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Risk Factors Management for Flight Safety Improvement Purposes

Gestión de Factores de Riesgo para Mejorar la Seguridad de Vuelo

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Content

ABSTRACT:

This article explores the use of methods of identification of hazards, risks and risk management based on the "barrier analysis". The essence of the method is to identify the risk (the source of danger), to analyze the level of a protective "barrier" that prevents a hazardous situation, to monitor the status of the protection and to adapt or build new "barriers" when required, but to identify and apply measures to restore control of the risk and, if possible, to reduce the negative effects of the transition a dangerous situation in the aviation event in case of emergency. This publication presents for reference the information about the achievements and initiatives that help achieving the improvements in safety and also encouraging and inspiring the air transportation organizers to participate in development and implementation of innovative and practical programs to improve all aspects of flight safety.
Keywords: flight safety, identification of hazards, threats, risk management, safety concerns.

RESUMEN:

Este artículo explora el uso de métodos de identificación de riesgos, riesgos y gestión de riesgos basados en el "análisis de barreras". La esencia del método es identificar el riesgo (la fuente del peligro), analizar el nivel de una "barrera" protectora que evite una situación peligrosa, vigilar el estado de la protección y adaptar o construir nuevas "barreras" cuando Sino identificar y aplicar medidas para restablecer el control del riesgo y, de ser posible, reducir los efectos negativos de la transición una situación peligrosa en el evento de aviación en caso de emergencia. Esta publicación presenta para referencia la información sobre los logros e iniciativas que ayudan a lograr las mejoras en seguridad y también alentar e inspirar a los organizadores del transporte aéreo a participar en el desarrollo y la implementación de programas innovadores y prácticos para mejorar todos los aspectos de la seguridad de vuelo.
Palabras clave: seguridad de vuelo, identificación de peligros, amenazas, gestión de riesgos, preocupaciones de seguridad.

1. Introduction

ICAO recommendations are aimed at transitioning the operators to the safety management system with proactive methods based on the identification of hazards and threats by monitoring daily activities instead of on the results of investigation of the events (accidents/incidents). Routine monitoring is aimed at pooling the data for analysis, synthesis and flight risk management.

The objective of the safety management system is to determine the causes of accidents and to take relevant actions for preventing them. The effectiveness is determined by the future causes repetition factor as the more accurately the causes and recommendations are identified the better the quality of their implementation for the improvement of safety becomes.

2. Safety concerns determination

The main objective of flight accidents investigation is to find out the facts, conditions and circumstances relating to the accident, to determine the probable cause and take appropriate measures to prevent a recurrence of the accident and factors contributing to it (*Doc 6920-AN/855)*.

Safety management is aimed at identifying hazards and managing flight safety risk factors and extends the projected field of activity to include human factors and human activities as the key safety issues during development and operation of the system (Ksenofontova 2013).

Hazards and risks management comes down to determining the dangers and assessment of the effectiveness of protective barriers at the first stage, the recovery and mitigation measures – at the second stage, monitoring of the situation at the third stage.

At the same time, the results of the accident investigation as the information related to the materialized threats should be also studied in order to use it to strengthen the protective "barriers" or mitigation.

The identification of hazards is an integral part of organizational processes aimed at the secure provision of aviation services.

Safety concerns can be determined after the actual events relating to the safety (accident/incident) or they can be detected by means of proactive and predictive processes designed to identify hazards before they cause the safety-related events (*Doc ICAO 9859-AN/74)*.

Examples of internal sources of hazard identification include:

• Analysis of the flight information collection system;

• system of voluntary reporting;

• checking the status of flight safety;

• monitoring the activities in normal conditions;

• incidents investigation and follow-up.

Examples of external sources to hazard identification include:

• newsletters;

• information exchange system;

• state system of compulsory notification (Decree of the Government of the Russian Federation No. 303 "On the Approval of the State Program of the Russian Federation "Development of the Aviation Industry in 2013-2025").

