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## PRIORITY DIRECTIONS OF INTERNATIONAL AIRPORT INFRASTRUCTURE DEVELOPMENT

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The directions for restoring the infrastructure of Ukrainian airports after the cessation of the military aggression of the Russian Federation, which entailed incredible destruction, in particular, in the airport industry, are analyzed, the requirements for the design and construction of new and reconstruction of existing facilities at the airport, necessary for the optimal application of measures to ensure the security of international civil aviation, are characterized, the priority directions for the development of the infrastructure of international airports in Ukraine were established, the characteristics of modern trends in the development, transformation and modernization of the airport infrastructure were given.

**Key words:** international airport, aviation security, reconstruction, modernization of airport infrastructure, runway, operational suitability.

**Introduction.** Ukraine has joined the global efforts to achieve the UN Sustainable Development Goals, the achievement of which requires combining the capabilities of state, society and citizens in order to establish security and prosperity on the planet by 2030 y [1].

In order to meet the needs of the state in ensuring the stable development of the aviation industry, bringing the air transport infrastructure in line with international standards, ensuring Ukraine's transit status given its unique geographical location, improving the efficiency of state property management, the State Target Program for 2023 year [2]. In order to ensure the development of transport infrastructure in accordance with international and European standards, the Action Plan for the implementation of the National Transport Strategy of Ukraine for the period up to 2030 was approved [3].

The state of the material and technical base of airports, in particular, airfield buildings and structures, runways, passenger terminal complexes, existing equipment, etc. does not fully meet the needs of the growing air transport market, which hinders the transit potential of Ukraine and its integration into

the world economy. Therefore, it is necessary to study the priority areas of infrastructure development of international airports in Ukraine.

Rehabilitation of airport infrastructure requires new research, creating favorable conditions for the development of basic scientific developments for the design and scientific support of airport development programs. Creating an effective system of research in the field of air transport is one of the most important prerequisites for the development and improvement of the air transport system of Ukraine. Modernization of the infrastructure of international airports is becoming one of the factors increasing Ukraine's economic growth.

**Analysis of recent research and publications.** The development of the aviation industry, elements of production infrastructure of airports and their technical characteristics, application of international and European standards of civil aviation, international aviation security, management of infrastructure development of international airports in global competition Grigorov, O. Butkevych, Yu. Voloshin, O. Grigorov, R. Gerasimov, K. Konyukhova, Y. Palamarchuk, K. Sidorenko, G. Khalimova and others. Directly or indirectly, the elements of airport infrastructure that have certain functions and properties, features of the classification of airport infrastructure were analyzed by O. Lozhachevska, V. Kulyk, O. Avtomonov, G. Ageeva, M. Raskaley. However, the issues of regularities of infrastructure development at international airports, priority areas of infrastructure development at international airports are insufficiently developed and need to be improved, theoretical and practical significance determines the relevance of the chosen topic and areas of research.

**Presenting main material.** Ukraine's aviation has often gone through difficult times, accompanied by a significant decline in air traffic, the bankruptcy of many airlines, and the aging of airport equipment. Since 1991, most civilian airports, air bases and runways have needed to be rebuilt because they have been partially lost and abandoned for various reasons. Depending on the economic and political situation in the region, as well as the availability of valid operator certificates, passenger airports have been slowly resuming their work. Ukraine's accession to international and European organizations, including the International Civil Aviation Organization (ICAO) in 1992, resulted in the gradual growth of the airport industry as international interest in Ukraine emerged, new opportunities for airlines, and domestic resorts gradually revived.

After 2014, there was a significant reduction in the main indicators of Ukraine's air transport, due to the military-political situation in the country, the annexation of Crimea, recommendations of international organizations and EU safety authorities to bypass alternative routes in Ukraine's airspace. According to the State Aviation Service of Ukraine, in 2016 passenger traffic through domestic airports increased by 20.9% compared to the previous year, in 2017 - by another 27.6%. The volume of postal cargo flows increased by 21.9% during 2017 and amounted to 52.3 thousand tons. The number of received and sent aircraft amounted to 159.9 thousand, which is 20% higher than in 2016. However, despite increase in the volume of domestic airports, most of which are currently in a very difficult economic situation. The condition of the ground

airport infrastructure is unsatisfactory and is characterized by considerable wear, the level of aviation security equipment at airports is also insufficient.

The state target program for the development of airports defines the main guidelines for the stable development of the aviation industry, bringing the aviation transport infrastructure in line with international standards [2]. At the end of 2021, work continued on the construction of new runways, platforms and taxiways at various airports in Ukraine. After the completion of the airport could accommodate large aircraft, including Boeing 777 and Airbus A330, a significant increase in passenger traffic was expected.

