Technical aspects of flight safety of military aircraft

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Abstract:

Introduction/purpose: The use of modern military aircraft requires an extraordinary effort of human and material potential to ensure the conditions for the execution of specific tasks. Complex technology, different spatial and temporal conditions of aircraft use impose the need to create organizational and technical conditions to assist the pilot during flight with the aim of safely and completely accomplishing the flight task. The aim of this paper is to identify possible problems in the organization of the flight safety system through the description of the influence of technical factors on flight safety and to find the best solutions for overcoming problems during the life cycle of the aircraft. Methods: In the research of the subject area, first of all, the analysis of the regulations regulating the field of flight safety was carried out, and then a description of the technical means and their impact on flight safety was carried out. Results: On the basis of the performed analysis, the activities to ensure the reliability of the aircraft during development and production were defined, and directions for improving flight safety were proposed through the amendments of regulations, organizational and technical as well as technological measures. Conclusion: The results of the analysis confirm the assumptions about the possible directions of development and improvement of flight safety of military aircraft through improvement and installation of technical systems (devices and equipment), both aviation and ground.

Keywords: flight safety; military aircraft; aircraft reliability

INTRODUCTION

Flight safety is an actual and complex problem and not only the lives of passengers and crews depend on its successful solution, but also the efficiency and readiness of the aircraft for use.

The actuality of the issue of flight safety is conditioned by an increase in the speed of flight, take-off and landing, an increase in the intensity of air traffic, considerable complexity of aircraft construction and high requirements of the use of military aviation (Miličević & Bojković, 2021; Duarte et al, 2016). Aviation equipment on modern aircraft is very complex, and crew workload and flight safety largely depend on its quality and operational reliability.

The reliability of aviation technology is an important factor that affects the readiness of the aircraft for flight, the efficiency of its use and flight safety. However, flight safety is primarily affected by in-flight failures of aircraft equipment. Failures also reduce the efficiency of the use of aircraft equipment. Malfunctions (failures and breakdowns) that occur on the ground and in flight require time to be repaired. Malfunctions mainly occur due to structural and manufacturing defects, non-compliance with technical conditions for production, poor assembly, foreign objects entering aggregates and into the flight control system, insufficient reliability of aggregates, equipment and systems of aircraft and their power units, insufficient ability to control the condition of the aircraft itself, before and during the flight (Živaljevic & Siladić, 1997). Flight safety is also affected by operational factors: errors by flight personnel, deficiencies in planning, organizing and managing flights, malfunctions and disruption of the system for managing and securing flights from the ground.

The aim of this paper is to identify possible problems in the organization of the flight safety system through the description of the influence of technical factors on flight safety and to find the best solutions for overcoming problems during the aircraft life cycle.

The paper describes the basic technical factors that affect flight safety, as well as the ways of collecting, systematizing and processing data necessary for flight safety assessment (Honcharenko et al, 2020). The activities in the process of design, production and exploitation of aircraft to ensure high reliability of aviation technology are listed. An insight into the current technical means for ensuring flight safety is given, which include avionics, additional equipment, ground equipment, as well as equipment of objective flight control. After the analysis, a model was proposed for the improvement of the flight safety system with an emphasis on technical factors in accordance with the needs that arise with the introduction into use of new types of aircraft, equipment, tools and control and verification apparatus, as well as changes in terms of procedures and aircraft maintenance technology.

FUNDAMENTALS OF MILITARY AIRCRAFT FLIGHT SAFETY

The basic act that regulates the flight of military aircraft in the Republic of Serbia is the Rulebook on the Flight of Military Aircraft which more closely prescribes the organization of the flight of military aircraft and risks to flight safety (Službeni vojni list, 2018). The Rulebook provides risk assessment guidelines as well as measures to prevent flight safety risks. These measures are implemented in the instructions for aircraft maintenance, where the duties of aviation technical staff: managers, controllers and technicians, as bearers of aircraft technical support, are defined in terms of performing analysis of malfunctions of aviation technology, determining the cause of failure, developing and implementing measures to prevent and eliminate failure causes within the framework of their duties.

The flight safety system in the narrower sense consists of: expert bodies for flight safety in the Air Force and Air Defense Command, aviation brigade commands, flight safety assistants in flight units, Councils for Methodology and Flight Safety as well as all other bodies involved in the planning process, preparation, organization, performance and analysis of flying, in accordance with their competences.

In the flight safety system, no technical bodies were formed to deal with the organization of flight safety, analyses of the impact of certain factors and taking measures to prevent mishaps, but this function was assigned, as an additional one, to the bodies leading the preparation and execution of flights. In this way, aviation technical managers deal with ensuring the conditions for the safe execution of the planned flight, but without a deeper analysis and prediction of the future impact of technical factors on endangering flight safety.

The periods of the development of flight safety systems are shown in Figure 1, (International civil aviation organization - ICAO, 2018). Until 1970, the main cause of plane accidents was a technical factor. With the improvement of the production technology and the reliability of the aircraft, the period of influence of the human factor in the servicing and maintenance of the aircraft as a primary factor affecting flight safety begins. In the mid-1990s, the causes of flight organization as a cause of aviation accidents were investigated in order to introduce the term total flight safety at the beginning of the 21st century through the management of a flight safety system that combines technical, human, organizational and safety factors into a single system.

