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The Safety Management System in Aviation Companies

Ewa KAŁUŻNA
ekaluzna@polsl.pl
https://orcid.org/0000-0002-9384-2754
Silesian University of Technology, Gliwice, Poland

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Abstract

This article presents the key elements of the functioning of the safety management system in an aviation organization. Enterprises must have safety-related issues in line with international and internal regulations. While striving to achieve an acceptable level of safety, enterprises develop safety indicators, the purpose of which is, among other things, to assess the effectiveness of the safety management system. In order to respond appropriately to an emerging threat, it is necessary to have a mechanism for efficiently assessing risks and their severity, thanks to which the units responsible will be able to develop a plan for necessary actions to weaken or completely eliminate the threat.

Keywords: acceptable level of safety performance, risk management, safety management system, safety performance indicators.

1. Introduction

In civil aviation, safety is defined as "a state in which the risks associated with various aviation activities, associated with or in direct support of aircraft operations, are reduced to an acceptable level and controlled" (ICAO, 2018). With the help of tools in the form of regulations, reports, training, and those responsible for controlling the security system, aviation organizations can identify threats at an early stage and evaluate them, taking proportionate steps to mitigate them and maintain an acceptable level of safety.

The Safety Management System can be considered one of the tools that allows an organization to control risk effectively. The article entitled "A Pragmatic Approach to the Limitations of Safety Management Systems in Aviation" explains that modern SMS approaches seek to implement a performance-based framework that emphasizes the integration of safety with other business processes in meeting commercial, quality, and safety equirements (Kontogiannis, Malakis, & Smoker, 2023). It should be kept in mind that the safety of air operations is the responsibility of all persons involved within the scope of their duties.

This paper presents the modern safety management system in aviation organizations, its legal background, method of implementation and execution by various companies, tools for identifying and scaling the threats and their impact on the safety level. The international law regulations, applicable to all organizations, build a framework for implementing and continuously monitoring SMS effectiveness. I have studied and analyzed information from a broadly understood safety management system to present the elements creating the system, i.e., the law, safety acceptable level, safety indicators, safety risk management, and risk awareness. These constitute the basis of the risk management process and determine the level of safety in an aviation company. Section risk awareness shows the risk matrix that organizations can use to assess a potential risk. This paper highlights the benefits of having a safety management system structured, developed, and based on mutual trust.

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2. Legal and administrative bases establishing safety management requirements in the airlines

The most important document governing air transport regulations is the Chicago Convention signed in 1944 on international civil aviation. The International Civil Aviation Organization (ICAO) was established based on it. ICAO member states are required to work to improve efficiency and the level of safety (Konert, Kasprzyk, Łaciński, & Łuczak, 2016).

According to ICAO Doc 9859 Safety Management Manual, the safety management system seeks to proactively combat risks before they lead to an aviation incident. By implementing a safety management system, countries can ensure safety in a consistent, coordinated, and integrated manner. Together with the aviation industry, they are aware of their role in shaping safety by properly evaluating risks and creating a list of priority actions to prevent risks, as well as by properly managing resources when pursuing aviation safety (ICAO, 2018). An example of a proactive safety policy is identifying areas of increased risk in locations in which accidents may occur and taking preventative action (Oster, Strong, & Zorn, 2013).

The air carrier safety management system and training are governed by the ORO.GEN.200 regulation together with ORA. GEN.200, ICAO Annex 19 to the Convention on International Civil Aviation, ICAO Doc 9858 Safety Management Manual, IATA IOSA Standards Manual (ISM).

According to Annex 19 of the Convention on International Civil Aviation Safety Management, the safety management system for civil aviation is understood as a systematic approach to security management, including the necessary organizational structure, responsibilities, policies, and procedures (ICAO, 2013). The convention also provides definitions of four terms that are important in the process of studying an air carrier's safety management system. Another is safety performance, or the safety level achieved by a State or civil aviation operator, as defined by the Target Safety Level values and Safety Level Indicators (ICAO, 2013), where Safety Performance Indicators are understood as a data-based parameter used to monitor and evaluate the Safety Level (ICAO, 2013), while the Safety performance target is the planned or intended, over a given time period, target values for Safety Level Indicators (ICAO, 2013). To be able to manage safety efficiently, it is necessary to be able to determine a "safety risk," which is the anticipated probability and severity of the consequences or effects of a hazard (ICAO, 2013).

