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CONTEMPORARY CHALLENGES OF AVIATION LOGISTICS SAFETY

Dmytro Bugayko, Svitlana Smerichevska, Danylo Bugayko. *"Contemporary challenges of aviation logistics safety". Safety is an integral criterion for the development of aviation logistics. With the development of jet aviation, the first key problem was the failure of new aviation equipment. In these conditions of rapid development, Annex 13 to the Chicago Convention of 1944 was adopted, which included Standards and Recommended Practices in the field of methods for investigating disasters and serious incidents. Thanks to active work in the field of flight safety, the industry managed to overcome the criticality of technical failures. However, as always in aviation safety, a decrease in the criticality of one component leads to an increase in the criticality of another component. Thus, the weak link in the man-machine-environment triangle turned out to be a person. The organizational factor brought a conceptual shift in understanding the place of the human factor in safety. At the same time, the following problem emerged. Against the background of an active decrease in the probability of aviation accidents, unfortunately, the annual number of fatalities in aircraft crashes is relatively stable. Recognizing the problem, Annex 19 to the Chicago Convention of 1944 was developed, which*



included generalizing approaches to the development of a comprehensive aviation safety system. The dramatic events of the last decade - numerous wars and conflicts, economic recessions and crises and, first of all, the COVID-19 pandemic - outlined modern challenges to the aviation logistics safety system.

Keywords: aviation logistics, safety, challenges, proactive risk management.

Дмитро Бугайко, Світлана Смерічевська, Данило Бугайко. «Сучасні виклики безпеки авіаційної логістики». *Безпека є інтегральним критерієм розвитку авіаційної логістики. З розвитком реактивної авіації першою наріжною проблемою стала відмова нової авіаційної техніки. В цих умовах стрімкого розвитку отримав додаток 13 до Чиказької конвенції 1944 року, який включив в себе Стандарти та Рекомендовану Практику з напрямку методики розслідування катастроф та серйозних інцидентів. Завдяки активній роботі в сфері безпеки польотів галузі вдалося подолати критичність технічних відказів. Однак, як завжди у безпеці авіації, зниження критичності однієї складової призводить до збільшення критичності іншої складової. Отже слабким ланцюгом у трикутнику людина-машина-зовнішнє середовище виявилась людина. Організаційний фактор приніс концептуальний зсув у розумінні місця людського фактору у безпеці. При цьому виявилась наступна проблема. На фоні активного зменшення вірогідності авіаційних катастроф, на жаль, щорічна кількість загиблих авіа трощ має відносно стабільний характер. Усвідомлюючи проблему, було розроблено Додаток 19 до Чиказької конвенції 1944 року, який включив в себе узагальнюючі підходи щодо розвитку комплексної системи безпеки авіації. Драматичні події останнього десятиліття – чисельні війни та конфлікти, економічні спади та кризи та, в першу чергу, пандемія COVID-19 окреслили сучасні виклики системі безпеки авіаційної логістики.*

Ключові слова: авіаційна логістика, безпека, виклики, проактивне управління ризиками

Introduction. Safety is an integral criterion for the development of aviation logistics. Over the years of development, the aviation safety management system has gone through a number of conceptual stages.

Technical era. With the development of jet aviation, the first key problem was the failure of new aviation equipment. The probability of a disaster in these conditions was 1 disaster per 1000 flights, which is an excessively high figure [1].

In these conditions of rapid development, Annex 13 to the Chicago Convention of 1944 was adopted, which included Standards and Recommended Practices in the field of accident and serious incident investigation methodology [2]. Thanks to active work in the field of flight safety, the industry managed to overcome the criticality of technical failures. They continued to occur, while, as a rule, not leading to catastrophic consequences. The probability of disasters gradually decreased to one

disaster per 10,000 flights and continued to decrease [1].

The era of the human factor. However, as always in aviation safety, a decrease in the criticality of one component leads to an increase in the criticality of another component. Thus, the weak link in the triangle of man-machine-environment turned out to be a person. In 1970-2000, standards and Recommended Practices of the 18 Annexes to the Chicago Convention of 1944 were actively developed. Particular attention was paid to solving human factor problems, developing the principles of Crew Resource Management and Fatigue Risk Management Systems. The probability of disasters gradually decreased to one disaster per 100,000 flights and continued to decrease [1].