Technical factors of flight safety

The reliability of aviation technology is an important factor that affects the readiness of the aircraft for flight, the efficiency of its use and flight safety. The requirements that determine the parameters of the given flight technical characteristics and efficiency of aircraft use are set in the phases of aircraft design and production (Bolshakov et al, 2018). However, they are also significantly affected by the process of aircraft maintenance and use: organization, scope and periodicity of maintenance works, methods and equipment used during maintenance, qualification structure and psychophysical condition of technical personnel, quality and reliability of ground equipment for securing flight, etc.

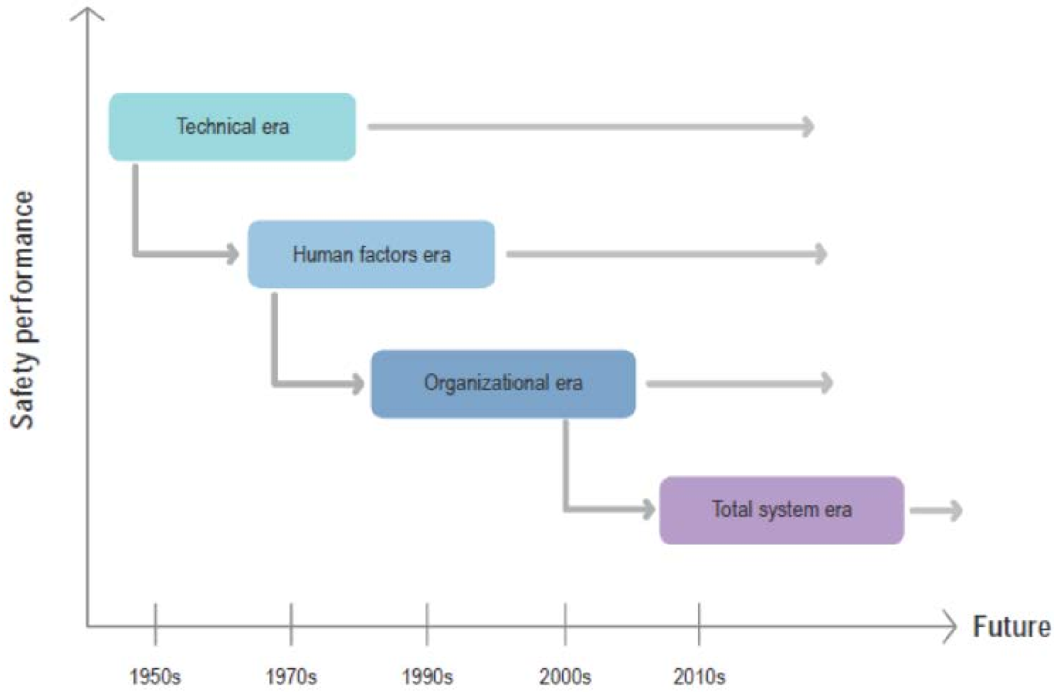

Figure 1 – Flight management system development
Рис. 1 – Разработка системы управления полетом
Слика 1 – Развој система безбедности летења

Aviation technology characteristics that affect flight safety arise from the requirements to expand the range of flight speeds and altitudes and from the complexity of tasks performed by flight crews. The complexity of the tasks to be solved causes an increase in the number of instruments, pointers and signalers, which imposed the need to introduce an automatic flight control system.

Flight safety is also affected by operation factors: mistakes by flight crews in piloting techniques, deficiencies in planning, organization and flight management, failures and disruption of the systems for control and security of flights from the ground (Solomonov, 1975).

Mistakes of flight and technical staff as well as mistakes of flight managers can be caused by insufficient qualification of the staff, insufficient knowledge of the technique and the regulations for its exploitation, the absence of solid habits and training, depreciation of the aviation technical staff, deviations from the established regulations for the maintenance and servicing of the aircraft and their ground equipment (Marinković & Drenovac, 2015). Critical situations in flight can also be facilitated by external factors which include: storms, rain and hail clouds, hail, gusts of wind, fog, snow flurries and dense fog, intense icing of the aircraft in flight, strong turbulence, the presence of balloons or birds in the air.

Initial information for identifying critical situations in flight includes pilot reports, objective control data, aircraft operational documentation, personal observations of air traffic controllers, observations of superiors and eyewitness accounts.

Malfunctions are a special factor of flight safety. An important source of data are records of failures of parts, assemblies and aggregates, which are an integral part of maintenance reporting, as part of analyses of work at individual maintenance levels. The analysis of these data can provide a basis for predicting the failure of certain assemblies in the future and serve as a basis for changing procedures in preventive maintenance and exploitation of aircraft.

ENSURING FLIGHT SAFETY OF MILITARY AIRCRAFT IN THE PROCESS OF THEIR ACQUISITION AND EXPLOITATION

The constant improvement of the quality and reliability of aircraft requires collective efforts of researchers, test centers, manufacturers and organizations that operate and maintain aircraft. In order to avoid high maintenance costs during aircraft exploitation and large losses due to malfunctions, due to non-use of aircraft during exploitation, research and development and design organizations strive to ensure high reliability of aircraft.