Annex 19 regulates security management at the national level. States are required to create their own National Safety Program in civil aviation appropriate to the structure of aviation activities in their country. Its purpose is to create conditions for safety management in the state so that an acceptable level of safety can be achieved. The plan will consist of four elements: state security policies and objectives, state management of security risks, state assurance of safety and state promotion of safety (ICAO, 2013). Within the framework of European regulations, Regulation (EC) No. 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in civil aviation, and establishing a European Aviation Safety Agency plays a predominant role in safety issues. It is complemented by the European Commission's implementing regulations, which are designed to regulate specific issues related to aviation activities. The European Commission has a subsidiary body for legislative matters relating to aviation safety in the form of the European Aviation Safety Agency (EASA). EASA prepares proposals for regulations implementing the basic regulation and supporting materials, whose role is crucial in the application of the implementing regulations (Konert, Kasprzyk, Łaciński, & Łuczak, 2016).

Regulations regarding the safety of flight operations and its management should be updated on an ongoing basis based on safety reports to respond to current risk factors that could compromise safety and lead to an aviation incident.

3. Acceptable level and safety indicators of flight operations

The acceptable level of safety (ALoSP) is set by countries and is expressed through safety goals and indicators as part of the National Security Plan. Its purpose is to set the desired level of safety. Carriers are required to strive for an acceptable level of safety set by the state, and the effects of their actions are expressed in terms of the difference between the safety goals and the results achieved (ICAO, 2017).

The effectiveness of striving for an acceptable level of safety in aviation is expressed through safety targets and indicators (SPIs). Safety indicators are data-based parameters, mainly obtained from reports, that are used to monitor and evaluate the performance of the safety management process. Figure 1 is part of an incident report, which, when completed, is sent to the Civil Aviation Authority, as the entity responsible for developing indicators and safety targets:

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NAME Of THE ORGANIZATION (OPS)				
DATE Of COMPLETION				
SEND THE COMPLETED FORM TO THE FOLLOWING ADDRESS **SPI@ULC.GOV.PL**				
RWY EXCURSION / 10 000 operations				
Quarter	Months	Number of Operations	Number of Events	SPI for 10 000 Operations
Q1	January			
Q1	February			
Q1	March			
Q2	April			
Q2	May			
Q2	June			
Q3	July			
Q3	August			
Q3	September			
Q4	October			
Q4	November			
Q4	December			
TWY EXCURSION / 10 000 operations				
Quarter	Months	Number of Operations	Number of Events	SPI for 10,000 Operations
Q1	January			
Q1	February			
Q1	March			
Q2	April			
Q2	May			
Q2	June			
Q3	July			
Q3	August			
Q3	September			
Q4	October			
Q4	November			
Q4	December			

Figure 1. An example of the parts of the set of SPIs covered by the monitoring obligation for air operators
Adopted from the Civil Aviation Authority, Safety Performance Indicators. Copyright 2016 by the Civil Aviation Authority.

Forms are generated for entities subject to reporting requirements, such as public-use airport managers (ADRs), aircraft operators (OPS), aviation training organizations (ATOs), air navigation service providers (ATM/ANS), ground handling agents for handling hazardous materials, or supplying aircraft with propellants (AHAC). Airlines fill out the form in the event of incidents

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of runway excursion, taxiway excursion, parking stall bypass, non-standard touchdown, incidents involving fumes or smoke on board, incidents involving a fire on board, the number of TAWS alerts, the number of "stall warnings," the number of "level bust," the number of incidents of pilot fatigue due to extended duty hours (Fatigue Reports) per number of flight operations in a given month, and the number of incidents of cabin crew fatigue due to extended time of performing duties (Fatigue Reports) per number of flight operations in a given month. The CFI factor is reported per ten thousand operations (ULC, 2023).

The Civil Aviation Authority publishes averaged SPI values on a quarterly basis so that it is possible to identify risks and assess the level of safety on a national scale on an ongoing basis. The greater the number of entities submitting reports, the greater the chance of introducing more effective preventive measures, thus reducing the costs and resources of carriers and the state needed to counteract the negative consequences of aviation incidents (ULC, 2023). The SPIs are published in Appendix B, presenting a summary of SPIs values with a monthly breakdown of the National Security Plan 2023-2025 (ULC, 2023).