The era of the organizational factor. The organizational factor brought a conceptual shift in understanding the place of the human factor in safety. By organizational factor we mean the following maxim: "if a person makes

a mistake during interaction in the triangle of man-machine-environment, not only the person is to blame, but also the system that allowed the person to make this mistake and did not provide him with additional means of protection after it was made.

At the same time, the following problem has emerged. Against the background of an active decrease in the probability of aviation accidents, unfortunately, the annual number of fatalities in aircraft accidents is relatively stable. This is due to the global trend of a doubling of the number of flights every 15 years. And although the probability of a disaster now reaches a record figure of one disaster per 10,000,000 flights [1], the situation is reminiscent of the conversation between Alice and the Queen from Lewis Carroll's book "Alice in Wonderland" - here you need to run very fast to stay in the same place [3]. Recognizing the problem, Annex 19 to the 1944 Chicago Convention was developed [4], which included general approaches to the development of a comprehensive aviation safety system, which creates the basis for the development of a global system-wide era of aviation safety.

The dramatic events of the last decade – numerous wars and conflicts, economic recessions and crises, and, above all, the COVID-19 pandemic – have outlined modern challenges to the aviation logistics safety system.

The purpose of the article: analysis of modern challenges to the aviation logistics safety system and development of a set of proactive measures to maintain a globally agreed level of safety in conditions of uncertainty.

Presentation of the main research material.

Global tendencies of aviation safety. The COVID-19 pandemic has had a devastating impact on the development of civil aviation. For the first time in history, the reduction in air traffic has become critical for the industry. This has led to conceptual changes in industry management strategies at the global, regional and national levels [5]. Fig. 1 shows Global traffic of passengers. Fig. 2 shows Global traffic of flight departures.

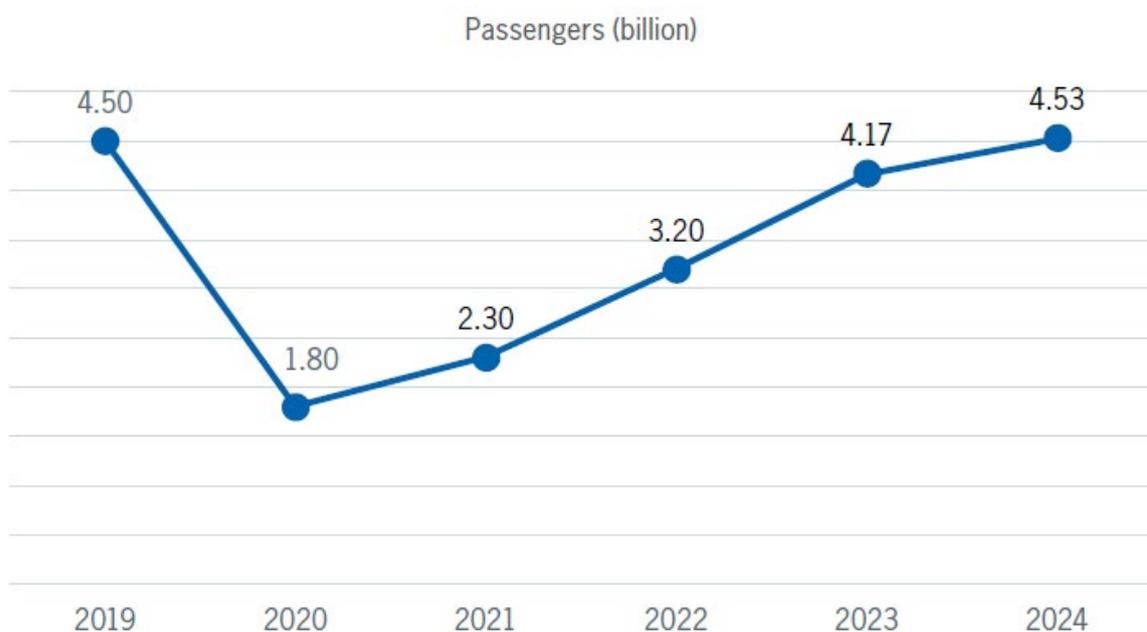


Figure 1 – Global traffic of passengers (billion)

Source: ICAO Safety Report 2025 Edition [6].

