# HUMAN FACTOR IN FLIGHT SAFETY

## A REPÜLÉSBIZTONSÁG EMBERI TÉNYEZŐI

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*Abstract*

*The aim of the article is to identify types of errors and to characterize selected conditions causing the occurrence of the human factor, and as a result of the aviation accident. Analyse selected human factor accidents motivated by selected errors and present current and future solutions to reduce human factor involvement in aviation accidents. The main research problem was formulated as a question: How does the human factor affect the safety of aviation flights and what are the ways of reducing it?*

***Keywords:*** *aviation, human factor, flight saftety, Safety Management System*

*Absztrakt*

*Jelen közlemény célja, hogy azonosítsa azokat a típusú hibákat, valamint jellemezze azon emberi tényezőket, amelyek légi katasztrófákat okozzák.*

*Emberi tényezők miatt bekövetkezett balesetek kerülnek elemzésre, és a jelenlegi és a jövőben alkalmazható megoldások bemutatásra, hogy milyen módon lehet csökkenteni az emberi mulasztásból bekövetkezett légi katasztrófákat. A legfőbb kutatási kérdés megfogalmazható egy kérdésben: Hogyan befolyásolja az emberi tényező a légi közlekedés biztonságát, és milyen módon lehet csökkenteni annak negatív hatásait?*

***Kulcsszavak:*** *repülés, légi közlekedés, emberi tényező, repülésbiztonság, Biztonság Irányítási Rendszer*

# INTRODUCTION

Human is an element of the anthropotechnical system, oriented on flight safety. The term "human" in aviation conceals a lot of meanings, it is the organizer of an aviation organization, a designer, a constructor, a mechanic, a meteorologist, a navigator, a controller, a pilot, a cabin crew member or even an ordinary passenger. Incorrect operation in any of these areas can lead to an air crash. Apart from human, the flight safety system also includes: environment, task and technology, management. In all of these elements a human plays a key role in making him responsible for the function he performs, the decisions he makes, and the responsibility for the consequences of those decisions. Flight safety is a priority for every aviation institution and organization, including people. The people who create these institutions and organizations supervise the other elements. Despite the development of technology, the deployment of new technologies, and the ongoing automation of many tasks by only devices, human remains are controlling the operation of the technical systems, which is the decisive factor in the flight safety system.

The human factor in the most general sense is the human action (incorrect), which has contributed to the occurrence of an aviation accident. Human's way of doing things consists in many things: training, communication or psychophysical parameters. Hence, the sources of errors may be: weaknesses during training, communication problems or abnormal psychophysical conditions. Despite regulatory modifications, increasing awareness and analyses of already-existing air accidents, the human factor continues to be a major threat to flight safety.

The main research problem was formulated as a question: How does the human factor affect the safety of aviation flights and what are the ways of reducing it?

In order to solve the main problem, detailed research questions were asked in the form of questions:

1. What are the types of errors that result in aviation accidents and what are the conditions that favour these errors?
2. What is the impact of the human factor on the safety of air operations?
3. What actions are being taken to limit the impact of human factors on the occurrence of aviation accidents?

In the process of verifying the above questions, research methods such as critical analysis of literature, articles, publications, synthesis of acquired information, analysis of acquired materials, comparisons, analogies, abstraction, inductive and deductive inference of the described problems were applied.

# HUMAN FACTOR IN THE FLIGHT SAFETY THEORY

Flight security is the basis for a reliable aviation activity, which consists of many elements. The definition of the concept of *flight safety* should be clarified. By introducing the concept of factors, *safety* itself means *the state in which the risks associated with various types of aviation activities, related or directly support aircraft operations are reduced to an acceptable level and controlled.*[1] *Flight safety* means *the conditions under which a flight may be carried out by an aircraft without danger to the safety of the crew, passengers and the aircraft itself and to the population and ground equipment.*[2] Generally speaking, flight safety is a system of many

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[1] Annex 19 to the Convention of The International Civil Aviation: Safety Management, ed. I, ICAO 2013.
[2] Military knowledge literature: Publishing house MON, ed. I, Warsaw 1979, p. 40.

elements which, by common interventions, prevent emergency situations and, in the event of such a situation, minimize their consequences.

This system consists of elements such as:
- − Aircraft, its capabilities and properties;
- − A man with mental and intellectual predispositions, including preparation for airborne tasks, security and flight insurance on the ground;
- − Mision;
- − Environment;
- − Aviation management system

The term human refers to the concept of human factor. The definition of this concept is many, depending on the source Human Factor (HF) is: *Inadequate actions of pilots and other people closely related to the system of activities related to organization, security and flight, which caused or threatened the accident , when it was triggered by factors independent of the human, and there were real opportunities to remove or reduce the threat[3]*. By contrast, Annex 11 to the Convention of International Civil Aviation - The air traffic services, defines human performance as *defined by human capabilities and constraints that affect the safety and effectiveness of air operations*.

