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Contents

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Bugayko D.O. Doctor of Science (Economics), Associate Professor, Vice - Director of International Cooperation and Education Institute, Instructor of ICAO Institute, Associate Professor of Logistics Dept. National Aviation University (Ukraine)

ORCID – 0000-0002-3240-2501
Researcher ID – ABF-5564-2021
Scopus author id: 57216582348

Borysiuk A.V. Vice - Director of ICAO Institute, National Aviation University (Ukraine)

ORCID –
Researcher ID –
Scopus author id: –

Perederii N.M. PhD in Economics, Vice-Dean Faculty of Management, Transport and Logistics, Associate Professor of Air Transportation Management Department National Aviation University (Ukraine)

ORCID – 0000-0003-4173-9445
Researcher ID –
Scopus author id: –

Sokolova N.P. PhD at Technical Sciences, Associate Professor of Automation and Energy Management Department National Aviation University (Ukraine)

ORCID – 0000-0001-5190-2934
Researcher ID –
Scopus author id: –

Bugayko D.D. Student of Logistics Dept. National Aviation University (Ukraine)

ORCID –
Researcher ID –
Scopus author id: –

ROLE OF ICAO CO2 EMISSIONS STANDARD FOR NEW AIRCRAFT IN CIVIL AVIATION SUSTAINABLE DEVELOPMENT PROCESS

Dmytro Bugayko, Anton Borysiuk, Nadia Perederii, Natalia Sokolova, Danylo Bugayko. "Role of ICAO CO2 emissions standard for new aircraft in civil aviation sustainable development process". *Achieving emissions reductions through technical standards is a fundamental element of ICAO's basket of* *measures to address aviation emissions. The sector remains the last major transport mode without vehicle emission standards, so the intensive CAEP work over the past years was an important opportunity for ICAO to deliver on its stated climate goals. The development of an aeroplane CO2 Standard was one recommended element within the ICAO Programme of Action on International Aviation and Climate Change, which was subsequently endorsed by the ICAO High-level Meeting of Member States. Following the agreement of a draft Annex 16 Volume III certification requirement1 at CAEP/9, the CAEP/10 work programme for WG3 included work items E.05 on an aeroplane CO2 emissions Standard and E.06 on interdependencies (Appendix A). These items were allocated to the CO2Task Group (CO2TG). The 36-State ICAO Council has adopted a new aircraft CO2 emissions standard which will reduce the impact of aviation greenhouse gas emissions on the global climate. Contained in a new Volume III to Annex 16 of the Chicago Convention (Environmental Protection), the aircraft CO2 emissions measure represents the world's first global design certification standard governing CO2 emissions for any industry sector. The Standard will apply to new aircraft type designs from 2020, and to aircraft type designs already in-production as of 2023. Those in-production aircraft which by 2028 do not meet the standard will no longer be able to be produced unless their designs are sufficiently modified.*

Keywords: air transport, emissions, regulation, standard, civil aviation sustainable development.

Дмитро Бугайко, Антон Борисюк, Надія Передерій, Наталія Соколова, Данило Бугайко. «Роль Стандарту ІКАО щодо викидів CO2 для нових літаків у процесі сталого розвитку цивільної авіації». *Досягнення скорочення викидів за допомогою технічних стандартів є фундаментальним елементом заходів ICAO щодо вирішення проблем негативного екологічного впливу авіації. Цей напрямок залишається головним аспектом, який потребує відповідних стандартів. Тому інтенсивна робота CAEP протягом останніх років стала важливою можливістю для ІКАО досягти заявлених кліматичних цілей. Розробка стандарту CO2 для літаків була одним із рекомендованих елементів Програми дій ICAO щодо міжнародної авіації та зміни клімату, яка згодом була схвалена Нарадою держав-членів високого рівня ICAO. Після погодження проекту Додатку 16 були визначені Вимога сертифікації Тома III1 на CAEP/9. Робоча програма CAEP/10 для WG3 включала робочі пункти E.05 щодо стандарту викидів літаками CO2 та E.06 щодо взаємозалежностей (Додаток A). Ці пункти були розподілені до робочої групи CO2 (CO2TG). Рада ICAO з 36 країн прийняла новий стандарт викидів CO2 від літаків, який зменшить вплив авіаційних викидів парникових газів на глобальний клімат. Інформація міститься у новому Томі III до Додатку 16 Чиказької конвенції (Захист навколишнього середовища), присвяченого вимірюванню викидів CO2 для літаків. Він є першим у світі глобальним стандартом сертифікації проектів, що регулює викиди CO2 для будь-якої галузі промисловості. Стандарт застосовується до нових конструкцій типів повітряних суден з 2020 року та до конструкцій типів літаків, які вже перебувають у виробництві, починаючи з 2023 року. Ті серійні літаки, які до 2028 року не відповідатимуть стандарту, більше не зможуть вироблятися, якщо їхні конструкції не будуть перероблені та достатньо модифіковані.*