The aircraft reliability depends on the scope and depth of aircraft research and testing in the design and development phase. During the design process, the basics of the reliability of each aircraft, their construction strength and material fatigue, service life, and convenience for maintenance are defined. In the same phase, problems of functional efficiency are solved as well as problems of technological, repair and exploitation indicators.

In order to ensure aircraft reliability, and thus flight safety, highquality constructive materials are used in the construction of aircraft. The use of composite materials provides strength, stiffness, and stability at elevated temperatures, as well as other positive properties that contribute to the increase of aircraft flight safety.

Constructive methods for increasing reliability include: development and production of reliable aggregates, improvement of structural strength calculations, provision of favorable operating conditions for aggregates, as well as proper selection of aggregate operating parameters. The construction of aircraft, engines, equipment and systems must have a high coefficient of maintenance convenience, and if possible, built-in sensors and measuring elements to signal probable occurrence of malfunctions. In addition to the basic exploitation characteristics, aircraft must also have features that facilitate their exploitation, such as ease of servicing, minimum possible time required to prepare the aircraft for use, mechanization and automation of fueling, special liquids and gases, battery charging, etc.

During aircraft development, tests of aggregates and vital systems are performed in laboratory conditions, and tests are carried out regarding the determination of resources in simulated environment conditions, with the aim of assessing reliability in the design phase. As shown in Figure 2 (Čestić, 2022), an effective way to increase the reliability of aviation technology is the reservation (redundancy) of especially vital aircraft systems, the failure of which directly threatens flight safety.

Based on the analysis of reliability test results in the stages of development and production, an assessment is made on the operational reliability of aviation technology, measures are developed for its maintenance or increase, the life cycles of operation of the aircraft structure, aggregates of its equipment and systems is determined, and operational documentation is defined (Solomonov, 1975).

During operation, ensuring the required level of reliability of aviation technology is done primarily through the aviation technical maintenance system, where modern diagnostic, special testing and measuring equipment and modern data processing methods are used (Pokorni, 2021).

Quantitative evaluations of various factors, according to the importance of their influence on emergency events in flight depend on the permitted methods of testing aircraft in terms of flight safety (Kublanov, 2021).

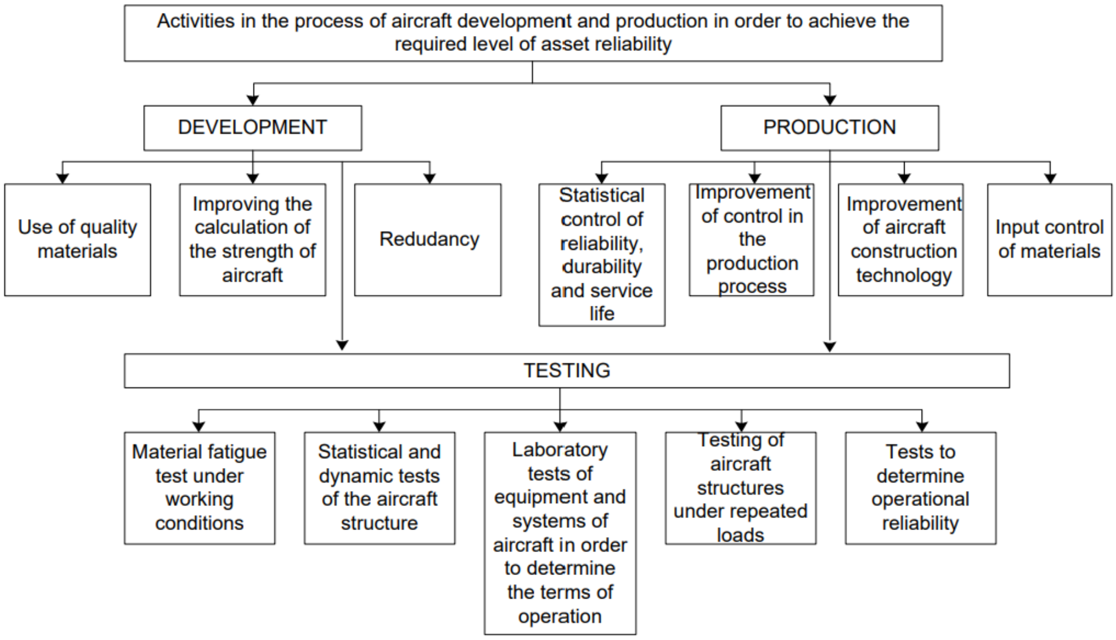

Figure 2 – Activities in the development and production process to ensure aircraft reliability
Рис. 2 – Деятельность в процессе разработки и производства в области обеспечения надежности воздушного судна
Слика 2 –Активности у процесу развоја и производње на обезбеђењу поузданости ваздухоплова (in Serbian)

To determine the initial stage of the development of cracks, corrosion, internal (hidden) deformities of materials and malfunctions of parts, assemblies and aggregates, physical methods of defectoscopy are used (magnetic, electroinduction, gamma defectoscopy, ultrasonic, penetration - using a penetrating liquid and challenger, etc.).