However, the military aggression of the Russian Federation against Ukraine has begun, which results in huge losses for our state. During the shelling, rocket and bomb strikes caused countless damage to Ukrainian airports, destroyed runways, airfields, and destroyed airport terminals and technical equipment. It will take a long time to repair such destruction, and new programs for the development of the airport industry need to be adopted.

The International Civil Aviation Organization (ICAO) is developing measures and programs to prevent such intrusions, analyzing possible cases of illegal intrusions into the airspace that pose a serious threat to the safety and reliability of international civil aviation. The ICAO Council condemned the violation of the territorial integrity and airspace of Ukraine and called on the Russian Federation to stop its illegal activities to ensure flight safety and security of civil aviation in all countries [4]. It was recognized that such actions contradict the principles of the UN Charter and the Convention on International Civil Aviation, which emphasizes the need to avoid conflicts and promote cooperation between nations and peoples.

The design and construction of new and the reconstruction of existing facilities at the aerodrome shall take into account the infrastructure requirements necessary for the optimal application of security measures of international civil aviation. The problem of transformation and modernization of airport infrastructure is relevant for Ukraine in connection with the adaptation to international and European standards and ICAO guidelines, taking into account the priority areas of integration and liberalization of airspace.

The preamble to the Convention on International Civil Aviation emphasizes that ICAO International Civil Aviation Standards and Recommended Practices are designed to ensure that international civil aviation can develop in a safe and orderly manner, that international air services can be established on an equitable basis and run efficiently and economically [5].

Standards and recommended practices are adopted by ICAO to ensure the unification of rules for international air navigation and international air transport, are not strictly mandatory, but the standards set out, in particular, safety parameters that encourage states to use. The long-standing practice of applying ICAO standards has become commonplace, with states making ICAO standards mandatory [6]. The standards set out certain requirements to be met and complied with by all states that have agreed to be bound by an international treaty.

Among the priority areas of adaptation of Ukrainian legislation to international and European standards are technical rules and standards governing the processes of design, reconstruction, construction and operation of airport infrastructure. The state undertakes to ensure the most unified approach possible to the rules, standards, procedures related to civil aviation infrastructure, in particular, aircraft, routes, ancillary services, characteristics of airports and landing sites, as well as other issues related to safety, regularity and efficiency of air navigation [7].

If a State considers it difficult to comply with ICAO rules, it shall immediately notify the International Civil Aviation Organization of any differences between its own practice and those established by the International Standard so that the ICAO Council may immediately notify all other States of any differences between the International Standard's provisions. and the relevant national practice of that State.

An airport is a complex of facilities intended for the reception, departure of aircraft, maintenance of air transportation, maintenance work, with such an aerodrome, airport, other ground facilities and necessary equipment, and the airport is a major part of the airport, including any which buildings, structures and equipment, intended in whole or in part for departure, arrival, parking and movement on such a surface of aircraft [8]. The airport provides regular reception and departure of passengers, luggage, cargo and mail, organization and maintenance of aircraft flights. The world's largest airports receive and serve up to 40 million passengers a year, providing more than 660,000 takeoffs and landings. Approximately 1,800 take-offs and landings of aircraft carrying about 100,000 passengers are performed daily. The number of employees at the airport can exceed 30,000 people.

According to Article 63 of the Air Code of Ukraine, the aerodrome includes the following elements: surfaces (artificial, soil or water), intended for landing, takeoff, movement, parking of aircraft, ground traffic at the aerodrome; ground elements of the aerodrome; air traffic service facilities; means of communication, navigation and surveillance; visual means of flight support; facilities and means of emergency rescue and fire safety, aviation security, meteorological services, electricity supply of the aerodrome; structures and networks of engineering communications that ensure the operation of aerodrome facilities. The aerodrome shall have one or more runways, which are structures suitable for use for take-off, landing, movement and parking of light aircraft with a maximum take-off weight of not more than 5700 kilograms.

Construction and use of land on the aerodrome territory is carried out during the planning of territories by developing and approving urban planning documentation in accordance with the Law of Ukraine "On Regulation of Urban Development" [9] taking into account restrictions on the use of aerodrome territory, protection zones of aeronautical equipment, as well as restrictions related to landing and departure at the aerodrome, the use of zones for training and other types of flights).

Requirements for airport construction planning are contained in Annex 14 of the Convention on International Civil Aviation [10], which applies to all airports

open to the public in ICAO Member States and covers the area from airport planning to details such as switching time, power supply from a backup source, from civil engineering to lighting, from the provision of advanced rescue and firefighting equipment to simple requirements for cleaning airports from birds.

