

## REPLACEMENT OF COMBAT AIRCRAFT FLEET IN TERMS OF IMPROVING POLISH NATIONAL SECURITY

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### Abstract

The content presented in the article focuses on an assessment regarding of replacement of the combat aircraft fleet in terms of improving Poland's security. The introduction contains a general outline of the problem situation regarding the need to replace the fleet of combat aircraft in Poland and identifies the research problem that the article focuses on. The subsequent parts of the assessment are: analysis of military threats and the essence of modern and future aerial warfare on the basis of which the author defines the requirements related to the specification of desirable combat aircraft and conducts a statistical survey indicating the recommended number of combat aircraft in Poland. The summary of the article contains conclusions from the conducted research and possible directions for further research in this area.

**Key words:** military threats, Poland, combat aircraft, fleet replacement, national security

### Introduction

Poland joining the North Atlantic Treaty has contributed to improving its safety. Thanks to the signing of the accession treaty, the Armed Forces committed themselves to applying appropriate military standards, which led to many transformational changes in the Polish army. By participating in training and international missions, the Armed Forces of the Republic of Poland achieved a high level of interoperability<sup>1</sup> and acquired new military equipment. Participation in NATO, recognized as a guarantee of Polish security in accordance with Art. 5 of the Treaty, should be treated as a measure that supports the country's defence capabilities and should not lead to the so-called "loosening of Polish armament intentions"<sup>2</sup>.

<sup>1</sup> Interoperability - the ability of an element or system to cooperate, function in compliance, source: <http://interoperability-definition.info/pl/> [access: 14.02.2018].

<sup>2</sup> Marczak J., *Potęga obronna Polski - fundamentem bezpieczeństwa narodowego Polski i Europy w XXI wieku*, Source: <https://obronanarodowa.pl/artykuly/display/potga-obronna-polski-fundamentem-bezpieczenstwa-narodowego-polski-i-europy-w-xxi-wieku/> [access: 26.01.2018].

The National Security Strategy of Poland focuses on defensive and peaceful activities, as expressed in the following paragraph: “Major tasks of the Polish Armed Forces, setting the direction for the planning activity and training during peacetime, are concerned with ensuring the ability of the state to: defend and oppose aggression, maintain readiness to execute missions related to the defence and protection of the inviolability of borders, conducting a strategic defence operation on the territory of the Republic of Poland, participation in anti-terrorism activities in the country and abroad, participation in defence operations outside the country in accordance with allied obligations under Article 5 of the North Atlantic Treaty, and conducting reconnaissance activities and intelligence”<sup>3</sup>.

Despite numerous modernisations and purchases of military equipment by the Polish Air Force, apart from modern multirole aircraft, there is a lack of anti-aircraft defence, warships and helicopters. The Polish Air Force is equipped with Soviet equipment<sup>4</sup>, which does not meet the requirements dictated by the modern warfare. The Soviet armaments are outdated and do not raise the real combat capability of Poland. This equipment generates high costs associated with the indirect possibility of buying parts from Russia. In Poland, the possession of Soviet equipment imposes the obligation to train a new generation of soldiers using outdated technology. The Polish Air Force, on which the security of Poland’s airspace is based, requires thorough modernisation and replacing the aircraft fleet. Currently, the Ground-Based Air Defence System of Polish airspace is not sufficient to cover all the national territory, without the effective support of aviation. Polish combat aircraft are unable to meet the requirements of modern warfare, which adversely affects the security of the country’s air space and weakens Poland’s position in the international arena. The Polish Air Force should also focus on needs that the modern combat aircraft and multirole fighters should meet due to economic reasons<sup>5</sup>.

The importance of the abovementioned problem situation became the basis for conducting research in which the following main research problem was selected: *What impact will the replacement of the fleet of combat aircraft have on Poland’s security?*

Insight into the theoretical and practical range in the research issues area, and paying heed to the methodological foundations above allowed the author to put

3 Lasoń M., *Zagrożenia dla bezpieczeństwa Polski w XXI wieku w świetle analizy porównawczej kolejnych Strategii Bezpieczeństwa Narodowego RP, Bezpieczeństwo - teoria i praktyka*, Kraków 2016, s. 128, 129.

4 The term „Soviet equipment” refers to vehicles, aircraft, weapons and devices found in all types of the Polish Military Forces. The weaponry is what Poland received or purchased under the Warsaw Pact.

5 Multirole combat aircraft – MRCA, it is a combat aircraft designed to perform differently in terms of specific, combat tasks dependent on its equipment and weapons. Due to its wide range of applications, it is able to replace several types of combat jet fighters, e.g. fighter-bomber, hunting and reconnaissance aircraft. <https://www.defenceaviation.com/2008/02/air-superiority-fighters-vs-multirole-fighters.html> [access: 22.02.2018]

forward assumptions as to the probable solution of research problems in the form of a hypothesis:

I suggest that the replacement of combat aircraft used by Poland will favourably improve security. Purchasing modern combat aircraft will contribute to more effective cooperation between air squadrons in Poland as part of defending the territory of the Republic of Poland. Replacing the combat aircraft fleet used by the Polish Air Force with state-of-the-art multirole aircraft will improve the combat capability of the Air Force, which will increase the ability to maintain security. Thanks to modern combat aircraft, international cooperation as regards aerial field training exercises as part of NATO will ensure a high level of training of pilots, which will translate into an improvement of Poland's security.