Ключові слова: повітряний транспорт, викиди, регулювання, стандарт, сталий розвиток цивільної авіації.

Дмитрий Бугайко, Антон Борисюк, Надежа Передерий, Наталья Соколова, Даниил Бугайко. «Роль Стандарта ИКАО по выбросам CO2 для новых самолетов в процессе устойчивого развития гражданской авиации». *Достижение сокращения выбросов с помощью технических стандартов является фундаментальным элементом мер ICAO по решению проблем негативного экологического влияния авиации. Это направление остается главным аспектом, требующим соответствующих стандартов. Поэтому интенсивная работа CAEP в последние годы стала важной возможностью для ИКАО достичь заявленных климатических целей. Разработка* *стандарта CO2 для самолетов была одним из рекомендованных элементов Программы действий ICAO по международной авиации и изменению климата, впоследствии одобренной Совещанием государств-членов высокого уровня ICAO. После согласования проекта Приложения 16 были определены требования по сертификации Тома III на CAEP/9. Рабочая программа CAEP/10 для WG3 включала рабочие пункты E.05 по стандарту выбросов самолетами CO2 и E.06 по взаимозависимостям (Приложение A). Эти пункты были распределены в рабочую группу CO2 (CO2TG). Совет ICAO из 36 стран принял новый стандарт выбросов самолетами CO2, который снизит влияние авиационных выбросов парниковых газов на глобальный климат. Информация содержится в новом томе III к Приложению 16 Чикагской конвенции (Защита окружающей среды), посвященного измерению выбросов CO2 для самолетов. Она является первым в мире глобальным стандартом сертификации проектов, регулирующим выбросы CO2 для любой отрасли промышленности. Стандарт применяется к новым конструкциям типов воздушных судов с 2020 года и к конструкциям типов самолетов, уже находящихся в производстве, начиная с 2023 года. Те серийные самолеты, которые до 2028 года не будут соответствовать стандарту, больше не смогут производиться, если их конструкции не будут переработаны и модифицированы.*

Ключевые слова: воздушный транспорт, выбросы, регулирование, стандарт, устойчивое развитие гражданской авиации.

Introduction. The development of world civil aviation is accompanied by continuous technological progress and requires constant improvement in the field of control and reduction of the negative impact of CO2 emissions. Achieving emissions reductions through technical standards is a fundamental element of ICAO's basket of measures to address aviation emissions. The sector remains the last major transport mode without vehicle emission standards, so the intensive CAEP work over the past years was an important opportunity for ICAO to deliver on its stated climate goals. The article is a logical continuation of a number of publications devoted to the development of air transport sustainable development of Ukrainian scientists D. Bugayko [1 – 8], Y. Kharazishvili [1, 2, 4, 7], M. Hryhorak [2 – 3], Y. Ierkovska [5 – 6], O. Ovdiienko [3], V. Marchuk [3], V Lyashenko[4], V Sokolovskiy [4], V Baranov[4], Mariia Bahrii [6], Polish scientists (Z. Zamiar [2,7]), Azerbaijan Scientists F. Aliev [6], and scientists of other countries.