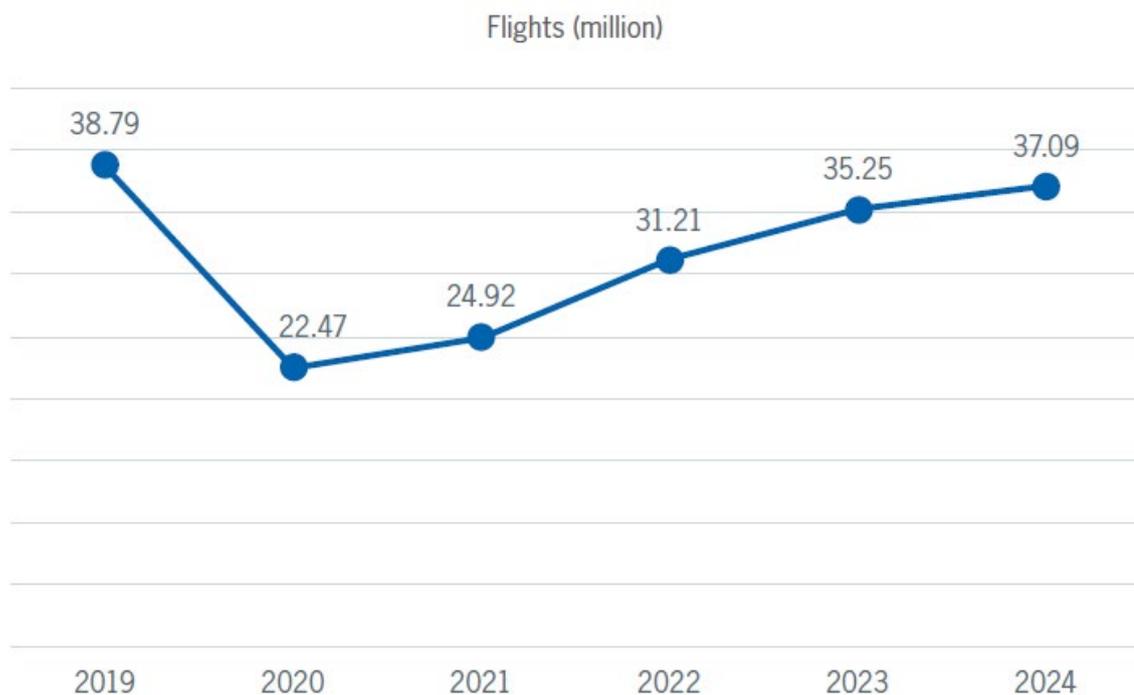


Figure 2 – Global traffic of flight departures (million)
Source: ICAO Safety Report 2025 Edition [6].

2020 became a crisis year for the entire industry as a whole. Thus, in 2020, the global volume of transportation decreased from 4.5 to 1.8 billion passengers

(- 60%), and the number of flights from 38.79 to 22.47 (- 42%).

The main risks of the crisis were:

- unprofitability of passenger transportation,
- rapid burnout of financial assets of industry enterprises,
- reduction of the aircraft fleet,
- and, as a result of the implementation of a strict cost-saving program, a sharp reduction in experienced, certified aviation personnel.

To assist civil aviation authorities in managing aviation safety risks during the Coronavirus disease (COVID-19) pandemic, ICAO developed "ICAO Guidance for Civil Aviation Authorities on Aviation Safety Risk Management Issues Related to COVID-19" (Doc 10144) [5, 7].

Gradually, the civil aviation industry stabilized its work by implementing proactive

risk management, diversifying activities towards the development of cargo and mail air transportation, introducing special quarantine measures and mandatory vaccination of the population. In the period from 2021 to 2024, we see a gradual increase in civil aviation production indicators. In 2026, we can state - aviation industry at the pre-pandemic level and support the trends of double growth in transportation volume every 15 years. The industry gradually coped with economic crisis phenomena, the aircraft fleet and infrastructure stabilized. The main residual vulnerability of the system is the provision of Critical Element 4 of the ICAO Safety Oversight System "Qualified technical personnel". During the years of the pandemic, many employees of the global civil aviation industry lost their certification, resigned and found new jobs. The rapid growth of air traffic volume is leading to a growing gap in personnel shortages and skills that cannot be quickly overcome. Figure 3 shows the 2024 Safety Review. Figure 4 shows Fatal accident records: 2019–2024 scheduled commercial operations.