When determining the improvement of Poland's security, it is necessary to indicate the threats that may affect it. The main threat to Poland's security may be military aggression from Russia, whose actions are aimed at strengthening its economic and military position in the world, using various strategies for action<sup>6</sup>. These strategies often violate international law, are based on violence and cause regional destabilisation. The aggressive attitude of Russia is directed, among others, against the eastern flank of NATO, to which Poland can be included. Increasing the military potential of the Kaliningrad Oblast region of Russia, by arming it with modern missile systems is a direct threat to Poland. Terrorism caused by religious fanaticism among emerging migration waves in Europe, although it may be a threat to Poland, in the context of aircraft fleet replacement and military security of the country, will not be included in the article<sup>7</sup>.

Selecting the appropriate combat aircraft is associated with the determination of its use, which could not have been achieved without characterising the war theatre on which it will operate. Modern warfare is very diverse in terms of technologies used and methods of achieving a goal using combat aircraft. Modern combat aircraft warfare can be characterised through the prism of ongoing military conflicts, international training exercises and through the analysis of the intended use and equipment of the latest aircraft. Differences in the technological advancement of combat aircraft significantly affect how they perform on combat missions. Military actions in the theatre of modern war are conditioned by many factors, but all actions are characterised by the principle of an optimised way of achieving the goal. Obtaining an information advantage in warfare is one of the key aspects that is currently being pursued and towards which activities related to the war theatre will be aimed in the future. Directions of development of the warfare in terms of the use of combat aircraft is focused on refinement of technological use of equipment, substitution of man by a machine in areas where such a possibility is justified and creating combat

<sup>6</sup> Krasiewski O., *Czynnik rosyjski jako zagrożenie dla bezpieczeństwa narodowego Ukrainy i Polski*, Studia Europae Gnesnensia, Gniezno 2015, p. 2.

<sup>7</sup> Doran P., Bugajski J., Brown M., *Strengthening Strategic Security in Central and Eastern Europe*, Center for European Policy Analysis, 2017, p. 13.

strategies, optimised in terms of achieving the goal and minimising the risk of losing equipment and of casualties. The future use of combat aircraft on the battlefield is also the combined action of air, space and cybernetic forces and the deepening of the information warfare.

The requirements in relation to the prospective purchase of a combat aircraft for Poland should include the supersedure in tasks by replaced combat aircraft and meeting the requirements of modern warfare. These aircraft should be, among other things, capable of performing combat missions in the area of “air to air” and “air to ground”, aerial refueling, being undetectable by radar, and having the capability to attach additional fuel tanks and additional weaponry. A detailed analysis of the Air Force’s demand for modern warplanes should be the key for Poland’s airspace security. The tender should be preceded by a multi-aspect analysis which takes the long-term perspective of using new combat aircraft into account. I suspect that the optimal number of combat aircraft in relation to the area and population of Poland will be greater than the number of combat aircraft currently used by Poland. Quantification may imply the need to increase the number of combat aircraft within planned purchases in order to increase the security of Poland.

### **Contemporary military threats to Poland’s security**

The official position on military rearming in the Kaliningrad Oblast and on the Eastern NATO flank is defined by Russia as a defensive reaction to NATO’s offensive moves. Numerous facts indicate that this is a Russian lingual manipulation which does not constitute the true state and Russia’s threats cannot be underestimated.

Recent events such as the war with Georgia, the annexation of the Crimean peninsula and military exercises with Belarus, “Zapad-17” have shown that Russia’s economic and military operations are definitely offensive. This “Zapad-17” exercise was commented on and evaluated by the press and independent experts as an exercise aimed at the Baltic countries, Ukraine and Poland. The “Defence Concept of the Republic of Poland” was developed in 2017 as a response to “growing threats to Poland”. It assumes that (...) *until 2032, Moscow will maintain an aggressive line in foreign and security policy.*

*This poses a direct threat to Poland and other NATO eastern flank countries, due to the asymmetry of military potentials between Russia and these countries. In the further part of the study, there is a fragment, “Russia implements a broad plan for technical modernisation of the armed forces, conducts an intensive programme exercise and militarises society. Expenditure for military purposes is their national priority and will be maintained at a high level even with long-term economic stagnation. Russian politics is highly coordinated with the operations of special services, including active measures (e.g. disinformation activities) applied to other countries. Moscow uses the tools that allow it to reduce the asymmetry of forces in relation to NATO, such as attacks in cyberspace or the threat of the use of force*

*against selected states, including tactical nuclearweapons against countries without a nuclear potential*<sup>8</sup>.

A hypothetical attack from Russia would probably be a combined action<sup>9</sup> of the Russian Armed Forces supported by medium-range missiles from the Kaliningrad Oblast. Crossing the border with the use of armoured combat vehicles and tanks, would be preceded by aircraft bomb attacks on important tactical objects such as airports and bridges. Russian bomber aircraft are an easy target for Polish F-16 fighters, due to their large mass during a mission (fuel, armaments) and therefore poor maneuverability and they would have to be protected by Russian air-superiority fighters.

At the moment, Poland would only have 46 F-16 Fighting Falcon aircraft, which could take on the defence of its territory, but both the number of aircraft and their current equipment would prove insufficient. Poland would not be left alone in the face of a threat because an attack on its territory would probably lead to the outbreak of World War III, but before allied states lead by the United States could support Polish defence operations, maintaining a defensive position would belong to the Polish Armed Forces. Massed land invasion is somewhat easy to repel with the help of aircraft, but leaving enemy air forces over its own territory without providing an effective response in the form of combat aircraft and anti-aircraft missile launchers, can determine the rapid defeat of any state. While the issue of buying the most modern anti-aircraft and anti-missile systems (Patriot<sup>10</sup>) for Poland has already been resolved, the combat aircraft fleet replacement remains a matter of time and one which is necessary to consider.