To determine changes in technical characteristics (parameters) and evaluate the working capabilities of aggregates and hydraulic devices, devices for air, fuel, cabin pressurization and air conditioning systems and other aircraft systems, instrumental checks using automated devices, counters, as well as various devices and instruments are used. To assess the technical condition of the aircraft electronic equipment, instrumental checks are applied using built-in external control systems, control-measuring devices for general and special purposes, special workbenches and various instruments.

Control and assessment of the technical condition of aviation equipment in flight units is carried out using standard and special measuring devices, based on appropriate inspection lists for specific aviation equipment. A particularly important role in ensuring the reliability of aviation technology, preventing failures and aviation accidents is played by periodic inspections and preventive works that are carried out based on the hourly or time limit of aircraft use. Periodic inspections include activities to inspect the condition of all elements of the aircraft according to the prescribed periodic inspection lists for a specific type of aircraft.

To increase the efficiency of the use of aircraft and their operational safety, it is important to quickly and correctly determine the causes of technical failures, as well as to quickly and efficiently eliminate them, prevent their recurrence and forecast their eventual occurrence.

Technical diagnostic methods for early failure detection which are increasingly being developed represent one of the most important modern directions for increasing reliability and reducing aircraft exploitation costs. The improvement of diagnostic methods enables the automated collection and processing of information on parameters for failure forecasting and signaling (warnings to the crew) about malfunctions on the aircraft during flight.

Control in operation is primarily aimed at detecting gradual failure of elements and devices, whose failure indirectly affects flight safety. Particularly important data for the diagnosis of the state of certain aircraft systems are provided by recorders for the analysis and processing of dynamic parameters of aviation technology, such as vibrations, pressure changes in hydraulic and air devices, and the like.

TECHNICAL EQUIPMENT FOR ENSURING FLIGHT SAFETY

To ensure flight safety, aircraft are equipped with special technical equipment that make up the safety scheme. They are designed to eliminate the consequences of the failure of vital systems or to prevent the possibility of these systems entering a dangerous mode of operation (Solomonov, 1975). Constructively, safety schemes are applied in the form of vital systems and devices or in the form of the installation of special blocks in aggregates (control, safety), automatic safety, control, restrictions, exclusions and the like. New generations of aircraft are equipped with electronic blocks that have self-checking options, where correctness checks are performed automatically without disassembly and special tests during periodic inspections. It is particularly important that during the self-diagnosis of a certain set (e.g. radio station or navigation devices), in the event of malfunction, accurate information is given on which block or which communication line from the set has failed, which significantly reduces the time of defection and repair and ultimately raises flight safety to a higher level.

On many aircraft, in order to prevent exceeding the permissible value of the workload coefficient, limiters of the speed (tempo) of the movement of the pilot stick are installed, either mechanically or by software in systems with "fly by wire" technology.

Some multi-engine airplanes are equipped with automatic course maintenance (correction) devices when one of the engines fails.

An effective way to increase flight safety is the diagnostic control of the basic structural elements of the aircraft, especially the resistance (firmness) of its engines, based on the analysis and control of vibrations. The vibration control system consists of vibration transmitters, electronic blocks and indicators or vibration recorders (Nacional'nyj centr vertoljotostroenija imeni M.L. Milja i N.I. Kamova, 2019). In addition, aircraft can be equipped with means which control aircraft in emergency situations (Solomonov, 1977). All modern airplanes are equipped with autopilots in which control blocks are installed, which the autopilot automatically shuts down in the event of failure, as well as rudder end deflection transmitters. Many aircraft are equipped with dangerous altitude blocks that signal the autopilot and the pilot to enter climb (Kurdel et al, 2019).

Modern aviation equipment has imposed the need to install a large number of devices, instruments and signals necessary for the pilot to be informed about the state or flight mode of the aircraft. Special attention is paid to the display of parameters and signaling in the form of multifunctional indicators, which significantly relieve the instrument panel from classic analog instruments, and where it is possible to select parameters or groups of parameters that are important for monitoring, as seen in Figure 3 (Airbus Helicopters, 2016).

The desired data displayed on multifunctional indicators are processed in the flight management computer system Flight Management System (FMS) in which error signals are processed in parallel, as well as signals about a dangerous situation in flight, on the basis of which warnings to the crew are generated. Signal lights, light boards (inscriptions), pointers and tone (sound) signaling are often used as signals to inform the pilot about the operation of aircraft systems, their failures, the aircraft's entry into critical flight modes and to indicate targets.