The human factor in aviation concerns the actions of people involved in a particular aviation task, including human skills and everything that limits a person. In addition, the human factor is related to the environment in which a person performs his professional duties and influence. It should be noted from the above definitions that the human factor in aviation does not apply only to "in the cockpit", the "human" refers to any human being associated with a given aviation operation whose action may result in the occurrence of a human factor. The human factor is currently identified as the cause of 80% of civil aviation accidents according to ICAO (International Civil Aviation Organization), as shown in Table 1.

| Accident causes | Number of accidents [%] | |
|---|---|---|
| | All kinds of transport | Aeronautical transport |
| Human factor | 50 | 80 |
| Technical defect | 30 | 10 |
| Enviroment | 10 | 5 |
| Other (unexplained) | 10 | 5 |

**Table 1.** Causes of aviation accidents according to ICAO
*Source: S. Augustyn's book  in: Pilot decision model for safe helicopter use, AON, Warsaw, 2009.*

This fact demonstrates the magnitude of the human factor in aviation and its validity as the most common cause of aviation accidents. Other causes such as technical damage, environmental impact, and other causes represent a small percentage of accidents against human error. Given the huge contribution of human factors to aviation, the more important is

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[3] R. Błoszczyński:  Air Psychology - Selected Issues, MON, p.472

the presentation of selected types of human error, motivating this factor and analyzing the accidents caused by them.

## TRAINING ERRORS AS A CAUSE OF THE OCCURRENCE OF HUMAN FACTORS IN AIR ACCIDENTS IN AVIATION

Aeronautical training is an inherent and essential step in the aviation environment of any person intending to work in an aviation organization. Aeronautical training covers both pilots, operating personnel, controllers, navigators, cabin crew, security personnel, mechanics, engineers, aerospace executives including planners and managers. Each participant must undergo training in the performance of their work, training varies in purpose and subject matter depending on the specialty of the training group. The priority for training in aviation is the establishment of an appropriate program that includes the phases:
- Theoretical training related to the acquisition of aviation knowledge (for all types of aviation personel);
- Practical training on both land and flight, involving the acquisition of practical qualifications (applies to all types of pilots, flight mechanics, navigators, on-board radio, parachute jumpers);
- practical training on the ground (for service technicians, flight dispatchers, air traffic controllers, air traffic information service);
- Supplementary practical training conducted by aeronautical surveillance (applies to practical training instructors with license entry, professional pilots / parachute jumpers, entitlements related to the type of service and type of aircraft with the entry into the service authorization certificate).[4]

Aviation belongs to this area of the economy of the state, which needs specially selected personnel. Aviation organizations emphasize the selection of staff who will perform their duties reliably, aiming at achieving the organization's goals and maintaining the desired level of safety. Training is therefore the basis for an adequate understanding of the needs of the organization and the performance of the tasks entrusted as expected. It allows you to consolidate basic and desirable behavior patterns in specific situations, influences the maintenance of an appropriate level of skill, and teaches new, useful skills related to changing procedures or tasks. Aerial training allows for the efficient execution of aerial tasks and the maintenance of crew, handling or securing personel in appropriate condition and efficiency to perform assigned tasks. An important role, in the context of training, is the source of errors made in aviation, which affect the air accidents. Major problems can be in perception, decision-making, and action during information processing phases. Decision making is influenced by the results of selected activities, so it seems most important in the training system. Impact on decision making, they have factors like:
- Type of training;
- Emotional or commercial pressure;
- Fatigue;
- Motivation;
- Psychological factors.[5]

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[4] B. Grenda: Training of Flying and Security Personnel for Civil Aviation, AON, Warsaw 2013, p. 26.
[5] A. Isaac, B. Ruitenberg: Air Traffic Control: Human Performance Factors, England 1998, Ashgate, s. 26.

Decisions are made in everyday life even in the simplest of ways. In aviation the wrong decisions result in an aviation event often catastrophic as a result. This makes the ability to choose an element that contributes to safety as a priority in aviation. By combining human factors, training and decision making, the strong dependence of these elements is evident.

## ERRORS IN THE RECIVING OF INFORMATION AS A MOTIVE INFLUENCING THE OCCURRENCE OF HUMAN FACTORS IN AIR ACCIDENTS

A mistake is called unintentional action, unconscious, resulting from lack of knowledge or ability but not intentional. There are three types of errors, namely: training errors - relating to aircraft piloting techniques, decision errors related to wrong decision making, and errors in receiving information, the causes of which are many, and the most common ones are differences in language accents or communication problems. Making mistakes is one of human nature and is an integral part of humanity. Errors are the result of improper means of orientation, decision making, or performance.[6] The purpose of communication is to provide the most important data, tips and guidelines for taxiing, flight, route or weather.