### **Characteristics of combat aircraft war theatre**

The modern war theatre can be characterised by the current conflicts, international exercises and through the analysis of the purpose and equipment of the latest aircraft. A characteristic feature of current combat aircraft is its diversity and versatility in terms of purpose, as it can be used for both defensive and offensive actions, over its own territory and abroad.

Currently, conflicts in which combat aircraft are being used focus mainly on the fight against terrorism, and thus attacking ground targets, such as headquarters of

<sup>8</sup> Assumptions of the defensive concept Republic of Poland [in:] The Concept of Defence of the Republic of Poland, Ministry of National Defence, Warsaw 2017, p. 3.

<sup>9</sup> Combined action in the context of the use of armed forces - military operations involving aviation, navy, land forces or other governmental and non-governmental forces and institutions [in:] Air and Space Power in Nato, Future vector part II, The Joint Air Power Competence Centre, Germany 2014, p. 6.

<sup>10</sup> Purchase of Patriot missiles for Poland, [in:] <http://mon.gov.pl/aktualnosci/artukul/najn-owsze/modernizacja-i-rozwoj-sil-zbrojnych-82017-12-22/> [access: 22.01.2019].

leaders, small armed groups or vehicles carrying weapons. Differences in employment of combat aircraft in terms of attacking ground targets is huge and depends on many factors<sup>11</sup>. Until recently, these tasks were carried out with the help of heavy aircraft bombers that are capable of dropping high caliber bombs. The solution turns out to be used less and less, due to the large loss of own aircraft and the high operating costs of these machines and the long recovery time of combat readiness on the ground and limited possibilities of taking off in difficult conditions (length and surface of runways). Many countries use multirole aircraft as an alternative to bombing aircraft, which reduces the likelihood of their radar detection, and thanks to the universality of their use, costs are reduced. Nevertheless, the problems remaining are related to the time of reconstruction of combat readiness, poor condition of runways at landing stations and possibly high losses in the event of aircraft crashing. The American army solves this problem by using combat drones, and is also planning to buy light warplanes equipped with a propeller engine that would solve the aforementioned problems.

Armed actions in modern warfare are conditioned by many variables, but all are guided by the principle of an optimised way of achieving the goal, which is determined by factors such as political situation, environmental and spatial-temporal conditions and operational and tactical conditions. Referring to the diversity of modern warfare, it is worth mentioning the differences in technological advancement of combat aircraft, which significantly affects the way they perform during combat missions, thus shaping the rules in the war theatre.

Some countries with combat aircraft fleet are carrying out 24-hour combat duty over their territory, in order to identify and intercept foreign aircraft if necessary, and land planes with inefficient systems. With regard to this use of combat aircraft, states focus on multirole aircraft and light front fighters. In the context of duty “warfare” occurs when reacting to the violation of the airspace procedure, or the appearance of an aircraft without a legal permit (without an approved flight plan or without the consent of ATC<sup>12</sup>).

During peacetime, the task of the F-16 on duty is limited to the identification of a given aircraft, which means reading the nationality insignia, the side number of the aircraft and attempting to establish communication. The intercepted aircraft is escorted to the country of affiliation or is allowed to continue the flight. Arms are used very rarely because it would threaten to escalate international conflict. The last use of weapons during the policing took place in 2015, when a Russian Su-24 aircraft was shot down by the Turkish F-16 aircraft, which allegedly violated the Turkish border of Turkish airspace; however, international conflict was avoided.

**11** Air and Space Power in NATO, Future vector part II, The Joint Air Power Competence Centre, Germany 2014, p. 158.

**12** ATC - Air Traffic Control - air traffic control serve to prevent aircraft from closing in to one another, both on the ground and in flight, [in:] [http://www.pansa.pl/?menu\\_lewe=o\\_pazp&lang=\\_pl&opis=dzialalnosc](http://www.pansa.pl/?menu_lewe=o_pazp&lang=_pl&opis=dzialalnosc) [access: 23.04.2018].

Modern warfare is extremely diverse in terms of technologies used and strategies aimed at achieving the target using combat aircraft. Most modern aircraft multitasking, such as F-35 are based on system concepts combined activities in which a single aircraft is one of the elements of an entire air-superiority combat system. AWACS might be considered an element of the aforementioned system, and aircraft tankers, command and guidance centres and Joint Terminal Attack Controllers (JTAC).

The functioning of such a system is associated with a number of advantages and disadvantages. The advantages undoubtedly include a wide range of use on the war theatre and control over a large battle area, which translates into strength and efficiency. The disadvantages of such a system may be the fact that failure or disability of one of the components of the system, may result in failure to complete the task. Russia represents diametrically different concept of using multirole aircraft in the warfare. After the construction of aircraft such as the Su-30, one can clearly see the unfaltering interest of Russians in increasing the manoeuvrability, performance and the killing power of aircraft, thus placing importance on the strength of the individual. Russian propaganda comparisons of their own combat aircraft with the US, in terms of manoeuvring and the dominance of Russian fighters through more favourable flight parameters, do not reflect the actual capabilities of aircraft due to a different strategy being utilised.

In spite of the current situation of no conflict, in which combat aircraft would be set against each other in a direct clash, a field training exercise in this respect, is an inseparable part of military combat aircraft pilots' training and keeping them ready for execution of combat missions. The largest periodic aircraft exercise of the NATO member countries is called Red Flag<sup>13</sup> and is held in Alaska.

