CONTEMPORARY THREATS TO THE STATE AIR DEFENCE SYSTEM

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Abstract

The contents of this article are focused on presenting the results of research concerning development of the means of air threat as a major determinant of changes in the modernisation of the air defence system in Poland. In this regard, the authors emphasise the role and means of air threat as a kind of pacemaker development of air defence systems. In this article, the main area of scientific considerations are technical and tactical aspects concerned with the evolution of manned and unmanned aircraft. The directions of their development of combat capabilities and an estimate of their use in contemporary and future battlefields against military objectives and non-military ones are covered. The article has high educational value and highlights future threats to the state air defence system and development trends in the twenty-first century.

Keywords: air defence, air defence systems, fighter aircraft, ballistic missiles, air threats, air terrorism

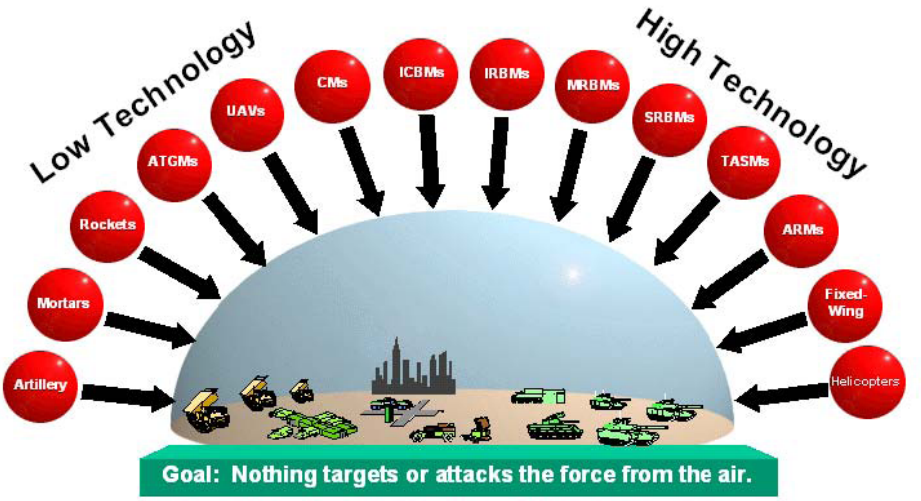
Introduction

Intense political, economic and military changes, which took place in Poland after joining NATO and the European Union also required a number of restructuring activities in the Polish armed forces. Mostly they were associated with adoption of the appropriate model for the NATO Air Defence System. It turned out that

the air defence organisation required reasonable changes and concrete actions to be taken not only for adaptation but also development. The basis of these considerations is the answer to questions regarding what the Polish air defence forces need and how this is to be achieved. Scientific considerations on present and future air defence have a largely forward-looking character. It is important to achieve the probability of hitting a rational solution, if only from a theoretical point of view. This seems difficult to achieve due to the fact that the system of air defence is complex and deliberately acts (functions) amongst other subsystems of security and defence with which it is surrounded. Polish air defence does not currently have sufficiently distinct features including "compliance" with the main objective of the system of state security in the section of airspace. This seems especially important because in today's political and military conditions, the strength of the state security system is largely determined by strong and well-organised Air Defence. Strong and effective Air Defence is now one of the main criteria in the evaluation of the state of preparation for defensive action and resolving crisis situations. The Air Defence system can be assessed by its modern equipment and effective means of struggle. Therefore, it should be emphasised that Air Defence should be subject to continuous development, which would be consistent with trends in the art of war, the development of the military means of air threat and the prevailing views on their use. Under these conditions, the requirements are specified as Air Defence transformation and modifications. The possibility of their fulfillment depends, on the one hand, on the pace and rhythm of development of the Air Defence system that shape the events taking place in its environment. On the other hand, the development of the Air Defence system has an internal tempo and rhythm resulting from joint or individual experiences and preferences of individual countries in the development of indigenous forces. There is no doubt that a crucial role is played here by the economic condition of the country. The other important spheres beside economic ones are other areas, such as legal, political, technical or international. They have a growing influence not only on the development of the Air Defencse system, but also on its organisation and operation in peacetime, crisis or war. This particularly concerns the principles of the use of specialised equipment including Air Defence fighting measures in accordance with Rules of Engagement - ROE. An equally important message for modern warfare is striving to minimise civilian losses and the desire to limit the damage. This can be achieved mainly by using precise identification