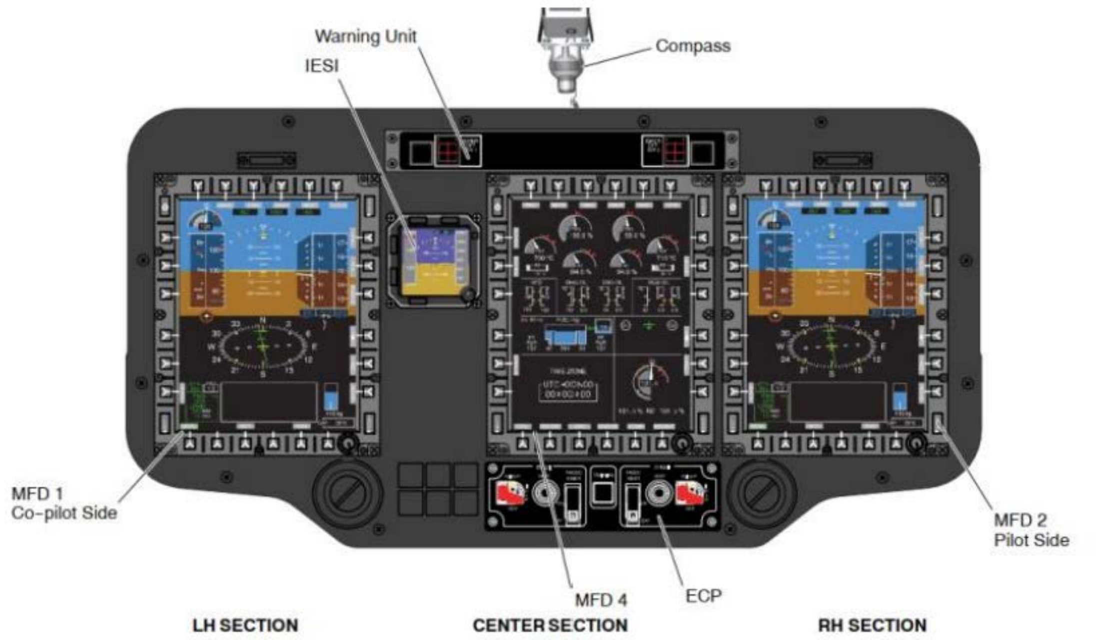

Figure 3 – Layout of multifunctional indicators of the H-145M helicopter
Рис. 3 – Компоновка многофункциональных индикаторов вертолета H145M
Слика 3 – Распоред мултифункционалних индикатора хеликоптера Х-145М

An effective tool that facilitates piloting in certain phases of flight and increases flight safety is the display of aiming and navigation data on the windshield through which the pilot observes the area in front of the aircraft, as well as the way of displaying the level of warnings and errors on the systems or the values of certain parameters through colors, where the pilot is aware of the existence of a certain error but does not need to pay attention if that error does not jeopardize the performance of the task (Peysakhovich et al, 2018).

The additional means that aircraft are equipped with to ensure flight safety include collision prevention devices, anti-icing devices and prevention of electrical (atmospheric) discharges to the aircraft, pilot notification devices, rescue equipment, fire fighting equipment, etc.

Special Airborne Collision Avoidance System (ACAS)/Traffic Collision Avoidance System (TCAS) systems have been developed and are being perfected to prevent collisions in flight. The basic criterion of the system for assessing the possibility of an aircraft collision is the flight height. A signal transmitted from one aircraft at a precise moment in time is received by the devices of another aircraft, and their distance is determined according to the time difference between the transmission and reception of the signal (Vorobev et al, 1989).

In flight, rare cases of electrical discharges to the aircraft may occur. To ensure BL, reliable electrical connection of all elements of the aircraft structure is performed with appropriate metallization; and at least 2 mm thick plating is used on all parts of the structure near the fuel system elements to prevent burn-through. The structure of the aircraft is designed in such a way as to prevent the creation of an electric arc in the space of the fuel tanks. Flame extinguishers are also installed at the fuel system outlets (Solomonov, 1977).

For flying at extremely low altitudes, the limitations of the aircraft's maneuverability and the pilot's physiological capabilities are taken into account. Flight controls for flying at extremely low altitudes must provide manual, semi-automatic and automatic aircraft control modes.

To monitor the terrain (relief) situation, a radar is used that provides data on the distance from the nearest elevation and the angle of its elevation in relation to the reference plane (Zuluaga et al, 2017). When overcoming obstacles, there are possible cases of the aircraft arriving at a flight mode close to the landing mode, as well as descending to below the permitted height. For this reason, equipment is installed on the aircraft that warns of obstacles about the approach of the aircraft to the landing mode and signals to the pilot that the flight height above the obstacles is lower than the set one, the so-called Terrain Awareness and Warning System (TAWS) devices.

The basic method of rescuing the crew during emergency situations in flight is to leave the aircraft using the ejection seat. The improvement of ejectable pilot seats represents today the main direction in the fight to increase the efficiency of the means for forced abandonment of the aircraft (Zubkov et al, 2007). Ejectable seats installed in helicopters are also significant, but they are not widely distributed due to the complexity of the construction and the possibility of installation only in helicopters with a coaxial carrier rotor.

Most modern aircraft are equipped with devices for broadcasting the GPS position of the aircraft Emergency Locator Transmitter (ELT), in order to quickly find an aircraft that has suffered an accident or forced landing. Figure 4 (Airbus Helicopters, 2016) shows the configuration of one set of ELT devices, consisting of special modules with the antenna part and the power supply, a pointer and a control module.