Battle scenarios and strategies of countries participating in these field training exercise are secret; therefore, defining modern warfare based on them is impossible. It is only known, from an unconfirmed media information, that pilots are divided into teams - practicers and enemies that are against each other, which could indicate the existence of manoeuvring elements. It is also known that in the area of the training ground the OPL launchers designed to resemble Soviet missile launchers were placed.

Combat aircraft warfare in the perspective of the next several years will be shaped in many directions. The first of these is the development of technologies currently used in combat aircraft in order to increase combat effectiveness and achieve an informative advantage. Development of technologies such as stealth, radars with

**13** Red flag – advanced US combat aviation exercises taking place in the desert in Nevada, which NATO member states can also take part in. The purpose of the exercises is to increase the capabilities of the air combat forces through a realistic reversal of the aircraft warfare. [in:] <https://www.globalsecurity.org/military/ops/red-flag.htm> [access: 24.04.2018].

active AESA electronic scaling<sup>14</sup>, and HMD-helmets<sup>15</sup> will ensure that they remain undetectable to radar and will allow more airspace to be observed, thus winning a tactical advantage over the opponent. The idea of introducing a laser weapon, which due to the large power consumption and dimensions, has so far only been tested by land forces and on ships, can turn out to be a considerable shift in the combat aircraft warfare<sup>16</sup>.

Another of the directions for future development of military aviation warfare is the desire to replace manned combat aircraft by unmanned armed aerial vehicles. Despite the fact that combat aircraft of the 5<sup>th</sup> generation and conceptual aircraft, referred to as the 6<sup>th</sup> generation, still assume the presence of a pilot in the cabin, the dynamic development of technology in the coming years may mean the replacement of the pilot by a computer controlled with a ground simulator, or autonomously programmed. The third possible direction of development of combat aircraft warfare is the succession of technological development and assumes optimising the activities towards achieving the goal while minimising casualties. This vision creates the use of many functional solutions, refined strategies and technological facilities, to improve combat operations while reducing the threat to the operator (soldier, pilot). The concept includes the use of small combat drones known as “loitering munition”, which fly fast in a loose group consisting of numerous vehicles (a swarm), fly over the target, distracting the means of preventing air attacks, and then destroying the programmed objects. It’s a cheap solution, safe for the operator and a very effective one. The possibility of using EMP weapons<sup>17</sup> emitting an electromagnetic pulse in the present-day war theatre is a serious threat for modern aircraft. It causes the creation of an electromagnetic wave, which generates large currents induced in electronics, destroying unprotected components. It is a dreaded prospect for the most modern combat aircraft, whose entire operation functions based on electronic circuits. The use of the EMP impulse reverses the current development trend of aircraft heading towards full digitalisation. The last possible direction development of combat aircraft warfare is a systemic Network Centricity<sup>18</sup> operation focused on information advantage. The concept of a system-based approach to warfare is constantly being

**14** AESA Radar – the most modern type of radiolocation station with active electronic scanning, [in:] <https://news.northropgrumman.com/news/releases/northrop-grumman-successfully-completes-f-22-radar-flight-test-certification>.

**15** HMD - (Helmet mounted display) – device mounted in helmets to display information in front of the pilot’s eyes. Thanks to HMD, it is also possible to target targets by directing the cursor displayed in front of the pilot’s eyes in the helmet towards the target [in:] <https://www.f35.com/about/capabilities/helmet> [access: 16.04.2018].

**16** Laser weapon - a weapon that uses a laser beam, or a beam of electromagnetic radiation.

**17** EMP weapon - weapon, based on the phenomenon of electromagnetic pulse [in:] <http://www.defence24.pl/bomba-elektromagnetyczna-coraz-realniejsze-zagrozenie> [access: 08.02.2018].

**18** Network Centricity - a platform for quick and effective exchange of information, mainly in the following areas for military purposes. It aims to secure an advantage over the opponent by distributing data regardless of geographical location.



developed. Faster, more detailed and more extensive – being provided with such information on the war theatre is currently determining the tactical advantage over the enemy and the direction of development of combat aircraft warfare, which shall be observed in the future<sup>19</sup>.

### **Requirements set for prospective combat aircraft for Poland**

Limited combat capabilities of aircraft owned by Poland result in being unable to accomplish modern combat missions or take part in international field training exercises, thereby weakening Poland's military potential and reducing its involvement in shaping security in NATO. Outdated technologies limit the possibility of combat aircraft utilisation and mission performing and pose a threat to a pilot's life in the event of a conflict. Technological shortages limit international cooperation in the field of internal and international aerial exercises within NATO. Maintaining the Polish military potential and security by replacing currently operated aircraft should be a priority for the Ministry of National Defence. Extending the organisation of the tender in time and an attempt to draw public attention to unmanned aerial vehicles have a negative impact on both the image of Polish authorities and the potential for providing security. Throughout the world, tactical planning is currently implemented, which for economic reasons assumes, among other things, the withdrawal of aircraft specialised in a narrow range of activities, e.g. fighter-bombers, tactical bombers and fighter aircraft for multirole aircraft that are advanced electronic extensive platforms enabling the implementation of the whole spectrum of combat missions. This solution is particularly beneficial because it provides unification of the utilised combat aircraft fleet to one type, purchase of a smaller number of machines while maintaining combat potential, the possibility of negotiating aircraft prices and operational parts when purchasing a large quantity, and improving cooperation and exchange of experiences between air squadrons through cooperation in national and international field training exercises.