systems and weapons. These conditions affect the Air Defence system that needs to be taken into account in its functioning. They are difficult to meet because the Air Defence system, beyond national requirements, must also be compatible with allied solutions. It should be noted that factors mentioned above are essential determinants - the basic interpretation of the strategic development of the Air Defence system. They define its current and future state, shape and ability to counter-act the predicted air threats. We should be aware that while initiating the process of creating a modern system of Air Defence, other determinants shown in the figure below will affect it[1]. Without these, it is difficult to imagine the possibility of effective military operations and the functioning of targets under conditions of threat[2] from the air.

One of the determinants that affect the effectiveness and efficiency of the Air Defence system is a threat from the air.



Source: http://www.fas.org/spp/starwars/docops/amd/Chapter-3.htm.

Figure 1. The main objective of air defense

1 I. Kamińska-Szmaj, *Dictionary of Foreign Words*, Publisher Europe, Warsaw 2001.
2 R. Zięba, *National and international security at the end of the twentieth century*, Warsaw 1997, p. 5.

Risk from the air can be identified as an opportunity to attack military facilities or civilian targets relevant to the functioning of the state[3].

Source: http://www.fas.org/spp/starwars/docops/amd/Chapter-3.htm.

Figure 2. The main task of the Air Defence system

The scale and level of threat largely depends on the potential quantitative and qualitative means of air threat and the possibility of their development. Their development requires each adjustment capability of the Air Defence, to change with a threat from the air. At this point, it should be emphasised that air threat can be both carriers of destruction, as well as the same means of destruction that could in any way affect the objectives of the land, air and sea .

Diverse risks from threat depend largely on the quantitative and qualitative potentials of means of air threat and qualitative changes to the Air Defence system, including its functional subsystems: command, reconnaissance aircraft fire and destruction. In turn, the defensive nature of Air Defence makes its principal area of activity the territory of its own country where there are spatial

3 Safe sky (ed. Science.) J. She cooked, conference, National Defense University, Warsaw 2002, p. 53.

parameters, military and non-military objects. It should be noted that the biggest challenge for all Air Forces is the detection and destruction of military targets often adequately protected, hidden or masked, or dispersed and also mobile, which require continuous monitoring (tracking).

The progressive development of state in economic, political and military spheres affects non-military objects of different purposes and characteristics in terms of air cover. Based on the experience of armed conflict, it can be stated that the targets of the aerial attacks were not only military facilities (military bases, radar stations, airports), but also government ones (government offices, embassy, consulates), industrial infrastructure, energy and transport as well as economic summits, political meetings, sport and cultural events.

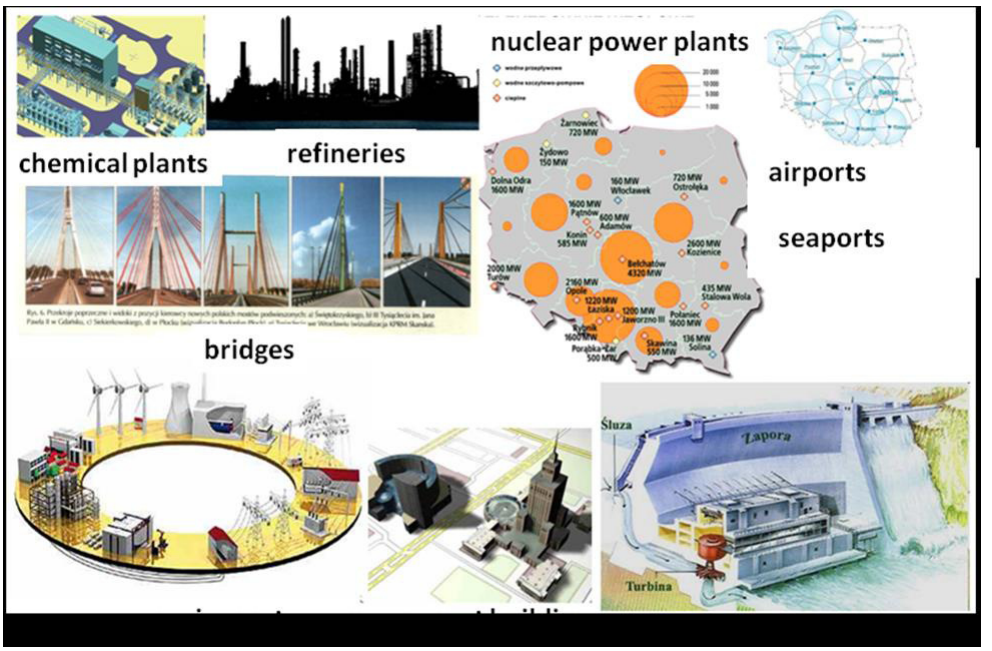


Figure 3. Examples of non-military facilities that could be potential targets of air terrorism