The purpose of the article is to provide structural analysis of CO2 emissions standard for new aircraft in civil aviation sustainable development process.

Presentation of the main results. *Global challenges of climate change.*

The problem of climate change is one of the most serious modern challenges of mankind. In September 2015, world leaders gathered at the United Nations (UN) and adopted the 2030 Agenda for Sustainable Development. It is an action plan aimed at achieving global sustainable development in economic, social and environmental directions, which ensures that no UN member country is left behind. The 17 sustainable development goals in the 2030 agenda can be used as guidelines for the coordinated development of UN member countries.

Sustainable development goal 13. Climate change. Urgent action to combat climate change and its impacts is a key priority for every responsible citizen or organization today. Therefore, the global ecological situation is actually getting out of control [9].

According to the latest figures from the Intergovernmental Panel on Climate Change, international and domestic aviation activities account for approximately 2% of global CO2 emissions. At the same time, the percentage of international aviation is approximately 1.3 percent of global CO2 emissions [3]. Therefore, the environmental component is a priority for the development of world civil aviation, which is constantly improving its actions in the following areas: combating climate change (CORSIA), aviation noise and emissions of CO_2, NOx..., environmental technologies and operation, ecological aviation fuel, and others. One of the effective tools for countering the trend on the part of civil aviation is the implementation of the new CO_2 standard for aircraft.

New CO2 standard for aircraft.

Subsonic jet aeroplanes, including their derived versions, of greater than 5 700 kg maximum take-off mass for which the application for a type certificate was submitted on or after 1 January 2020, except for those aeroplanes of less than or equal to 60 000 kg maximum take-off mass with a maximum passenger seating capacity of 19 seats or less;

Subsonic jet aeroplanes, including their derived versions, of greater than 5 700 kg and less than or equal to 60 000 kg maximum take-off mass with a maximum passenger seating capacity of 19 seats or less, for which the application for a type certificate was submitted on or after 1 January 2023;

All propeller-driven aeroplanes, including their derived versions, of greater than 8 618 kg maximum take-off mass, for which the application for a type certificate was submitted on or after 1 January 2020;

Derived versions of non-CO2-certified subsonic jet aeroplanes of greater than 5 700 kg maximum certificated take-off mass for which the application for certification of the change in type design was submitted on or after 1 January 2023;

Derived versions of non-CO2 certified propeller-driven aeroplanes of greater than 8 618 kg maximum certificated takeoff mass for which the application for certification of the change in type design was submitted on or after 1 January 2023;

Individual non-CO2-certified subsonic jet aeroplanes of greater than 5 700 kg maximum certificated take-off mass for which a certificate of airworthiness was first issued on or after 1 January 2028; and

Individual non-CO2-certified propeller-driven aeroplanes of greater than 8 618 kg maximum certificated take-off mass for which a certificate of airworthiness was first issued on or after 1 January 2028 [10, 11].

The CO2 standard for aircraft – key points

Reduces aircraft CO_2 emissions by encouraging the integration of fuel efficient technologies into aircraft design and development.

Ensures that older aircraft models end production in an appropriate timeframe or that manufacturers invest in technology to improve their efficiency.

The standard also ensures that new designs go beyond the highest fuel efficiency of today's aircraft. Is a challenging and robust standard that brings CO_2 emissions into the formal certification process that new aircraft need to pass in order to enter service.

Is a significant milestone for the sector: the first such standard for aircraft and is key to the sector's long-term commitment to reduce CO_2 emissions from aviation.

Is part of a basket of measures to deal with industry's climate impact which include improved operations, sustainable alternative fuels, better use of infrastructure and new technology (which the CO_2 Standard will support).

Is complementary to an agreement in September/October this year on a global market-based measure to cap the growth in aviation CO_2 emissions from 2020 and meet the industry's mid-term goal.

Was developed by the ICAO Committee on Aviation Environmental Protection (CAEP) over a six-year period through 26 meetings and some 700 papers and pieces of analysis by 170 aviation experts from governments, industry and environmental groups [10].

