МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Аерокосмічний факультет
Кафедра підтримання льотної придатності повітряних суден

ДОПУСТИТИ ДО ЗАХИСТУ

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“____”______________ 20___р.

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬО-КВАЛІФІКАЦІЙНОГО РІВНЯ
«МАГІСТР»

Тема: **«***Підвищення ефективності технічного обслуговування конструктивних елементів планера літака»*

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Київ 2021

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

NATIONAL AVIATION UNIVERSITY

Aerospace faculty
Aircraft Airworthiness Continuing Department

PERMISSION TO DEFEND

The Head of the department

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“____”________________ 2021

MASTER DEGREE THESIS

(EXPLANATORY NOTE)

Topic**:** *“Improving the efficiency of maintenance of structural elements of the airframe”*

Fulfilled by: _____________ Konovchenko A.V.

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Kyiv 2021

NATIONAL AVIATION UNIVERSITY

Faculty: *The Aerospace Faculty*

Aircraft Continuing Airworthiness Department

Educational and Qualifications degree: *Master*

The specialty: 272 «Aviation transport»

Educational-professional program «Maintenance and Repair of Aircraft and Engines»

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«____”________________ 2021

Graduation Project Assignment

Student's name: Konovchenko Artem Volodymyrovych

1. The Work (Thesis) topic: «***Improving the efficiency of maintenance of structural elements of the airframe*** *»*

   approved by the Rector's order of December 14, 2017 №594/од.
2. The Graduation Project to be performed: *October 25-2021—December 12-2021.*
3. Initial data for the project:
4. The content of the explanatory note (the list of problems to be considered):
5. The list of mandatory graphic materials:

Time and Work Schedule

Stages of Graduation Project Completion	Stages Completion Dates	Remarks
Search for and analysis of reference material	05.10.2021 – 11.10.2021	Completed
Analysis of composite materials	12.10.2021 – 16.10.2021	Completed
Preparation for conducting experiments	17.10.2021 – 24.10.2021	Completed
Conducting necessary experiments	25.10.2021 – 02.11.2021	Completed
Processing of experiments' results	03.11.2021 – 11.11.2021	Completed
Fulfillment of individual sections of degree work	12.11.2021 – 23.11.2021	Completed
Preparation of explanatory note	24.11.2021 – 12.12.2021	Completed

2. Advisers on individual sections of the work (Thesis):

Section	Adviser	Date, Signature	
		Assignment Delivered	Assignment Accepted
Labour precaution	Konovalenko V.V.		
Environmental protection	Saenko T.V.		

3. Assignment issue date ____

Graduate Project Supervisor *Smirnov Y.I.* ____________________
(supervisor signature)

Assignment is accepted for performing:

Graduate student *Konovchenko A.V.* ____________________
(graduate student's signature) (Date)

ABSTRACT

The explanatory note to master's degree work « Improving the efficiency of maintenance of structural elements of the airframe »

77 pages, 11 figures, 3 tables, 18 literature sources.

The research object - the evaluation of design, and reliability and structural integrity of aircraft airframe structure and it is components.

The research subject - the development of recommendations directed to improving the workability and maintainability of airframe.

The purpose of diploma work - the development of methods, directed on improving and simplifying of the maintainability and reliability of the airfame.

Method of research - analysis of accident investigations, which identify the causes of accidents and incidents, design defects, and statistical data analysis to provide solutions to problems identified.

The optimal essence of this diploma work is to ensure that the results is realized investigations and research has optimal value which could be applied in the practice of aviation in terms of providing quality technical exploitation efficiency of AC aiframe.

CONTENTS

LIST OF ABBREVIATIONS AND TERMS

AC- aircraft

AW- airworthiness

PTO- process of technical operations

AT- aviation technic

AOG- aircraft on ground

MEDA- maintenance error decision aid

CSC- customer support center

TP- technical personnel

GSF- ground support facilities

MSG-3- maintenance steering group 3

MRBR- maintenance review board report

MPD- maintenance planning document

AMS- approved maintenance schedule

INTRODUCTION

In the conditions of the modern world market, the process of technical operation to maintain the required level the serviceability of the aircraft fleet in airlines should be economically profitable in terms of labor, time and material costs. The solution to this problem can be achieved by planning and managing the activities of airlines in order to improve the efficiency of the process technical operation of civil aviation aircraft. Planning and implementation of activities, related to the activities of airlines to improve the reliability of aviation equipment, the safety and regularity of flights, the intensity of the use of aircraft and their efficiency the process of technical operation, requires the organization of joint work and interaction of the developer, aircraft manufacturer and operator. In this work substantiates the need to develop a technology for planning and implementing measures related to the activities of airlines, which allows, in stages, according to the activities of the developer, manufacturer and operator of aircraft, to establish the relationship and influence on the level of serviceability of the fleet, thereby increasing the efficiency of the process. Technical operation by all possible control actions. A comprehensive technology has been developed to improve the efficiency of the process of technical operation of aircraft, including measures in the areas of "Aircraft reliability", "Technology", "Personnel", "Equipment", "Materials", in order to increase the level of serviceability of the aircraft fleet. The integrated technology is presented in the form of a route technologies with an abbreviated description of the set of activities in the directions in the route map, indicating the entrances and exits at each stage. The advantages of using complex technology are shown on the example of improving one of the target indicators of the efficiency of the process of technical operation of aircraft.

Chapter 1

AIRFRAME STRUCTURES

1.1 General

The structure of the airplane (figure 1.1) is designed to provide maximum strength with minimum weight. This object has been achieved by designing alternate load paths into the structure, so that a failure of one segment cannot endanger the airplane, and also by the use of appropriately selected materials. The materials most commonly used throughout the structure are aluminum, steel and magnesium alloys. Of these the most extensively used are certain aluminum alloys, which are selected according to the particular type of load they are best suited to withstand. Aluminum and fiberglass honeycomb core material is used extensively on secondary areas of structures and many of the flight surfaces.

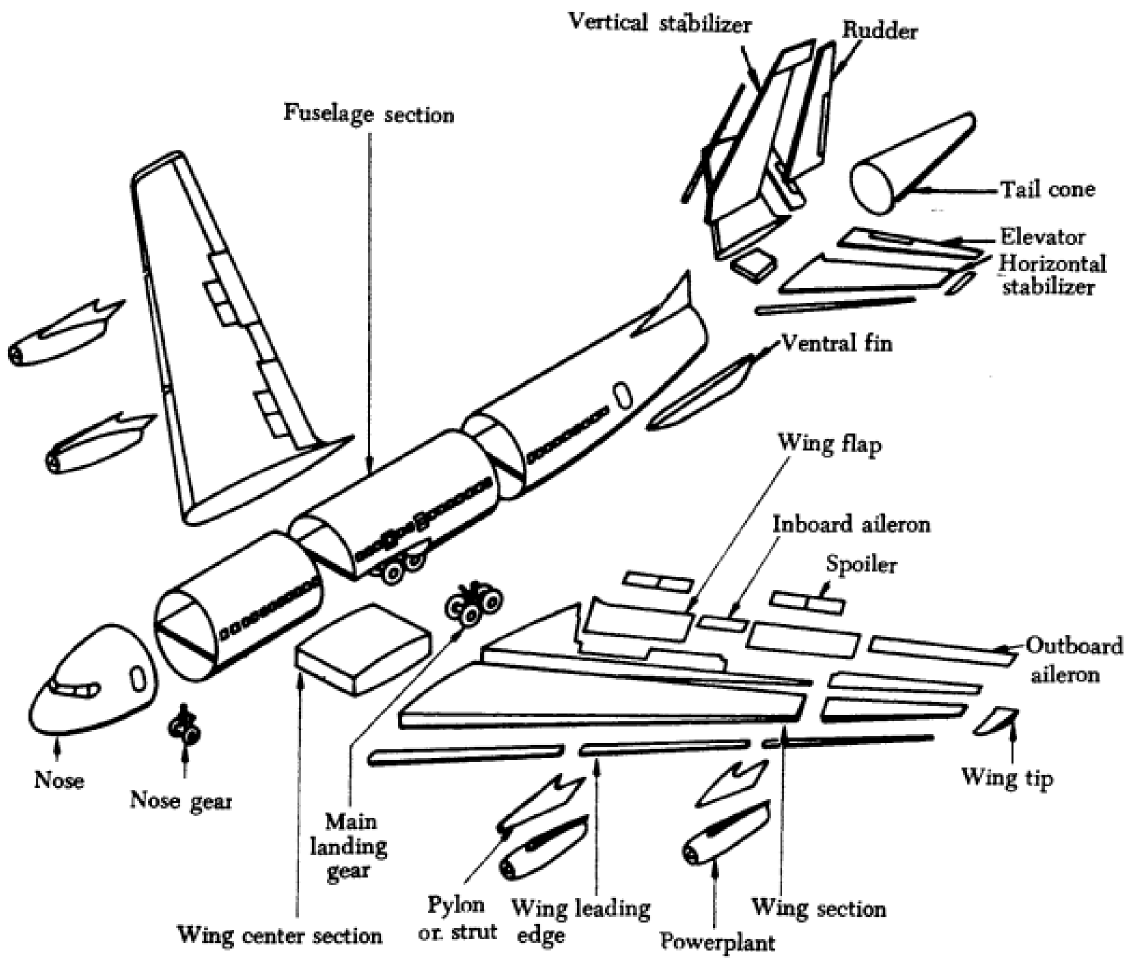


Fig. 1.1 Typical structural components of a turbine powered aircraft

1.2 Fuselage

The fuselage is the main structure or body of the fixed-wing aircraft. It provides space for cargo, controls, accessories, passengers, and other equipment. In single-engine aircraft, the fuselage houses the power plant. In multiengine aircraft, the engines may be either in the fuselage, attached to the fuselage, or suspended from the wing structure. There are two general types of fuselage construction: truss and monocoque.

1.2.1 Truss type

A truss is a rigid framework made up of members, such as beams, struts, and bars to resist deformation by applied loads. The truss-framed fuselage is generally covered with fabric. The truss-type fuselage frame is usually constructed of steel tubing welded together in such a manner that all members of the truss can carry both tension and compression loads. In some aircraft, principally the light, single engine models, truss fuselage frames may be constructed of aluminum alloy and may be riveted or bolted into one piece, with cross-bracing achieved by using solid rods or tubes.

1.2.2 Monocoque and semi-monocoque types

The **monocoque** (single shell) fuselage relies largely on the strength of the skin or covering to carry the primary loads.

The design may be divided into two classes:

1. Monocoque(Fig. 1.2.)
2. Semi-monocoque(Fig. 1.3)

Different portions of the same fuselage may belong to either of the two classes, but most modern aircraft are considered to be of semi-monocoque type construction. The true monocoque construction uses formers, frame assemblies, and bulkheads to give shape to the fuselage. The heaviest of these structural members are located at intervals to carry concentrated loads and at points where fittings are used to attach other units such as wings, power plants, and stabilizers. Since no other bracing members are present, the skin must carry the primary stresses and keep the fuselage rigid. Thus, the biggest problem involved in monocoque construction is maintaining enough strength while keeping the weight within allowable limits.

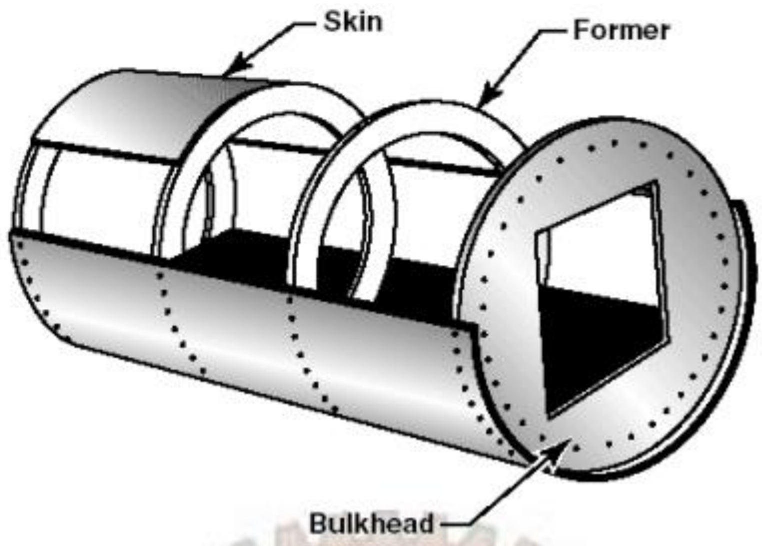


Fig. 1.2 Monocoque construction of fuselage

Semi-monocoque Type

To overcome the strength/weight problem of monocoque construction, a modification called semi-monocoque construction was developed. It also consists of frame assemblies, bulkheads, and formers as used in the monocoque design but, additionally, the skin is reinforced by longitudinal members called longerons. Longerons usually extend across several frame members and help the skin support primary bending loads.