Experience of the course of armed conflicts clearly shows that the incapacitation of these objects in the first stage of the war provides, at the outset, an advantage to one of the sides and sometimes even determines the final success. In addition, more and more often it can be observed that these objects can also become targets

of terrorist attacks using aircraft in peacetime. To implement them, terrorist groups may use different types of civil aircraft.

Forecast of development of air threats as the primary determinant of changes to the air defence system

In the current political situation in Europe, Poland - as a sovereign country leading an independent foreign policy - can build its national defence system, and this AD system of Poland, not against someone specific, but primarily because of the obligation to ensure the safety of the public. Therefore, we advocate forecasting of the nature of future threats from the air[4] that can bring a variety of conflict situations. These can be violations of the airspace of the country, air terrorism or even armed conflict, comprising an area of the country or its essential part and task forces in operations outside its borders. In these circumstances, it seems expedient to divide the air threats into those that may occur in peacetime, and those still possible in an armed conflict. Times of peace may be in jeopardy - as already stated - accidentally or intentionally. An accidental cause of the threat from the air can be treated as the existence of an aviation disaster and its tragic consequences. These threats include[5]:

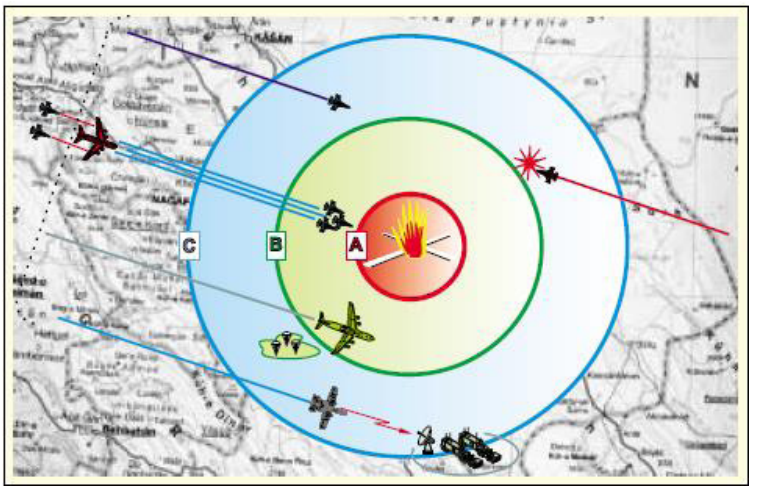
- air piracy or terrorism;
- purposeful, planned attack on a specified object , device , institution to force action or behaviour dictated by the attacker;
- execution of retaliation by the enemy against which the coalition intervenes , and Poland is a participant ;
- provoking AD system into continuous effort and fatigue;
- impact on targets located in the interior of the country (after achieving this, the attacker will probably want to freeze the action by avoiding direct clashes).

There are possible ways of examining the phenomenon, a threat to Poland by interaction from the air can occur in virtually every state military and political relationship. . It results from the fact that today it is considered that the air force

4 The threat from the air - it's all Possible impacts in a variety of ways the third dimension by an opponent, which may cause adverse effects, ie .: loss of material and human conditions restricting the use of equipment, affecting the circulation and credibility of the information.

5 B. Zdrodowski, *Air defense, National Defense University,* Warsaw 1996, p. 44.

like no other types of forces, has unique features and rapid achievement of a region of conflict and intimidation of an aggressor[6].



Source: J. Gotowała, Six steps beyond the horizon of modernity. Trends in the development of military aviation, "Overview of the Air Force and the Air Defense," 2004, No. 7, p 4.