CO_2 differs fundamentally from ICAO's noise and NOx standards because fuel efficiency has always been a major aircraft design parameter whereas noise and (to a large extent) engine emissions abatement measures, are not in themselves inherent to building aircraft – at least until regulation was introduced. While those measures simply add costs, every fuel efficiency improving technology has both costs and savings [12].

Fuel efficiency is central to aviation's business and sustainable growth strategy — as evidenced by the huge gains in fuel efficiency over the decades. The formalization of a CO2 Standard for aircraft is an important part of the sector's overall basket of measures for climate action and is complementary to the significant work already underway in the sector: new aircraft and alternative fuels technology; optimizing operational procedures; and improved infrastructure.

The Standard will ensure that all newly-developed aircraft and engines incorporate the latest commercially-available proven technologies, mindful that no single technology can be applied across the entire range of new aircraft and engine models from small regional and business aircraft to the very large capacity long-range commercial aircraft.

The CO2 emissions of aircraft become part of the certification process, alongside safety compliance and noise measures, among other elements.

The establishment of the first global CO2 standard will allow monitoring and progress in the future towards achieving CO2 emissions reductions in line with research and development targets and technical feasibility.

How does the CO2 standard work?

The CO2 Standard focuses on cruise flight performance because the cruise portion of a flight is typically when the most fuel is consumed and the majority of CO2 is emitted.

It takes account of the 'transport capability' of the aircraft — i.e. what is transported and how far it is transported. These two elements, the payload and the range, are essential in the design of any aircraft. For each aircraft type, depending on its size and weight, the CO2 Standard defines a maximum metric value (fuel burn per flight kilometre) that may not be exceeded.

For each aircraft type, depending on its size and weight, the CO2 Standard defines a maximum metric value (fuel burn per flight kilometre) that may not be exceeded.

CO2 metric system to measure the aeroplane fuel burn

The intent of this CO2 metric system is to equitably reward advances in aeroplane technologies (e.g. propulsion, aerodynamics and structures) that contribute to reductions in aeroplane CO2 emissions, and differentiate between aeroplanes with different generations of these technologies. As well as accommodating the full range of technologies and designs which manufacturers can employ to reduce CO2 emissions, the CO2 metric system has been designed to be common across different aeroplane categories, regardless of aeroplane purpose or capability. An overview of the CO2 Metric System can be found in Figure 1 [13].

To establish the fuel efficiency of the aeroplane, the CO2 metric system uses multiple test points to represent the fuel burn performance of an aeroplane type during the cruise phase of flight. Specifically, there are three averaged (i.e. equally weighted) points representing aeroplane high, middle and low gross masses, which are calculated as a function of Maximum Take-Off Mass (MTOM). Each of these represents an aeroplane cruise gross mass seen regularly in service. The objective of using three gross mass cruise points is to make the evaluation of fuel burn performance more relevant to day-to-day aeroplane operations. The metric system is based on the inverse of Specific Air Range (i.e. 1/SAR), where SAR represents the distance an aeroplane travels in the cruise flight phase per unit of fuel consumed. In some aeroplane designs, there are instances where changes in aeroplane size may not reflect changes in aeroplane weight, for example when an aeroplane is a stretched version of an existing aeroplane design [13].