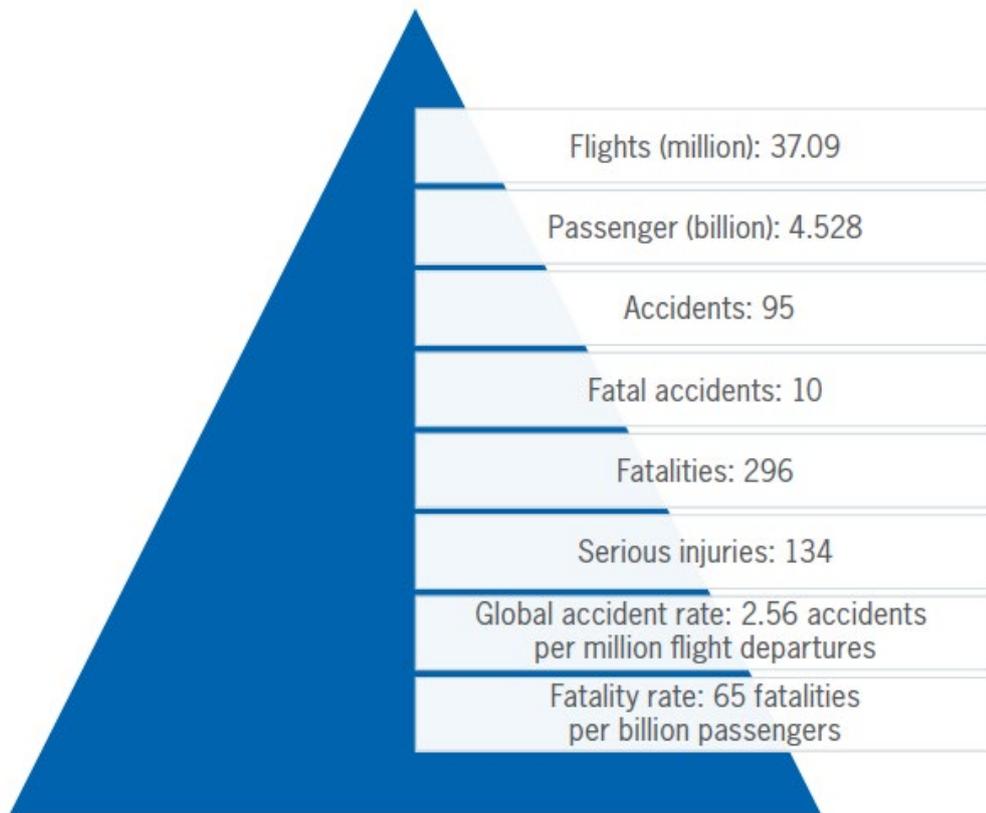


Figure 3 – Safety Overview 2024
 Source: ICAO Safety Report 2025 Edition [6].