In accordance with the current development of the air transport industry, the provisions of the Annex may change. New aircraft models are emerging, the number of flights, low visibility flights and technological improvements to airport equipment are increasing. This document sets out the minimum technical requirements for aerodromes designed for modern aircraft. Such issues shall be assessed and taken into account, as appropriate, by the authorities for each aerodrome. Guidance on the possible impact of future aircraft on these technical requirements is provided in the ICAO Aerodrome Design Manual (Doc 9157) [11].

The content of Annex 14 reflects the following airport-related aspects: planning, design, operation and airport equipment. The large maneuvering area of the airport starts from the runway and covers taxiways. Today, large modern aircraft require more accurate design of these elements. The main part of Annex 14 is devoted to the specific characteristics required by physical indicators, namely, width, slope of surfaces and distances that separate them from other elements. Special advice is provided on items such as runway and safety zones, obstacle-free zones, and end braking zones. These elements are the building blocks of airports, which determine their overall shape and size and allow engineers to create a plan of the basic structure of the airport.

Asphalt and concrete are used for covering. While concrete is generally used in the construction of large airports due to its high durability (up to 40 years), asphalt (cheaper material, service life of 15 to 20 years) is more often used for small airports [12].

When laying both building materials, a particularly high level of the base and good friction properties must be ensured, regardless of weather conditions. Thus, it is necessary to create optimal conditions for air travel and aircraft. In order to avoid aquaplaning, the concrete pavement is provided with grooves in the transverse direction, providing drainage.

Along with defining the airport's ground conditions, the recommendations need to define the requirements for the airspace of the airport, which must be free of obstacles so that aircraft can arrive and depart from the airport. Obviously, such freedom from interference is necessary for flight safety. It is also important that this amount of space takes into account the possibility of guaranteeing the development and existence of the airport. Failure to comply with the requirements of Annex 14 may result in airports becoming unusable.

An important feature of airports at night is the hundreds and sometimes thousands of lights used to guide and control the movement of aircraft. Unlike flight, when guidance and control are performed by radio, movement on the ground is generally directed and controlled by visual means. Annex 14 details the many systems for use in different weather and other circumstances. As these visual aids must be immediately clear to pilots around the world, it is essential to unify their location and lighting characteristics.

The latest achievements in the field of lighting maximize the brightness of lights. Innovative small light sources have simplified the installation of lights at the surface level of aircraft coatings [13]. Modern high-brightness lights are effective for both day and night flights, and in some day conditions, marking can be highly effective. Their use is also defined in the Annex. In large airports and high-traffic airports, it is important to provide this type of guidance for pilots, which allows them to find their way in the work area.

The purpose of most standards is to increase aviation safety. One section of Annex 14 deals with the security of equipment installed at airports. Noteworthy are the recommendations regarding the design and placement of equipment near runways, which aim to reduce the danger to aircraft movement. It also characterizes the requirements for backup power supply, along with the characteristics of the electrical circuits of lights and the need to control the operation of visual aids.

Aviation security is an integral part of the design and operation of aerodromes. The technical requirements are intended to increase the level of safety at aerodromes. There are many factors and characteristics that contribute to the design of aerodromes for effective development with safety. The ICAO Runway Design Manual (Doc 9157) provides additional information that supports the operational requirements required for runway configuration, runway length, aircraft performance parameters, impact on runway length and runway length. placement of future aircraft. In addition, the information covers factors such as weather, geographical location and aircraft characteristics that need to be considered in the runway infrastructure [11].

Rules for determining the suitability for operation of airfields and airfields of state aviation of Ukraine, approved by the Order of the Ministry of Defense [14] developed on the basis of generalized international practice of aerodrome certification, research results on aircraft safety Civil Aviation Organization (ICAO). The Rules take into account the requirements of Annex 14 to ensure the specific plane of runways, limit obstacles and the size of these planes, determine the requirements for the arrangement of airfields and runways of state aviation of Ukraine to ensure the safety of aircraft.

For each airfield structure, the aerodrome airworthiness code sets the following data: Runway (runway) - true azimuth to one hundredth of a degree, numerical designation, length, width, location of the offset runway threshold to the nearest meter, slope, type of surface, type of runway, and for runway equipped for accurate approach to category I, - the presence of an area free from obstacles, if any; runway, side safety strip, end safety strip, end braking strip - length and width to the nearest meter, surface type; emergency braking system - location and its description; steering wheel - designation, width, type of surface; parking place - length, width, type of surface; obstacle-free strip - length to the nearest meter, profile of the earth's surface, etc. [7].