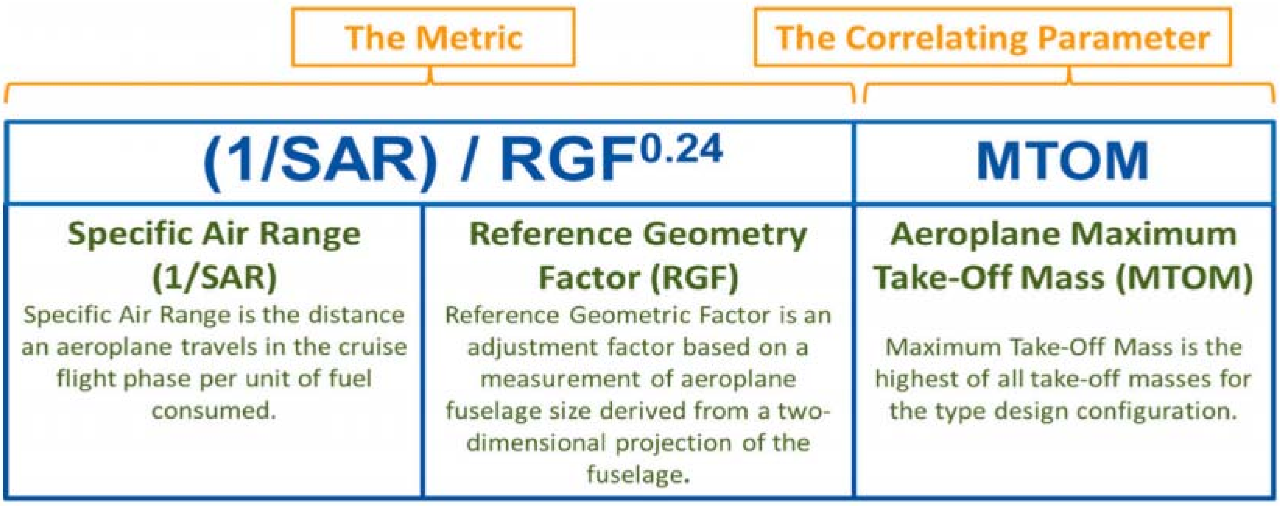

Figure 1 - An overview of the CO2 Metric System [7].
Source: 2016 Environmental Report - Aviation And Environment/ the CAEP/10 recommendation on a new ICAO AEROPLANE CO2 EMISSIONS STANDARD by Stephen Arrowsmith (European Aviation Safety Agency) and Laszlo Windhoffer (US Federalaviation Administration) ICAO, 2016 – P.112 – 114 [13].

To better account for such instances, not to mention the wide variety of aeroplane types and the technologies they employ, an adjustment factor was used to represent aeroplane size. This is defined as the Reference Geometric Factor (RGF), and it is a measure of aeroplane cabin size based on a two-dimensional projection of the cabin. This improved the performance of the CO2 metric system, making it fairer and better able to account for different aeroplane type designs.

The overall capabilities of the aeroplane design are represented in the CO2 metric system by the certified MTOM. This accounts for the majority of aeroplane design features which allow it to meet market demand. Based on the CO2 metric system, CAEP developed procedures for the certification requirement including, inter alia, the flight test and measurement conditions; the measurement of SAR; corrections to reference conditions; and the definition of the RGF used in the CO2 emissions metric. CAEP utilized manufacturers' existing practices in measuring aeroplane fuel burn in order to understand how current practices could be used and built upon for the new Standard [13].

Setting the regulatory limit

ICAO environmental Standards are designed to be environmentally effective, technically feasible, economically reasonable, while considering environmental interdependencies.

This involved defining an analytical space within which CAEP would work to investigate the options available. This included the development of options for the regulatory limit line, applicability options and dates, and all the associated assumptions which allowed the CAEP working groups to perform the cost - effectiveness analysis required to make an informed decision on the Standard at the CAEP/10 meeting. The foundation of the CAEP/10 recommendation on the CO2 emissions Standard was supported by this significant data informed process, involving input from ICAO member states and stakeholders.

The modeling exercise involved several analytical tools, including fleet evolution modeling, environmental benefits, recurring costs, non-recurring costs, costs per metric tonne of CO2 avoided, certification costs, applicability scenarios and various sensitivity studies to inform the decision-making process. This work allowed CAEP to conduct an analysis, with the aim of providing a reasonable assessment of the economic costs and environmental benefits for a potential, CO2 standard in comparison with a "no action" baseline [13]. The CO2 Standard regulatory limits can be found in Figure 2.