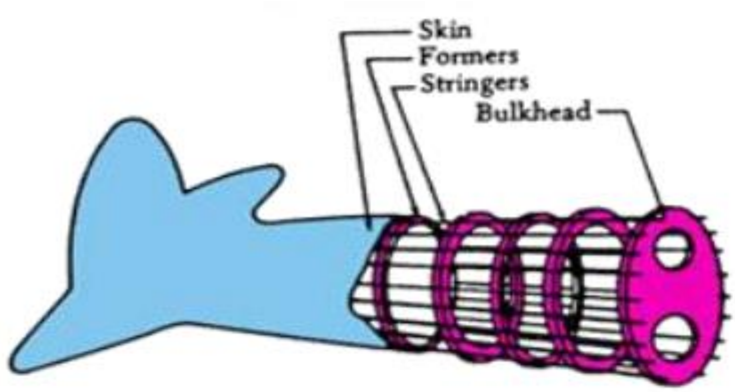


Fig.1.3 Semi-monocoque constraction of fuselage

They are typically made of aluminum alloy either of a single piece or a built-up construction. Stringers are also used in the semi-monocoque fuselage. These longitudinal members are typically more numerous and lighter in weight than the longerons. They come in a variety of shapes and are usually made from single piece aluminum alloy extrusions or formed aluminum. Stringers have some rigidity but are chiefly used for giving shape and for attachment of the skin. Stringers and longerons together prevent tension and compression from bending the fuselage.

1.3 Wing Structure

The wings of an aircraft are designed to lift it into the air. Their particular design for any given aircraft depends on a number of factors, such as size, weight, use of the aircraft, desired speed in flight and at landing, and desired rate of climb. The wings of aircraft are designated left and right, corresponding to the left and right sides of the operator when seated in the cockpit. Often wings are of full cantilever design. This means they are built so that no external bracing is needed. They are supported internally by structural members assisted by the skin of the aircraft. Other aircraft wings use external struts or wires to assist in supporting the wing and carrying the aerodynamic and landing loads. Wing support cables and struts are generally made from steel. Many struts and their attach fittings have fairings to reduce drag. Short, nearly vertical supports called jury struts are found on struts that attach to the wings a great distance from the fuselage. This serves to subdue strut movement and oscillation caused by the air flowing around the strut in flight. Figure (1.4) shows samples of wings using external bracing, also known as semi-cantilever wings. Cantilever wings built with no external bracing are also shown.

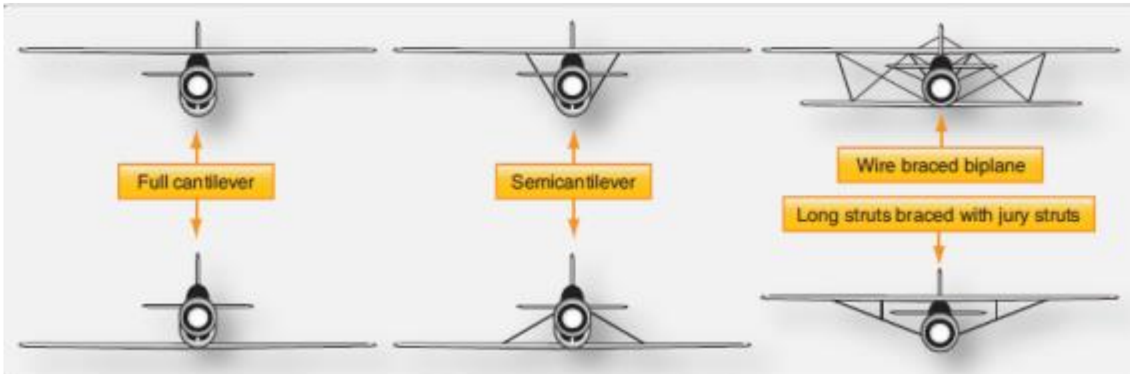


Fig. 1.4. Samples of wings

Aluminum is the most common material from which to construct wings, but they can be wood covered with fabric, and occasionally a magnesium alloy has been used. Moreover, modern aircraft are tending toward lighter and stronger materials throughout the airframe and in wing construction. Wings made entirely of carbon fiber or other composite materials exist, as well as wings made of a combination of materials for maximum strength to weight performance.

The internal structures of most wings are made up of spars and stringers running span wise and ribs and formers or bulkheads running chord wise (leading edge to trailing edge). The spars are the principle structural members of a wing. They support all distributed loads, as well as concentrated weights such as the fuselage, landing gear, and engines. The skin, which is attached to the wing structure, carries part of the loads imposed during flight. It also transfers the stresses to the wing ribs. The ribs, in turn, transfer the loads to the wing spars.

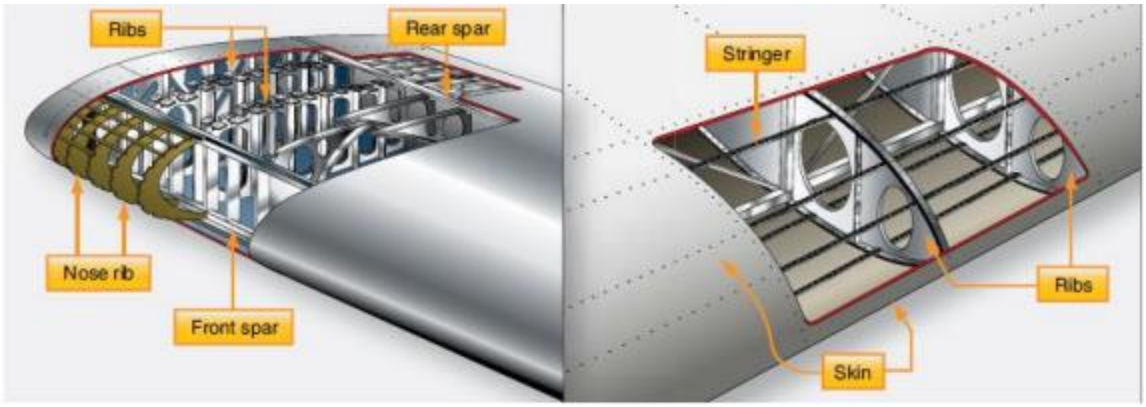


Fig. 1.5. Wing structure nomenclature

In general, wing construction is based on one of three fundamental designs:

1. Monospar
2. Multispar
3. Box beam

1.3.1 Wing Spars

Spars are the principal structural members of the wing. They correspond to the longerons of the fuselage. They run parallel to the lateral axis of the aircraft, from the fuselage toward the tip of the wing, and are usually attached to the fuselage by wing fittings, plain beams, or a truss. Spars may be made of metal, wood, or composite materials depending on the design criteria of a specific aircraft. Currently, most manufactured aircraft have wing spars made of solid extruded aluminum or aluminum extrusions riveted together to form the spar. The increased use of composites and the combining of materials should make airmen vigilant for wings spars made from a variety of materials. Figure(1.6) shows examples of metal wing spar cross-sections

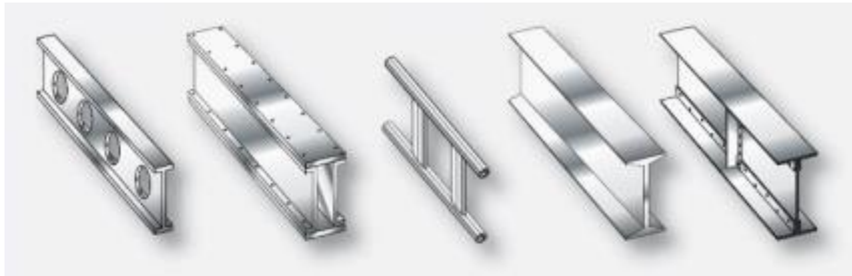


Fig. 1.6 Types of metal wing spar

1.3.2 Honeycomb construction

Honeycomb (Fig. 1.7) structures are natural or man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. The geometry of honeycomb structures can vary widely but the common feature of all such structures is an array of hollow cells formed between thin vertical walls. The cells are often columnar and hexagonal in shape. A honeycomb shaped structure provides a material with minimal density and relative high out-of-plane compression properties and out-of-plane shear properties

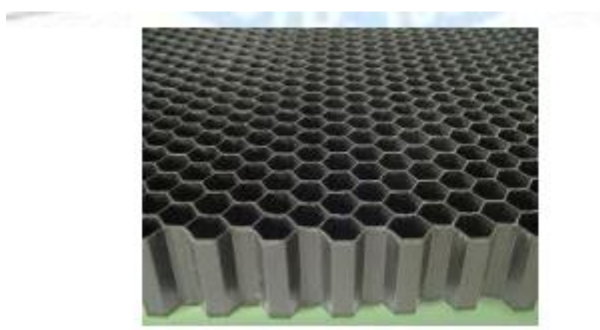


Fig. 1.7 Honeycomb construction

Man-made honeycomb structural materials are commonly made by layering a honeycomb material between two thin layers that provide strength in tension. This forms a plate-like assembly. Honeycomb materials are widely used where flat or slightly curved surfaces are needed and their high strength is valuable. They are widely used in the aerospace industry for this reason, and honeycomb materials in aluminium, fibreglass and advanced composite materials have been featured in aircraft and rockets since the 1950s. They can also be found in many other fields, from packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards. The main use of honeycomb is in structural applications. The standard hexagonal honeycomb is the basic and most common cellular honeycomb configuration.

1.3.3 Bulkheads

The bulkheads (Fig. 1.8) provide shape for the fuselage. The skin of the fuselage to bear the structural load with bulkheads at each end and forming rings at intervals to maintain the skin shape. A hybrid of truss and monocoque, in semi-monocoque construction panels of aerodynamicallycurved skin are riveted on top of an internal structure consisting of bulkheads, stringers and followers to absorb the bending forces. The monocoque design uses stressed skin to support almost all imposed loads. The true monocoque construction mainly consists of the skin, formers, and bulkheads. The formers and bulkheads provide shape for the fuselage. The semi-monocoque system uses a substructure to which the airplane´s skin is attached. The substructure, which consists of bulkheads and/or formers of various sizes and stringers, reinforces the stressed skin by taking some of the bending stress from the fuselage.

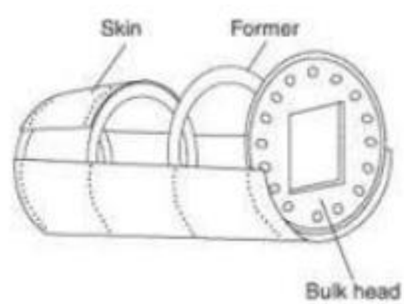


Fig. 1.8 Example of bulkhead

1.3.4 Stringers

Stringer (Fig.1.9) is a stiffening member which supports a section of the load carrying skin, to prevent buckling under compression or shear loads. Stringers keep the skin from bending. Longitudinal members are sometimes referred to as longitudinal, stringers, or stiffeners.

In aircraft construction, a stringer is a thin strip of material to which the skin of the aircraft is fastened. In the fuselage, stringers are attached to formers (also called frames) and run in the longitudinal direction of the aircraft. They are primarily responsible for transferring the aerodynamic loads acting on the skin onto the frames and formers. In the wings or horizontal stabilizer, longerons run span wise and attach between the ribs. The primary function here also is to transfer the bending loads acting on the wings onto the ribs and spar.

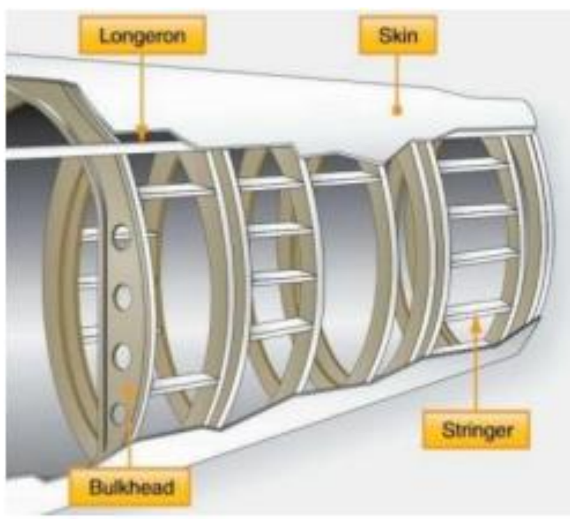


Fig. 1.9 Stringers

1.4 Empennage

Modern long-range aircraft, as a rule, have a swept tail of a classic aircraft, which has horizontal and vertical tail.

To the horizontal tail of the stabilizer and the elevator. The gimbal can try the pitch angle in flight using the control actuators.

To the vertical tail, the keel and rudder.

Note: The disadvantage of the classical scheme is the inevitable shading of the stabilizer by the forward wing at certain angles of attack, which can lead to buffetting and loss of the effectiveness of the elevator. From the point of view of flight safety, such a tail assembly cannot be called "normal".

The stabilizer can try the pitch angle in flight using the control actuators.

The stabilizer and keel consist of spars, ribs and skin. Dorsal fin is installed in front of it.