Aviation communication involves both the flight crew, the cockpit, the onboard crew, communication between the aircraft and the ground (eg during taxiing, landing, landing permission or weather information), as well as communication between mechanics and pilots , management with staff or mechanics among themselves. In each case, it is important that the communication is clear, and understand the most important information pertaining to the task being performed. There are many threats that cause communication errors or information loss, those are:

- Disturbances in the information transfer process involve transmitting information in an incomprehensible, unclear or complex way. Including language problems;
- Communication difficulties, noise, interference, or difficult to read;
- Disturbance of reception of information regarding misinterpretation of information;
- Physical problems related to poor reading skills, hearing loss, non-use of corrective glasses[7]

Ambiguity or complexity of information leads to loss of time by the recipient to understand the message. Time in aviation is very valuable, tasks are usually performed in a specific time deficit, which causes a greater sense of stress, so it is important to provide clear information. In addition, the language of aviation is English. Depending on the country or region of origin, the accent of that language will be different, which in turn may cause it to be incomprehensible to a citizen of another country. For example, communication between an air traffic controller and a pilot arriving in a foreign country may lead to a misunderstanding resulting from accents differences, or the use of abbreviations and additional distortions for example due to disturbance of communication, which implies the occurrence of a dangerous situation at the most critical moment of the flight, and as a result of even an aviation accident. Communication is a very important aspect that should be emphasized during training and taken into account by the personnel involved in the organization. Emphasis should be placed not only on the mistakes that can be made in the communication process, but also on the various types of communication obstacles. We can specify the obligations that apply to both the sender and the receiver:

The duties of the broadcaster include:

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[6] E. Klich, J. Karpowicz: Flight Safety and Aviation Protection against Unlawful Interference, Warsaw, AON 2004 p. 63
[7] See: Presentation: Human error. Models and theories of error, Civil Aviation Office, 17.01.2009, sl. 7.

- − Clear information;
- − Accurate information at the right time;
- − Request for verification and feedback;
- − Expressing plans by words

The responsibilities of the recipient include:
- − receipt of the message;
- − Repeat information;
- − Paraphrasing information;
- − Clarification of information
- − Providing helpful feedback, which allows you to determine if the information received has been received and decoded correctly.

All these efforts are aimed at eliminating information reception errors. According to the basic principle of information transmission: *Information should be short, clear, unambiguous and by the addressee received, understood and confirmed*.[8] This ensures correct reception of information and avoids unnecessary errors. Without information, a human being cannot do much, and without the necessary guidance or data necessary to perform a task like aerial operations, it is impossible to do so. In addition to the usual information, the reliability and clarity of their transmission should be taken into account in order to correct errors. Information as a source of knowledge should be appreciated and conveyed respectfully to the sender, the receiver and the message itself, creating a clear message for the safety of operation.

## PSYCHOPHYSICAL DETERMINANTS AS A SOURCE OF HUMAN FACTOR IN AVIATION ACCIDENTS

Psychophysics is *a department of psychology that deals with the study of sensory impressions, in terms of detecting the relationship between the physical properties of the stimuli and the corresponding sensory properties*[9]. There are lots of stimulants in the profession of aviator, and there are often a few of them at once, giving rise to many sensations. In the case of pilots, they are associated with the acquisition of information, both auditory and visual, by monitoring the flight parameters - mainly by visual, environmental and consequently - altitude, temperature and pressure, and by the physical performance of flight maneuvers. In connection with these stimuli, a person undertakes a specific action, and this action must be appropriate to the situation and lead to the desired result. Emotions are an inherent part of humanity, and each human action produces a variety of emotions. Often, thanks to emotions, a person can perform a given task better, focus more on him, and be more effective. Emotional awakening can also contribute to lowering the level of the task or discouraging the task. The emotions experienced relate both to the outside of the person but also to the interior. Studies on this subject indicate two types of emotional reactions in this regard, one is a stenotic response - stimulating external activity, the other a asthenic response - stimulating internal activity but not stimulating the general activity. Both of these reactions can lead to emotional disturbances.[10] According to the literature of the

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[8] R. Makarowski, T. Smolicz: Human factor in aviation operations. Man, opportunities and limitations- psycho-physiological conditions, Adriana aviation, Kosovo 2014, p. 249
[9] Knowledge Portal: Psychophysiologic, in: http://portalwiedzy.onet.pl/37491,,,,psychofizyka,haslo.html [access: 17.10.17.]
[10] Aeronautical Psychology: edited by R. Błoszczyński, Ministry of National Defense Publishing House, p. 192.

subject, due to the complexity of the work, the profession of the pilot is included in professions exposed to the higher probability of emotional disturbances that affect pilots very often.