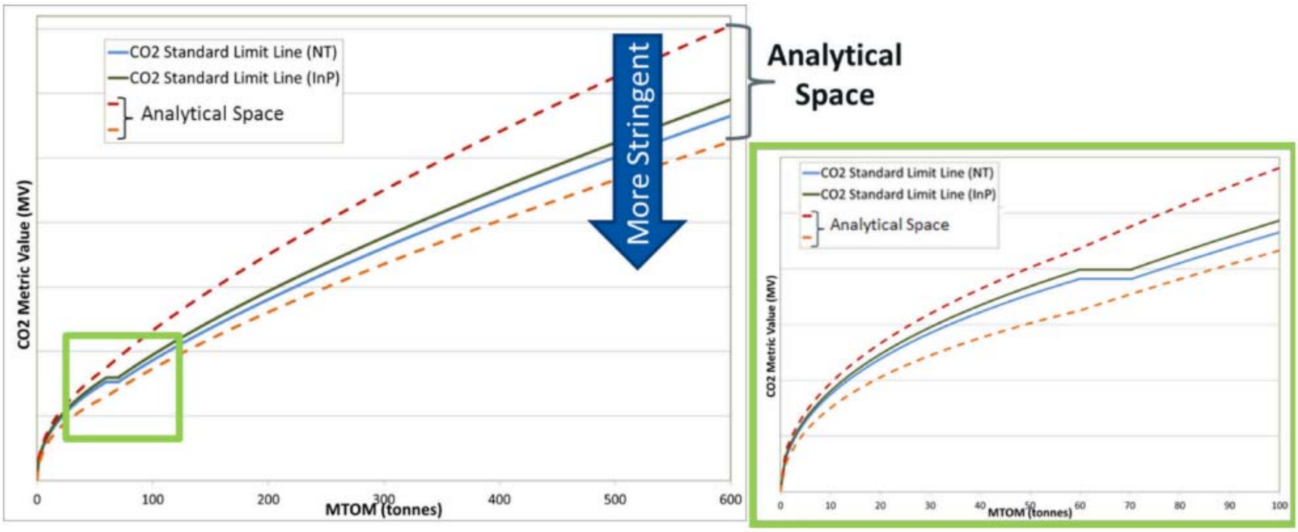

Figure 2 - The CO2 Standard regulatory limits
Source: ICAO'S CO2 standard for new aircraft, ICAO, 2017 [10].

Choices considered during the co2 standard work
- Ten Regulatory Limit Lines;
- Treatment of aeroplanes above and below 60 tonnes;
- New Type and In-Production applicability;
- Production cut-off; and
- Applicability dates of 2020, 2023, 2025 and 2028.

Conclusions. Each new generation of aircraft is roughly 15-20% more efficient than the model it replaces. The CO2 Standard mandates that these improvements continue.

However, the continuous development of new aircraft and engine technology, underpinned by the CO2 Standard, is only one part of overall aircraft efficiency improvements.

The aviation industry approach focuses on four pillars of climate action: reducing fuel use (and CO2 emissions) through new technology and alternative fuels; better operations of existing aircraft; and improvements in infrastructure. For all emissions that cannot be reduced through these pillars, a global market-based measure will be used to offset the remaining emissions in order to meet the targets set by the industry. The CO2 Standard will be reviewed as part of the regular cycle of ICAO's Committee on Aviation Environmental Protection (CAEP) [14].

At the same time, without diminishing the great importance of the introduction of this standard for the greening of global aviation transport, it is advisable to make some polemical remarks. From the point of view of the authors, its implementation will lead to further globalization of the aviation industry. Under such conditions, the most innovative manufacturers of aircraft and aircraft engines virtually monopolize the global aviation sales market. Under such conditions, other aviation equipment enterprises, in particular the Ukrainian enterprises «Antonov» and «Motor Sich», need to use proactive risk management procedures and plan mandatory changes in the design of aviation equipment. This will allow them to maintain a segment in the market and contribute to the greening of the industry.

The use of the CO2 Standard is a robust evolution of the sustainability toolkit for global, regional and national air transport. Regulation of the environmental component of the industry's work allows it to be a necessary component to achieve the United Nations Sustainable Development Strategic Goals.