The Armed Forces of the Republic of Poland, are equipped with three types of combat aircraft, Su-22 (NATO name - Fitter) - 18 aircraft, MiG-29 (NATO name - Fulcrum) - 30 aircraft, and F-16 block 52 + (NATO name - Fighting Falcon) - 48 aircraft.

The requirements in relation to the prospective purchase of combat aircraft for Poland should include the supersedure in combat missions previously carried by the replaced aircraft, and because of this, those missions that the abovementioned combat aircraft perform should be noted.

<sup>19</sup> Wizja sił Zbrojnych RP - 2030, Ministerstwo Obrony Narodowej – Departament Transformacji, Warszawa 2008, s. 30.

Su-22 is a front air force aircraft, whose task is to combat ground and surface targets, mobile and immobile targets and, to a limited extent, fighting manoeuvring air targets. It can also perform exploratory functions and direct support of the infantry.

The purpose of MiG-29 in the Polish Air Force is to carry 24-hour on-call duty over the territory of the Republic of Poland and international waters as well as provide assistance to military and civilian personnel in the event of an emergency. Training MiG-29 pilots, due to its use, is therefore focused on aerial combat and practicing of aircraft interception.

F-16 block 52 + is a multirole aircraft designed to perform missions as part of the battle for air superiority, to support other types of armed forces and to conduct reconnaissance. Its extensive mission planning system is notable for its intuitiveness and many possibilities for performing a combat mission. F-16 provides flexibility in the performance of a mission, i.e. the capability to perform offensive and defensive missions in one flight and adapt to performing combat missions in difficult weather conditions. The abovementioned uses of combat aircraft operated by the Armed Forces of the Republic of Poland will help to define the requirements to be set for the prospective combat aircraft for Poland, meeting the requirements shaped by the modern warfare at the same time.

A new combat aircraft for the Polish Air Force should be of the so-called 5<sup>th</sup> generation<sup>20</sup>. To provide long aerial time, usefulness when on duty, and provide the opportunity to perform offensive combat missions over the enemy territory, it is necessary that it has fuel-efficient engines and the capability of aerial refuelling. MiG-29 aircraft, currently operated by Polish Air Force, are equipped with gas-powered RD-33 engines and are incapable of aerial refuelling, so their flight duration is low compared to modern combat aircraft from NATO countries<sup>21</sup>. High manoeuvrability and a large scale of used speeds (from minimum to maximum) are very important parameters in manoeuvring during combat and intercepting air targets. Despite the fact that, according to the assumptions of present-day warfare, prompting a direct manoeuvring combat is the result of previous tactical errors, it should also be geared up for such a contingency. In the event of needing to research a the destination or rapidly change position in the war theatre, it should be taken into account that supersonic speed is reached by combat aircraft without requiring an afterburner. This solution is possible due to the high efficiency of the engine and low frictional resistance of the airframe, which allows the saving of fuel and increasing the flight duration, as the jet engine on the afterburning range burns up to 4 times more fuel

**20** 5<sup>th</sup> generation jet fighter - the latest development stage of combat aircraft, a plane meeting the requirements of the fifth generation should achieve supersonic speed without using afterburning, be designed in stealth technology, have a vectorised string and a modern radar station with electronic scanning [in:] Hood J., *Defining the 5th Generation Fighter Jet*, 633rd Air Base Wing Public Affairs, USA 2017, p. 1.

**21** Information about the RD-33 engine, [in:] <http://www.klimov.ru/en/production/aircraft/RD-33-family/> [access: 10.05.2018].

than on the maximum range. The airframe of a prospective combat aircraft for Poland should be made largely of light and durable composite materials and designed in accordance with techniques that minimise detection - Stealth. On the board of a new combat aircraft for Poland, there should be a radiolocator with AESA type active electronic scanning. It is a standard in 5<sup>th</sup> generation combat aircraft and it allows the search range and target interception to be increased, as well as noise immunity and high resolution. The implementation of the Link-16 system, used in NATO countries and allied countries, enables exchanging data with AWACS early warning aircraft and transferring it to NATO's integrated defence system, NATINAMDS<sup>22</sup>. Thanks to Link-16 it is also possible to transfer data between aircraft which during combat operations significantly improves situational awareness in the war theatre during flights in combat groups<sup>23</sup>. The functioning of this system is part of the concept of network centricity of modern warfare and is an indispensable criterion element for the selection of a future combat aircraft for Poland. The provision of a modern electronic radio warfare system would enable combat pilots to eliminate threats in conditions of limited visibility, through wave interference.

The use of HMD would provide pilots with excellent situational awareness, providing speed, course, height, target and warning information that is displayed on the helmet visor rather than on a traditional one Head-up display. This approach significantly reduces pilot load and increases reaction speed. In addition, this system is able to send real-time images of the infrared camera, mounted around the aircraft, allowing the pilots to look through the airframe. The helmet also provides night vision with the help of an integrated camera. Moving a large number of combat assets and compatibility in the attachment of the latest weaponry produced by Poland's allies, constitute an important aspect in the selection of future combat aircraft. It is also important to mind the pilot's safety by equipping the aircraft in duplicated on-board systems and installations, and battle-proved and reliable catapult seats.