There were two types of emotional disturbances of pilots:
- − Acute anxiety reactions – which affect the drug before an air accident (such anxiety usually goes away, but can also deepen, leading to sleep disorders, nightmares, lack of appetite);
- − Chronic anxiety – related perceptual stress (symptoms include anxiety, phobias or psychosomatic reactions)

The profession of a pilot is undoubtedly a difficult one. Level of responsibility, complexity of tasks, continuous monitoring of instruments, compliance with procedures, environment, all these elements, as well as many others, force pilots to focus, attention, error, accuracy and speed of decision-making due to time deficit. All these activities are also very common at one time. Each action triggers a given emotion, which indicates the difficulty level of the pilot's work, so attention is paid to the conditioning of the psychophysical pilot / future pilots.

Beyond emotions, stress is an important part of the pilot's or aviator's work. Stress is understood ambiguously. Stress is such a condition that causes irritation or excitement and defect, it is also a fear of a situation, a feeling of tension, uncertainty or a feeling of lowering the body's ability (various kinds of pain, dizziness). Compliance, however, is about the types of stress that are divided into biological and psychological. Physiological stress is related to the human and the body, while psychological refers to the human response to the occurrence of a complex situation or accident. This stress manifests itself in the emotional disorders described above. Stress reduces the body's ability and consequently discomfort and reduced human performance. Due to the above-described psychophysical conditions, pilots and other people involved in aviation activities are on the one hand subjected to continuous situations requiring high concentration and coping skills in emergency situations and, on the other hand, they are affected by stress and, as a result, emotional and lowering the level of the task performed. This makes aviation, the domain of a highly threatened human factor, aimed at continually monitoring this factor in achieving its objectives.

The study makes it possible to make the following conclusions: Making mistakes is a human nature, while at the same time causing unwanted effects of the actions. Training, as the name implies, develops and maintains correct habits and knowledge. Communication in aviation is a very important and demanding element in the performance of aviation tasks, strongly influencing the results of actions taken in the field. Presented errors and conditions neglected or unnoticed in time contribute to the occurrence of the human factor and, consequently, the aviation accident. Those are main reasons, why training, communication and psychophysical determinants should always be monitored and maintained at the highest level.

## CHARACTERISTICS OF AIR ACCIDENTS IN CIVIL AVIATION

At the outset, the concept of an incident should be clarified and the classification of events in the common interest should be presented. An aviation accident is the most common term *and is related to the use of an aircraft by a crew and occurs when it has, or could have, an impact on the safety of the flight or the occurrence of an aircraft crash. An aviation accident means anything that happened during an aircraft use, including: deviations from aviation standards and procedures, aviation incidents, aviation equipment damage, and aviation crashes.*[11] An

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[11] E. Klich, J. Karpowicz: Flight Safety and Aviation Protection against Unlawful Interference, Warsaw, AON 2004 p. 22.

aviation accident, so all that has a negative impact on aviation safety, and what is integrated with the operation of aircraft.

| Air accidents | |
|---|---|
| Air incidents | Air crashes |

**Table 2.** Classification of civil aviation incidents
Source: E. Klich, J. Karpowicz in: Safety of flights and protection of aviation against acts of unlawful interference, Warsaw, AON 2004.

Air Incident - *this is an accident involving the operation of an aircraft other than an air crash that had or could have had an adverse effect for operational safety[12]*. In addition to the aviation incident category, there is *a serious aviation incident defined as an air incident whose circumstances indicate that there has been an aviation crash.*[13] This is an incident where neither the crew nor passengers have suffered any injury and the aircraft is capable of further flight, but has contributed to the safety of the flight. Another type of civil aviation incident is an *air crash defined as: an accident involving the operation of an aircraft that has occurred since any person entered the aircraft with the intention of making a flight until the aircraft was abandoned by all people on boardand during which any person has suffered at least serious injury or the aircraft has been damaged or has destroyed its construction or the aircraft has been lost and has not been found and the official search has been canceled or the aircraft is located at a location not accessible to.*[14]

## AN AVIATION DISASTER CAUSED BY AN ERROR IN THE RECEPTION OF INFORMATION IN AVIATION

An example of an aviation event caused by communication errors is a catastrophe that took place on July 1, 2002, in the airspace of Germany over the town of Überlingen. The disaster concerns two planes, one among them is a passenger plane, produced by Russian Tu-154, flying from Moscow to Barcelona, the second plane belonged to DHL and it was a transport aircraft, type Boeing 757, which was flying from the Italian city- Bergamo to Brussels. It is worth noting that the number of Russian crew was 5 people (two controllers, two pilots and a navigator) due to the pilots' test flight[15].