The Safety Index for Aviation Operators discusses each hazard in three variants: per 10000 operations, alert average with zero, alert average without zero. The index showing runway excursions from January 2021 to June 2023 in each variant is shown in the following charts: Safety index for airline operators representing runway excursions from January 2021 to June 2023 monthly/10000 operations, National Security Plan 2023-2025 Appendix B.

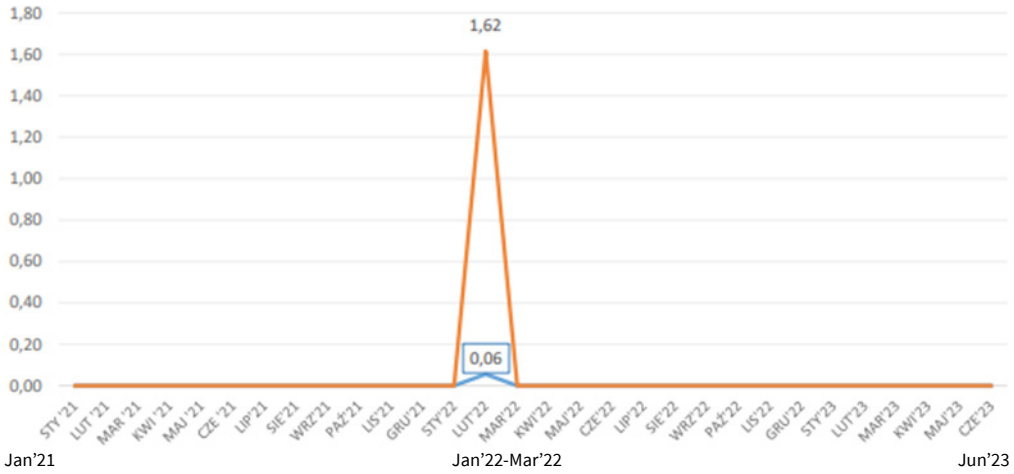

Figure 2. Safety index for airline operators representing runway excursions from January 2021 to June 2023 monthly/10000 operations, National Security Plan 2023-2025 Appendix B.
Adopted from ULC [Polish Civil Aviation Authority]. Copyright 2023 by ULC.

Safety Index for Air Operators Showing Alert Levels for Runway Excursions – Average with Zero from January 2021 to June 2023.

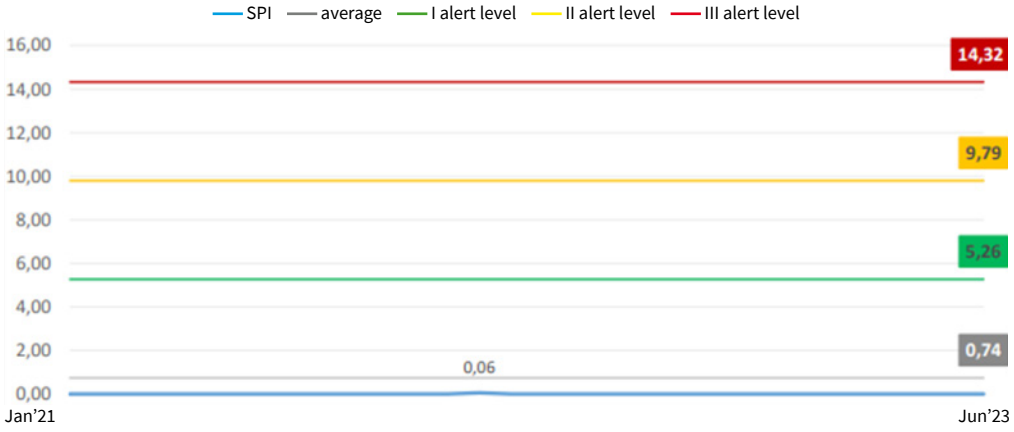

Figure 3. Safety Index for Air Operators Showing Alert Levels for Runway Excursions – Average with Zero from January 2021 to June 2023
Adopted from the Civil Aviation Authority. Copyright 2023 by the Civil Aviation Authority.