Flight Operations Safety Management System (FOSMS) should include at least:

a) The process of identifying the actual and potential sources of safety hazards and relevant risks evaluation;

b) The process of development and implementation of corrective actions necessary to maintain an acceptable level of safety;

c) The function of providing continuous monitoring and regular assessment of the adequacy and effectiveness of safety management measures (*Appendix 19 to the Convention on International Civil Aviation. Flight Safety Management")*.

The main modes of operation according to the FOSMS are as follows:

- Discussion (development) of a set of measures during the leadership meeting;

- Special classes for flights safety;

- Training flights;

- Methodical council meeting; sharing the experiences, error analysis, interviews, etc.

FOSMS operation provides:

- Study (clarification) of the normative legal acts and official documents governing the organization, implementation and maintenance of this type of work requirements;

- Study (identification) and analysis of safety concerns active with the FOSMS during a new type of work implementation;

- Planning the elimination (reduction of the impact) of all known hazards at the stages of preparation and performance of flights;

- Development (clarification) of security measures based on the stages of flight training type performance taking the actual deployment of helicopters in the upcoming weather conditions into account;

- Organization of monitoring of the preventive measures implementation and the compliance with safety measures at the stages of preparation and execution of flights (Zubkov and Minaev 1987).

3. Methods

It should be noted that despite the fact that the complete avoidance of accidents is highly desirable, achieving 100% security level is practically impossible. In spite of all efforts to prevent deviations and errors they will still take place as any artificially created system, particularly one related to human activity, cannot be considered safe and risk-free.

Adopted before approach to flight safety requires detailed regulation of all aspects of the aviation personnel activities and monitoring of compliance with increasingly complex regulatory requirements. This approach has allowed aligning the dynamics of accidents in the world till the end of the 1980s. However, incidents had continued and still continue to take place despite the created "modern" system of rules and regulations (Decree of the Government of the Russian Federation No. 303 "On the Approval of the State Program of the Russian Federation "Development of the Aviation Industry in 2013-2025"). As has been previously mentioned, the safety problems appeared along with the first flight on the aircraft. From that very moment, different accident prevention theories have emerged.

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The entire flight safety system has been oriented to the exclusion of the similar reasons adverse events repetition. And the world aviation community's efforts were aimed at ensuring compliance with minimum standards rather than at the definition and legal consolidation of best operation practices or the most preferred (desired) standards (Smurov, et.al. 2016).

Statistics show that with the frequency of fatal accidents equal to ten to the minus six power (one fatal accident per million flights) the usage of this approach for further enhancing the level of safety is very problematic.

Safety has always been a fundamental component in the activities of civil aviation. This is clearly reflected in Article 44 of the Chicago Convention, which explicitly defines the ICAO responsibility "for ensuring the safe and orderly development of international civil aviation throughout the world". Throughout its operations, ICAO aims to develop adequate flight safety measures (*Air Traffic Control",* n. d.).

ICAO conducts constant work aimed at ensuring the flight safety and improving the flight safety indicators all over the world due to the implementation of the following types of coordinated activities:

- Monitoring of the main trends and indicators in the field of flight safety.
- Analysis of flight safety.
- Initiatives to develop policies and standards.
- Implementing programs to address issues related to flights safety (*Risk Management"*, 2016).

4. Flight safety risk assessment and reduction

Risk management covers the assessment and reduction of risk factors for the safety-related consequences of hazards that threaten the production capabilities of the airline to the lowest practicable level (LPL).

Effective risk management should be aimed at the maximum benefit from taking/tolerating risk (reduction of time and costs) at the same time reducing the risk itself.

Risk reduction consists of measures to address this potential threat or reduce the likelihood and severity of the risk.

Risk analysis should focus on the identification and elimination and/or reduction to an acceptable level of risk threatening the organization operations through a balanced distribution of resources and real control of risks and their extent reduction (Zubkov and Minaev 1987).