Despite the location of aircraft over the territory of Germany, responsibility for control of the airspace in this place was subjected to ATC located in Zurich in the territory of Switzerland and only one controller was operating that day. When the controller in Zurich realized the collision course of the aircraft he ordered an Russian Tupolev crew to lower the flight level by 1,000 feet. Despite the fact that aboard, the anti-collision TCAS[16] system recommended climbing, Tupolev's crew complied with the controller's order lowering the flight. TCAS, after identifying collision risk, sends information to aircraft crews, recommending, for example, one climb and the other lowering to avoid collisions. In the case of this incident, it was Tupolev's

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[12] Ibidem, p. 14
[13] Annex 13 of the Chicago Convention:  Aviation Accidents and Incidents, Tenth Edition, July 2010, p.1
[14] E. Klich, J. Karpowicz: Safety of flights and protection of aviation against acts of unlawful interference, Warsaw, AON 2004 p. 21
[15]Air Crashes Portal: Berlingen Accident, in:
http://www.katastrofylotnicze.8log.pl/wpisy/43175/zderzenie_nad_%C3%A3%C5%93berlingen_(71).html
[dostep: 14.10.2017].
[16] TCAS – Traffic Alert and Collision Avoidance System.

crew to rise higher, and the crew of the DHL plane was to lower the ceiling according to the system recommendations. However, the Russian crew followed the controller's instructions while the Boeing crew followed the system command. As a result of these circumstances, both machines began to lower the flight, still in the collision direction. Boeing's crew informed the controller of the downgrade, but the information did not reach the controller, probably did not hear it. As a result of the machines collision, the DHL plane cut off the Russian – Tupolev aircraft, all on both planes, died because of accident. As a result of the disaster, Zurich's air traffic control systems were shut down for maintenance; There was only one controller on duty, who could not connect to another control center; Additional support for another plane at the same time as unplanned flight; The uncleanly formed aeronautical regulations which, at the time of the incident, did not clearly determine what to choose if the information provided by the system was contrary to the information coming from the controller.[17] Another reason for the misinformation was the failure of one of the antennas in the control center, which the controller did not know.

Starting from an inadequate number of service controllers who could track the situation together, the failures of the systems and the antennas in the control center until the lack of a telephone connection that would allow the controller to connect to another center and end up with a controller in Zurich was a catastrophe. Evidently it would not have been if the information system and the communication between the tower and the crew were correct. The lack of a second controller – who could supervise the situation and correct communications irregularities if needed –  resulted in the workload of one person. The night time in which the event occurred may additionally indicate fatigue of the controller and its effectiveness. There is also an abnormal information system between the ground personnel at the control center who has not communicated with the controller about switched off the main antenna. The controller was not aware that if the TCAS system was on board – one of the airplanes will not get him information about this. Another downside to the flow of information was the disabled telephone system, which enabled the controller to establish contact with another center. The controller was also unaware of the operation of the external telephone line, which would allow him to contact the German controllers, who were aware of the situation of both planes on the basis of their own radar. In addition, the aviation rules did not indicate how to make a decision in the event of discrepancies between TCAS information and those from the controllers. Tupolev pilots decided to listen to the controller's recommendations despite the fact that the system was the only right. Boeing pilots reported a decrease in altitude as recommended by the system but the controller did not hear this information. If it were known, the situation would not be tragic. Despite a prior recommendation to the Tu-154 descent, he would have advised the Boeing crew to climb, which would also be contrary to TCAS recommendations, but would not result in a collision. The given incident analysis reveals not only errors in the reception of information such as bad communication between the controller and the crew or a lack of understanding or misunderstanding of the message. The accident analysis also points to other errors that affect inaccurate internal air traffic control in Zurich, so the controller was unaware of switching off the systems and the central antenna at the center. The controller also did not have information on a working external telephone line that would allow contact with another center. Communication disturbances and many negligence have resulted in the described accident. Communicating in the present world is very short, fast and often inaccurate. In aviation it is

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[17] Air Crashes Portal: Berlingen Accident, in:
http://www.katastrofylotnicze.8log.pl/wpisy/43175/zderzenie_nad_%C3%A3%C5%93berlingen_(71).html
[checked: 14.10.2017].

also required to make a message and deliver it in the shortest possible time, but it is important to ensure that the information is comprehensible and serves a safe flight.

## MEASURES INTRODUCED TO IMPROVE TRAINING IN AVIATION

In order to guarantee high qualifications of personnel and safety, the training system is constantly being improved with new ideas and procedures. Considering staff responsible for handling and managing airworthiness of aircraft on the fly, as well as staff responsible for planning and management, the main purpose of the training is to raise awareness and understanding of efficiency constraints, your own and the others, as well as the limitations associated with the human factor as an system component. In addition, the specific objectives of the technical personnel training were appointed and focus their attention on:
- the concept of the HF and its importance in the technical service of the aircraft;
- presentation of human factor requirements and recommendations in organizations responsible for continuous airworthiness management and aircraft organizations;
- clarify the limitations that arise from HF, both in terms of system and individuality, which affect safety and airworthiness of the aircraft;
- creation of skills related to HF, important for safety, quality and efficiency (including: communication, teamwork, problem solving, task management, procedures);
- popularizing awareness, responsibility, and activity in the attitude of aircraft service;
- instructing to develop a HF program in organizations.[18]

Training is intended to raise awareness and promote the attitudes responsible for the task being performed, which is related to safety. It is highly important to provide training objectives and detailed implementation in order to prevent mistakes in the future and to identify errors already committed. Management is responsible for shaping the organization's policies and the rules that apply to its employees, so it is important to educate the staff, to make them aware and to identify the security threats they face in order to minimize them to the right level.