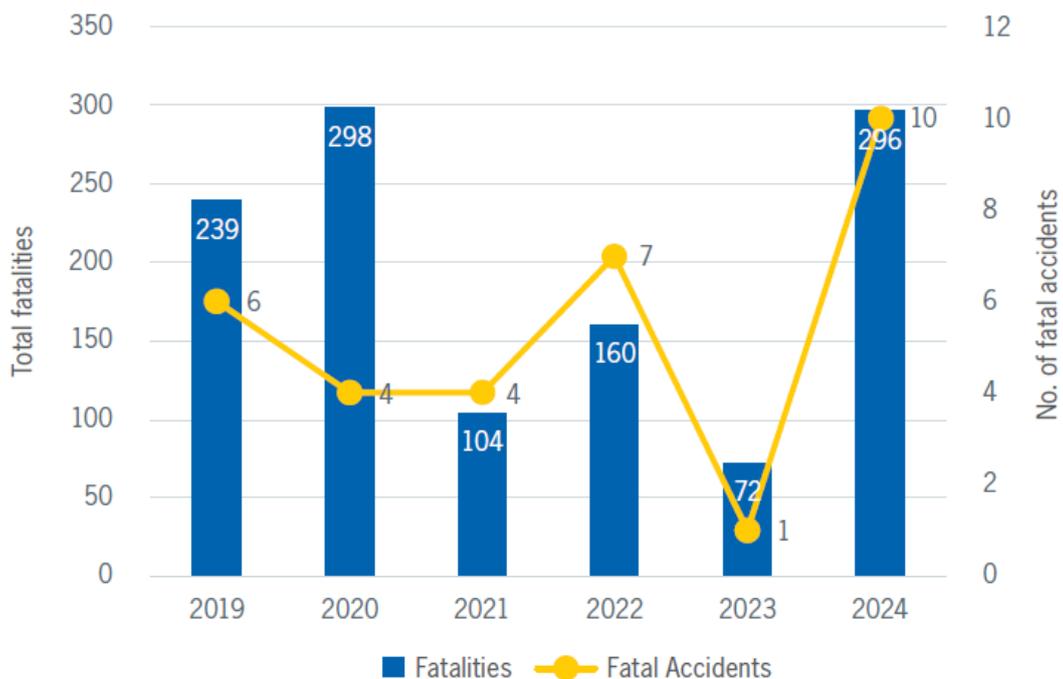


Figure 4 – Fatal accident records: 2019–2024 scheduled commercial operations
 Source: ICAO Safety Report 2025 Edition [6].

Thus, in 2024, after many years of decreasing fatal accidents and their victims, we are witnessing a quantum leap in the decline of the global level of aviation safety. In 2024, there was a tenfold increase in fatal accidents (10 compared to one in 2024) and a more than fourfold increase in the number of victims (296 compared to 72 in 2023). In addition, 134 serious injuries were registered. The global accidents rate was 2.56 accidents per million aircraft departures. The fatality rate was 65 victims per billion passengers [6].

Of course, civil aviation is an open system and is subject to thousands of different threats, but this trend cannot but worry experts. The green zone risk zone is sharply decreasing. This tendency requires the development of a number of rapid institutional measures.

Regional tendencies of aviation safety. Let's consider regional tendencies of aviation safety. Fig 5 shows number of fatal accidents by ICAO Region in 2024.