The analysis of threats should be carried out during the air carrier's periodic analysis of the security status of flights and immediately upon the detection of any new threat.

Risk management includes five key elements:

- identification of safety concerns;
- analysis of the risk factors likelihood;
- analysis of the risk factors severity;
- assessment and the admissibility of risk factors;
- control and the ability to reduce the risk factors (Gubenko and Ksenofontova 2015).

Being associated with the effects of hazards, the process of taking the flight safety risk factors under the organizational control starts with the estimation of probability. The probability of the flight safety risk factors is defined as the possibility of an unsafe event or condition occurrence.

In assessing the likelihood of an unsafe event or condition occurrence, it is important to relate to the past years data contained in the "library of safety information" of the airline shown in Table 1 in order to make informed decisions.

TABLE 1. Probability of the unsafe event or condition occurrence

Probability of occurrence		

Quantitative definition	Meaning	Category
Often	May occur many times (has occurred frequently)	**5**
Periodic	May occur from time to time (occurred occasionally)	**4**
Rare	It is unlikely, but may occur (occurred rarely)	**3**
Unlikely	Very low probability of occurrence (cases of occurrence are unknown)	**2**
Next to impossible	It is almost impossible to imagine a situation in which the event can occur	**1**

Risk severity means the worst possible consequences of dangerous situations and hazardous events. The severity of the risk factors for the flights safety is defined as the possible consequences of an unsafe event or condition, while the worst foreseeable situation (Table 2) is taken for the benchmark.

TABLE 2. Risk factors severity (consequences of an unsafe event or condition)

Severity of the accident		
Definition	**Meaning**	**Degree**
Catastrophic	Hull loss Multiple human losses	**A**
Dangerous	A significant reduction of the "reserve factor", the physical pain or the workload level that does not guarantee clear and full implementation of the organization objectives. Serious injury of a large number of people. Serious airplane damage.	**B**
Significant	A significant reduction of "reserve factor", reduction of the organization's ability to overcome adverse operating conditions as a result of increased workload or because of conditions that reduce their effectiveness. Serious incident. Injuries of individuals.	**C**
Insignificant	Interference. Operational constraints. Use of emergency procedures. The possibility of the incident.	**D**
Minor	Minor consequences	**E**

For general risk assessment of flight safety combining and introducing tables of probability and severity of flight safety risk factors into the risk assessment matrix should be done (Table 3).

TABLE 3. Risk factors assessment matrix

Risk probability	Risk severity				
	Catastrophic A	Dangerous B	Significant C	Insignificant D	Minor E
Often (5)	A5	B5	C5	D5	E5
Periodic (4)	A4	B4	C4	D4	E4
Rare (3)	A3	B3	C3	D3	E3
Unlikely (2)	A2	B2	C2	D2	E2
Next to impossible (1)	A1	B1	C1	D1	E1

Types of aviation events (catastrophic situation, emergency situation, severe situation, worsening of flight conditions) (Zubkov and Minaev 1987). presented in accordance with the gradation of their impact on flight safety, respective to types of special situations are presented in Table 4.

TABLE 4. The extent of aviation event impact on safety

Overall risk assessment	Matching the special event	Impact on safety
5A, 5B, 4A	KS (CS) – catastrophic situation	Flight safety threat

5C, 4B, 3A	AS (ES) – emergency situation	Strong impact
5D,5E, 4C, 3B,2A	SS (SS) – severe situation	Medium impact
4D,4E, 3C, 3D,2B, 2C	UUP (WFC) – worsening of flight conditions	Low impact
3E, 2D, 2E, 1A, 1B, 1C, 1D, 1E	Prospective events	Do not affect safety, but capable of influencing the event impacting the flight safety

Events severity categories are inextricably linked with aspects of the activities, which affect aviation events. These include aspects such as: "people", "failures, violations, deviations" and "property" (Table 5).