1.5 Conclusion

In this chapter, we went over all the parts of the airframe structure and what they are made of.

Chapter 2

TECHNOLOGY OF IMPROVEMENT THE PROCESS OF AIRCRAFT MAINTENANCE EFFICIENCY

2.1 Integrated technology of increasing the efficiency of the process of maintenance of airframe

The solution of the most important problem of science and technology of ensuring the efficiency of the operation of civil aviation (CA) aircraft based on the intensification of their use with the outstripping growth of the final results in comparison with the growth of costs requires constant efforts of aviation specialists to identify and rational use of production reserves.

An important place in solving this problem belongs to the units involved in the maintenance of the airframe. The end results of their work are the full and timely provision of the needs of airlines in serviceable aircraft, improving the safety and regularity of flights with a minimum investment of time, labor and funds for maintenance and repair (MRO) of the airframe. Reducing these costs is the most important task of science and production, since they constitute a significant part of operating costs.

The process of technical operation (PTO) of an airframe is a sequential change in operation states in time in accordance with the adopted strategy. The states of operation include:

- intended use,
- various types of maintenance,
- transportation,
- storage,
- waiting for receipt in each of these states, etc.

The effectiveness of airframe PTO is the most general, defining property of any purposeful activity, which is revealed through the category of the goal, is objectively expressed by the degree of goal achievement, taking into account the cost of resources and time. The indicator of efficiency of airframe PTO is a quantitative characteristic of one or several properties of the efficiency of airframe PTO .

Airframe PTO management is the development and implementation of targeted control actions on the processes (object) of the aircraft's PO, focused on maintaining the aircraft's compliance with the current requirements.

The object of efficiency management is the PTO of a fleet of aircraft of the same type of the corresponding level: industry, region, enterprise. The conditions for managing the efficiency of the aircraft fuel and power plant are implemented through the set input control actions and output parameters, as well as the appointment of methods for controlling the efficiency of the air power plant’s fuel and power components (Fig. 2.1).

The input control actions in the management of the efficiency of the PTO of the airframe are the internal reserves of time, labor and funds used to improve production in order to increase its efficiency. The output parameters are indicators of safety and regularity of flights, reliability of aviation equipment, intensity of use, cost-effectiveness of the process of their technical operation.

The interrelation of the input control actions and the output parameters is established by the aircraft technical specification model and the analytical dependences of the efficiency indicators on the reduction of the number of failures, aircraft downtime, labor and material costs for maintenance and repair.

The target approach to the management of the effectiveness of the technical operation of the airframe makes it possible to divide the general goal of the aircraft technical operation system into a number of subgoals by constructing a multi-level structure of goals. When managing efficiency at each level, its own local criterion is used, which does not contradict the global (general) criterion and corresponds to the goals of the tasks solved at the upper level. Essential in the target approach is that when forming management goals at lower levels, the general goal is already taken into account in the form of a subgoal of its level.

Efficiency management of the airframe PTO provides for the effective and systematic use of all technical, economic, organizational and social capabilities to achieve the goals of the aircraft technical operation system.

The main goal of the aircraft technical operation system is the complete and timely satisfaction of the needs for serviceable aircraft, ensuring their reliability and intensity of use for their intended purpose with minimal time, labor and funds for maintenance and repair.

To achieve the main goal of the airframe technical operation system, it is necessary to ensure the implementation of a set of interrelated main goals that determine the areas and target orientation of the activities of enterprises and their divisions to improve the efficiency of the PTO of the airframe.

The degree of achievement of the main goal of management of the aircraft fuel and energy efficiency is characterized by a system of performance indicators, which includes the following indicators:

- reliability of aviation technology and aircraft flight safety;
- regularity of aircraft departure on flights;
- the effectiveness of the use of the aircraft in time;
- efficiency of aircraft PTO .

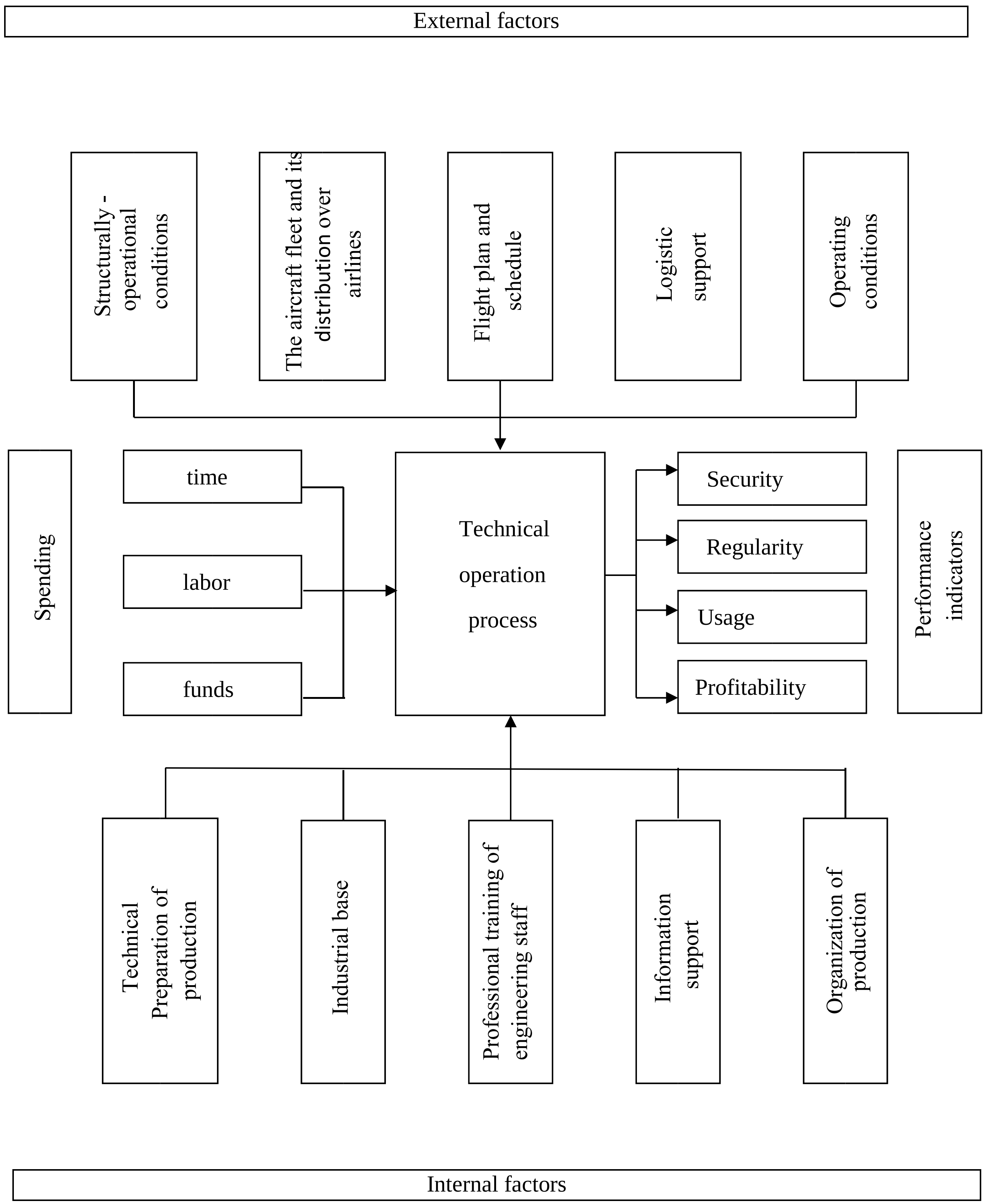


Fig. 2.1 Managed according to aircraft technical operation process efficiency

In the process of PTO of the civil aviation, a variety of measures are carried out to maintain airworthiness related to their maintenance and preparation for flights. The complex of MRO measures is conditionally subdivided into two groups: planned preventive work related to the prevention of failures and damages, the main purpose of which is to maintain a healthy state; work on the detection and elimination of sudden failures and damages, aimed at restoring the operational state of the AT.

Between these groups of works in practice, there may be different ratios, depending on the adopted criteria of optimality and strategies for prevention. But in the conditions of the modern world market, the PTO of airframe, in addition to ensuring a given level of safety and regularity of flights, should be economically profitable in terms of the time, labor and funds required to maintain the aircraft fleet in good condition. The solution to this issue can be achieved by managing the activities of airlines to improve the efficiency of the airframe operating instructions.

The effectiveness of the airframe technical equipment is the result of the airline's work to maintain the required level of flight safety, regularity of flights, intensity of use of the aircraft fleet, its serviceability and economy of operation.

2.2 BASIC PROVISIONS

During operation, aircraft equipment failures occur, leading to delays or cancellations of flights, aircraft replacements, aviation events (incidents) and aircraft downtime due to a malfunction. All this and much more leads to an increase in the time the park remains out of order.

The analysis of this information and its distribution among the aircraft systems make it possible to determine not only the most vulnerable systems, but also the aircraft components that often cause Aircraft on ground (AOG) situations.

An AOG situation is a situation when, due to technical reasons, an aircraft cannot be operated and, at the same time, is not in scheduled maintenance. There are situations such as AOG defect, AOG supply of components, AOG aircraft. These situations lead to delays, disruptions in the schedule and, as a result, losses for airlines, and above-planned downtime of aircraft, as a rule, is associated with high costs. To rebuild an aircraft, it is often necessary to replace a certain component or part. This component must be delivered as quickly as possible, and therefore, in logistics, this situation is also considered an AOG.

Based on the analysis of the array of operational data, the interrelationships of the operational manufacturability indicators and taking into account the analytical practices of the operators, the reliability indicator K, which is the number of AT failures per 1000 flight hours, was adopted as the Target performance indicator of the PTO.

Based on the analysis of statistical information provided by one of the Russian airlines operating the RRJ-95 aircraft, a system for assessing ranking priorities and forming a procedure for taking measures to reduce the K index and systematically occurring AOG situations by components was justified and selected.

Since we are dealing with a new aircraft that has been in operation for only 6 years, and given that the level of serviceability of the fleet directly affects the efficiency of the PTO, it is especially important to develop a comprehensive technology to increase the efficiency of the PTO.

Integrated technology for increasing the efficiency of PTO is a combination of technologies aimed at increasing the level of serviceability of the aircraft fleet, taking into account the influencing factors.

This integrated technology includes a route technology for increasing the efficiency of PTO, which provides for the implementation of a set of activities with an abbreviated description of them in the route map and indicating the inputs and outputs at each stage.

Each stage, prescribed in the route map, is one of the main factors affecting the serviceability of the aircraft fleet. It is possible to influence each of these factors due to certain input control actions characteristic of each factor. The output parameters, which are the result of the implementation of control actions, will be indicators of reliability of AT, flight safety, regularity of departures, intensity of use, efficiency of PTO, i.e. indicators of efficiency of PTO, by which the degree of achievement of the main goal is determined.

The essence of the integrated technology for increasing the efficiency of the airframe technical specification consists in organizing and taking into account the joint activities of the aircraft developer, manufacturer and operator, aimed at increasing the level of serviceability of the fleet. It should be noted that a number of factors, such as "Aircraft reliability", "Technology" and "Materials" are in the joint responsibility of the aircraft designer, manufacturer and operator, and a number of factors, such as "Personnel" and "Equipment", are in the zone responsibility only of the operator performing maintenance and repair of the aircraft.

The route map provides for the impact on the level of serviceability of the aircraft fleet not only due to design improvements and assembly quality that affect the reliability of the aircraft, but also due to: rational planning of work, high-quality processing of incoming requests to the Customer Support Center (CSC), correction of errors in technical documentation , availability of a sufficient number of qualified engineering and technical personnel (TP), timely satisfaction of the need and the required amount of ground support facilities (GSF) and equipment, rationing of the time spent by the aircraft in the hangar and expansion of the range of the feeding warehouse and its filling with a sufficient number of batch numbers of products in order to avoid downtime Aircraft while waiting for spare parts. These factors interact with each other, a change in one of the factors may lead to changes in others, and not always in a positive direction, therefore it is important to comprehensively consider their impact on the efficiency of the operational fuel system of the aircraft.

This technology will allow not only to improve the serviceability of the fleet, but also to take into account the economic component of the PTO of the airframe.

The efficiency of the airframe technical control system is a complex property that characterizes the work of an airline in servicing aircraft. It is divide into a number of separate properties, called "performance criteria". Each criterion corresponds to certain indicators of the effectiveness of the PTO of the aircraft.

The performance indicators of the airframe PTO is understood as a quantitative characteristic of the properties that determine its ability to ensure the fulfillment of the tasks facing the aviation enterprise. The relationship between criteria and performance indicators is as follows.

- Flight safety:

  - the number of refusals per 1000 flight hours K.

- Regularity of departures:

  - coefficient of regularity of departures.

- Use of aircraft:

  - the utilization rate of aircraft for their intended purpose;
  - the utilization rate of aircraft in flights;
  - the coefficient of the possible use of aircraft on flights.