Figure 4. The idea of illustrating the possibilities of the Air Force to perform combat tasks at different points in space

Probably the future Air Force will be even more than now focused on identifying and destroying the „centre of gravity" an opponent in one hit[7]. Another aspect of the growing importance of air forces in crisis management is, and will probably remain, engaging them broadly in operations other than war, which will be of an expeditionary[8] nature. This becomes fully understandable in the context of the global trend for replacing the numerically large and lumbering armed forces with smaller armies in the future based on cutting-edge solutions in the field of military technology.

Despite the general trend for reducing the armed forces, it can be assumed that air power will not undergo such a reduction. A factor confirming the above requirement

6 R. Szpyra, *The power of international air policy instrument of the state, "Overview of the Air Force and the AD"* 2004, No. 4, pp. 5-14.
7 M. Fryc, *War of the contemporary face,* Ed. MADO, Toruń, 2009, p. 24.
8 *Report on United States Air Force Expeditionary Force Vole 1: Summary*, United State Air Force Scientific Advisory Board, November 1997, p. 1–10.

may be that the Air Force, far more than other types of armed forces have been, has benefitted from newer technology. The dynamics of this process will be characterised by successive years of the twenty-first century. In this regard, there can be no doubt that the new technology will allow, as never before, a new use of aircraft with a clear division of tasks carried out at supersonic and subsonic levels[9].This first development will contribute to a safer overcoming of an enemy's air defence military zone. The second developmentvwill provide favourable conditions for the attack and destruction of facilities and the crews' safe return to home base[10]. To have the ability to make precise and decisive strikes, it will be necessary to reduce the possibility of enemy reconnaissance, maneuver and fire by simulating interfering activities and sending disinformation to his reconnaissance systems. For these reasons, the designers of future combat aircraft will reach not only the technology of „stealth", passive and active systems of disturbing, but also a whole range of different traps[11].

Source: http://livefist.blogspot.com/2007/10/farce-generation-fighter-aircraft.html.

Picture 1. Aircraft made in stealth technology

9 J. Gruszczyńki, M. Fiszer, Joint Vision 2020. *Keynote US defense doctrine, «Overview of the Air Force and the AD»* 2003, No. 5, p. 20.

10 J. Gotowała, *System development and technological conditions the Air Force,* "Scientific Papers AON", No. 2 (special), Warsaw 2002, p. 33.

11 N. Lynn, *Amerykanischer stealth-bomber B-2 erstmals vorgestell, „Flug Revue"* 1989, No 1, p. 49–51.

The main direction of aircraft construction will be to further reduce the effective reflection surface through the use of composites and special top coat airframe components. It will be possible that at least half of the currently operated aircraft will be adapted for self-exploration, recognising and destroying not only the surface targets, but also small mobile ground objects in all weather conditions - day and night[12]. This will be made possible by providing them with the so-called intelligent means of destruction.

Source: http://www.voodoo-world.cz/hornet/u/arm1.jpg; http://www.voodoo-world.cz/hornet/u/arm3.jpg; http://www.voodoo-world.cz/hornet/u/arm2.jpg.

Picture 2. Examples of air threat being removed by the destruction of modern aircraft

On the basis of collected facts defining the main directions of development of manned aircraft, it can be assumed that the fight against them conducted by the ground-based air defence systems in the future will be much more difficult and expensive than it is now. Despite the high costs of production and operations over the next few years, it can be assumed that manned aircraft will keep their position in the Air Force. One can also assume that their main potential of impact will be

12 J. Gotowała, *Night importance in modern aviation combat operations, "Overview of the Air Force and the AD"* 1999, No. 1, p. 16.

mainly multi-role aircraft designed to carry bombs and missiles of different class and destination. In this regard, it should be noted, however, that future rounds will be universal designs that can be easily adapted to destroy any targets through the expanded memory board computer[13]. Dormant inside the miniaturised missile are combat loads (bullets) enriched with artificial intelligence which will be able to independently search and destroy key targets.

Multi-role aircraft will be used mainly for the tasks of destroying military potential as well as economic and political and administrative centres, the fight against ground targets (surface) of small and medium sizes[14]. This will be supported by research on the improvement of air weapons based on the latest in technology (e.g. Nanotechnology, lasers, and other types of energy beam)[15].

The offensive actions of manned aircraft will dominate the strategic impact made in the first instance to elements of the air defence system[16]. These tasks will be performed primarily by strategic bombers. Their actions will assume the form of sequential (consecutive) strokes or simultaneous attacks. The basis of sequential attacks („Series Warfare - Sequential Attack") will be elements of an early warning system, airports and antiaircraft systems (missiles and artillery)[17].