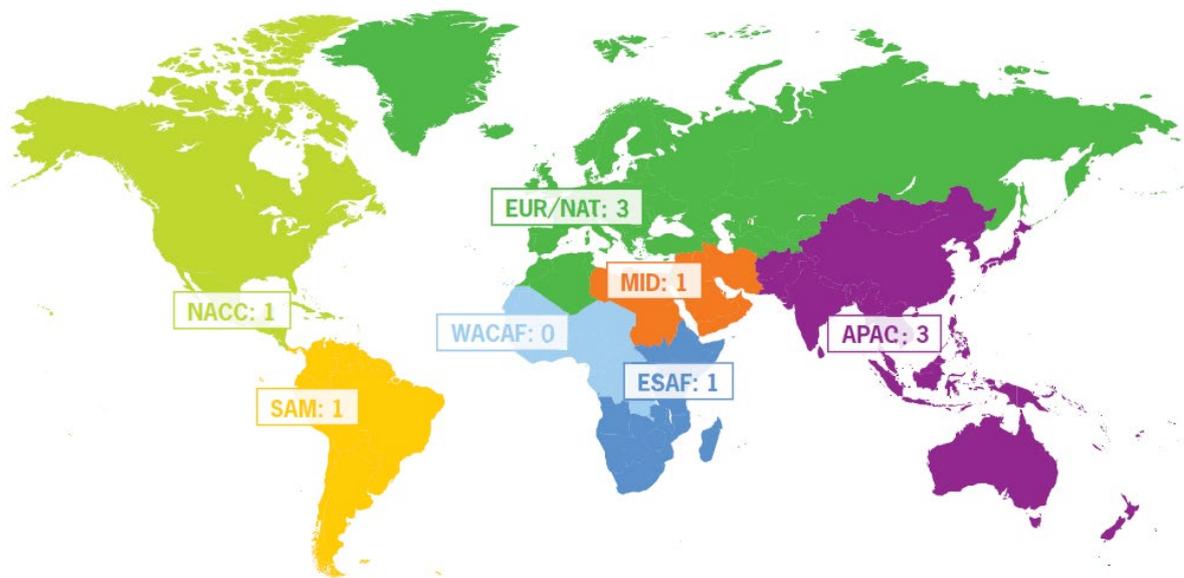


Figure 5. Number of fatal accidents by ICAO Region in 2024
Source: ICAO Safety Report 2025 Edition [6].

An analysis of the regional safety status in 2024 reveals that fatal accidents occurred in virtually all ICAO regions, with the exception of Western and Central Africa (WACAF), where passenger traffic is significantly lower than in other regions. Table 1 shows departures, accidents, and fatalities by ICAO Region based on State of Occurrence in 2024.

An analysis of regional statistics confirms the dependence of the number of accidents and casualties on the number of departures.

In 2024, the highest number of accidents occurred in the regions with the highest

aviation traffic: North America, Central America and Caribbean NACC (37), Asia and Pacific APAC (23), Europe and North Atlantic EUR/NAT (22) [6].

A similar number of fatal accidents (3 per region) occurred in Asia and Pacific APAC and Europe and North Atlantic (EUR/NAT) [6].

The highest number of casualties was recorded in Asia and Pacific APAC (185), South America SAM (62), Europe and North Atlantic EUR/NAT (40) [6].

Table 1. Departures, accidents and fatalities by ICAO Region based on State of Occurrence in 2024

ICAO Region	Estimated departures (million)	Number of accidents	Accident rate (per million departures)	Number of fatal accidents	Number of fatalities	Serious injuries
Asia and Pacific APAC	12.37	23	1,86	3	185	78
Eastern and Southern Africa (ESAF)	0.78	3	3,85	1	2	1
Europe and North Atlantic (EUR/NAT)	9.23	22	2,38	3	40	23
Middle East (MID)	1.40	2	1,43	1	1	1
North America, Central America and Caribbean (NACC)	11.10	37	3,33	1	6	24
South America (SAM)	1.95	6	3,08	1	62	6
Western and Central Africa (WACAF)	0.26	2	7,62	-	-	1
World	37.09	95	2,56	10	296	134

Source: ICAO Safety Report 2025 Edition [6].

The highest number of serious injuries was recorded in Asia and Pacific APAC (78), North America, Central America and Caribbean NACC (24), Europe and North Atlantic EUR/NAT (23) [6].

Based on the above, unfortunately, even the most technologically advanced regions of the world are not 100% safe for civil aviation operations.

National tendencies of aviation safety of Ukraine. Despite the stereotype that during the war, Ukrainian civil aviation does not fully perform operational activities due to the closure of airspace, this is not the case. A number of Ukrainian airlines continue commercial operations from foreign bases, flight crew training is provided, and aviation work is performed [8].

In 2024, the total flight hours of certified airlines amounted to 90,988 flight hours, which is 12% more than the flight hours in 2023 (80,378 hours). This was due both to an

increase in commercial transportation, as a result of which transport companies flew 86,655 hours (in 2023 - 76,999 hours), and to an increase in the flight hours when performing aviation work and scientific and technological research, where the flight hours amounted to 4,333 hours (in 2023, the flight hours were 3,379 hours) [9].

Among the main threats that accompany the operational activities of Ukrainian airlines during the war period, it is possible to highlight:

- The difficulties to perform regular flights from the territory of other countries.
- Economic problems associated with the increase in operating costs on the territory of other countries.
- Remoteness from repair and material and technical bases.
- Insufficient staffing with qualified aviation personnel, and as a number of aviation workers defend the Motherland, and

many women with children are temporarily abroad.

An increase in the volume of transportation combined with the impact of objective threats in rare cases leads to

aviation incidents. The classification of aviation incidents in Ukraine in 2024 is presented in Figure 6.