- Serviceability of the aircraft fleet:
  - specific total downtime for MRO;
  - serviceability factor.
- Cost-effectiveness of MRO:
  - specific total labor intensity of maintenance and repair .

The target indicator of the health of the fleet is the K indicator, for which the analysis of statistical data accumulated during the operation of the RRJ-95 aircraft fleet in the airline made it possible to reveal the following dependence of the $K_{servicebility}$.

As can be seen from the graph (Fig. 2.2), the dependence is linear.

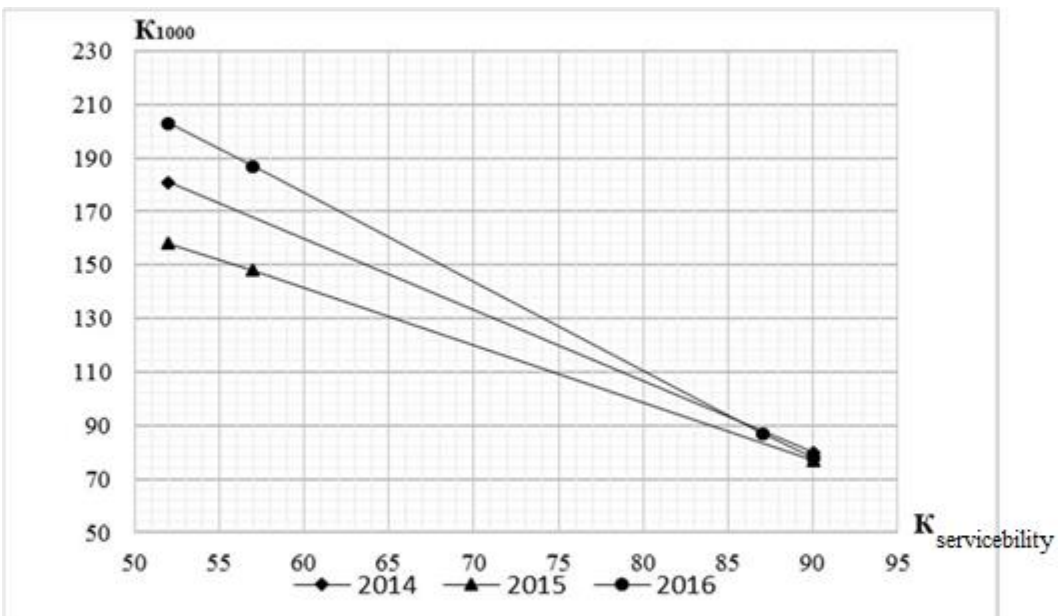


Fig. 2.2 The graph of dependence of coefficient K to $K_{servicebility}$

An improvement in each of the indicators included in dependence (2) leads to an improvement in the K indicator, which in turn leads to an increase in the health of the fleet.

As a result of the application of the developed integrated technology to increase the level of serviceability of the fleet to all aircraft systems, the range of the K indicator will reach 110–126 with an increase in the level of serviceability of the fleet to 75%, which is the minimum target indicator.

2.3 Maintenance Steering Group-3 (MSG-3)

MSG-3(Maintenance Steering Group) 'Operator/Manufacturer Scheduled Maintenance Development' is a document developed by the Airlines For America (A4A) (formerly the Air Transport Association or ATA). It aims to present a methodology to be use for developing scheduled maintenance tasks and intervals, which will be acceptable to the regulatory authorities, the operators and the manufacturers. The main idea behind this concept is to recognize the inherent reliability of aircraft systems and components, avoid unnecessary maintenance tasks and achieve increased efficiency. The underlying principles are that:

- Maintenance only effective if task applicable
- No improvement in reliability by excessive maintenance
- Needless tasks can also introduce human error
- Few complex items exhibit wear out
- Monitoring generally more effective than hard-time overhaul - Condition-based maintenance (sometimes known as CBM)
- Reliability only improved by modification
- Maintenance may not be needed if failure cheaper

MSG-3 is widely used to develop initial maintenance requirements for modern commercial aircraft which are published as a Maintenance Review Board Report (MRBR). It has two volumes (1 for fixed wing aircraft and 2 for rotorcraft), and its application will proceed alongside the Type Certification process.

MSG-1 was first published in 1968 and used for developing scheduled maintenance for B747. Subsequently MSG-2 was developed and used for developing scheduled maintenance for 1970's aircraft such as L1011 and DC-10. MSG-2 was process orientated and used a bottom-up approach. It also introduced 'condition monitored maintenance' concept.

Based on the experience and the identified weaknesses of MSG-2, the original version of MSG-3 was first published in 1980 and it introduced a top-down approach by focusing on 'consequences of failure'. MSG-3 expected the assessment of functional failures and the assignment of the consequences of those failures into two basic categories, 'SAFETY' and 'ECONOMIC'. Unlike MSG2, MSG3 is a task orientated and this eliminated the confusion associated with the different interpretations of 'Condition Monitoring', 'On-condition' and 'Hard time'. The other fundamental improvement was the recognition of 'damage tolerance rules' and the 'supplemental inspection programs'.

Since 1980, regular amendments have been made to MSG-3, the most recent in 2015 but, as yet MSG-4 has not followed. The latest version of MSG-3 introduced some elements related to Structural Health Monitoring Systems (SHMS), which was the result of issue papers published by the International Maintenance Review Board Policy Board (IMRBPB).

A so-called Industry Steering Committee (ISC) appoint specialist Maintenance Working Groups who carry out detailed analysis [using the MSG-3 process]. The latter then develop an appropriate series of maintenance tasks for ISC approval.

The Maintenance Review Board (MRB) consists of appropriate regulatory personnel to monitor development and finally approve the Initial Maintenance Program. The ISC submit the complete schedule to MRB for approval, and once approved, the MRB will approve it to as a Maintenance Planning Document (MPD).

As experience with an aircraft type accumulates, the Type Certificate Holder (or manufacturer) and the various operators will seek to develop the MPD throughout the aircraft life. This is due to the fact that the initial MPD may be conservative, and task intervals may be increased as experience is gained. Maintenance periods may also be extended as components are modified to give longer life. However, all extensions should be agreed in a controlled manner i.e. under regulatory oversight.

As a further step, the MPD will be adapted to suit a particular operator's requirements. Once it has been approved by the appropriate regulatory authority, it becomes an Approved Maintenance Schedule (AMS), but for that operator only.

The basic goal of MSG-3 is to identify maintenance tasks which are both effective and efficient in enabling a new aircraft to be designed and operated in a manner which achieves a satisfactory level of safety and reliability throughout its life. The process is applied for the following four sections:

- Systems and Powerplant (including components and APUs)
- Aircraft Structures
- Zonal Inspections
- Lightning/High Intensity Radio Frequency (L/HIRF).

Each section contains methodology and specific decision logic diagrams. Specifically, the ‘Systems & Powerplant’ section requires the identification of Maintenance Significant Items (MSI) before the application of logic diagrams to determine the maintenance tasks and intervals.

Similarly, in the ‘Aircraft Structures’ section the initial step is to divide the aircraft structure into workable areas or zones. Within these Structural Significant Items (SSIs) will be selected within which Principal Structural Elements (PSEs) can be identified. A failed PSE will be capable of causing a catastrophic effect. The remainder of the structure is referred to as Other Structure (OS).

MSG-3 again provides methods and logic diagrams which are to be used for the development of structural inspections tasks. Regulatory guidance concerning damage tolerance and the fatigue evaluation of structure is also found in (FAR/CS 25.571)

2.4 Conclusion

This chapter substantiates the need to develop an integrated technology for increasing the efficiency of the maintenance process by means of control actions in order to increase the level of serviceability of the airframe .A route map of integrated technology has been developed with an abbreviated description of a set of measures for areas of interaction and an indication of the inputs and outputs at each stage.

The advantages of using integrated technology are shown on the example of improving one of the target indicators of the efficiency of the process of maintenance of airframe - K1000.This technology will allow not only to improve the serviceability of the fleet, but also to take into account the economic component of the process of maintenance of airframe.

For the organization of joint work and interaction of the developer, manufacturer and operator of the aircraft to improve the efficiency of the operational safety equipment of the aircraft, including the level of serviceability of the aircraft fleet, it is advisable to use the proposed integrated technology for increasing the efficiency of the operating safety equipment of the aircraft.

CHAPTER 3

ANALYSIS OF FAILURES. FACTORS AFFECTING THE MAINTENANCE OF AIRFRAME, CAUSES AND DECISIONS.

3.1 Statistics of accidents analysis

Plane crashes started happening from the moment when a person rose into the air on the technical progress of the apparatus due to development. At the same time, science has never stood still, constantly improving both in production flying machines - planes, and in the passport of the reasons why the planes were sent to the ground. Some of the main factors in unsuccessful flights are traditionally called natural factors - weather conditions.

With the beginning of the era of mass air travel in the second in the mid-1940s, the number of plane crashes and the number of victims began to skyrocket. Increase reliability of aircraft and improved safety standards have led to a decrease in these indicators in the first half of the 1950s. However, the beginning of the jet era and the expansion of air transport to third world countries led to a new increase in the number of accidents, which ceased only by the mid-1960s. To that time, new, more reliable jet liners, relatively safe operation of aviation has been established in all countries the world. The annual number of plane crashes reached its peak in the mid-1970s (the largest number of deaths occurred in 1972). It was connected as with an increase in the number of air transportation, and with an increase average airliners. A new factor decline in aviation security in the 1970s became terrorism. After a series of major plane crashes a systematic tightening of standards for monitoring the condition of aircraft, their maintenance, training of crews and screening of passengers began. As a result, the average number of fatalities in plane crashes by the mid-1980s fell by more than twice. In the next decade and a half, however, it has grown again - from 1000 to 1500 people annually lost their lives as a result of plane crashes. It was due not so much to the increase in their number, how much with an increase in the average passenger capacity of airliners, the massive proliferation of wide-body aircraft.

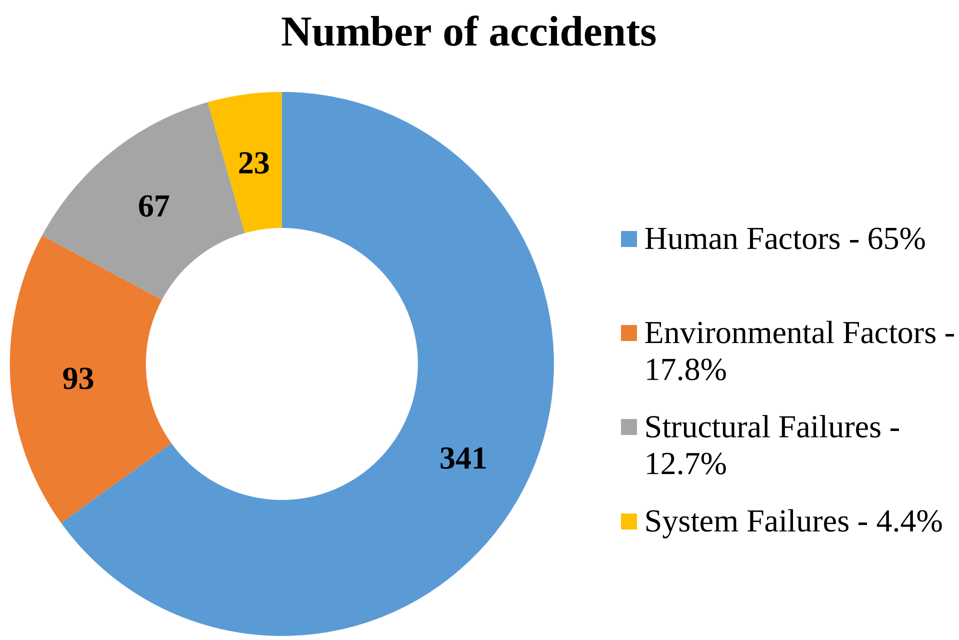
In the last decade, despite significant growth in air traffic, it has been decreasing as the number of plane crashes, and the number of people killed in them.

3.2 Dangers and accidents in aviation transport

Every year, air transport is used by more than a hundred million people around the world. The reliability and safety of aviation is constantly improving. Modern methods of protection are being introduced in case of an aircraft accident, modern methods of screening passengers and baggage at airports are used, a thorough inspection of the ship before departure and close interaction with meteorological services, the presence of clear rules and regulations for aircraft control. But, despite the fact that the protection and safety of flight in priority is given to aviation, accidents varying degrees of severity still continue take place. A small accident or inattention can lead to a plane crash and victims.

As mentioned at the beginning, there are some categories of accidents, which influencing on aviation safety. The frequency of each of the four main accident causes is shown in Diagram (3.1). The set of data includes only accidents for which a cause was released. The NTSB website contains 551 cases of aviation accidents from 1990 to 2015, whereas the causes of 524 accidents were released

Diagram (3.1) shows that 341 accidents (65% of the total accidents for which a cause was released) engaged human factor as a contributing source. Environmental factors took place in 93 (or 17.8%) of total number of accidents. Structural failure accounted for 67 accidents (or 12.7%), and system failure was involved in accidents 23 (or 4.4%) of the total. Each of these general categories is further divided into sub-categories and particularly analyzed in the next subsection.