In this case, the impact on the elements of the Air Defence system will open the way to attack the next target. With the intention of rapid destruction of the AD system, its individual components will be attacked simultaneously. The impact, however, will require the simultaneous use of high capacity air power on multiple targets spread over a large area, such as a country[18]. Simultaneous execution of

13 J. Szczygieł, *Development means the air assault,* „Przegląd Sił Powietrznych" 2011, No 1, p. 50.

14 M. Kobuz, *Conflicts early twenty-first century. The use of the Air Force,* National Defense University, Warsaw 2007, p. 92.

15 Michael R. Doyle, Douglas J. Samuel, Thomas Conway, Robert R. Klimowski, *Electromagnetic Aircraft Launch System – EMALS*, *Naval Air Warfare Center, Aircraft Division*, Lakehurst, NJ 08733, p. 1–6.

16 S. Zajas, *Air Force operations combined. **Theory and practice***, Przegląd Wojsk Lotniczych i OP" 2003, No 7, p. 23.

17 A. Radomyski, *Risk of Air Army,* „Myśl Wojskowa" 2003, No 6.

18 M. Nawrocki, *Air strike strategic air doctrine of the United States, "Review of the Air Force and the AD"* 2004, No. 4, p. 33.

attacks on several targets of high value will quickly overcome the defences, which will be necessary to secure freedom of action on land and sea[19].

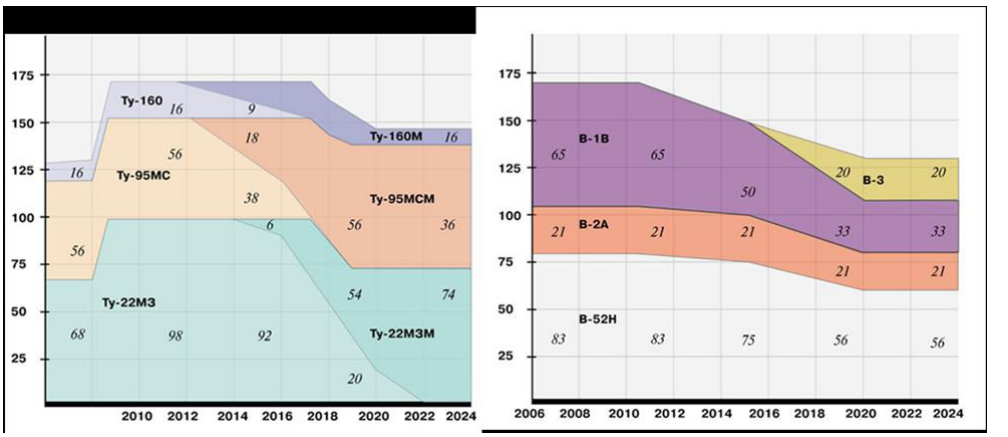


Figure 5. Forecast development of long-range Air Force bombers of the Russian Federation and the United States until 2024

As a result of projected changes, there also seems to be a gradual move away from the traditional structure of bombers that will be displaced by „stealth" technology aircraft. Some sources even predict that the use of this type of aircraft will end after 2020[20]. Under these conditions, manned aircraft will increasingly be replaced by unmanned aerial platforms which are universally equipped with intelligent detection and precise means of destruction[21]. In the group of dynamically developing unmanned attack aircraft of various types, will also be cruise missiles of comparable or even greater strength and precision destruction in relation to current aircraft and helicopters[22]. Global growth of interest in the development of unmanned aerial vehicles is essentially their relatively low cost of production and operation, high efficiency, greater security man (operator), and the wide range of

19 A. Radomyski, *The use of air defense forces in situations of strategic air strike,* National Defense University, Warsaw 2008.

20 J. Gruszczyński, *Tactical and technical conditions for the development of aviation fighter-bomber,* "Scientific Papers AON", No. 2 (special), Warsaw 2002, p. 55.