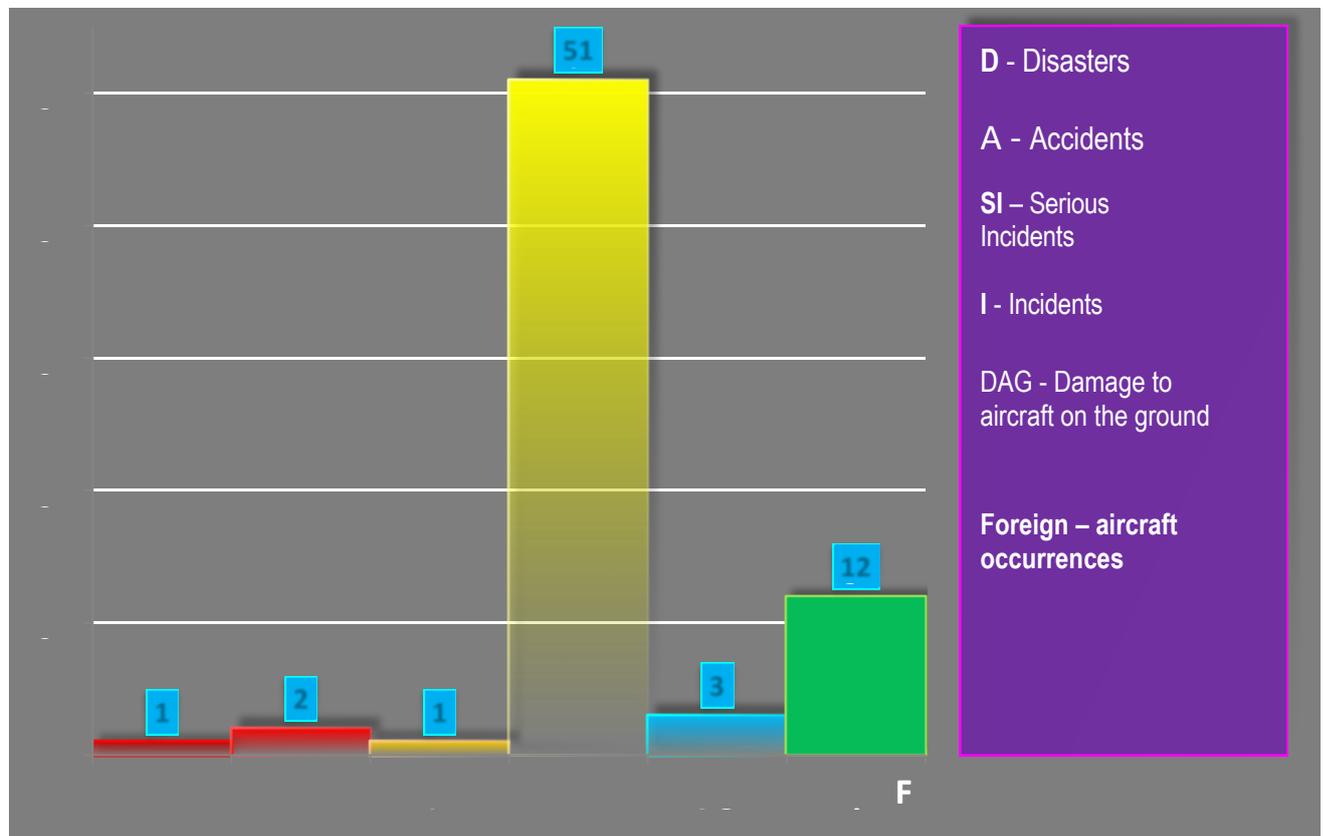


Figure 6 – Distribution of occurrences involving aircraft entered in the Civil Aircraft Register of Ukraine and aircraft of foreign registration that occurred in 2024 by class

Source: "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2024". National Bureau of Transport Investigations of Ukraine [9].

In 2024, during the operation of commercial civil aircraft of Ukraine during passenger and cargo transportation, aviation work, training flights and operation of general aviation aircraft, the following occurred: 1 disaster (during a training flight); 2 accidents (during training flights); 1 serious incident; 51 incidents; 3 aircraft damage on the ground; 2 extraordinary events [9].