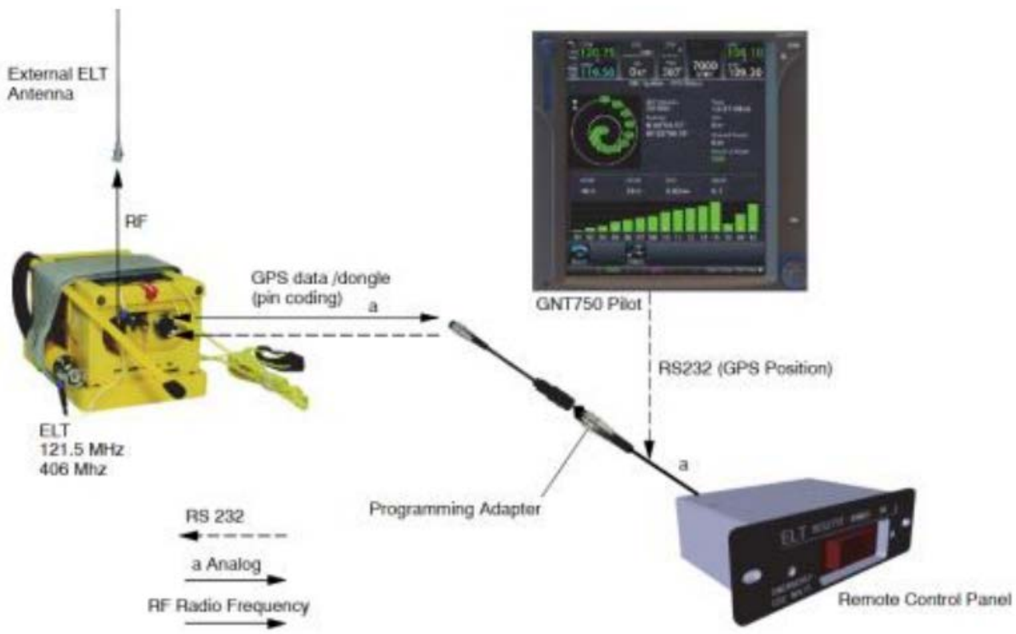

Figure 4 – Components of the ELT device
Рис. 4 – Компоненты устройства ELT
Слика 4 – Саставни елементи ELT уређаја (in Serbian)

Ground means for ensuring flight safety

Ground-based technical means for ensuring flight safety include aircraft guidance and flight control equipment, airport lighting equipment, technical means for dispersing birds, means for preparing and training personnel, and storage means. All major airports also have ILS (Instrument Landing System) systems that ensure precise guidance of the aircraft during landing. Figure 5 shows the navigation device PNP-72 which, with the combined operation of several devices and equipment in aircraft, enables landing in conditions of reduced visibility.

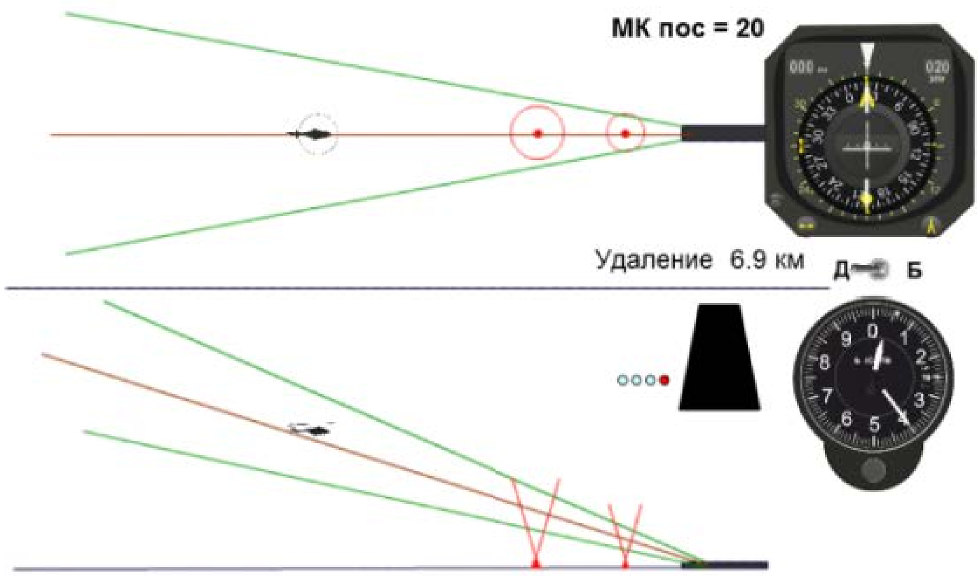

Figure 5 – Display of the operation of the ILS system in conjunction with the helicopter navigation device
Рис. 5 – Отображение работы системы ILS совместно с навигационным устройством вертолета
Слика 5 – Приказ рада ILS система у спрези са хеликоптерским навигационим уређајем (in Serbian)

For the implementation of light, navigation and signal security, starting radio stations, light signaling devices with servers for stationary night start and mobile night start, mobile flight control, as well as other ground radio-navigation equipment are provided.

Special runway curtains and braking devices, which both aircraft and airports are equipped with, are used in the cases of aircraft disembarking from the runway. Systems with arresting nets and arresting ropes are most often used to stop the aircraft on the runway. Along with them, the method of covering the runways with foam for the forced stop of the aircraft is also used.