The 5<sup>th</sup> generation of combat aircraft provides all these requirements in relation to the outfitting equipment for Poland. The purchase of the Lockheed Martin F-35 Lightning II aircraft due to the wide range of deployment and the latest technologies, in the perspective of a long service life, could be a future solution for Poland. Despite critical reports from US experts and unfavourable media statements commenting on the F-35 aircraft's malfunction and high production costs, the project is being successfully continued and more and more countries are deciding to purchase, examples of which are Norway, Turkey and Australia. For Poland, a cheaper solution would be the purchase of an F-16 aircraft fleet adapted to the MLU standard (Mild Life Update). The construction of the F-16 allows for numerous refinements and software upgrades, therefore it is prospective to invest

**22** NATO NATINAMDS – North Atlantic Treaty Organization Integrated Air and Missile Defense System.

**23** Link-16 tactical information exchange network NATO [in:] <http://www.defence24.pl/238560,wojsko-uruchomilo-system-transmisji-danych-nato-link-16> [access: 10.05.2018].

in the technological development of this aircraft. Poland could use the American modernisation programme after which the block 52+ version would evolve into the MLU standard version. In 2006, when Poland acquired the F-16 block 52+, which was one of the most high-tech combat aircraft in the world, technological progress made it necessary to update its equipment. Lockheed Martin Group offers the users an F-16 retrofit package to the MLU standard<sup>24</sup>, the premise of which is installing a new colour for MFD displays, updating avionics systems and modernising the modular mission computer. The MLU package includes the installation of a new fire radar (FCR) and an advanced foreigner identification system (IFF).

The F-16 MLU cabin will be equipped with a modern colour audio - video recorder and modernised HMD helmet display and an expanded Electronic War Management System (EWMS). Although the F-16 with the MLU package is not a 5<sup>th</sup> generation aircraft, its deployment range is very wide and it could replace the MiG-29 and Su-22 used by Polish Air Force.

### **Determination of the optimal number of combat aircraft in Poland in relation to its area and population**

Before replacing the aircraft fleet, it is necessary to precisely determine the number of combat aircraft Poland shall have. The safety concerns of the airspace suggest that the greater the number of the aircraft, the better, but you also need to follow the state budget and restrictions imposed by the Treaty on conventional armed forces in Europe (CFE)<sup>25</sup>. According to the restrictions of this treaty Poland cannot have more than 460 combat aircraft. The number of combat aircraft in individual countries depends primarily on financial resources and armaments policy; however, when deciding on the quantity, factors should be considered such as:

- the area of the state that is to be protected in the event of conflict,
- population of the state - a large population should be protected by more combat aircraft than in the case of rarely dispersed populations,
- participation in conflicts<sup>26</sup>.

For the purpose of determining the approximate number of combat aircraft in Poland with regard to its area and population, a study assigning the optimal number of combat aircraft in Poland in relation to its area and population was carried out.

<sup>24</sup> MLU (Mid Life Upgrade) – modernisation package for F-16 [in:] [http://www.f-16.net/f-16\\_versions\\_article2.html](http://www.f-16.net/f-16_versions_article2.html) [access: 26.02.2018].

<sup>25</sup> CFE (Treaty on Conventional Armed Forces in Europe) - The Treaty on Conventional Armed Forces in Europe, which limits the number of armed forces in countries that joined it [in:] *Government Statement of 6 November 1994 on the accession of the Republic of Poland to the Treaty on Conventional Armed Forces in Europe, signed in Paris on 19.11.1990. 1995 No.15 item 74.*

<sup>26</sup> Verhagen W., Newcamp J., Udluft H., Curran R., Application of a Greedy Algorithm to Military Aircraft Fleet Retirements, Delft University of Technology, Netherland 2016, p. 3.

The study was carried out in 4 stages. The first stage consisted in determining two factors:

- 1) O (area) - coefficient defining the area given in km<sup>2</sup> for one combat aircraft (e.g. in a country which has an area of 10000 km<sup>2</sup> and has 100 combat aircraft, it will be  $O = \frac{10000}{100} = 100$ , that is, every 1 combat aircraft is responsible for 100 km<sup>2</sup>).
- 2) L (population) - coefficient determining the number of inhabitants in a country in relation to the number of combat aircraft (e.g. a country that has a population of 10 million people and 100 combat aircraft will be  $L = \frac{1000000}{100} = 10000$ , that is, each combat aircraft is responsible for the safety of 10000 people).

**In the second stage**, data on the number of combat aircraft, surface and population in militarily significant countries of the world was collected. The coefficients “O” and “L” were calculated for selected countries, this data is shown in Table 1.

Table 1

**Data used for research on determining the optimal number of combat aircraft in Poland**

Country	Combat aircraft	Area (km <sup>2</sup> )	Population	„O”	„L”
AUSTRIA	15	83871	822300	5591	548200
BELGIUM	59	30528	1045000	517	177119
FRANCE	233	643801	6625900	2763	284373
GREECE	231	131900	1077600	571	46649
SPAIN	144	505990	4773700	3514	331507
HOLLAND	63	41543	1687700	659	267889
GERMANY	228	357376	8099700	1567	355250
NORWAY	56	324220	514800	5790	91929
RUSSIA	1287	17075400	14247000	13268	110699
The USA	2201	9834000	32310000	4468	146797
SWITZERLAND	83	41285	8061000	497	97120
TURKEY	402	783580	61619000	1949	153281
UKRAINE	85	603700	42805000	7102	503588
The UK	306	242495	63742000	792	20837

Source: Self-reported data based on <http://www.nationmaster.com/country-info/stats/Military/Air-force/Combat-aircraft>.