During 2024, no flights of foreign civil aircraft were performed on the territory of Ukraine, however, during the analyzed period, 12 reports were received about incidents with aircraft manufactured or developed in Ukraine, or such incidents

during which citizens of Ukraine died, in particular: 8 incidents with amateur-built aircraft of the Ukrainian enterprise Aeroprakt LLC - a manufacturer of ultralight aircraft, namely 4 crashes, 3 accidents and 1 serious incident; 2 crashes with foreign-made aircraft during which 4 citizens of Ukraine died; 1 accident and 1 serious incident with aircraft developed by Ukraine [9].

Statistics of aviation incidents and incidents with civil aircraft of Ukraine in 2024 are presented in Table 2.

When performing passenger and cargo transportation on regular and irregular routes: in 2024 there were no disasters and accidents,

as in 2023; 1 serious incident occurred, while in 2023 there were none; the number of incidents is 51, in 2023 there were 48; 3 damage to the airframe occurred, in 2023

there were 7; 2 emergency events occurred, and in 2023 there were 5 emergency events [9, 10].

Table 2. Aviation accidents and incidents with civil aviation of Ukraine in 2024

№	Occurrences classification	Number of occurrences				Number of victims			
		absolute quantity		for 100 thousand hours		died		injured	
		2024	2023	2024	2023	2024	2023	2024	2023
I	Number of accidents and incidents during commercial transportation								
1.1	Disasters								
1.2	Accidents		1	0	1,29				2
1.3	Serious incidents	1		1,15	0				
1.4	Incidents	51	48	58,8	62,3				
II	Number of accidents and incidents during aviation operations, including training flights								
2.1	Disasters	1		2,3	0	1			
2.2	Accidents	2		4,6	0			2	
2.3	Serious incidents								
2.4	Incidents								
III	Total number of accidents and incidents with Ukrainian civil aviation								
3.1	Disasters	1		1,1	0	1			
3.2	Accidents	2	1	2,2	1,24			2	2
3.3	Serious incidents	1		1,1	0				
3.4	Incidents	51	48	56	59,7				
3.5	Total	55	49	60,4	60,9	1		2	2

Source: "Analysis of the state of aviation safety based on the results of the investigation of aviation accidents and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2024". National Bureau of Transport Investigations of Ukraine [9].

When performing aviation work (including training flights): in 2024 there was 1 disaster, while in 2023 there were none; 2 accidents occurred, and in 2023 there were no accidents; There were no serious incidents, incidents, aircraft damages and emergencies, as in 2023 [9, 10].

In the operation of general aviation: information on disasters, accidents, serious incidents, incidents, aircraft damage on the ground, emergencies that occurred during 2024 was not received, as in 2023 [9, 10].

Thus, despite the extremely difficult conditions of operational activities in wartime, Ukrainian civil aviation managed not only to gradually increase its presence in the global and regional air transportation market, but also to maintain a consistent national level of safety through the development of safety management systems.

Managers and specialists of the National Bureau of Transport Investigations of Ukraine and Ukrainian airlines constantly improve their qualifications at the ICAO Institute of the National University "Kyiv Aviation Institute",

which creates a platform for dialogue and proactive risk management, both at the state level and at the level of aviation organizations. Strategic management of national aviation security is based on synergy from the development of the interface between state regulatory authorities and the industry [11].

Conclusions. Unfortunately, despite the fact that aviation has been and remains one of the safest modes of transport, we can state that its safety status at the global, regional and national levels is not absolute. The industry faces a number of objective threats, one of the most urgent of which is the problem of experienced, certified and stable personnel. This problem is becoming even more urgent for Ukraine, which for the fourth year in a row has been counteracting military

aggression unprecedented in the 21st century. At the same time, the role of training, retraining and upgrading of aviation personnel and strengthening the role of aviation educational institutions in this process is fundamentally increasing. A significant role in the national provision of Critical Element 4 of the ICAO Safety Oversight System "Qualified technical personnel" belongs to the National University "Kyiv Aviation Institute". The development of interaction between the teaching staff of aviation higher education institutions, scientists, experts from international organizations and the aviation community is the key to achieving a synergistic effect for increasing the acceptable level of safety at the global, regional and national levels.

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