As can be seen from the above data, at least half of aviation accidents happen due to human errors, in the overwhelming majority of cases – members crew.

Let's take a closer look at some of the reasons:

- Violation of the piloting regulations, insufficient qualification of pilots for a certain aircraft model;
- Crew errors in difficult weather conditions;
- Fatigue of crew members, problems with physical and psycho-emotional state;
- Errors of the ground dispatching service;
- Improper aircraft maintenance or lack thereof;

- A bird getting into an aircraft engine;
- Loss of control when entering a zone of high turbulence,
- Act of terrorism.

The most common type of disaster is collision with the ground in controlled flight caused by loss of attitude of the aircraft.

3.3 MODERN MAINTENANCE PROBLEMS

The basic concepts of Human Factors were describe as well as organizational and managerial factors affecting aviation safety. In particular, SHEL and Reason models are conceptual frameworks for understanding context, in which normal, healthy, qualified, experienced and well-equipped personnel perform human error, whether pilots, air traffic controllers, or maintenance technicians aircraft. Based on these structural foundations, the following is a description of some modern problems affecting the day-to-day working environment of aircraft maintenance technicians.

- **Lack of time.** Increasingly, airlines operate around the clock and especially the staff on maintenance and inspection of airframe. Competition in the aviation industry very tough and economic pressure is forcing higher usage rates aircraft and less often to change operational parts. As a result, the staff, working at the aviation technical base and engaged in the maintenance of air ships on the apron, constantly experiencing a large shortage of time to prepare aircraft for scheduled departure. Maintenance personnel an unstable balance has to be maintaine every day to ensure fulfillment of the maximum commercial coverage and fulfillment of the necessary technical service.
- **New technologies.** To stay competitive, many airlines start operating new aircraft using the latest technologies and structures made of composite materials, electronic display systems in cockpit, highly automated systems and built-in equipment diagnostic control. Maintenance and control equipment, and related

procedures have become more automated (based on the use of computers). Accordingly, currently the maintenance personnel, who has been repairing mechanical systems must adapt to computerized systems. This often means that they need to return to classroom for teaching. At the same time, many professionals need to support the level of requirements of their usual professional skills, in order to serve more old aircraft fleet. Therefore, such specialists must be able to adapt to new conditions faster than ever, and maintain the necessary knowledge and skills to the level of requirements to safely handle a mixed fleet of aircraft.

- **Aging of the aircraft fleet.** Despite the commissioning of aircraft, made using new technologies, however, many airlines operate fleets of aircraft with an average age of 20-25 years, and when this plan to exploit them indefinitely. As such airy ships, they begin to require more attention in terms of maintenance and conducting thorough checks to detect signs of material fatigue and structural elements, corrosion and general wear. For inspectors, conducting technical checks when it is necessary to inspect each rivet and in inconvenient hard-to-reach places, this work becomes tedious and monotonous. Considering what there may be consequences of not detecting often subtle signs associated with As they age, this work can also be stressful for them. Several incidents with aircraft that have recently taken place have highlighted problems related to the wiring (abrasion of the wires in the harnesses), which creates the danger of fire in flight.
- **Lack of feedback.** Unlike pilots and air traffic controllers, even diligent aircraft maintenance technicians may often be unaware of what they have created a serious threat to flight safety. The mistakes they make in their work can for months to remain unnoticed and not to make themselves felt. Even if it happened an aircraft accident, possibly in a few months or years, nevertheless, they have there is little reason to consider their actions as reasons for creating dangerous conditions that have become a factor in the accident. For example, when in 1989

on a DC-10 flying near Sioux City, Iowa, destruction of the disk in the engine, presumably a failure in the inspection procedure took place seventeen months before this incident.

- **The main thing is to "fix it."** Aircraft maintenance technician first pays attention to ensuring the airworthiness and serviceability of specific components in in accordance with the deadlines. He pays less attention to providing systemic health of the aircraft, not to mention the organization for the technical service in general. This can be demonstrated with the following example: a technician, aircraft maintenance, forgot to install the anti-vibration clip on a hydraulic drive attached to the engine, and after a few months this hydraulic drive collapsed as a result of fatigue stresses, which led to the failure of the hydraulic system in flight. Later, another technician served the same aircraft, but on a different aviation technical base, and, having discovered this error, replaced the failed hydraulic drive and install the desired anti-vibration clamp. This issue was as expected registered by him as "no clamp", but no action was taken with the purpose of determining why the first technician did not install the clamp, or, more importantly, why the maintenance organization was unable to locate this omission.
- **Causal Analysis.** Often, there are not enough in-depth analyzes of the role of human a factor in making mistakes in the process of aircraft maintenance. After flight crew-related incidents are recorded much more information than "procedural errors". For example, information about specific disruptions in action, such as a hasty approach, incorrect crew response, poor crew coordination or incomplete feedback dispatching clearance. Except for major aviation accidents, when the causal factors of specific errors in the maintenance process can be recreated, errors in the maintenance process are most often combined under the heading "maintenance or inspection omissions". Such approach to human error in aircraft maintenance in significantly limited the ability of

maintenance organizations identify and mitigate the impact of organizational practices that promote creating and maintaining hazardous conditions.

- **Expansion and merger.** Deregulation in the aviation industry has caused significant reorganize some airlines at least. Many airlines are rapidly expanding in in order to meet the needs of new markets, other expansions have taken place in as a result of corporate mergers, sometimes associated with taking control of bankrupt airlines. The resulting corporate pressures in forms such as dismissal of personnel, transfer of employees to other places, lack of specialists certain qualifications and a chaotic corporate climate, merging seniority lists and conflicting organizational goals have added stress to maintenance and inspection personnel.
- **Subcontracting relationship.** One of the most common organizational changes, carried out as a result of deregulation, is to transfer the implementation of many maintenance functions to subcontractors. By itself, this is not always dangerous. practice, if all necessary protective measures are taken to ensure that quality the work performed by them met the safety requirements. But quite often this is not the case. Unqualified personnel working without proper supervision, and poor quality control often create conditions that can easily provoke airworthiness problems.

3.4 GENERAL ASPECTS AFFECTING HUMAN PERFORMANCE CHARACTERISTICS, IN THE PROCESS OF MAINTENANCE OF AIRFRAME

3.4.1 Introduction

According to world statistics, in aviation, two out of every three flight accidents occur through the fault of the so-called "Human factor". The role of the "human factor" also increases during maintenance and repair complex aviation technology. From work efficiency aviation maintenance specialists depend not only safety and regularity of flights, but also economic indicators of operational enterprises due to unproductive downtime of aircraft during their maintenance, control, replacement, repair products and systems of aircraft.

Of the total time for maintenance, when manual method of checking, approximately 87% of the time is to identify malfunctions of systems, assembly, unit, parts and only 13% - to eliminate them. According to research from 25 to 35% of flight accidents and incidents in civil aviation over the past 20 years occur through the fault of the aviation engineering service in mainly due to poor quality of maintenance.

According to American data, out of the total number of refusals ground electronic computing 30% accounted for the share of maintenance personnel due to insufficient qualifications . In general, human errors can be divided into four categories :

- failure to perform the required action;
- inaccurate performance of the required action;
- execution of an unrequired action;
- untimely execution of the required action.

However, when analyzing human errors, a number of additional difficulties that are generated untimely detection by a person of his mistake and its elimination, permissible errors for the considered operating conditions of the system, the difficulty of establishing them the root cause, etc.

3.4.2 Aircraft design and configuration

Aircraft design and configuration is always a compromise of many competing needs. Accessibility for inspection or repair, which is very important for technical service, is often sacrificed to the performance of the aircraft or aircraft commercial download. The aircraft maintenance technician should, at a minimum, be able to reach the part and remove it using normal force, and then replace it while observing the correct orientation. Differences between aircraft types can be causal factors in error technicians, if such differences in configurations require performing technical tasks maintenance in a different way than usual, or working with slightly different parts. Besides, correct part design requires feedback to assist the maintenance technician understand that the operation is being performed correctly, and therefore differences in such feedback may also lead to errors. For example, a service technician might get used to the latching effect of some specific electrical connector, which serves as a feedback that the installation is correct, and in the same time it may overtighten an electrical connector that does not have such a device.

3.4.3 Working conditions

The pilots work in relatively constant comfortable conditions. The same way ATC controllers operate in relatively constant physical conditions. Working conditions for a technician aircraft services are extremely diverse. Three different collections can be defined environmental conditions:

- **Maintenance on the apron.** Serving aircraft on the apron, a technician works in conditions constantly changing in a wide range of temperature, noise, wind, visibility, general lighting and moisture that makes work surfaces slippery. In addition, the necessary tools, auxiliary equipment are not always readily available. and materials. Already only these factors affect the physical condition (and possibly on health) of aircraft maintenance technicians, and accordingly they contribute to creating conditions that cause errors during maintenance.

- **Maintenance workshop.** Working conditions in technical workshops maintenance, for example in an electrical repair shop and tire workshop, much more stable than on the platform. Not so fast and not in this range changes in temperature, noise, lighting level, air quality and almost always the necessary tools and materials are at hand than when performing work on street, and therefore reduces the potential for these factors to facilitate errors in the maintenance process. Undoubtedly, working conditions in a workshop for the repair of avionics can be equate to working in an air-conditioned cab.
- **Maintenance hangar.** Many types of maintenance aircraft are carried out in the peculiar conditions of large aircraft hangars. High ceilings make it difficult to properly light the room, and large open doors make it very problematic to control temperature, humidity and drafts. That's why working conditions in the hangar takes an intermediate place between the conditions of the technical service on the apron and conditions in the maintenance workshop.

The likelihood of making mistakes during the maintenance process is directly related to with these working conditions. None of them are immune to errors in the maintenance process, and it cannot be said that they can equally contribute to errors and serve as the same causal factors. Each of them must be carefully considere when planning workplaces and definition of tasks and it is necessary to proceed from the typical working conditions to perform a certain type of maintenance.

3.4.4 Work schedules and shift work

As noted above, airlines operate flights around the clock and often under large pressure due to lack of time. Aircraft maintenance organizations should provide services for such flights. Accordingly, aircraft maintenance technicians are often work in shifts, as a result of which they experience the same disturbance in the natural rhythms of their organisms, like flight crew members, crossing several time zones in one night.

For technicians working night shifts, the issue of fatigue can be very serious. As it turned out, in as a result of recent studies, 75% of people working at night experience drowsiness during the night shift and of these, about 20% reported that they fell asleep during the night shift. It is not simple coincidence that many of the major accidents (including accidents, maintenance-related) have occurred for reasons that were caused by mistakes made early in the morning.

The work schedule may also worsen the effects of such diurnal arrhythmias, or vice versa may reduce some of the natural stresses associated with altered sleep cycles. The carried out research suggests that rolling shift schedules should be planned in such a way that provide a longer biological day, that is, rotation of shifts should be carried out, focusing to later shifts, not earlier. However, those involved in scheduling work, are regularly faced with a situation where employees want a schedule that allows them optimize your free time, even if such a work schedule will disrupt their cyclicality more. This is not to say that the issue of shift work is often included in the agenda of managers, despite the fact that that this could potentially cause serious errors in the maintenance process, often performed by tired technicians.

3.4.5 Automation

An important factor in changing the nature of the work of airframe maintenance technicians is that the process of automation and computerization of their work is accelerating. More and more processes, operations and decisions are made using computers and modern technical systems, or even controlled by them. Their application goes well beyond design and training with computers. Increasingly, computerized systems are used in almost all areas information management, including scheduling, reporting, monitoring tools and material expenditures, access to available information, etc. Most aircraft manufacturers have or are developing electronic versions of their manuals for maintenance. Technicians can get the latest information directly from video terminals installed at maintenance sites. Using a video terminal, located near the aircraft, the technician can easily access the entire manual maintenance, all airworthiness directives, service bulletins, flow charts and specialized procedures for the inspection of this aircraft.

Airframe maintenance technicians spend a lot of time on filling out the documentation. However, nowadays, more and more often, accounting documentation can be kept neat (and legibly) with the help of computerized systems, which improves access to them for intercessors duty of shifts and, if necessary, with their help it is easy to get the required additional information for reference.

Many new generation aircraft are equipped with built-in diagnostic systems, allowing to monitor the state of onboard equipment. On these aircraft, if equipment failure in flight, this information is automatically recorded and stored, and then telemetrically transmitted to the aircraft maintenance service by the built-in diagnostic equipment without any action by the flight crew. Immediately after landing the aircraft service technicians can be ready to service it with the necessary tools and materials to quickly return the aircraft to service.