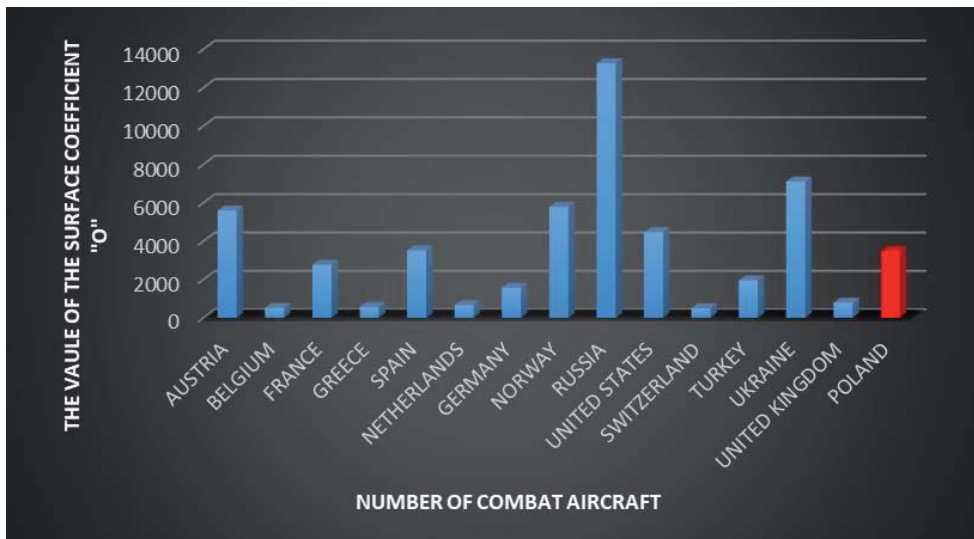
**In the third stage** of the study, the average value of the coefficient “L” and “O” for the countries participating in the study was determined, with the following results:

- 1) The average value of the coefficient “O” for the countries studied amounted to  
- O = 237336
- 2) The average value of the “L” coefficient for the countries studied amounted to  
- L = 3504

Tests carried out on the basis of mathematical calculations of the arithmetic mean of the number of aircraft corresponding to the area and the population of the countries studied determined that:

- minding the area (312 679 km<sup>2</sup>), Poland should operate 90 combat aircraft.
- minding the population (37 970 000), Poland should operate 160 combat aircraft.

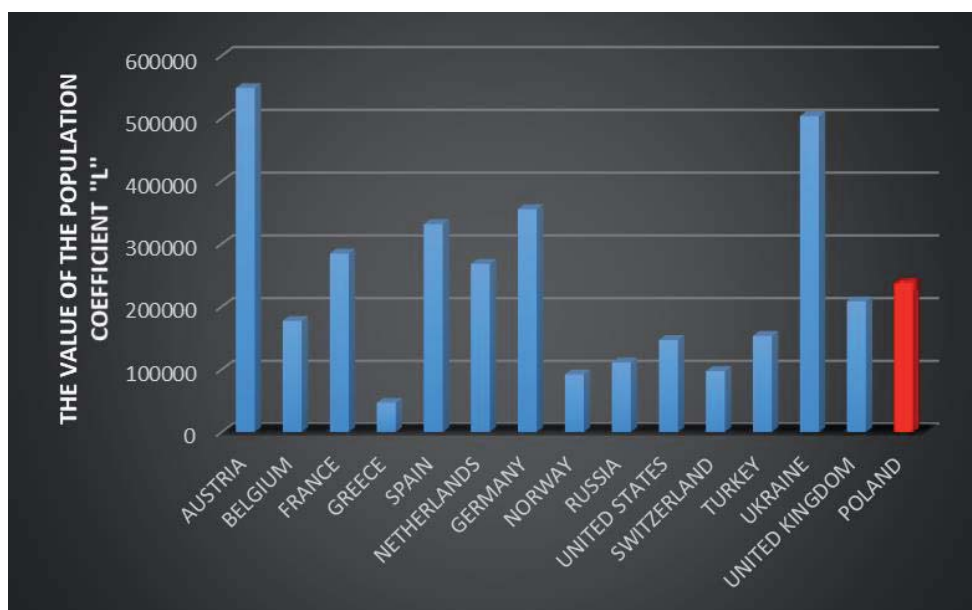
In the fourth stage, to obtain a measurable result in the form of one number, the arithmetic mean of numbers 90 and 160 was calculated, which amounted to 125 (combat aircraft), which was considered the final result of the study (results are shown in charts No. 1 and 2).



Source: self-reported data

**Chart 1. Number of combat aircraft in selected countries in relation to area (for Poland, the test result of the survey - 125 combat aircraft)**

The assumptions of the conducted study resulted in the determination of such a number of combat aircraft for Poland, that it would correspond to the arithmetic mean of selected countries, referring to their area and population. The data from graph 1 show that, with a total of 125 combat aircraft, the territory of Poland would be guarded by relatively more aircraft than in countries such as Great Britain, Germany, Turkey and Greece. On the basis of graph 3, it can be concluded that the inhabitants of Poland would be relatively better protected against air attacks than residents of such countries as United States, Russia, Belgium and Norway. The results of the conducted research are mathematical results, which means that they do not take into account many factors related to the real combat potential of a given state and are not able to determine the real security of its citizens and territory.



Source: self-reported data.

**Chart 2. Number of combat aircraft in selected countries in relation to the population (for Poland, the result of the survey - 125 combat aircraft)**

### **Improving Poland's security after replacing the combat aircraft fleet**

Combat aircraft fleet as an important component of the state defence system should ensure interoperability within this system. The cooperation of combat aircraft fleet with anti-aircraft defence, lead-in positions, radiolocation surveillance aircraft (AWACS) and air tankers creates a tight system of defence of the air space of the state, thus contributing to the security of its territory. Airplanes such as MiG-29 and Su-22 are incapable of meeting the requirements of modern warfare. To a limited extent, they are part of an integrated system of state defence, weakening the effectiveness of this system.