Experience shows that some critical situations in flight are conditioned by the so-called "human" factor, i.e. mistakes (Poussin et al, 2017). Therefore, the introduction of trainers and simulators into use is of great importance for ensuring flight safety (Vlačić et al, 2022). The possibility of effective training of crew emergency procedures when modeling failure and imitation of emergency events on simulators (engine failure, autopilot and auxiliary systems failure, fire simulation, etc.) creates conditions for systematic training of flight personnel with the aim of acquiring the necessary habits and maintaining them at a certain level (Rudnjanin & Debijađi, 1984).

Also, very often interactive and 3D classrooms are used in addition to flight simulators, as a good technical basis for training pilots and training technical staff.

Technical means of the objective flight control

Determining the real causes of critical situations in most cases is possible only if there is reliable information about the flight parameters of the aircraft, about the correct operation of its systems and the work of the crew during the development of an emergency event in flight. Certain types of aircraft in the world are equipped with means of objective control that have a direct data link with the home base, another aircraft or a flying command post, where it is possible to monitor the parameters of the aircraft in real time (Zubkov, 2007). Also, these types of communication have the possibility of direct transmission of radar and sensor images and are installed on 4++ and 5th generation multipurpose aircraft. Flight parameter recorders, Figure 6 (Nacional'nyj centr vertoljotostroenija imeni M.L.

Milja i N.I. Kamova, 2019), are used in the investigation of aviation accidents and critical situations in flight.

Figure 6 – Flight parameters recorder BUR-1-2 of the Mi-17V-5 helicopter
Рис. 6 – Регистратор параметров полета БУР-1-2 вертолета Ми-17В-5
Слика 6 – Регистратор параметара лета БУР-1-2 хеликоптера Ми-17В-5 (in Serbian)

In practice, data on engine operating times, collected from the flight parameters recorder, can also be used during homologation tests of certain engine parts (Banjac et al, 2017). Also, based on recorded data using the recorder, it is possible to observe changes in the parameters of individual parts, assemblies and aggregates that provide a basis for predicting future failures and a basis for preventive inspection or replacement of a specific part or assembly.

IMPROVEMENT OF FLIGHT SAFETY OF MILITARY AIRCRAFT BY APPLYING ORGANIZATIONAL AND TECHNICAL-TECHNOLOGICAL MEASURES AND PROCEDURES

Ensuring flight safety is a constant task and a continuous process to which special attention is paid regardless of the current circumstances in which flight tasks are performed. However, there is room for improving the current situation through the application of organizational, normative and technical-technological measures and procedures (Bogdane et al, 2019).

Organizational measures for flight safety improvement

An important area in flight security is organizational measures, such as: flight management, preparation, training and control of flight and aviation technical personnel and the organization of the use of ground assets for flight security in flight units (Bilbija, 2017). The basis for raising the level of flight safety in terms of technical factors is the adaptation of the administrative authorities of the commands to the requirements of the profession, whereby the work of the technical authorities would be organized and controlled primarily by the technical service and only then by the line of command. A system in which "everyone can do everything", in a situation where it is necessary to provide the maximum of professional capacities, cannot fully meet the requirements of maintaining modern aviation technology.

The recruitment of aeronautical personnel must be based on quality and not on quantity. The process of education and training of staff should follow the needs of the units for professional staff of all aviation technical specialties. Individuals who work on aviation technology must be confident in their knowledge and actions and constantly improve themselves. It is necessary to introduce permanent monitoring and verification of training in specialties, practically as a form of license renewal, with prescribed rights and obligations of individuals. Also, it is necessary to prescribe the training levels of specialists according to the degree of professional competence and experience in working on a specific aircraft, which should be accompanied by appropriate benefits.

Measures for normative regulation of flight safety improvement

Along with organizational measures, an important role is also played by continuous improvement of the content and form of documentation and records that regulate flight training, flight planning, maintenance, especially for newly introduced aircraft. The departments dealing with technical documentation, their updating, systematization, monitoring and distribution of changes and bulletins are of particular importance. Those departments must be the link between the manufacturer and the user of the aircraft in terms of documentation, which is one of the essential requirements of the concept of integral logistics support (ILP). The efficient work of the aforementioned departments creates the conditions for reducing the costs of the aircraft's lifetime through a more efficient organization of technological measures and procedures within the specific level of maintenance, shortens the time for carrying out maintenance procedures, enables efficient planning of the procurement of spare parts, aviation ordnance, electronic equipment as well as keeping the same. Failure to adhere to the concept of ILP results in the exact opposite.

Another important area of ensuring flight safety is the analysis of the causes of aircraft malfunctions and failures. An objective analysis includes the development of scientific methods and recommendations for investigating the causes of critical situations in flight based on registered flight parameters, performing the necessary calculations, flight modeling, tests and research in flight (Hooper & O'Hare, 2013).

In particular, it is necessary to make efforts to prescribe a detailed scheme of the operation of the flight safety system, with the bearers of individual activities, and the duties of each authority when analyzing critical events and failures, or any other negative impacts on aircraft maintenance.