A relatively new trend for aviation is the SMS (Safety Management System). In order to increase the safety of air operations, ICAO - International Civil Aviation Organization, together with the European Union, has taken the initiative to introduce SMS. In May 2012 ICAO decided to implement a new Annex to the Chicago Convention No. 19 - Safety Management, which deals with the Safety Management System. Following the recommendations of the ICAO and the EU, each aviation organization is required to draw up, initiate and maintain a management system that includes, inter alia, a provision for adequate training and staff competence to enable it to carry out its tasks. With SMS, staff training will help reduce the likelihood of making a wrong decision, and aviation organizations will be able to more effectively identify and prevent threats, and thereby achieve the most important SMS goal, which is to increase safety.[19] The SMS is applicable to all, new law acts also apply to all aviation schools. This also applies to carriers, service organizations, manufacturers, organizations responsible for continuing airworthiness management. The new law is constantly being developed and disseminated. According to preliminary findings, SMS is to be introduced in the entire aviation industry by 2018. Another way to improve the crew preparation stage is Crew Resource Management (CRM). Generally speaking, the rules that govern CRM are a way of using existing standards,

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[18] I. Leszczyńska: Human Factor in Technical Service of Aircraft, Presentation, Civil Aviation Office, Warsaw 2009, p. 7.
[19] Civil Aviation Administration: SMS as part of the ATO management system, Presentation, Spała 2013, p. 21

rules, law, and experience, and observing the various types of accidents and situations that occur in aviation. Crew resource management is a way of gaining knowledge and learning cooperationwith other crew members also influencing human behavior to ensure a high level of safety. CRM refers to any person working in an aviation organization directly related to safety. In addition, the categories of behaviors that are the subject of CRM training are defined:

- situational awareness - is related to perception and attention components;
- task management - involves factors related to the procedures for setting priorities for cognitive load;
- decision-making - involves assessing and taking action on the level of risk of a particular task;
- job analysis - refers to the analysis and planning processes during the flight, as well as issues discussed during pre-flight check-in;
- communication - refers simultaneously to the exchange of information inside the cockpit, as well as the way and quality of communication with the external environment;
- coordination of the crew - refers to the leadership processes of subordination in a passive or active way.[20]

Management of crew resources is a continuous process that can not only be applied in daily work situations. CRM is used in the training process and improved during the performance of the tasks. All of the ways described in this subsection are designed to increase the level of training and make the right decisions by presenting the human factor, with emphasis on training in the field, and shaping the right policy in the organizations that put safety first.

## CHANGES INTRODUCED TO IMPROVE COMMUNICATION AND INFORMATION RECEPTION IN AVIATION

The process of communicating, receiving and processing informationis the basic way to obtain the necessary data and the necessary informationfor the proper control of the aircraft by the crew. Every maneuver carried out by the pilot is warned by the right amount of information to make the correct decision and execute the maneuver, which during flight forces the pilot to realize the position of the plane. The information comes to crews from different sources, from the ground, from crews of other aircrafts, on board crew and from the second pilot. The amount of information that reaches the cockpit from the moment of taxiing on the airport until the plane will land is very large. As a result of the amount of information and the technical complexity of the aircraft, the division of responsibilities between pilots, which strictly identifies the areas of information received and the actions performed, divides them between the two pilots. Pilots are therefore divided into: Pilot Flying (PF) and Pilot Not Flying (PNF). Taking the example of the most critical and demanding part of a flight which is landing, the division of information and tasks is as follows:

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[20] R. Makarowski, T. Smolicz: Human factor in aviation operations. Man, opportunities and limitations - psycho-physiological conditions, ADRIANA AVIATION, Kosovo 2014, p. 206.

| Pilot Flying | Pilot Not Flying |
|---|---|
| Responsible for: Receiving, some information about the flight, namely: speed, altitude, vertical speed, course, indication ILS, Marker signals controls the aerodynamic controls of the aircraft and the power of the engines. | Is responsible for: communication, navigation, cockpit service, landing gear ste up and landing flaps. Turns on lights and headlights, serves aircraft installations, and also monitors PF pilotage |

**Table 3.:** Division of information and tasks between PF and PNF
*Source: R. Makarowski, T. Smolicz In : Human factor in aviation operations. Man, opportunities and limitations - psycho-physiological conditions, ADRIANA AVIATION, Kosovo 2014, p. 206.*

The data provided on the information received by PF and PNF and their quantity, it is clear how important is the division of responsibilities of pilots. The greatest responsibility lies with the flying pilot, which focuses on the most important data needed to execute the maneuver. The landing maneuver is referred to as the hottest moment of the flight and it is estimated that due to crew malfunctions, as many as 90% of the accidents occur during landing approach. Designation of PF and PNF is a great help in the division of responsibilities between pilots, thus eliminating the communication errors that may arise from the excess of information not always needed only by the pilot. Thanks to this solution, the pilot can focus on the most important information by performing a specific maneuver, while the monitoring pilot monitors the operation of the other equipment, receives other messages and supervises the PF activities, which ensures efficient communication between the crew, exchanges key information and results in correct maneuvering.