All modern automated systems for airframe maintenance must be designed taking into account the capabilities and limitations of service technicians and their working conditions. In addition, specialized training needs to be organized so that service technicians aircraft could acquire and maintain the required skills to perform and safely operate new technical means, since in another case automation will create new problems, and there will be additional factors that can potentially provoke errors during the technical service.

3.4.6 Technical knowledge and skills

Airframe maintenance technicians must acquire a variety of knowledge and skills, sometimes called abilities. Continuous improvement and complication of systems aircraft and special test equipment for maintenance requires deepening the knowledge of technicians and at the same time mastering new physical skills, which is often requires high dexterity.

Technical knowledge refers to the understanding of a large amount of information that directly related to the performance of maintenance or inspection work. Technicians it is necessary to master three categories of knowledge, namely:

- **Knowledge of the airline's manufacturing process.** By this we mean the processes and the practice of the airline or repair shop where the service technician works, such as shift handover procedures, part marking requirement and to the registration of the work performed.
- **Knowledge of the design of the aircraft and its systems.** By this we mean the physical structure of the aircraft, its systems and equipment. For example, location and operation of hydraulic pumps, recovery options corroded or worn parts.
- **Knowledge of the procedure for performing maintenance work.** Under this there are in kind of specific knowledge that is necessary to perform individual work on maintenance, such as bleeding the hydraulic system.

Technical skills are related to tasks or subtasks that a maintenance technician aircraft must be able to perform without resorting to the use of other information, such as installing a retaining wire ring, using torque wrenches, or dismantling of standard parts.

While some technical knowledge and skills can be learned in the workplace, it is not less in most cases essential for mastering basic knowledge and qualifications have formal training programs.

3.4.7 Education

The root causes of many mistakes made by airframe maintenance technicians are lie in insufficient or inadequate preparation. Maintenance work require a combination of deep knowledge, the ability to intelligently process data and the ability to do well do it by hand, so maintenance training is designed to help you effective assimilation of the required knowledge, and the development of skills to perform professional duties in in accordance with established procedures. It is not surprising that in the countries of the world various teaching methods, both in initial training courses and in refresher courses for technicians in maintenance of aircraft. In the framework of some programs, the candidate is trained in a very structured program in the classroom, and then additionally undergoes practical training in basic types of aircraft. Trainees trained in such programs need additional training, especially in practical internship, before they are ready to perform work on maintenance on large commercial aircraft in a competitive environment airlines. In some states, such training programs are organized according to the principle of apprenticeship, when a future technician as an apprentice works with a qualified air maintenance technician ships for several years. Those who graduate from such programs may have practiced skills in their area of specialization, however, they often lack the theoretical knowledge they need to solving complex problems.

For the most part, training of airframe maintenance technicians is carried out in the form of work placements. This internship has many positive aspects. One of them is that trainees can acquire qualifications by performing many of their professional duties by observing the actions of highly qualified technicians performing such duties in real production conditions. Another possibility is to learn one-on-one with mentor. Unfortunately, all too often a workplace internship mentor, being highly qualified as a technician, may not have been trained as an instructor (and may not be interested in such training). On-the-job internship programs are quite often not structured, do not transfer the necessary theoretical knowledge and do not have the proper systems for evaluating the effectiveness of training or validating training programs, including effectiveness instructor.

Regardless of the approach chosen for training aircraft maintenance technicians, an effective training program should include:

- detailed analysis of professional responsibilities to be performed;
- clearly defined learning objectives and performance performance standards, set out in a progressive sequence of feasible learning units, defined taking into account the capabilities and limitations of the trainees, whose training will be be carried out;
- instructors selected based on their technical qualifications and teaching experience;
- formal teaching and assessment of knowledge and critical elements;
- structured practice of gradual mastery of skills under the supervision of instructors trained in the teaching method;
- further evaluation and validation of the curriculum.

3.4.8 Information transfer and communication

The transfer of information and communication are human factors that have critical in the maintenance of airframe. If you do not provide an exchange information between maintenance managers, their personnel, manufacturers, dispatchers, pilots and the public, government and other organizations, it will be difficult maintain security standards at the level of requirements. There are a huge number of information to be collected, registered, stored, retrieved, transmitted, be compared and applied to maintain aircraft airworthiness.

Maintenance communication is highly vulnerable to four errors main categories of communications:

- **Reading.** Content of technical documentation, including technical manual maintenance, schematic diagrams, operational bulletins and technological maps should be written in a language and format that would targeted at inspectors and aircraft maintenance technicians in all parts of the world who are engaged in performing routine maintenance work aircraft, as well as diagnostics and repair of aircraft. Mostly such documentation may be provided in a language that is not the native language of the technicians for service.
- **Ability to speak.** Senior and line managers of the service maintenance and aircraft maintenance technicians should be are able to accurately represent verbally detailed technical information both upward, and down the hierarchical ladder and provide a high level of understanding. It may require the speaking professional to accurately translate what is written in the language original technical documentation in the native language of the audience.
- **Listening skills.** Senior and middle managers of the technical service aircraft servicing and maintenance technicians must have effective listening skills to accurately assimilate detailed technical information. Partially this understanding

of spoken language can be achieved through the use of the mother tongue listeners.

- **Ability to write.** Senior and mid-level maintenance managers must be able to give precise written instructions to service technicians aircraft. In addition, aircraft maintenance technicians must be are able to keep accurate records of technical inconsistencies, work performed, etc.

At every stage of the communication process, there is a high probability that there will be no an understanding is reached that is necessary to ensure safety.

Communication problems can also arise due to manufacturer's documentation, on-board systems and maintenance procedures. A huge challenge for the manufacturer is to provide all the necessary documentation written in a simple and understandable way for all technicians the world's language, most of which do not speak the manufacturer's primary language. Anecdotal is the case where a specific procedure, that is, it was meant that it is prohibited. It is quite clear that the technician, after reading this, considered that this is a typographical error and that this word means the word "prescribed (prescribed)", that is, that it denotes the correct procedure to be follow.

The civil aviation authority also faces communication challenges. Maintenance-related regulations must be clearly presented and maintained their compliance with the requirements, and actions to ensure compliance with the rules of maintenance and safety program provisions must be credible and communicated to the entire aviation community to serve as a preventive measure as much as possible. Plenipotentiary the regulator and its inspectors can become the point of contact for manufacturers and airlines in with regard to the interpretation of changes, as necessary, of the manufacturer's directives, taking into account attention to local operating conditions.

3.4.9 Well-coordinated group work

As aircraft become more sophisticated, the importance of well-coordinated work of a group of airframe maintenance technicians. Simultaneously technical maintenance of aircraft requires an increasingly narrow specialization of technicians who need to know new the materials from which the aircraft are made, the systems installed on them and, increasingly computerized systems. However, paradoxically, there is now a tendency to create independent departments of technical specialists, which gives them the status of self-sufficient functional divisions. Quite often, this leads to disruption of communication and undermines well-coordinated work. Technicians, which is so necessary to combine aircraft maintenance technicians into one a coherent operating and efficient unit. Accident reports include many examples of interruptions in communication between technicians and / or between work shifts, when safety critical information has not been communicate or understood.

Within the organizational structures of self-sufficient functional units technicians are assumed to have the same skills. Centralized authority maintenance distributes them as the need arises. Quite often this the maintenance body misunderstands work order requirements and directs them to performance of technicians who come to the place of service, lack of understanding of the requirements for the work assignment, and often bring the wrong tools with them, etc. Observations from several services international maintenance operators indicate that they have a separate reporting line and a limited number of general goals. The efficiency of individual technicians is encouraged, rather than the efficiency of group work. As a result of this technique cease to identify with the group, and they may develop an indifference to their responsibilities if individual technicians feel that their diligence is useless due to poor performance the work of other members of the group. Typically, in such organizations, technicians are blamed for their mistakes, disciplinary action is taken to punish violators and little is done to determine and eliminate systemic organizational deficiencies that threaten flight safety.

Due to the fact that many maintenance work is very complex, it requires different specialized skills and their implementation requires more than one shift, managers maintenance services must coordinate the work of different specialists in different brigades. Coordination of the work of different specialists in different shifts, while ensuring compliance established procedures remains a very difficult task for the heads of technical services maintenance of aircraft.

Taking into account the accumulated experience on a global scale in optimizing management resources in flight deck management (CRM) to improve the coherence of flight crews, some airlines are now providing CRM-like training for their technicians in the maintenance organization. This training, similar to that of flight crew members, focuses on communication, leadership, confidence in action, decision making and stress management, that is, all those skills that are vital to the effective work of the team. V unlike flight crews, who work collectively and side by side, maintenance technicians aircraft can perform many seemingly unrelated tasks in different locations a large hangar. However, organizations that have prioritized the brigade principle tend to unite different specialists into coordinated operational teams. Individual software technicians servicing aircraft, a sense of belonging to the crew is formed when they are treated as with key specialists, and not as with nameless bipods. At least one airline reported that after specialized training of service technician teams, she some performance indicators improved, namely the number of scheduled flights and decreased number of work-related injuries. Now this type of preparation has begun to be called resource optimization when maintenance (MRM). However, caution should be exercised with regard to MRM. Preparation CRM is very contextual in nature and it is also relevant for MRM training. To programs MRM training has been effective and must take into account local culture. It is completely unacceptable to simply adapt existing programs. An important element an effective MRM training program is an assessment of how human factors can affect performance characteristics and, accordingly, flight safety.

MRM training closely is associated with the development of a corporate culture for ensuring flight safety, including a system reporting incidents and errors, which is important to better understand the hidden causal factors of human error.

3.4.10 MAINTENANCE ERROR MANAGEMENT

Increasingly, airframe maintenance professionals recognize that maintenance errors are inevitable and widespread. Currently the main attention is paid to how best to manage such errors. Actions are taken with a goal like to reduce the number of such mistakes, and to mitigate the consequences of those that continue to be committed. Maintenance errors include both human errors and system errors such as as insufficient staffing, lack of the necessary tools and materials.

Many States have mandatory reporting systems in place accidents where accident data are systematically collected and serious incidents. Voluntary or confidential reporting systems used by some other States (and some operators) are also effective data collection tools that allow you to understand why certain mistakes are made. At present time, some States and operators are implementing programs that use the lessons learned retrieved from the investigation of errors committed during the maintenance process. Such programs are design to identify the causative factors of maintenance errors in order to make the system more robust against such errors. In one of the states, a system was create maintenance error managements (MEMS) to identify the most commonly used industry practices that should be applied in such programs, for example:

- clearly defined goals and objectives;
- clearly defined requirements to demonstrate corporate readiness to fulfill responsibilities within the MEMS;
- encouraging and participating in consolidated incident reporting the process of all employees;

- a well-defined policy of disciplinary action and its boundaries;
- the procedure for the investigation of incidents;
- criteria for initiating investigations;
- training of investigators;
- training personnel on MEMS as required;
- appropriate follow-up to findings from investigations;
- familiarization of employees with the results of actions taken;
- analysis of all collected data in order to determine the trends of changes in contributing factors.

Boeing has developed a systematic analysis tool for airlines, contributing to errors in the maintenance process. This tool called The Maintenance Error Decision Aid (MEDA) is based on the following prerequisites: aircraft maintenance technicians do not deliberately make mistakes. Most maintenance errors are caused by a number of contributing factors; as many contributing factors are part of day-to-day operations airlines, then they can be controlled. Therefore MEDA is the first line of control as proposes a structured method for analyzing the tracking of contributors to errors in maintenance process, and recommends error prevention strategies.

Boeing has advised that MEDA can reduce the number of departure delays and facilitate the replacement of the organizational structure of the respective operators culture that punishes employees who do not fully comply with the established procedures, on the organizational culture, within which attempts are made to understand why this is happening.

Experience has shown that States and operators that carry out maintenance error management programs (and possibly using a tool like MEDA) are much more effective in developing and implementing an error reduction strategy, maintenance-related and / or mitigation. It is assumed that such programs will be effective if:

- a clear distinction is made between mistakes made in normal conditions of performing assigned tasks and mistakes made due to negligence or negligence (which deserves disciplinary action);
- working conditions were created without searching for the culprit (this requires the establishment of an atmosphere of mutual respect between employees and managers);
- there is open communication between employees and managers;
- a corporate culture of error tolerance has been created.

3.4.11 MAINTENANCE SAFETY CULTURE

As noted, there are a number of errors and hazardous conditions that are specific to maintenance. The order of work established by the management on the apron, in the hangar for maintenance or in technical workshops, is critical to ensure safety. The concept of a dedicated maintenance culture is outline below.

A safe maintenance organization rewards its employees honestly submit reports of errors made in the process of maintenance, especially those which jeopardize airworthiness in order to be able to take timely steps effective action. This requires creating a culture where staff are not afraid to report on errors to your supervisor or shop manager immediately after errors are detect. Leaders must take immediate action to determine the following:

- the exact nature of the error committed, and what actions and operations were performed at the moment when the error occurred;
- are there written instructions that include the maintenance practices that were in progress at the time the error occurred;

- any deviations from the instructions in writing that are routinely carried out by aircraft maintenance technicians and are considered the norm, why, in the circumstances, such deviations were considered necessary;
- what training was received by the staff involved in this work;
- what environmental conditions were in the workplace at the time the error occurred;
- all other justifying circumstances, for example, lack of proper management and control of the processes under investigation.