21 S. Walowski, *Airmen must wait,* „Przegląd Sił Zbrojnych" 2007, No 1, p. 87.

22 W. Wolski, R. Zając, *Battlefield twenty-first century. Requirements in relation to anti-aircraft weapons, the materials of the second international conference on science and technology,* Tarnów 1999.

tasks that they can perform. In addition to reconnaissance activities, they will be involved on a large scale to carry out strikes against ground targets and surface targets. In the longer term, it is also anticipated that they will cover their own attack aircraft in the air[23]. In the future, there will no doubt be a „platform" of different size carrying intelligent weapons, able to operate under a system of detection and identification of ground and air targets in areas particularly dangerous for manned aircraft, such as urban areas[24]. An example was initiated at the beginning of the twenty-first century, a programme called Prompt Global Strike (i.e. Instant Global Impact). Its aim is to obtain conventional means of destruction, capable of achieving any purpose in the world within an hour or two - started by the United States. Part of this programme is working on a obtaining hypersonic re-usable combat system.

The programme established the building of a rocket (SLV - Small Launch Vehicle) and hypersonic plane (HCV - Hypersonic Cruise Vehicle) and the carrying-out of the orbit of the SLV capable of maneuvering flight. The vehicle is able to overcome about 17000 km in 2 hours with a cargo of 5.5 tons. One of the stages of HCV vehicle design is HTV -2 Falcon: sweeping, unmanned flight transporting Supersonic cruise missiles into orbit (Hypersonic Cruise Vehicle - HCV) which may in the future constitute the backbone of strike forces. This will be able to carry out an attack on targets of about 16 000-20 000 km reached in no more than two hours. They are intelligent fighting objects, operating autonomously and can bring up to date analysis of a situation and make decisions about destroying ground targets. They are likely to become one of the key elements of NCW (Network Centric Warfare), the so-called Network battlefield[25].

On the basis of previously constructed examples of supersonic unmanned aircraft, it can be assumed that they will be similar in size to today's manned aircraft[26]. They will be able to carry a large amount of means of destruction from the air for various purposes. Such unmanned vehicles will be used mainly to destroy heavily

23 A. Bondaruk, *Unmanned flying impact on the field of battle ...,* ed. cit., p. 37-39.
24 M. Franklin, *Unmanned combat air vehicles: Opportunities for the guided weapons industry?* Military Sciences Department, Royal United Services Institute for Defence and Security Studies, September 2008, p. 3–11.
25 J. Gotowała, *Six steps beyond the horizon of modernity. Trends in the development of military aviation, "Overview of the Air Force-regulations and AD"* 2004, No. 7, p. 13.
26 M. Kamyk, *Hypersonic speeds,* „Przegląd Sił Powietrznych" 2011, No 1, p. 22 i 26.

fortified ground facilities, defended by means of Air Defence alone or together with manned aircraft[27]. However, an important link in the network-centric twenty-first century battlefield will be unmanned aerial vehicles performing tasks called 4D (Dull, Dirty, Dangerous, Deep)[28].

Dull refers to the lengthy, monotonous, repetitive missions, usually very exhausting for the crews of aircraft. The use of unmanned aircraft increases the durability performance of tasks in the area[29].

The term dirty is associated with the exercise of unmanned aircraft in the environment of use of weapons of mass destruction, and thus in places where health and even human life are seriously threatened. In turn, the term dangerous is used for tasks in which the risk of loss of life or health of the crew or the probability of the aircraft being destroyed would be so large that the task would not be burdened by too great a risk. In turn, the term deep is the ability of unmanned combat aircraft to perform tasks in remote areas inaccessible to manned aviation. The development programmes for unmanned aerial vehicles refer to three types[30]. The first group consists of platforms for reconnaissance and fire[31].

They are characterised by their long-term stay in the air for medium and high altitude and low-speed flights. Unmanned vehicles of this group can also perform the task of protecting their troops in close contact with the enemy and conduct direct air support missions[32]. They are also able to perform the tasks of sea basin-protection of key installations and maritime convoys, and, in the future, - to control targets on the sea. The second group of unmanned aerial vehicles use advanced technologies, including limiting the ability to detect[33]. In the group of UAVs, they are the principal means used to carry out strikes on targets located at