The runway is designed to ensure runway operations, which are usually performed in two mutually opposite directions. If the local conditions of the aerodrome do not allow for the take-off and landing of aircraft from two directions, the arrangement of the runway is allowed, which ensures the safe

performance of these operations from one direction with the possibility of entering the second circle. The runways are divided into the main ones, which have the longest length and are usually located in the direction of the prevailing winds, and the auxiliary ones.

During the construction of runways it is necessary to take into account their purpose: during takeoff - taxiing the aircraft to the launch site, run to the speed of separation, separation from the runway surface, acceleration in the air and partial altitude; when landing - keeping the aircraft in the air, which is performed at an altitude of 0.5-1.5 m above the surface of the runway with the gradual extinction of speed; landing, which captures the moment of contact with the wheels of the earth; mileage performed to extinguish the speed of the aircraft from landing to a safe speed of descent of the aircraft from the runway to the connecting road; taxiing from the runway [15]. The runway includes the runway, end and side safety strips. The runway is part of the runway specially prepared and equipped for the take-off and landing of aircraft.

The runway can be artificially covered or ground. Runways with artificial turf, as a rule, have lighting and radio equipment that provides round-the-clock performance of takeoff and landing operations, in particular, in conditions of poor visibility with the minimum weather set for this aerodrome. The operational suitability of artificial runway surfaces largely determines flight safety, quality and level of services provided by airports [16]. Artificial coatings provide aviation work at the airport during the year. High-end aerodromes mostly have artificial turf or ground, which form the working area of the runway. In difficult conditions of the aerodrome, in the presence of artificial turf, a runway device without a ground surface is allowed. At permanent aerodromes, there are one or more artificial runways and two or three ground runways.

The bearing capacity is determined for aerodrome surfaces. If the bearing capacity of the aerodrome surface intended for an aircraft with a ground weight of more than 5700 kg is determined by the ACN-PCN method (aircraft classification number - classification classification number) defined in ICAO documents, providing the following data: classification coverage number (PCN); coating type code (by design features); code of the strength category of the soil base; the category code of the maximum allowable pressure in the aircraft tires or the specific value of the maximum allowable pressure; code of the method of estimating the bearing capacity of the coating.

The actual runway length shall meet the operational requirements of the aircraft for which the runway is intended and shall not be less than the maximum length determined by applying local adjustments (elevation, air temperature, runway slope, humidity and runway surface characteristics) to the runways, characteristics of the respective aircraft. End lanes are planned sections of the runway located at the end of its working area, intended for cases of rolling out and premature landing of aircraft during landing, as well as rolling out of the working area to compensate for speed in case of interrupted takeoff.

When designing side safety strips, attention should be paid to the fact that these are ground sections of the runway, located along its working area and designed to ensure safety on the ground in the event of possible rolling of aircraft outside the

working area during takeoff and run. Side safety lanes are arranged for runways at aerodromes of all classes and runways. The lateral safety belts shall be located symmetrically on both sides of the runway, except when the ground runway is adjacent to the artificial turf on one side. There should be a soil area of 25 m between them to ensure drainage from the runway with artificial turf.

Regarding the final safety strip, its length can be reduced in the presence of an emergency braking system (based on the design characteristics of the system with the appropriate justification). Depending on the size of the land allotted for the aerodrome or the presence of obstacles, the length of the final safety strip may decrease. The width of the end safety belt must be equal to the total width of the runway and side safety belts. The end safety zone must be suitable for airplanes in the event of a short landing or rolling out of the runway. The final safety lane must be prepared in such a way that, in the event of an aircraft landing in short range or rolling out of the runway, it reduces the speed of the aircraft and facilitates the movement of rescue and fire-fighting vehicles.

The taxiway lane is important to protect the aircraft operated on the road, as well as to reduce the risk of damage to the aircraft that accidentally rolled out of the road. Taxiways are specially prepared and equipped tracks designed for taxiing and towing aircraft [14]. The taxiways connect the individual elements of the aerodrome and are divided into main, connecting and auxiliary. Trunk roadways are located, as a rule, along the runway, which provides taxiing of aircraft from the platform to the ends of the runway during takeoff and from the runway to the platform after landing. Connecting RDs provide communication between the runway and the main RD at the places where the aircraft is expected to end after landing. Auxiliary roads are designed to connect the parking lot and individual special areas with the main taxiway.