Disrupted failures should be reviewed by managers in order to reduce or eliminate systemic risks identified as a result of investigations. Leaders must demonstrate that they fair and reasonable necessary actions, and in addition, they must protect the employee who reported their mistakes from shame, shame and punishment. In this case, the actions of managers determine the level of trust in them with aircraft maintenance technicians, and this is a very important element of true safety culture. The focus of follow-up should be on the changes that needs to be done in order to strengthen the barriers in the line of defense against such mistakes, which may include retraining personnel, changing maintenance procedures, changing or improving conditions in the workplace.

Disciplinary action should only be taken in those (hopefully rare) cases when objectively the reason can be called the negligent actions of the technician. Negligence can be defined as behavior where individuals ignore the fact that their behavior is largely and without any grounds increases the risk that an accident or failure with serious consequences. Negligence manifests itself in a gross deviation from the standard norms of manifestation the discretion that a prudent aircraft maintenance technician must observe in such working conditions. Due to the fact that a negligent investigation may lead to the adoption of disciplinary measures, they should be carried out separately from those investigations, which are aimed at identifying and eliminating hidden systemic deficiencies in maintenance organizations.

3.5 Conclusions

This chapter shows how an airframe maintenance technician can create hidden hazardous conditions that may not show up for months (or even years) and then manifest itself possibly in combination with other hazardous activities or conditions, and become a possible cause a serious aircraft accident. Basic human factors concepts, including organizational, managerial and cultural factors are fully applicable to air service technicians ships. However, the responsibilities of airframe maintenance technicians in relation to repair inspection airframe are operated by them in conditions that are completely different from the conditions in which flight crews or air traffic controllers are working. Therefore, as the understanding of the impact the human factor on the performance characteristics of airframe maintenance technicians, many of the world's top safety operators are starting to develop and implement programs and tools that correspond to the truly correct safety culture.

CHAPTER 4

Labour Protection

4.1 Introduction

This qualification work affects the work of aviation personnel Aviation mechanic - a high-risk profession, which is subject to additional labor protection requirements, including special requirements for theoretical training, practical training, certification, admission to independent work, training in labor protection and periodic knowledge testing. profession and labor, safety. The work place of an aircraft mechanic has enough places that can harm a person, both mechanical and chemical.

4.2 Analysis of working conditioning

To begin with, the technician must be responsible for adhering to safety standards in the workplace. Maintenance personnel work in hangars, on racks, which requires a certain amount of physical activity associated with this activity. They can work outdoors, at any time of the day or night, season. There are potential hazards associated with working around aircraft, electricity, compressed air, hydraulic systems, hand and power tools, solvents, lubricants and other flammable substances (aviation fuel).

For maintenance and repair, tools of different types and complexity are required. There is some potential for moderate injury from the equipment, therefore correct use of tools and safety precautions must be followed. It is also necessary to wear protective clothing, goggles and face mask, special shoes.

4.2.1 Workplace organization

The maintenance hangar is designed for 4 aircraft at the same time. Total area of hangar is equal to:

$$A=a*b\ [m^2]$$

$$A=95*75=7125[m^2]$$, where a-length,b-width

In the hangar there is a warehouse with tools, a place for storing hanging equipment, equipment for working on the ground.

Hangar is equipped with ceiling lights, small windows and main gate. There is also an electrical network for connecting aircraft (220V, 50Hz), must be constant air ventilation, heating and air conditioning system.

Temperature must be 18-22 C^o, humidity must be 30-60%.

And most importantly a fire extinguisher system, both general and local (hand-held fire extinguishers)

4.2.2 The list of harmful and hazardous factors

From the standard "«Гігієнічна класифікація праці за показниками шкідливості та небезпечності факторів виробничого середовища, важкості та напруженості трудового процесу»" we can separate a list of harmful and hazardous factors for our place.

Physical factors group:

- increased or decreased air temperature in the working area
- increased noise level at the workplace(ultrasound,infrasound);
- increased vibration level;
- illumination: natural(lack or insufficiency), artificial(insufficient, direct and reflected dazzling glare).

4.2.3 Analysis of harmful and dangerous production factors

Depending on the purpose, the following types are distinguished:

- normalizing the air environment of the workplace(ventilation, air-conditioning, heating);
- protection against noise and vibration(sound insulation, vibration insulation);
- normalization of illumination of the workplace(light-source, lighting devices)

4.2.3.1 Microclimate of the workplace

Temperature is of great importance when servicing aircraft in a hangar, since at low or high temperatures, the properties of metals change, which can adversely affect the quality of maintenance.

	Optimal	Actual
Temperature, C^{o}	18-22 C^{o}	23 C^{o}
Humidity, %	35-50%	40%
Air velocity, m/sec	0.1-0.5 m/sec	0.2 m/sec

Table 4.1 Microclimate characteristics

In table 4.1 shows the climatic data to be followed according to the ICAO or local authority manual. The temperature in this facility has been slightly increased, which could lead to an error. To improve the temperature, you need to check the air conditioning system, if there are problems, fix them.

4.2.3.2 Noise level at the workplace

Noise adversely affects the human body, primarily its central nervous and cardiovascular systems. Prolonged exposure to noise reduces the acuity of hearing and vision, increases blood pressure, fatigues the central nervous system, as a result of which attention is weakened, the number of errors in the actions of the worker increases, and labor productivity decreases. Exposure to noise leads to occupational diseases and can also cause accidents. Industrial noise disrupts information communications, which leads to a decrease not only in efficiency, but also in the safety of human activities, since high noise levels interfere with hearing the warning signal of danger. In addition, noise causes normal fatigue. Under the influence of noise, the ability to concentrate, the accuracy of work related to the reception and analysis of information, and labor productivity are reduced. With constant exposure to noise, workers complain of insomnia, impaired vision, taste, digestive upset, etc. They have an increased tendency to neurosis. The energy consumption of the body when performing work in conditions of noise is higher, that is, the work turns out to be more difficult. Noise, adversely affecting a person's hearing, can cause three possible outcomes: temporarily (from a minute to several months) decrease the sensitivity to sounds of certain frequencies, cause damage to the hearing organs or instant deafness.

To combat noise in the premises, measures are taken of both technical and medical nature. The main ones are the following:

- elimination of the cause of the noise or its significant attenuation at the source itself during the development of technological processes and equipment design;
- isolation of the noise source from the environment by means of sound and vibration protection, sound and vibration absorption;
- reducing the density of sound energy in rooms, reflected from walls and ceilings;
- rational layout of premises;
- the use of personal protective equipment against noise;
- rationalization of the working regime under noise conditions;
- preventive measures of a medical nature.

The most effective way to combat noise caused by vibration from shocks, friction, mechanical forces, etc., is to improve the design of the equipment (change the technology to eliminate the shock). Reducing noise and vibration is achieved by replacing the reciprocating motion in the units of working mechanisms with a uniform rotary motion.

If it is impossible to sufficiently effectively reduce noise due to the creation of a perfect design of a particular machine, it should be localized at the place of occurrence by using sound-absorbing and sound-insulating structures and materials.

4.2.3.3 Illumination of the workplace

Workers' ability to perform various types of maintenance and inspection tasks largely depends on appropriate lighting in their work areas.

In the aviation maintenance domain, proper facility lighting is particularly important. Most scheduled maintenance is done inside a hangar during nighttime hours. The intensity of illumination is measured in lux, which is the metric equivalent of the foot-candle (ft-c). Each foot-candle is equal to about 10 lux. The level of illumination that is "adequate" depends on the type of task being performed. To give an idea of the range of "adequate" illumination, consider the following: ·

a) OSHA requires that EXIT signs be illuminated with no less than 5 ft-c (about 50 lux).

b) Difficult inspection tasks or fine bench work can require illumination of up to 500 ft-c (5000 lux).

In Fig. 4.1 shows recommendations to lighting

Lighting Levels

Lowest recommended level:	15-20 ft-c (150-200 lux)	Should be used only for infrequently used areas
Normal recommended level:	75-100 ft-c (750-1000 lux)	Adequate for many normal maintenance tasks

Fig. 4.1 Light level recommendations

To create the desired lighting in the workplace, you can use more modern lighting elements, place them evenly throughout the workplace. If the main lighting is not efficient enough, local luminaires can be used (starting with a conventional lamp and ending with mobile light stations).

4.3 Solution to prevent the effect of noise level

To combat noise in the premises, measures are taken of both technical and medical nature. The main ones are the following:

- elimination of the cause of the noise or its significant attenuation at the source itself during the development of technological processes and equipment design;
- isolation of the noise source from the environment by means of sound and vibration protection, sound and vibration absorption;
- reducing the density of sound energy in rooms, reflected from walls and ceilings;
- rational layout of premises;
- the use of personal protective equipment against noise;
- rationalization of the working regime under noise conditions;
- preventive measures of a medical nature.

To reduce structure-borne noise propagated in solid environments, sound and vibration isolation floors are used. Vibrations propagating through communications (pipelines, channels) are weakened by joining the latter through sound-absorbing materials (rubber and plastic gaskets). Along with sound insulation in industrial conditions, sound absorption means are widely used.

Reducing noise can be achieved through rational building planning: the most noisy rooms should be concentrated in the depths of the territory in one place. They should be removed from the premises for mental work and fenced off with green spaces that partially absorb noise.

In addition to technological and technical measures, personal protective equipment is widely used - antiphones, made in the form of headphones or earbuds. There are several dozen options for in-ear plugs, headphones and helmets designed to isolate the ear canal from noise of various spectral composition.

The negative effect of noise can be reduced by reducing the time of its exposure, organizing a rational regime of work and rest, providing for short breaks during the working day to restore hearing function in quiet rooms.

4.4 Fire safety of production facilities

According to НАПБ Б.03.002-2007 “Нормы определения категорий помещений, зданий и наружных установок по взрывопожарной и пожарной опасности” aviation facilities refers of category A. Causes of fire at an aviation enterprise are fuel and oil. Since the fuel vapors remain in the tanks of aircraft, which are more dangerous than the fuel itself. Also, if fuel and oil come into contact, an explosion may occur.

For fire extinguishing, hand-held fire extinguishers, sand, a fire-fighting system are used, based on the fact that this is an aviation enterprise on the territory of a fire department.

For evacuation from the enterprise, 4 exits are used (2 emergency exits), and in an emergency you can use the hangar gates.

4.5 Development of proposals to reduce noise levels in production facilities

The main goal of preventing the harmful effects of noise at workplaces is, first of all, to establish the maximum permissible noise level, which, during daily (except weekends) work, but not more than 40 hours per week during the entire working experience, should not cause diseases or deviations. in the state of health, detected by modern research methods in the process of work or long-term periods of life of the present and subsequent generations.

Also, the main preventive measure in production aimed at reducing noise is the effective protection of workers from the adverse effects of noise, which requires the implementation of a whole range of organizational, technical and medical measures at the stages of design, construction and operation of industrial enterprises, machinery and equipment.

Measures to prevent the harmful effects of noise are divided into four groups:

- The first group of events is technological. They are aimed at changing the technology of the processes and the design of the machines that are the source of noise. Measures of this type include:
    1) Replacement of noisy processes by noiseless ones;
    2) Shock-free shock processes;
    3) Reciprocating movements are replaced by rotary ones (replacement of riveting by welding, forging and stamping - by pressure treatment), etc.
- The second group of measures - a technical group of measures is primarily aimed at reducing noise and vibration of parts, especially those with large vibrating surfaces, by:
    1) Lining them with materials that absorb noise and vibration (rubber, cardboard, felt, asbestos, bitumen cardboard, sound-reducing film);
    2) The use of sound-insulating (damping) linings, skins, spacers, gaskets for impact treatment of large surfaces;
    3) Good insulation when installing machines and units on foundations, preventing the spread of vibration and noise through the foundations, floors, ceilings.
- If it is impossible to reduce the noise in its source, the noise-reducing units are isolated in separate noise-insulating rooms or closed with noise-insulating casings, and the workplace is removed at a certain distance with the organization

of remote control. At the same time, the walls of the premises are equipped with acoustic plaster, tiles, facing panels in order to reduce noise due to multiple reflections from internal surfaces.

- The third group of measures is sanitary and hygienic measures and organizational measures. These include:
    1) Measures for measuring noise at workplaces, decoding of the data obtained, conclusion on the results obtained on working conditions at workplaces of noisy industries;
    2) Reducing the time of contact with noise, building a rational regime of work and rest, providing for short breaks during the day to restore hearing function in quiet rooms, combining professions;
    3) Use of personal protective equipment for hearing organs from noise exposure. Currently, the country uses dozens of options for ear plugs, headphones and helmets designed to isolate the external auditory canal from noise of various spectral composition.
- The fourth group of activities is medical and preventive. Conducting preliminary and periodic medical examinations. Such examinations are subject to persons working in industries where the noise exceeds the maximum permissible level (MPL) in any octave band.