TABLE 5. Impact of aviation events on operational aspects of the enterprise

Overall risk assessment	**Aspect being impacted**		
	People	Failures, violations, deviations	Property
5A, 5B, 4A	Numerous deaths	Catastrophic situation	Major damage or destruction
5C, 4B, 3A	Single fatal event	Emergency situation	Extensive damage
5D,5E, 4C, 3B,2A	Significant injury	Severe situation	Significant damage
4D,4E, 3C, 3D,2B, 2C	Minor injury	Worsening of flight conditions	Minor damage
3E, 2D, 2E, 1A, 1B, 1C, 1D, 1E	Light injury	Not affecting flight safety	Light damage

After detecting the flight safety problem, the safety concerns influencing such and their potential effects are being revealed while the safety concerns related to the effects are being assessed in terms of probability and severity in order to determine the level of risk to flight safety (*Airline and Airport Discussion Forum"*, 2015).

An analysis of accidents and incidents within a certain period of time should be carried out on the cause-and-effect relationships. In this case, the cause of the event (incident, accident, etc.) is considered as a dangerous situation and the negative impact on the company in the financial or material losses is assessed (*Doc ICAO 9422-AN/923)*.

It is necessary to use the risk factors control/reduction strategy at the last stage of the process of taking hazard events or conditions consequences related risk factors under organizational control (*Connectivity and Growth. Directions of Travel for Airport Investments)*.

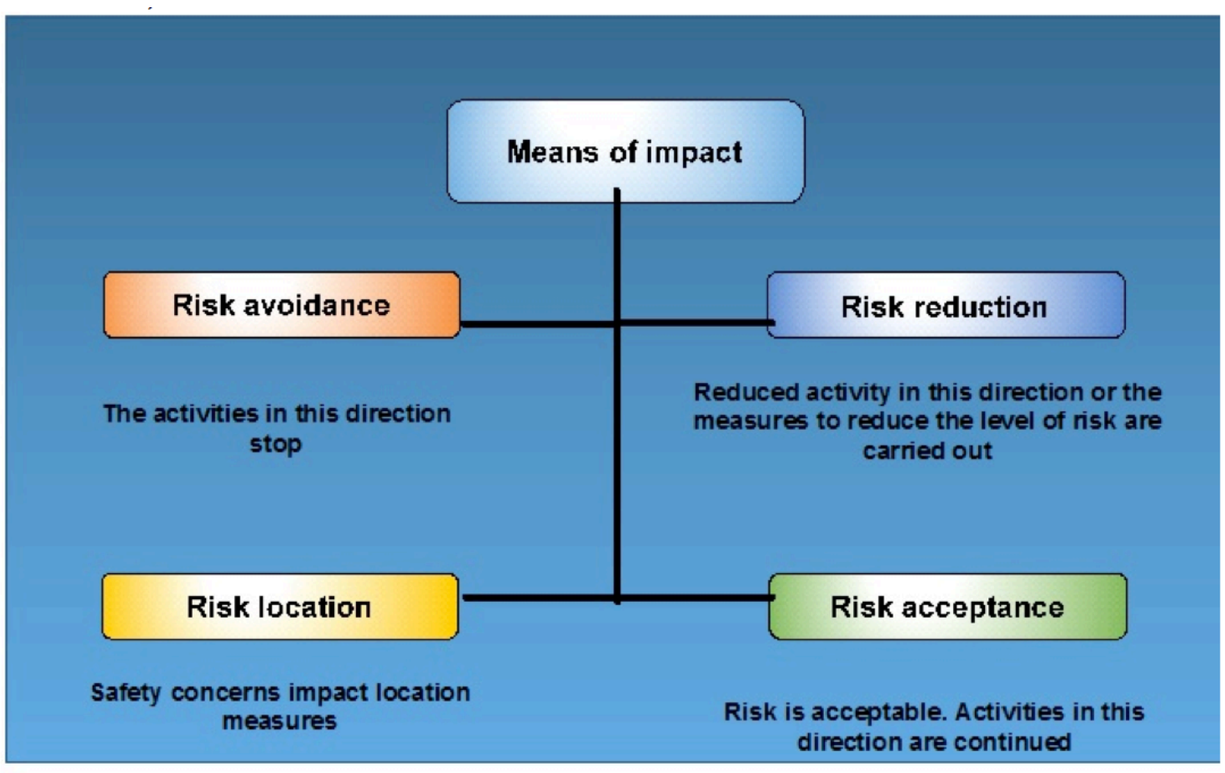

Figure 1. Risk factors reduction options

There are three general strategies to control/reduce risk factors of flight safety (Figure 1):