Requirements for waiting areas, waiting places near the runway, intermediate waiting places and waiting places on the route [14] stipulate, in particular, that the location of the waiting place near the runway should be such that the aircraft or vehicle on it, did not disturb the obstacle-free area, the approach surface, the take-off altitude surface or the critical zone / sensitivity zone of the instrument landing system / microwave landing system, or did not interfere with the radio landing equipment.

Parking areas at aerodromes must be comfortable and meet all safety requirements, in particular, individual (per aircraft) and scattered and / or group (aerodromes of training aircraft, etc.). The number, size and configuration of parking spaces must ensure: placement of the estimated number of aircraft and their safe maneuvering; travel and placement of ground support facilities; placement of stationary equipment intended for aircraft maintenance; placement of earthing devices, fasteners, devices for directing the flow of exhaust gases; possibility of mechanized cleaning of a covering from snow.

A separate detailed analysis is required to determine the length and width of the runway elements and the aerodrome area, as this is one of the main issues in the development of new aerodrome projects and existing reconstruction projects.

The length of runways generally depends on the following indicators: flight technical characteristics of aircraft (values of engine thrust during landing,



aerodynamic qualities, specific load on the wing, etc.); meteorological conditions (temperature and air pressure); operating conditions (relief, type of runway cover and condition of its surface); type of takeoff and landing operation (takeoff or landing); the degree of aerodrome equipment to ensure safe take-offs and landings in poor visibility.

The impact on the length of runways of most of these factors can be quantified, which allows you to calculate the required length of the runway by theoretical methods. The theoretical method of calculating the runway length is used in the process of developing a new aircraft model, but the accuracy of the calculation depends on certain factors. Therefore, in the practice of aerodrome design, the so-called experimental-theoretical method of determining the runway length is currently used [15]. According to this method, the runway length is determined by multiplying some standard runway length obtained by testing the aircraft by a number of coefficients that take into account the difference between actual (local) conditions and standard ones.

The values of the correction factors are calculated from simple dependences obtained theoretically or experimentally, taking into account some theoretical considerations. Standard conditions, taken as a model for the size of runways of civil aviation aerodromes, include physical indicators of air corresponding to the so-called standard atmosphere and the surface area of the artificially coated runway.

The standard atmosphere adopted in Ukraine coincides with the standard atmosphere adopted by the International Civil Aviation Organization (ICAO) and has the following characteristics: air is a perfectly dry gas; physical constants of air - density only at sea level  $\rho_0 = 1,23 \text{ kg/m}^3$ ; sea level temperature  $T_0 = 288,15 \text{ K}$ , or  $t_0 = 15^\circ \text{ C}$ ; air pressure at sea level  $760 \text{ mm Hg.st.}$ ; calm air - calm; the law of temperature drop in altitude (and altitude of 11000 m above sea level)  $t_n = 15^\circ \text{ C} - 0,0065 \cdot H$ , where  $H$  (m) is the altitude of the aerodrome above sea level.

The runway surface indicators also comply with ICAO recommendations: the longitudinal slope of the runway is zero, artificial concrete (concrete, reinforced concrete, ordinary or prestressed reinforced concrete floor), the surface is dry.

The use of standard conditions as a reference makes it possible to assess the suitability of an aerodrome for receiving international aircraft for which the required lengths of artificial turf in standard conditions are known, to compare the required runway lengths for different aircraft types, to select design aircraft and not to classify aerodromes. not only the strength of the coating, but also the length of the runway under the same standard conditions. The design conditions take into account the aerodrome location conditions to which the runway length determined for standard conditions is converted. The design characteristics of local conditions are: the height of the aerodrome above sea level; estimated air temperature; the average slope of the runway.

Indicators of other characteristics of the design conditions that affect the length of the runway with artificial turf: the density  $\rho$  and the pressure  $p$  of dry air are derived from the height  $H$  of the aerodrome location and the design air temperature  $t_{calc.}$  and are determined by calculation using the existing theoretical dependences  $p = f(H)$  and  $\rho = f(\rho_0, p, t_{calc.})$ , where  $\rho_0$  is the density of dry air under standard conditions.

So, the calculation of the required runway length for an aerodrome in a given area is to determine the required runway length separately for take-off and landing of the design type of aircraft in standard conditions, and to determine the correction factors to take into account the impact of local aerodrome location conditions. landing of all types of aircraft operated at this aerodrome.

According to the Ministry of Infrastructure of Ukraine, in December 2020 it was planned to hand over runways at several airports in Ukraine (Odesa, Dnipro), in 2021 they planned to reconstruct the runway and build a new one, install lighting and radio equipment at several more airports. for the construction or restoration of airports in recent years have been redirected to the needs of the fight against KOVID-19. Russia's military aggression has changed the state and short-term prospects for the development of key airports in the country, which need new calculations, new plans for restoration and construction.