4.6 Conclusion

Occupational safety at an aviation enterprise is the most important criterion, since there are many items hazardous to human life on it.

1. Observe all safety rules when working with aviation equipment and tools.

2. To prevent fires, train personnel to use fire-fighting equipment. Check all equipment according to the expiration dates.

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CHAPTER 5 ENVIRONMENT PROTECTION

5.1 Factors of negative impact on the environment

Routine maintenance and repairs maybe limited to changing engine oil and other small works. Maintenance and repair of a large scope may include repair and bulkhead work motors and other mechanical components; washing, cleaning and painting of aircraft parts or fuselages; as well as the use of a variety of toxic substances. Among environmental problems associated with technical maintenance and repair of aircraft, includes following:

- emissions into the atmosphere;
- wastewater;
- waste;
- noise.

Air emissions

Among the main sources of emissions into the atmosphere at maintenance and repairs of a large volume include processing and cleaning of metal surfaces associated with engine bulkheads (e.g. dust from grinding work, blasting and shot blasting, acid used in surface treatment, chromic acid in hard chromium plating and volatile organic compounds (VOCs) as a result of technical washing), cleaning and painting the outer surface aircraft (e.g. VOCs from cleaning and mixing and paint application) and running-in operations engines (e.g. exhaust fumes from combustion of fuel). Recommended measures for prevention and control include the following:

- Collection of dust generated during grinding work, blasting and shot blasting, with extraction and ventilation systems, removal dust using bag filters or other dust removal methods. Dust containing cadmium should be disposed of as hazardous or non-hazardous waste in depending on its properties, as described in General Environmental, Health and Safety Policy(EHSP) Guidelines;

- Preventing or minimizing the formation of acid emissions, especially aerosols containing acids and aerosols with mechanical impurities of such heavy metals, like chrome. Emissions of this type that can formed as a result of acid treatment metal surface and some operations on electrolytic coating should be avoid, or their volume should be reduced to minimized by the use of surfactants and, if necessary, wet scrubbers. Removed from exhaust gases chromic acid must be returned to the bath for electroplating or used in a different way in accordance with local regulations;
- When cleaning and painting should be minimized VOC(Volatile Organic Compounds) emissions. VOC-containing cleaning agents must be replaced with alkaline cleaning agents water-based products. When painting air vessels should avoid the use of containing VOCs for paints, solvents and pigments, or airlines should give preference to the external design of the aircraft, implying not painting, but polishing in order to minimize volumes of paints used. If possible, should strive to use paints on water base and avoid the use of solvents for removing paints based on methylene chloride or the use of chromate primers;
- It is necessary to minimize the possible impact run-in exhaust gases engines by placing test polygons away from urban areas, restrictions test time taking into account seasonal conditions the surrounding atmosphere or the acceptance of others organizational measures necessary for prevention of possible consequences from the point in terms of the quality of the surrounding atmosphere. Additional guidance on the quality of the surrounding atmosphere are contained in General EHSP Guidelines.

Wastewater

The release of hazardous substances into water can occur from production workshops, metalworking workshops, as well as as a result of washing the body of the air vessel and technical washes. Among the main types contaminants can include toxic metals, petroleum products (for example, oil, white spirit, fuel), complexing agents and surfactants substances, heavy metals (for example, compounds cyanides and hexavalent chromium) and organic solvents. Cadmium may also be present, as it is still often used for surface treatment of individual air parts ships (eg chassis, fenders). To recommended measures to prevent, minimize and control liquid effluent includes the following:

- Separation of highly toxic waste streams, in primarily containing cyanide, hexavalent chromium (Cr6 +), cadmium and other toxic metals. Other examples of wastewater streams requiring separations include concentrated solutions for surface pretreatment and coating; drainage from degreasing baths and etching; coating bath drains by chemical reduction (chemical coating) and baths for electroplating coatings (electrolytes); flushing water, containing cyanide, hexavalent chromium (Cr6 +), hypophosphite (as a result of nickel plating by chemical recovery), and effluent from washing and removal of paintwork;
- Divided or shared wastewater streams should be pretreated before discarding into local sewerage systems, including with using the technology of coagulation, flocculation, as well as methods of sedimentation and other appropriate cleaning methods for industrial Wastewater. Additional guidance in regarding the treatment of wastewater streams, including formed as a result of metalworking, contained in the EHS Guidelines for production of metal, plastic and rubber.

Waste

Hazardous or potentially hazardous waste generated during the overhaul and ordinary repair of aircraft, may include waste oil, oil emulsions and unused fuel; organic solvents and glycols; sludge containing metal hydroxides; lead storage batteries; nickel-cadmium and Nickel-metal hydride batteries; used solutions for surface treatment (after degreasing, etching, passivation, application electrolytic and chemical coating) containing cyanides, hexavalent chromium and cadmium; solid and semi-solid precipitate of cyanides; paint residues and water from nozzles; isocyanates; and also containing mercury fluorescent lamps and fluorescent lamps. Waste management, including hazardous waste, should comply with applicable guidelines, contained in the General EHSP Guidelines.

Noise

The main source of noise during technical maintenance and repair of aircraft is engine running-in. The tests should be carried out in specially designated areas, preferably located away from city blocks, or in places equipped with noise suppression or reflection devices. Additional noise control measures may include restrictions on day and night work. Noise levels at the nearest point of its perception should not exceed the recommended values contained in General EHSP Guidelines.

This section will only provide the most basic information. For those who wish to dig deeper, there are a number of available references that explain the finer points. Noise or any type of sound consists of fluctuations in pressure, measured in pascals.

The sound generated by an aeroplane movement at the observer location is expressed as a “single event sound (or noise) level”, which is an indicator of its impact on people. The received sound is measured on a decibel scale.

The metrics most commonly used to encapsulate entire aeroplane events are “single event sound (or noise) exposure levels”, L_{AE}, which account for all (or most of) the sound energy in the events. Making provisions for the time integration that this involves gives rise to the main complexities of segmentation (or simulation) modelling. An alternative metric is L_{Amax}, which is the maximum instantaneous level occurring during the event, and is simpler to model. In the future, practical models can be expected to embody both L_{Amax} and L_{AE}. Either metric can be measured on different scales of noise and in this manual only A-weighted sound level is considered. This applies a frequency weighting (or filter) to mimic a characteristic of human hearing. Symbolically, the scale is usually indicated by extending the metric suffix, i.e. L_{AE}, L_{Amax}.

The single event sound (or noise) exposure level is expressed as:

$$L_E = 10 * \log\left(\frac{1}{t_0}\int_{t_1}^{t_2} 10^{L(t)/10}\,dt\right)$$

where t_0 denotes a reference time. The integration interval $[t_1,t_2]$ is chosen to ensure that (nearly) all significant sound in the event is encompassed. Very often, the limits t_1 and t_2 are chosen to span the period for which the level L(t) is within 10 dB of L_{max}. This period is known as the “10-dB down” time. Sound (noise) exposure levels tabulated in the ANP database are 10-dB down values . For aeroplane noise contour modelling, the main application of equation is the standard metric sound exposure level (SEL) LAE . The exposure level equations above can be used to determine event levels when the entire time history of L(t) is known. Within the recommended noise modelling methodology, such time histories are not defined; event exposure levels are calculated by summing segment values. These are partial event levels, each of which defines the contribution from a single, finite segment of the flight path.

5.2 Performance indicators and monitoring of Environmental protection

Emissions and Effluent Standards

Air emissions and noise levels for air ships must meet certification requirements, developed by an international civil aviation organization (ICAO) in relation to the year of their production. Guideline values for process emissions in the industry are in accordance with the fixed in international practice, which is fixed in the relevant standards of countries with generally recognized regulatory framework. Emissions and effluents from maintenance facilities must be cleaned to a level that meets the requirements the operation of the local sewer network, or, if they discharged into surface waters, correspond standard values given in the Manual on EHSP for the production of metal products, plastic and rubber, in which guideline values are given for treated effluents applied to processes mechanical processing of metals, cleaning, cladding and finishing, including painting. Applied to this site can be determined by the levels of discharges at Based on the requirements of government collection and cleaning systems stock or, if they are dumped directly into surface water, then on the basis of the type water intake as described in the General EHSP Game.

Standards for emissions from combustion sources associated with the production of steam and electricity by sources of common with a capacity of not more than 50 MW of energy , are given in the General EHSP Guidelines, and emissions from sources with more high power - in the EHSP Guidelines for thermal power plants. Guidelines for background parameters of the environment, taking into account the total emission loads are presented in the General Guidelines by EHSP.

Environmental monitoring

Environmental monitoring programs for this industry should be built taking into account the need to cover all activities that potentially have a significant impact on the state of the environment during their implementation both in normal and abnormal conditions. Monitoring the state of the environment should be conducted along direct or indirect indicators of emissions, effluents and use resources applicable to this project. Frequency monitoring should be sufficient to obtaining representative data for a parameter, which is being monitored. Monitoring should exercised by specially trained persons in compliance with monitoring and data recording procedures with using equipment that has passed the proper calibration and maintenance.

Data monitoring should be regularly analyzed and studied, comparing them with current standards in order to taking corrective measures, if necessary. Additional guidance on monitoring programs are contained in the General EHSP Guidelines.

5.3 General Recommendations. Reduction Measures of Negative Impacts on Environment

There is a growing need in the aerospace industry to reduce product development time while using materials that meet increasingly stringent and sometimes conflicting performance criteria. Accelerated testing and manufacturing of products can lead to material and process development outpacing the parallel development of environmental health technologies. The result can be products that have been tested and approved, but for which there is insufficient data on health and environmental impacts. Regulations such as the Toxic Substances Control Act (TSCA) in the United States require:

- creation of new materials;
- developing sound laboratory practice for research and development;
- restrictions on the import and export of certain chemicals;
- monitoring health, safety and environmental studies and company records for significant health effects from exposure to chemicals.
- creation of fluids that have no impact on the environment

Airframe noise reduction measures are required, including landing gear and high lift systems for low noise levels. The goal should be to find a suitable geometry with practical noise, aerodynamic and mass parametric characteristics that can be used in the aircraft optimization process.

Among the main measures to prevent, reduce and mitigate the negative effects are the following:

- optimization of ground handling infrastructure at airports to reduce the movement of aircraft and ground vehicles on taxiways and at idle at the gates;
- renewal of the land vehicle fleet;
- minimization of fugitive air emissions from aviation kerosene and other fuel depots and from fuel handling;
- supply of electricity and air conditioning through ground equipment to minimize the use of NSU aircraft;
- initial use of mechanical methods of ice removal, such as sweepers and plows, supplemented with chemicals;
- providing a storm water management system for the collection and treatment of surface runoff, containing air and aerodrome fluids to protect against icing, including water from a pile of snow cleared of aprons and runways.

5.4 Conclusion

Although aviation is a relatively “clean” mode of transport by comparison, its climate and environmental impacts may become significant over time due to the ever-increasing air traffic, leading to increased pollution in the upper troposphere. Although currently estimates of such an impact are highly uncertain, International Civil Aviation Organization is taking measures to reduce the negative the impact of aviation on the environment. For this, new standards are being developed that tighten the requirements for operated aircraft on aircraft noise and emissions, and is also expanding list of aviation emissions for which certification is carried out aircraft engines. As the main instrument for regulating the negative impact of aviation on the atmosphere, the Committee ICAO for the Environment is proposing a Global market measures. Although not all ICAO members support this idea, the need to introduce new technologies in the aviation industry, contributing to the reduction of the environmental load of air transport to the environment is obvious.

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General conclusion

In the thesis of this project, a thorough analysis of the work of the technical staff is carried out. This led to the development and modification of the maintenance system, as well as modifications to the materials used in the manufacture and design of the airframe.

Changing the material from which some parts of the airframe are made will increase efficiency and durability, making it more reliable, easier to maintain, which can further lead to fewer maintenance problems, incidents and incidents.

Here is a brief review of the overall thesis;

1. Airframe maintenance is a highly dynamic and regulated industry characterised, for example, by complex and interdependent systems and technologies, detailed and legally binding task procedures and documentation, highly publicised accident rates and highly regulated management systems to ensure reliability, efficiency and safety at all times.
2. Changes in the materials used in parts can also improve fatigue life. For example, parts can be made from better fatigue rated metals. Complete replacement and redesign of parts can also reduce if not eliminate fatigue problems ,Peening a surface can reduce such tensile stresses and create compressive residual stress, which prevents crack initiation. All of these have been aimed at reducing the overall maintenance effort, as well as improving reliability.
3. Also examined current issues that affect maintenance and its quality. why it is important to observe all norms, rules and instructions for the maintenance of aviation equipment. How regular education and training improves service quality and reduces the risk of human error.

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