• **Avoidance of risk**. The operation or activity ceases, because the risk factors of flight safety are greater than the benefits of continuing the operation or activity.

• **Reduction of risk**. The frequency of operation or activity is reduced or actions to reduce the scale of the effects of risk factors are taken.

• **Isolation of the exposure**. Measures are being taken in order to isolate the impact of the effects of a hazard or to create redundancy to protect against them (Maragakis, et. al. 2009).

In assessing the specific options to reduce risk it should be taken in consideration that not all of them have the same potential for reducing flight safety risks. It is necessary to evaluate the effectiveness of each particular option before making a decision. To make the best decision, you must consider the full range of possible control measures and compromises to reconcile the various measures (*Air Traffic Control",* n. d.).

Each option to reduce the risk should be analyzed taking into account aspects such as:

• efficiency;

• technical measures;

• controlled measures;

• staffing measures;

• cost/benefit;

- practicality;
- acceptability of each party;
- durability;
- residual risk factor for flights safety;
- new challenges.

For safety management, it is necessary to evaluate flight safety risk factors related to the safety concerns consequences by assigning a specific risk to each safety concern. Each safety concern may generate one or many consequences, and each consequence can be assessed as a single or multiple flight safety risk factors (Figure 2) (Doiron 2014).

The first step in the process of reduction/control of flight safety risk factors is to identify dangers/consequences and flight safety risk factors assessment (Aviation Science and Technology Development Foresight till 2030 and Further, 2009).