The Order of the Ministry of Ukraine "On Approval of the Procedure for Registration and Admission of Airfields and Landing Sites of State Aviation of Ukraine" [17] regulates the registration and granting of permission for operation of airfields and permanent landing sites of state aviation of Ukraine. In the process of granting airfields and permanent runways access to operation, their compliance with regulatory requirements for aerodrome class, physical characteristics, marking of aerodrome surfaces, location, height and marking of obstacles in the aerodrome area, radio lighting equipment, meteorological equipment, meteorological equipment is established. rescue and rescue equipment, as well as the quality of working out instructions for flying at an aerodrome or permanent runway.

The procedure for registration and admission of aerodromes and runways of the state aviation of Ukraine establishes the grounds for obtaining the right to operate temporary runways: compliance of the temporary runway with regulatory requirements; availability of flight instructions on the temporary runway with a diagram that defines the size of the runway, runway, their mutual location, agreed with the owner, permanent user or tenant of the land to use the temporary runway for approved by the operator, as aerodromes are classified according to the length of the runway. The type and design of aerodrome surfaces shall be determined taking into account the aerodrome class, its purpose and regulatory load.

Government agencies constantly monitor and control the maintenance of state aviation entities 'compliance with airfields or permanent runways to the requirements of regulations governing the activities of state aviation of Ukraine, and the implementation of measures to ensure the level of flight

safety. Every aerodrome or permanent runway that is approved for operation must be inspected for compliance with applicable regulations.

The International Civil Aviation Organization supports a policy of technical support for technical assistance and technical cooperation, bearing in mind that the reconstruction and modernization of international airports can improve the economic development of states, as civil aviation plays an important role in technical, economic, social and cultural development, as well as in their global cooperation.

**Conclusions.** Based on the study, it can be noted that identifying priority areas for development, transformation and modernization of airport infrastructure is an important area of activity in all areas of international civil aviation, as Ukraine's development is influenced by current global trends to solve the problem of harmonious human development.

The main accents are substantiated directions of infrastructure development at international airports, taking into account international and European standards of civil aviation, developed by the International Civil Aviation Organization (ICAO). The standards indicate the desire of the international community to coordinate as much as possible the policies, means and methods of activity and the direct activities of the subjects of international law. The basic principles of cooperation in the field of international civil aviation are set out in the Chicago Convention, and their observance for the effective development of the infrastructure of international airports is fundamental in the development of the laws of any ICAO Member State.

The technical requirements of Annex 14 of the Convention on International Civil Aviation set out the physical characteristics and limitations of surface obstacles to be provided at aerodromes, as well as certain equipment, facilities and maintenance that are normally provided at aerodromes. Ensuring quality airport and air navigation services requires global costs and technical calculations to restore civil aviation. The state should pay more and more attention to the issues of increasing efficiency and profitability in the provision of airport and air navigation services.

Creating an effective system of research in the field of air transport is one of the most important prerequisites for the development and improvement of the air transport system of Ukraine. Modernization of the infrastructure of international airports is becoming one of the factors increasing the economic development of Ukraine.

Growing attention to airports after the end of Russia's military aggression requires the development of new programs that contain recommendations on technical support for airports, coverage capacity, the state of runway surfaces and the state of airport rescue and fire services. Ukraine's national transport strategy needs significant changes that will contribute to the growth of Ukraine's economic and social development.

For the effective development of the aviation industry, it is necessary to give priority to ICAO standards and recommendations for the identification, development, analysis, implementation and evaluation of civil aviation projects in the field of technical cooperation and technical assistance. Ukraine

should continue contacts with international and European organizations on technical cooperation and technical assistance, reconstruction and modernization of the infrastructure of international airports.

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*Максим'юк Ю.В., Чулінда Л.І., Корчова Г.Л., Почка К.І.*

## **ПРІОРИТЕТНІ НАПРЯМИ РОЗВИТКУ ІНФРАСТРУКТУРИ МІЖНАРОДНИХ АЕРОПОРТІВ**

Основна увага міжнародної цивільної авіації прикута до забезпечення безпеки авіаційної галузі, необхідності вирішення проблем безпечного та ефективного розміщення нових типів літаків, що супроводжується впровадженням нових типів експлуатантів в авіаційній діяльності. Реалізація ефективних міжнародних та європейських стандартів, трансформація та модернізація аеропортової інфраструктури є одним із напрямів роботи України у процесі адаптації законодавства цивільної авіації до міжнародних та європейських стандартів, а також у розробці Цілей сталого розвитку ООН. Ефективна діяльність міжнародних аеропортів у XXI столітті неможлива без удосконалення процесу уніфікації. В умовах глобальної конкуренції розвинена інфраструктура міжнародних аеропортів стає не лише одним із факторів підвищення спроможності країни до економічного зростання, а й перетворюється на конкурентну перевагу на глобальному ринку. Однак з розширенням обсягів авіаційних перевезень усе гостріше постає питання недосконалості інфраструктури аеропортового обслуговування, виявляється потреба у збалансованому розвитку всіх її елементів.