Replacing the combat aircraft fleet with the 5<sup>th</sup> generation aircraft will improve the security of Poland. Purchasing modern fighters, effectively using the strategy of combined actions, will contribute to more effective cooperation between air squadrons in Poland as part of the defense of the territory of the Republic of Poland. Replacing the combat aircraft fleet used by the Polish Air Force with the cutting-edge multirole aircraft will affect the improvement of the fighting ability of the Air Force, which will increase the ability to maintain security. Thanks to modern combat aircraft, international cooperation regarding field training exercises within NATO will ensure a high level of pilot training, which will also improve Poland's security. Thanks to better parameters of combat aircraft and refueling capability in

the air, the aircraft on-duty will be capable of staying in the zone of on-call duty longer, which will make carrying the mission of patrolling the territory of Poland much easier. Extending the flight time will have a positive effect on the combat capabilities of the aircraft, which will be capable of conducting longer operations in the war theatre. Thanks to modern radar stations target detection will be faster, so that the pilot of the combat aircraft will have more time for an appropriate response, which determines the advantage in combat operations. By replacing combat aircraft with modern, technologically advanced ones, will change the work attitude of current pilots of combat aircraft for the better, and thus their efficiency will grow. Flying on obsolete equipment and awareness of its technological backwardness and associated constraints in the execution of combat missions results in a low level of theoretical knowledge associated with the strategy of operating in the modern war theatre and the use of modern weapon systems among pilots. This translates into low morale of combat aircraft pilots, and not using their personal potential to its fullest. The purchase of modern aircraft will increase the involvement of pilots in the development of their skills used in modern warfare. The ability to compete in the air with combat squadrons from other countries, will instill the will to deepen theoretical knowledge and practical skills among combat pilots. Pilots of combat aircraft seeing the purpose in their actions and development, will stay in the military ranks longer, becoming a highly qualified commanding staff whose decisions will have an impact on Poland's security in the future.

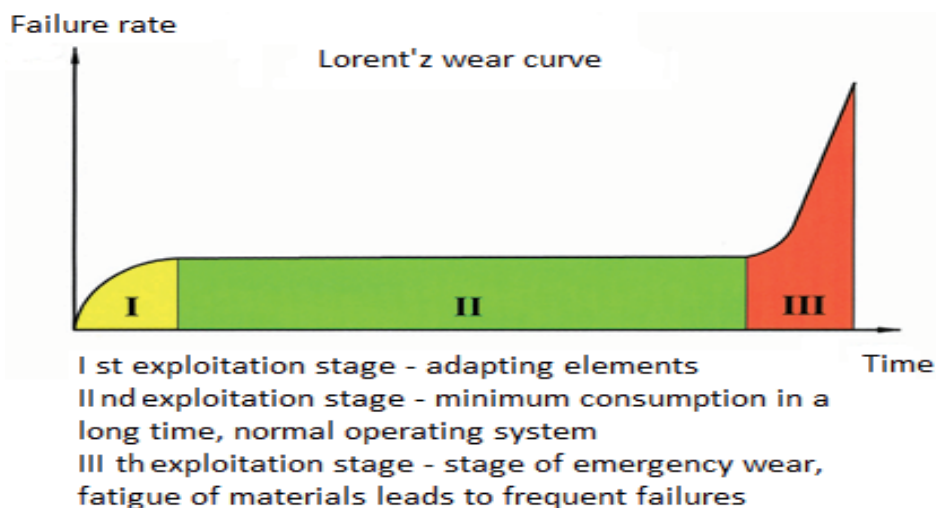
Currently, due to the age and condition of the combat aircraft used, it is necessary to deduct aircraft which are subject to periodic service and repairs, lasting up to several months, from their total number.

Su-22 and MiG-29 aircraft have extended resources and their expected withdrawal time was in 2015, and therefore they are in so-called III stage of operation (see graph no. 3)<sup>27</sup>. The purchase of new combat aircraft in an amount corresponding to the research conducted by the author will mean both an increase in the number and in the percentage of airworthy aircraft, which will improve the combat potential of Poland and the security of the state.

When considering the improvement of Poland's security after replacing the combat aircraft fleet, one should also take into account the positive aspect of the replacement of equipment. The purchase of the 5<sup>th</sup> generation aircraft would strengthen Poland's position in the international arena, not only at the military level but also indirectly at economic and political levels. Russia, which reacts to every Polish action towards strengthening its military potential, would receive another sign that Poland should not be ignored, both as a member of the NATO alliance and as an independent military force.

<sup>27</sup> Chart 3. shows the dependence of aircraft consumption and failure since its exploitation in an illustrative manner. The estimation of the exact percentages of wear and failure rates in relation to the specified service life is possible based on the specific type of aircraft, with approximate accuracy, based on data from the selected aircraft operation period, but this does not focus on the interest of the article.





Source: <https://www.komerc.pl> [access: 12.05.2018].

**Chart 3. Lorenz's wear curve**

Further research directions in this area may focus on an attempt to thoroughly analyse and compare the equipment of combat aircraft for the needs of the Polish Armed Forces in the selection of a specific type or types of combat aircraft, as the successors of Su-22 and MiG-29 aircraft. This will be a very important issue, which it is necessary to resolve before conducting a tender for the purchase of combat aircraft for Poland.

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