References

1. D. Bugayko, Yu. Kharazishvili. Theoretical principles of strategic aviation safety management in the context of ensuring sustainable development of the national economy. Bulletin of Economic Science of Ukraine. 2020. № 1 (38). P. 166-175. Institute of Industrial Economics of the National Academy of Sciences of Ukraine, Academy of Economic Sciences of Ukraine.

2. D.Bugayko, Yu. Kharazishvili, M.Hryhorak, Z.Zamiar. Economic Risk Management of Civil Aviation in the Context of Ensuring Sustainable Development of the National Economy. Logistics and Transport– Wroclaw: International School of Logistics and Transport in Wroclaw. – 2020. - №1-2(45-46). – P.71– 82.

3. Ovdiienko O., Hryhorak M., Marchuk V., Bugayko D. An assessment of the aviation industry's impact on air pollution from its emissions: worldwide and the Ukraine. Environmental & Socio-economic Studies. [Katowice]. 2021. Vol. 9. № 2. P. 1-10.

4. Yu Kharazishvili, D Bugayko, V Lyashenko, V Sokolovskiy, V Baranov. Strategizing for sustainable development of transport systems in the safety dimension. IOP Conference Series: Earth and Environmental Science. IOP Publishing. P. 012025.

5. Dmytro Bugayko, Yuliya Ierkovska. Institutional Measures of Air Transport Safety Strategic Management at the Level of State Regulation. Intellectualization of Logistics and Supply Chain Management. The electronic scientifically and practical journal v.9 (2021). P.6 – 19. ISSN 2708 - 3195. https://smart-scm.org.

6. Dmytro Bugayko, Yuliya Ierkovska, Fariz Aliev, Mariia Bahrii. The Concept of National Integrated Risk Management of Aviation Transport of Ukraine. Intellectualization of Logistics and Supply Chain Management. The electronic scientifically and practical journal v.10 (2021). P.6 – 18. ISSN 2708-3195 https://smart-scm.org.

7. Bugayko D., Kharazishvili Yu., Antonova A., Zamiar Z. Identification of Air Transport Ecological Component Level in The Context of Ensuring Sustainable Development of the National Economy. Intellectualization of Logistics and Supply Chain Management: the electronic scientifically and practical journal. 2020. № 3. October. P. 38-53. URL: https://smart-scm.org/wp-content/uploads/3_20_titul_j_full.pdf

8. Bugayko, D. (2012, September). Safety and Effectiveness of Civil Aviation in Conditions of Air Traffic Globalization. In Proceedings the fifth World Congress «Aviation in the XXI-st century»,«Safety in Aviation and Space Technologies (pp. 25-27).

9. Resolution adopted by the General Assembly (UN) on 25 September 2015 A/RES/70/1. Transforming our world: the 2030 Agenda for Sustainable Development.

10. ICAO. ICAO'S CO2 STANDARD FOR NEW AIRCRAFT, ICAO, 2017.

11. ICAO. ICAO Council adopts new CO2 emissions standard for aircraft. ICAO News release https://www.icao.int/Newsroom/NewsDoc2017/COM.05.17.EN.pdf.

12. ICAO. Assembly — 39th Session Executive Committee. Agenda Item 22: Environmental Protection – International Aviation and Climate Change – Policy, Standardization and Implementation Support/ ICAO'S CO2 STANDARD FOR NEW AIRCRAFT (Presented by the International Coalition for Sustainable Aviation (ICSA) https://www.transportenvironment.org/sites/te/files/publications/wp_207_en%20ICSA%20CO2%20Standard.pdf

13. ICAO. 2016 Environmental Report - Aviation And Environment/ the CAEP/10 recommendation on a new ICAO AEROPLANE CO2 EMISSIONS STANDARD by Stephen Arrowsmith (European Aviation Safety Agency) and Laszlo Windhoffer (US Federa Aviation Administration) ICAO, 2016 – P.112 – 114.

14. ICAO. 2019 Environmental Report - Aviation and Environment, ICAO, 2019.