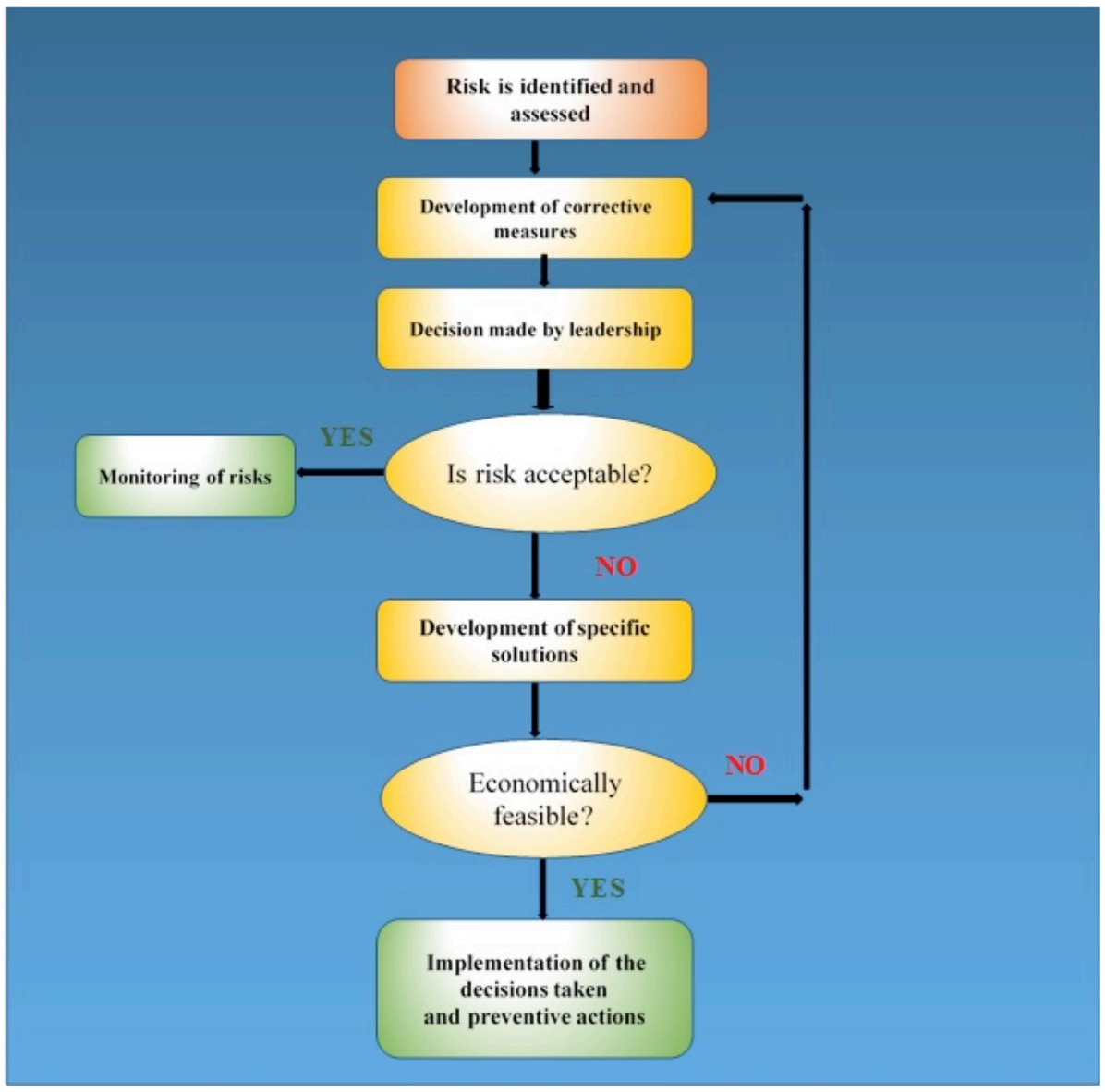

Figure 2. Evaluation and implementation of corrective measures to reduce the level of risk in terms of economic feasibility

After identifying the hazards and consequences and flight safety risk factors assessment, it is necessary to evaluate the effectiveness and efficiency of existing means of protection of aviation system (equipment, training, regulations) regarding the considered safety concerns and their consequences.

Typically, industrial activity analysis shows that removing all existing hazards is impossible and is not economically profitable. In this case, the rule of priority areas selection comes into force:

- Technical measures
- Control measures
- Staffing solutions
- Financial solutions
- Organizational and production solutions (Howell 2015).

5. Discussion

In case the number of air traffic doubles in the next 15 years as expected, current and new security threats must be studied in detail in advance to ensure that a significant increase will be carried out properly and maintained through the development of strategic infrastructure and regulatory system. In view of this, it is necessary for the countries and regions to continue focusing the attention on establishing, updating and specifying security priorities while continuing the expansion of the air transport sector. In order to provide the interconnected and continuous improvement of safety and coherent global air navigation modernization, it is necessary to plan the global, regional and national aviation safety. Global ICAO plans cover means and aims by which ICAO, countries and aviation communities can speed up and effectively manage the growth of air traffic with active maintenance or increase of safety level. Policies, procedures and systems that allow civil aviation to fulfill this role while staying safe, reliable, efficient and environmentally friendly mode of transport, are presented in ICAO coordinated International Standards and Recommended Practices (SARPS) (*Best Airports of 2014"*, 2014).

6. Conclusion

Every aviation event, a dangerous situation, any violation and deviation should be analyzed by the "barrier analysis".

The risks should be revealed, threats should be identified, methods of threats control should be planned, responsible leaders and performers should be defined, which means that all hazards should be managed. In order to avoid a situation of simultaneous carrying out a large number of tests, it is necessary to rank hazardous situations by conducting risk assessment, selecting those, negative effects of which are superior to the cost of their management.

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