Авіаційна галузь є однією з найбільш інноваційних у світі, де інфраструктура створюється через аеропорти та управління повітряним рухом. У статті проаналізовано напрями відновлення інфраструктури аеропортів України після припинення воєнної агресії РФ, яка спричинила неймовірні руйнування, зокрема, в аеропортовій галузі, охарактеризовано вимоги до проєктування та будівництва нових та реконструкції існуючих споруд на аеродромі, які необхідні для оптимального застосування заходів забезпечення безпеки міжнародної цивільної авіації.

Акцентується увага на тому, що незалежно від розміру та інтенсивності перевезень пасажирів до безпеки аеропорту висуваються особливі вимоги. При будівництві нових аеропортів безпека починає відігравати важливу роль ще під час підготовки відповідної документації. До конструкції злітно-посадкових смуг, рульових доріжок, перонів та паркувальних стоянок пред'являються виключно високі стандарти якості щодо їхньої несучої здатності, властивостей та довговічності. Визначається, що будівництво на приаеродромній території здійснюється під час планування територій шляхом розроблення та затвердження містобудівної документації з урахуванням обмежень використання приаеродромної території (поверхонь обмеження перешкод, зон обмежень забудови щодо умов авіаційного шуму, захисних зон аеронавігаційного обладнання, а також обмежень, пов'язаних із заходженням на посадку та вильотом на аеродромі, використанням зон для виконання навчально-тренувальних та інших видів польотів).

Метою статті є обґрунтування із залученням порівняльного та системного методів пріоритетних напрямів розвитку інфраструктури міжнародних аеропортів України, виявлення сучасних тенденцій розвитку, трансформації і модернізації аеропортової інфраструктури, оскільки розвиток України відбувається під впливом сучасних світових тенденцій щодо вирішення проблеми гармонійного розвитку людства.

**Ключові слова:** міжнародний аеропорт, безпека авіації, реконструкція, модернізація аеропортової інфраструктури, злітно-посадкова смуга, придатність до експлуатації.

*Maksymiuk Yu.V., Chulinda L.I., Korchova H.L., Pochka K.I.*

## **PRIORITY DIRECTIONS OF INTERNATIONAL AIRPORT INFRASTRUCTURE DEVELOPMENT**

The main focus of international civil aviation is on ensuring the safety of the aviation industry, the need to address the problems of safe and efficient deployment of new types of aircraft, accompanied by the introduction of new types of operators in aviation. Implementation of effective international and European standards, transformation and modernization of airport infrastructure is one of the directions of Ukraine's work in the process of adapting civil aviation legislation to international and European standards, as well as in developing the UN Sustainable Development Goals. Effective operation of international airports in the XXI century is impossible without improving the unification process.

In the context of global competition, the developed infrastructure of international airports is becoming not only one of the factors increasing the country's capacity for economic growth, but also becoming a competitive advantage in the global market. However, with the expansion of air traffic, the issue of imperfection of airport service infrastructure is becoming more acute, there is a need for balanced development of all its elements.

The aviation industry is one of the most innovative in the world, where infrastructure is created through airports and air traffic control. The article analyzes the ways to restore the infrastructure of Ukrainian airports after the cessation of Russian military aggression, which caused incredible destruction, in particular, in the airport industry, describes the requirements for the design and

construction of new and reconstruction of existing facilities at the airport. Emphasis is placed on the fact that regardless of the size and intensity of passenger traffic, special requirements are set for airport security. In the construction of new airports, security begins to play an important role during the preparation of relevant documentation. The design of runways, taxiways, platforms and car parks is subject to exceptionally high quality standards in terms of their load-bearing capacity, properties and durability. It is determined that construction on the aerodrome territory is carried out during the planning of territories by developing and approving urban planning documentation taking into account the restrictions on the use of the aerodrome territory (obstacle-limiting areas, aviation noise restriction zones, aeronautical equipment protection zones, as well as restrictions on landing and departure at the aerodrome, use of zones for training and other flights).