Another way to improve in-team communication and efficient flow of information is Briefing, which aims to discuss desirable flight operations related to various situations that must be identified and planned in advance. When talking about the briefing, it should be remembered that *the biggest mistake a commander is to be surprised by an unforeseen situation,* In other words: *the task of briefing is to counteract the surprise.*[21] Briefing is both a preparation for physical action in the event of unusual occurrences and a realization of the possibility of such occurrences, thereby reducing the level of stress that could occur as a result of complete surprise. There are two forms of briefing: before the flight and before approaching. Explaining the specificity of the briefing, it is important to note that before each flight, the flight crew receives a number of documents that provide all information about the planned flight, its route, expected weather conditions, information about previous crew activities for various types of repairs or aircraft inspections, or warning information. It is up to the crew to know the data and, if necessary, to make changes that, according to pilots, will be a better solution for the planned flight. During the analysis of the mentioned documents and the large amount of data contained in them, the crew is aware of the conditions under which the flight will be carried out so that the analysis can predict different situations. It also happens that the documentation does not work well and also for such variant the crew must be prepared. It is stated during the briefing that the plan of action in unforeseen circumstances requires decision-making based on

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[21] R. Makarowski, T. Smolicz: Human factor in aviation operations. Man, opportunities and limitations - psycho-physiological conditions, ADRIANA AVIATION, Kosovo 2014, p. 253.

observations of the current situation and practices from the past. It often happens that, as a result of an unusual situation, the crew must make their own decisions without informing the carrier. During the briefing, these situations are anticipated, defines correct reactions and actions, and distributes tasks between crew members. This forward-looking analysis of the likely circumstances that may occur during the flight greatly facilitates communication between the crew, prevents unnecessary information exchange, shortens planning time, anticipates the facts, and delineates the division of responsibility by eliminating the chaos and additional stresses that may occur in an emergency situation. Both the FP and NFP division as well as the briefing sail to clarity of communication eliminating unwanted bugs and streamlining the process of transmitting information.

## ACTIONS INTRODUCED TO REDUCE THE NEGATIVE IMPACT OF PSYCHOPHYSICAL CONDITIONS ON THE OCCURRENCE OF AVIATION INCIDENTS

Psychophysical determinants are an inherent part of human existence. These habits result in human behaviors, feelings, emotions, impressions, and as a result - the way in which a situation is dealt with. Thanks to emotions people are able to adapt to the new situation and the new conditions in which people work. It can be stated that emotions are the determinant of human activity. In spite of established operational procedures, national or international law, many regulations - it is through emotion that human finally decides, these processes occur both consciously and unconsciously. A human who does not have higher feelings can not make decisions regardless of his level of training, experience or skill.

The condition to take action is, therefore, to have an emotion.

According to research conducted by R.M. Yerkesa and J.D. Dodson in 1908, there was a relationship between the degree of emotional excitement and the quality of the task. Two rights have therefore been formulated:

    − I Yerkes - Dodson Law: With increasing activation, the performance level increases to the optimum and decreases with the maximum.

    − II Yerkes - Dodson Law: The harder the job, the lower the degree of excitement is enough to achieve maximum efficiency.
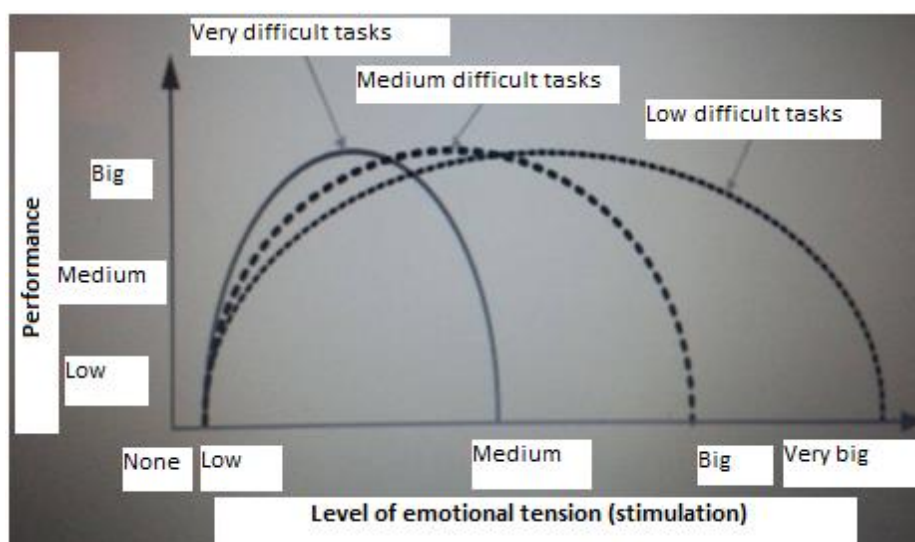