Application of technical-technological measures and procedures for flight safety improvement

Practically all work on aircraft is carried out with prescribed tools, control and measuring equipment, which reduces the degree of improvisation in the work to a minimum. Combat equipment must be stored in appropriate hangars, where it is possible to carry out maintenance activities in microclimate-controlled conditions in a closed space, with heating in the winter months, which, in addition to the technological requirements of maintenance activities, will also enable favorable psychophysical conditions for the technical staff to devote all their attention to the required work on aircraft. The hangars should provide effective conditions for working with modern stationary equipment (electric generators and rectifiers powered from the city network), thus reducing the engagement of electric starters and, therefore, maintenance costs. Also, it is necessary to invest in the continuous equipping of laboratories for testing and checking aircraft equipment, which would create the conditions for compliance with maintenance procedures according to the highest world standards, which is a prerequisite for the use of the most modern aircraft.

In terms of maintaining the correctness and reliability of measuring, control and verification equipment and tools, it is necessary to pay attention to metrology laboratories for verification, their equipment and devices, and to train personnel for the verification of highly sophisticated equipment.

In order to monitor and manage resources as efficiently as possible, it is necessary to reduce the involvement of aviation technical personnel in administrative tasks, by introducing a specialized information system that would improve the way of monitoring resources, keeping records and reporting (Senol, 2020). Practically, in one place it would be possible to create an overview of all important information, from the availability and training of staff, through the state of resources, filling with spare parts, data on the maintenance process through monitoring and analysis of malfunctions. Also, this system would have to include all analyses of flights performed by all types of aircraft equipped with such means, so that the technical authority would have the possibility of a more detailed investigation of the failure of parts and aggregates. In this way, the flight safety system would be improved, significantly reducing the time from the occurrence of the critical event, through the cause analysis to the appropriate reaction of the maintenance system.

CONCLUSION

Equipping with airplanes, helicopters and remotely piloted aircraft of new generations as a prerequisite requires an extremely high technical culture of pilots and aviation technical personnel. The challenge for aviation technical personnel is to maintain the reliability of modern aircraft, organize the maintenance process, develop methods and means for maintenance, as well as ensure the qualification structure and adequate psychophysical condition of flight and technical personnel.

The aircraft, as the final product of the aviation industry, is subject to modifications, modernizations, changes in the production process and especially changes in the process of preventive and corrective maintenance, the ultimate goal of which, in addition to improving tactical and technical characteristics, is to increase the level of flight safety.

The task for the aviation maintenance and safety system is to enable high-quality distribution, processing and analysis of data on the state of the organization and technique through the introduction of an information system.

Most of the mentioned proposals and requirements in this paper are solved in the phases of deesign and aircraft production, and sometimes during modernization, through the absolute application of the concept of integral logistic support.

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Технические аспекты безопасности полетов военных летательных аппаратов

Резюме:

Введение/цель: При использовании современной военной авиации требуются экстраординарные человеческие усилия и материальные средства, особенно в обеспечении условий для выполнения специальных задач. Сложная технология, различные пространственно-временные условия использования воздушного судна диктуют необходимость создания организационных и технических условий для оказания помощи пилоту во время полета с целью безопасного и полного выполнения полетной задачи. Целью данной статьи является выявление возможных проблем в организации системы безопасности полетов путем описания влияния технических факторов на безопасность полетов и поиска наилучших решений в преодолении проблем в течение жизненного цикла воздушного судна. Методы: При исследовании предметной области, прежде всего был проведен анализ нормативных правовых актов, регулирующих сферу безопасности полетов, а затем было проведено описание технических средств и их влияния на безопасность полетов. Результаты: На основании проведенного анализа были определены меры по обеспечению надежности воздушного судна в процессе разработки и производства, а также предложены направления повышения безопасности полетов путем внесения изменений в регламенты по организационным, техническим и технологическим мерам. Выводы: Результаты анализа подтверждают предпосылки о формировании возможных направлений в развитии и повышении безопасности полетов военных летательных аппаратов за счет совершенствования системы и установки авиационных и наземных технических систем (приборов и оборудования).

Ключевые слова: безопасность полетов, военная авиация, надежность летательных аппаратов

Технички аспекти безбедности летења војних ваздухоплова

Сажетак:

Увод/циљ: Употреба савремених војних ваздухоплова захтева изузетно напрезање људских и материјалних потенцијa за обезбеђење услова за извршавање наменских задатака. Сложена технологија, различити просторни и временски услови употребе ваздухоплова намећу потребу за стварањем организацијских и техничких услова за испомоћ пилоту у току летења, а ради сигурног и потпуног остварења летачког задатка. Циљ овог рада јесте да се, кроз опис утицаја техничких фактора на безбедност летења, идентификују могући проблеми у организацији система безбедности летења и пронађу најбоља решења за њихово превазилажење током животног циклуса ваздухоплова. Методе: У истраживању су прво анализирани прописи којима је регулисана област безбедности летења, а затим је извршена дескрипција техничких средстава и њихов утицај на безбедност летења. Резултати: На основу извршене анализе, дефинисане су активности на обезбеђењу поузданости ваздухоплова у току развоја и производње и предложени су правци унапређења безбедности летења, кроз измену и допуну регулативе, као и организацијске и техничко-технолошке мере. Закључак: Резултати извршене анализе потврђују претпоставке о могућим правцима развоја и унапређења безбедности летења војних ваздухоплова кроз усавршавање и уградњу техничких система (уређаја и опреме), како ваздухопловних, тако и земаљских.

Кључне речи: безбедност летења, војни ваздухоплов, поузданост ваздухоплова