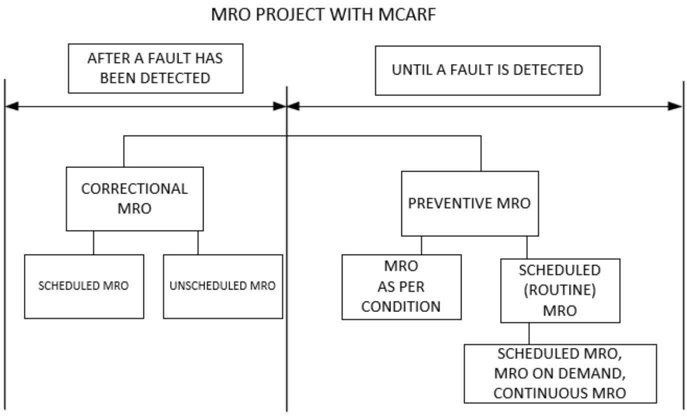

Fig. 5. MRO project with MCARF tool in maintenance and overhaul.

Based on the "rule-assumption" in the design of the MRO c MCARF model (Fig.5) - in our case, efficiency is achieved, in accordance with the main objective of the MRO system (managing the technical condition (TC) of an AC during its service life or resource, to ensure maintenance and restoration of its airworthiness and preparation for intended use, while ensuring the required levels of reliability and readiness of the AC for flight with minimum labor and cost for MRO performance), by eliminating delays due to unsupplied material resources as a consequence of higher speed and lower cost of inspection and repair work compared to the classical model[8].

5 Conclusion

Thus, we designed the possibility of MRO with MCARF.

MCARF in our case is the MRO tool for:

- preventive maintenance (preventive maintenance):
- corrective maintenance.

The application of MCARF in MRO is part of the "on-site maintenance" strategy.

MRO with MCARF allows, at the AC design stage, to build a concept for conducting an aircraft life cycle control strategy [9] under conditions of enhanced operation in different geographical locations, with no access to FSCS or aircraft repair facilities.

The next step in the study of the use of MRO with MCARF planned by the authors, the demonstration and analysis of the MCARF toolkit, the comparison of the model with traditional MRO and their evaluation, using the example of a transport aircraft.

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