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The safety index for aviation operators shows alert levels for runway excursions – a non-zero average from January 2021 to June 2023, National Safety Plan 2023-2025 Appendix B.

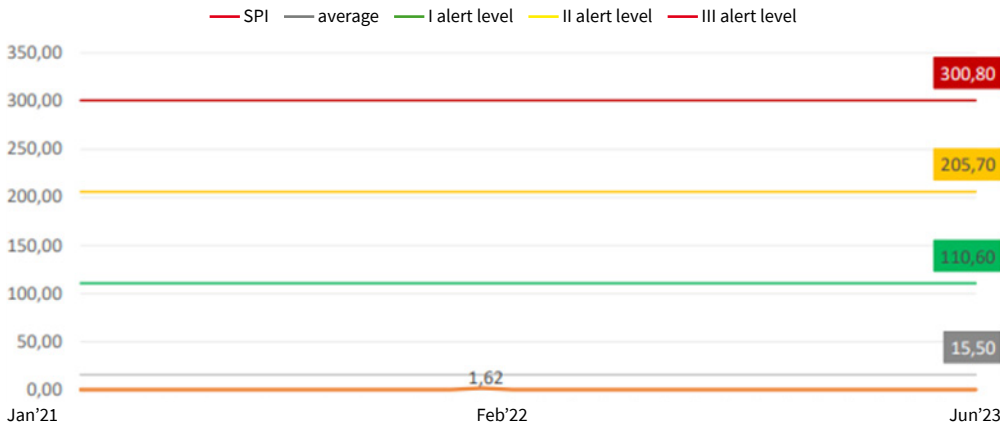

Figure 4. Safety index for aviation operators showing alert levels for runway excursions – non-zero average from January 2021 to June 2023
Adopted from: ULC, 2023. Copyright 2023 by the ULC.

The National Safety Program, in conjunction with the security management system, provide legal and organizational tools to support the effectiveness of the National Safety Plan (ICAO, 2018).

The Safety Management System, which is part of the National Safety Program for civil aviation, must be present in six types of civil aviation operators. The first is approved training organizations where there is a risk of hazardous incidents due to the performance of aircraft operations during the training. The second entity is aircraft or helicopter operators who perform international commercial air transport. The third group is approved maintenance organizations that provide services to aircraft or helicopter operators performing international commercial air transportation. The fourth group is organizations responsible for aircraft type design or production, according to Annex 8 to the National Civil Aviation Safety Plan. The fifth group is air traffic service (ATS) providers in accordance with Annex 11. The last group is certified airport managers in accordance with Annex 14. In addition, countries within the scope of their National Civil Aviation Safety Plan may require the implementation of a safety management system by international general aviation operators with turbojets and large aircraft in their fleets (ICAO, 2013).

4. Safety management system in airline companies.

The goal of safety management in an aviation organization is to take action on an ongoing basis to ensure that the number of aviation incidents, especially aircraft accidents, is kept at an acceptable level (ICAO, 2018).

The Safety Management Manual has identified ten key benefits for companies in implementing a safety management system. The first is strengthening the safety culture. This occurs by ensuring the highest possible level of safety and minimizing risks. In this case, subordinate staff take on high standards of conduct (ICAO, 2018).

The way SMS influenced the level of aviation safety in different regions of the world is presented in the figure below. It shows that thanks to effective safety management and hazard identification, the number of aviation incidents and their victims remains at an acceptable level.

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Eastern and Southern Africa (ESAF)	1	19
Europe and North Atlantic (EUR/NAT)	Nil	Nil
Middle East (MID)	Nil	Nil
North America, Central America and Caribbean (NACC)	1	1
South America (SAM)	1	2
Western and Central Africa (WACAF)	2	5

Table 1. Number of fatal accidents and total fatalities by ICAO region in 2022NACC

Figure 5. The number of fatal accidents by ICAO region in 2021. Adopted from: Zestiot. (2024). *Safety Management Systems in Aviation: A New Era of Safety* https://www.zestiot.com/safety-management-systems-in-aviation-2/