The aim of the article is to substantiate with the use of comparative and systematic methods of priority areas of infrastructure development of international airports of Ukraine, identify current trends in development, transformation and modernization of airport infrastructure, as Ukraine's development is influenced by current global trends.

**Key words:** international airport, aviation security, reconstruction, modernization of airport infrastructure, runway, operational suitability.

*Максимюк Ю.В., Чулинда Л.И., Корчевая Г.Л., Почка К.И.*

### **ПРИОРИТЕТНЫЕ НАПРАВЛЕНИЯ РАЗВИТИЯ ИНФРАСТРУКТУРЫ МЕЖДУНАРОДНЫХ АЭРОПОРТОВ**

Основное внимание международной гражданской авиации приковано к обеспечению безопасности авиационной отрасли, необходимости решения проблем безопасного и эффективного размещения новых типов самолетов, что сопровождается внедрением новых типов эксплуатантов в авиационной деятельности. Реализация эффективных международных и европейских стандартов, трансформация и модернизация аэропортовой инфраструктуры - одно из направлений работы Украины в процессе адаптации законодательства гражданской авиации к международным и европейским стандартам, а также в разработке Целей устойчивого развития ООН. Эффективная деятельность международных аэропортов в XXI веке невозможна без усовершенствования процесса унификации. В условиях глобальной конкуренции развития инфраструктура международных аэропортов становится не только одним из факторов повышения состоятельности страны к экономическому росту, но превращается в конкурентное преимущество на глобальном рынке. Однако с расширением объемов авиационных перевозок все острее встает вопрос о несовершенстве инфраструктуры аэропортового обслуживания, проявляется потребность в сбалансированном развитии всех ее элементов.

Авиационная отрасль является одной из наиболее инновационных в мире, где инфраструктура создается через аэропорты и управление воздушным движением. В статье проанализированы направления восстановления инфраструктуры аэропортов Украины после прекращения военной агрессии РФ, повлекшей за собой невероятные разрушения, в частности, в аэропортовой отрасли, охарактеризованы требования к проектированию и строительству новых и реконструкции существующих сооружений на аэродроме, которые необходимы для оптимального применения мер обеспечения безопасности международной гражданской авиации.

Акцентируется внимание на том, что вне зависимости от размера и интенсивности перевозок пассажиров к безопасности аэропорта предъявляются особые требования. При строительстве новых аэропортов безопасность начинает играть важную роль еще при подготовке соответствующей документации. К конструкциям взлетно-посадочных полос, рулевых дорожек, перронов и парковочных стоянок предъявляются исключительно высокие стандарты качества по их несущей способности, свойствам и долговечности. Определяется, что строительство на приаэродромной территории осуществляется при планировании территорий путем разработки и утверждения градостроительной документации с учетом ограничений использования приаэродромной территории (поверхностей ограничения помех, зон ограничений застройки в условиях авиационного шума, защитных зон аэронавигационного оборудования, а также ограничений, связанных с посадкой и вылетом на аэродроме, использованием зон для выполнения учебно-тренировочных и других видов полетов).

Целью статьи является обоснование с привлечением сравнительного и системного методов приоритетных направлений развития инфраструктуры международных аэропортов Украины, выявление современных тенденций развития, трансформации и модернизации аэропортовой инфраструктуры, поскольку развитие Украины происходит под влиянием современных мировых тенденций решения проблемы гармоничного развития человечества.

**Ключевые слова:** международные аэропорты, безопасность авиации, реконструкция, модернизация инфраструктуры аэропорта, взлетно-посадочная полоса, пригодность к эксплуатации.

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*Проаналізовано напрями відновлення інфраструктури аеропортів України після припинення воєнної агресії РФ, яка спричинила неймовірні руйнування, зокрема, в аеропортовій галузі, охарактеризовано вимоги до проєктування та будівництва нових та реконструкції існуючих споруд на аеродромі, які необхідні для оптимального застосування заходів забезпечення безпеки міжнародної цивільної авіації, встановлено пріоритетні напрями розвитку інфраструктури міжнародних аеропортів України, виявлено сучасні тенденції розвитку, трансформації і модернізації аеропортової інфраструктури.*

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*The directions for restoring the infrastructure of Ukrainian airports after the cessation of the military aggression of the Russian Federation, which entailed incredible destruction, in particular, in the airport industry, are analyzed, the requirements for the design and construction of new and reconstruction of existing facilities at the airport, necessary for the optimal application of measures to ensure the security of international civil aviation, are characterized, the priority directions for the development of the infrastructure of international airports in Ukraine were established, the characteristics of modern trends in the development, transformation and modernization of the airport infrastructure were given.*

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