**Picture 1.** II Yerkesa-Dodson Law

Source: R. Makarowski, T. Smolicz: In: Human factor in aviation operations. Man, opportunities and limitations - psycho-physiological conditions, ADRIANA AVIATION, Kosovo 2014, p. 124.

Which means that when the task is easier, the more stimulation it requires, in contrast to more difficult tasks that require less emotional stimulation. The optimal stimulus level is assigned to the average level of complexity of the task. It is not possible for all tasks to be of the same level of difficulty, so attention should also be paid to other factors influencing decision-making.

Another factor that strongly influences human performance and decision-making is stress. A condition that contributes to the improvement of human resistance to stress is to have good health. Aviation is a field where special attention is paid to the state of health. This not only applies to new employees but also to those who already have their aviation duties. The health of the aviator is constantly monitored and staff are periodically monitorem. Taking into account the work of an air traffic controller or flight crew, the health of these people can not raise any doubts as to the liability of the occupants. A controller who neglects worsen of his health puts at risk all the people he is responsible for. Depending on the type and cause of poor health, the level of danger increases. The crew must be resistant to work in varying physical conditions, overload, pressure or temperature changes, must act quickly to counter fatigue, and all of these elements, with worsening health, increase the risk of error and dangerous situations. Another way to reduce stress is the classification of personality categories definited by Hippocrates. Classifying a person according to this division allows you to determine how it works or the type of reaction in a given situation.



**Picture 2.** Four types of personality according to Hippocrates
*Source: R. Makarowski, T. Smolicz: In: Human factor in aviation operations. Man, opportunities and limitations - psycho-physiological conditions, ADRIANA AVIATION, Kosovo 2014, p. 139.*

Currently, terms are used according to the colors they mean:
- Melancholy / cool blue - meant depth and personality tendency to depression. At present: low endurance, high emotional reactivity, low activity;
- Phlegmatic / green soothing - was responsible for stability, calmness and passivity. Present: low emotional reactivity (means calm), low activity;
- Sangwinism / Sunny yellow - was associated with energy and optimism. Today: great information processing capabilities, high endurance, low emotional reactivity (calmness), high activity;
- Choleric / Fiery Red - was responsible for controlling anger. Currently: high emotional reactivity, high activity.

This model is useful when working with a frequently changing co-worker (eg captain - first officer) and during the selection of candidates or interviews. With this model, you can determine personality of the other person, their predisposition to work or the way they cooperate with you. Considering the number of long-haul flight crews, for example, three pilots, apart from a clear division of responsibility during a pre-flight briefing, crew members flying for the first time should have the ability to identify a co-worker. This skill is useful for quickly understanding the characteristics of a cooperative, how it reacts to a given situation, and how to prevent misunderstandings due to differences in character. Depending on the type of personality, there is also a way of communicating with the other person. According to the literature of the subject as one of the personality traits, it is stated that if a person is convincing and dynamic, and besides, he talks a lot, gesticulates, needs acceptance, loves to be loved, is the soul of the company that means he is also strong, calm and has great predisposition to message processing. The other person should be able to cast their vote and focus much attention on it, showing interest as well as being able to show up on the topic. For each personality, stressors, stress and antidote were also identified. The knowledge of this categorization is very useful and allows you to put an order in communication and cooperation with people who are familiar with these principles. By properly receiving the other person, according to her expectations, stress can be and save time from unnecessary communication.

## CONCLUSIONS

The human factor has long been a serious threat to flight safety and has a profound effect on it. It has often led to catastrophe, but the experience gained from such aviation accidents has enabled the development of preventive measures that have consequently improved the level of flight safety. Existing methods to prevent human errors as a cause of accidents are right and they do their job. The only difficulty in trying to completely eliminate the mistakes made by operating personnel are the psychophysiological factors of human. Human Factor is a human who, in pursuit of the highest level of safety, designs the aircraft, creates the aviation law and procedures, operates the aircraft on the ground and in the air, and manages the aviation organizations by introducing all the methods described in the article. In order to reduce the possibility of mistakes, attention should be paid to improving professional qualifications, increasing knowledge and improving the practical skills of aviation related people. In view of the dynamic development of aviation and the continuing need to ensure a high level of aviation safety, this issue requires continued research in this area to incessantly monitor and maintain required level of safety.

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