The second benefit is adopting a documentation- and process-based approach to providing safety, which, by its simplicity, is approachable and easy for employees to implement. Another benefit is a better understanding of security connections and relationships. As a result, those involved in the security management process carry it out with more efficiency. The fourth advantage is the early detection of threats. By detecting a threat at an early stage, institutions can take proactive measures to manage the risk. One of the key advantages that ensures accurate judgment is decision-making based on safety data. The units responsible for security analysis can make decisions, take action on the fly, and direct company resources to departments where the risk of danger is the greatest. The sixth advantage is improving communication about safety. This is made possible by introducing a common language of safety throughout the organization, which makes goals and safety achievements made to date widely known. In addition, a common way of communicating allows the exchange of safety information between different organizations in the aviation safety industry. The seventh advantage is not so easily noticed. It is proof that safety is a priority. In this case, the focus is on the company's management and is both an opportunity for them and the company as a whole to develop internally and strengthen its attractiveness for contractors and qualified personnel. Lower costs are another advantage achieved by discounts on insurance, among other things, which are determined by the company's performance on safety management. The penultimate benefit is increased efficiency. This involves identifying inefficient processes and systems, as well as integrating internal and external management models to achieve additional benefits. The last benefit, which gives both immediate and long-term gains, is the avoidance of direct costs related to injuries and damage to property, as well as indirect costs in the form of legal costs, loss of credibility, increased insurance premiums, and reduced efficiency of employees. This is done through proactive hazard identification or safety risk management (ICAO, 2018).

All employees of an aviation organization are responsible for safety management within the scope of their duties.

Safety management systems consist of seven main elements, which, when properly applied, provide the opportunity to detect hazards at an early stage and apply appropriate countermeasures. These include organization and personnel, identification and assessment of major hazards, operational control, change management, emergency planning, monitoring, audits, and reviews. In terms of organization and personnel, the organization should determine what roles and responsibilities are assigned to personnel entrusted with managing major hazards. It is also responsible for the proper training of personnel and, if necessary, subcontractors (CIOP-PIB, n.d.).

The safety system built under the provisions of ATM/ANS.OR.B.005 in an aviation organization must consist of four essential components. These include safety policy and objectives, risk management in the field of safety, safety assurance, and safety promotion. Safety policies and objectives focus on the organization of the safety management system. This element includes management's responsibility and commitment to safety, responsibilities for it during the implementation process and operation of the SMS, and authority to make safety decisions, the appointment of a safety manager who will be responsible for implementing and operating an effectively functioning safety management system. Another safety policy issue is the coordination of emergency response planning with other aviation services and entities that come into contact with the institution providing activities and

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services to aircraft crews, the purpose of which is to ensure the safety of crews and passengers during flight and maneuvering at airports (ATS). The final element of the safety policy and objectives is the creation of safety management documentation, which includes a description of all its elements, related processes, and the effects of introducing the SMS (Commission Implementing Regulation (EU) 2017/373 of 1 March 2017).

a. Safety risk management

Safety risk management involves three processes, including the process of identifying risks associated with the services provided, based on a combination of reactive, proactive and predictive security data collection methods. This process is to ensure that its contribution to the risk of aviation accidents is minimized to the extent reasonably practicable and a process to ensure that the safety risks associated with the identified risks are analyzed, evaluated, and controlled (Commission Implementing Regulation (EU) 2017/373 of 1 March 2017). Risk management is crucial for an organization to prepare for risks and their consequences. Another component of the SMS system stems directly from risk management – assurance of safety. This is realized by means of three tools. The first is safety performance monitoring and measurement indices. Their function is to check the organization's effectiveness in this regard and assess the effectiveness of safety risk control. The second tool is the process of identifying changes that affect the level of security risk associated with the services provided and identifying and managing the security risks that such changes may cause. The third tool is the process of monitoring and evaluating the effectiveness of the safety management system, which allows for improving the effectiveness of the system at a given company on a continuous basis. The last tool that also has educational value is safety promotion. It is implemented by means of a training program that will train and ensure the competence of staff members appropriate to their duties within the framework of the safety management system, and by means of adequate communication among staff about security, which will provide them with knowledge of system implementation (Commission Implementing Regulation (EU) 2017/373 of 1 March 2017).

b. Risk awareness as the basis of the risk management process

To assess risks, it is necessary to know what constitutes a threat. Hazard in aviation is defined as dormant damage potential that is present in one form or another in or around the system. This damage potential can exist in various forms, for example, as a natural condition (e.g., terrain) or a technical condition (e.g., horizontal runway markings) (ICAO, 2018). Its identification is an integral part of the first risk management process.

To properly identify risks, one must understand both the risk itself and its potential consequences. Hazards can originate from conditions or objects that can lead to a dangerous situation, while a consequence is the result of the hazard. It should be noted that a single hazard can lead to a number of consequences, the identification of which is possible with the help of a security risk assessment. Security threats can come both from within the organization and from external sources, such as cooperating companies. Threat identification can be done through audits, reporting systems, inspections, expert assessments, and even brainstorming. Voluntary reports are the most valuable source of information and the basis for a proactive security management model (ICAO, 2018).

Among other things, the likelihood of safety risks can be assessed by asking four questions: Is there a history of incidents similar to the one under consideration, or is it an isolated event? How many employees implement or are subject to certain procedures? What other equipment or components of the same type might have similar problems? What is the extent of the threat under consideration? For example, what percentage of operations use the equipment or activity in question? (ICAO, 2018). Table 1 shows the probability of safety risks.

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Table 1. Safety Risk Probability Table

Probability	Meaning	Numerical value
Frequent	Likely to occur many times (occurred frequently)	5
Occasional	Is likely to occur from time to time (occurred not very often)	4
Distant	Probably will not occur, but it is possible (occurred rarely)	3
Unlikely	Very unlikely to occur (case of occurrence is not known)	2
Extremely unlikely	Almost inconceivable that it could ever occur	1

Adapted from: Doc 9859 Safety Management Manual Fourth Edition, 2018 by ICAO. Copyright 2018 by the Civil Aviation Authority.

The most important thing in terms of safety prevention is awareness of risks. Knowing whether a risk is likely to occur, an organization should consider whether it is susceptible to it.

Knowing the probability of a risk may determine how severe its consequences will be to the environment. The severity of a security risk is the extent of the damage that the risk could cause (ICAO, 2018).

Table 2 shows the risk matrix in terms of the severity of a possible event and its probability:

Table 2. Safety risk matrix

Probability — What is the probability the risk will happen? / Impact — How severe would the outcomes be if the risk occurred?	Insignificant 1	Minor 2	Significant 3	Major 4	Severe 5
5 Almost Certain	Medium 5	High 10	Very high 15	Extreme 20	Extreme 25
4 Likely	Medium 4	Medium 8	High 12	Very high 16	Extreme 20
3 Moderate	Low 3	Medium 6	Medium 9	High 12	Very high 15
2 Unlikely	Very low 2	Low 4	Medium 6	Medium 8	High 10
1 Rare	Very low 1	Very low 2	Low 3	Medium 4	Medium 5

Adopted from: 5. Guevara, P. (2024, March 27). A Guide to Understanding 5x5 Risk Assessment Matrix. Copyright 2024 by Safetyculture.

When performing a severity assessment of an incident, it is necessary to analyze all the consequences that a threat may cause from the perspective of the worst-case scenario.

An organization with a well-functioning security management system has and correctly uses all the methods described above for identifying and risk analysis and can apply countermeasures appropriate to the assessed risk.

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5. Conclusions

Until recently, safety management has been approached in a reactive way – security and safety regulations were created on the basis of investigation reports of events that have already occurred. However, to effectively manage security, it is necessary to properly recognize and be aware of the risks and threats that may occur in a given company. Emphasis is now being placed on proactive and even predictive management that anticipates the possibility of entirely new risks and developing methods to prevent them. By setting safety goals and determining safety indicators, achieving an acceptable level of safety (ALoSP) is possible. It is important to remember that the safety management system is an ongoing process that requires continuous monitoring and introducing proactive measures to prevent risks. International regulations set out in detail which organizational units are required to have a safety management system unit within their structure. It analyzes past events, draws conclusions from them, and creates recommendations, but it is also able to anticipate a threat and put in place measures so that its effects are least severe for the environment. A well-functioning safety management system is an important link in the safety structure at every level of the company.

Without a proactive safety management system based on informed participation of those involved in carrying out an air operation, it is impossible to achieve an acceptable level of safety. Continuous risk monitoring, creating indicators, and setting security goals determine the effectiveness of the security management system by identifying threats and analyzing the severity of their effects on the environment.

Declaration of interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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