27 M. Isherwood, *Strike now. Next generation long range strike system provides strategic options*, „Armed Force Journal", February 2009, p. 27–28.
28 AA P-6(2009) *Glossary of terms and definitions NATO*, p. 410.
29 T. Zieliński, *Future combat unmanned aerial vehicle,* „Przegląd Sił Powietrznych" 2011, No 1, p. 9.
30 Ibid, p. 10.
31 R. Babut, *Unmanned flying. The development and application,* „Przegląd Wojsk Lotniczych i OP" 1993, No 11, p. 16–17.
32 E. Odon, *Future Mission for Unmanned Aerial Vehicle. Exploring Outside the Box*, „Aerospace Power Journal", summer 2002, p. 84–85.
33 C. N. Ghosh, *Application of unmanned combat aerial vehicles in future battles of the subcontinent*, „Strategic Analysis", Volume 25, Issue 4, 2001, p. 599–611.

large distances in the area of operations. Examples of unmanned airborne military vehicles are shown in the picture below.

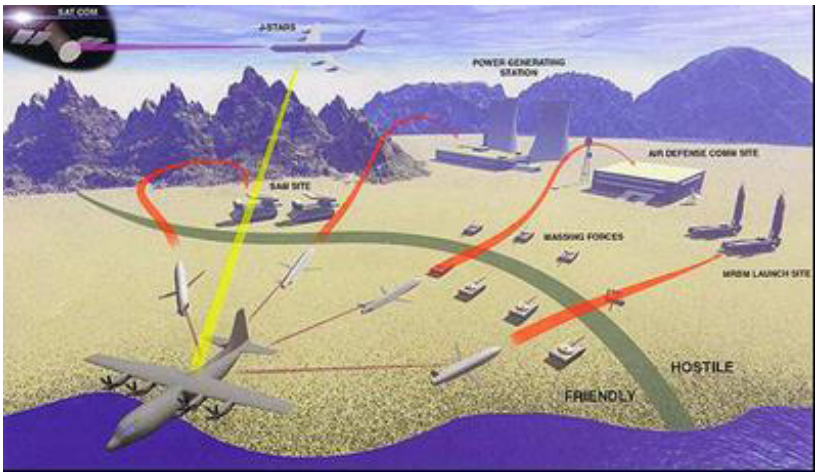
Source: http://theaviationist.com/wp-content/uploads/2012/01/fotolo77.jpg; http://theaviationist.com/wp-content/uploads/2012/01/fotolo77.jpg DARPA/USAF Unmanned Combat Aerial Vehicle Advanced Technology Demonstration Program Overview and Status Update, July 2000.

Picture 3. Future unmanned bombers intended to attack targets located deep in the opponent's area

The third group of unmanned aerial vehicles will provide a small and very combat maneuvering platform carried by manned aircraft, similar to the shape of missiles[34]. They will move with average speeds at very low altitudes, performing a flight profile[35]. These measures show that it will be difficult to detect. The idea behind their operation is that, in the safety distance for aircraft, the vector will be released from the deck. Thena solo flight is performed and the selected ground targets attacked, as shown in the picture below.

34 J. A. Jackson, Jr, B.L. Jones, Lee J. Lehmkuhl, An Operational Analysis for Air Force 2025: An Application of Value-Focused Thinking to Future Air and Space Capabilities, May 1996.

35 T. Zieliński, Future combat unmanned aerial vehicles ..., ed. cit., p. 11.



Source: http://www.airforce-technology.com/projects/foas/.(17.04.2012 r.).

Picture 4. The idea of unmanned combat camera (rocket) released from the deck of transport aircraft – carrier

Such unmanned combat will be used primarily to destroy the system of Air Defence in the fight for air superiority and to combat stationary and mobiletargets strongly defended by anti-aircraft measures[36]. In addition to developing the same design of unmanned aircraft, the development of their weapons and equipment looks very interesting. There is no doubt that, with regard to their design and their relatively small size, the means of air destruction will undergo further miniaturisation. This does not mean, however, reducing the precision and firepower, which will be comparable to or even higher than at present. Keeping these important parameters will be possible due to the use of new explosives and other types of energy: laser and electromagnetic. Arming or equipping new unmanned platforms will be bipolar. On the one hand, it will continue the process of developing a new type of weapon and also other existing aircraft will be upgraded. Particularly interesting are the concepts of micro-ammunition, electromagnetic bombs[37] and laser defence systems for airborne platforms. I mainly have in mind stand-off class weapons that will be able to be carried by different types of unmanned craft.

36 Robert. B. Chapman II, *Unmanned Combat Aerial Vehicles. Dawn of a New Age?*, „Aerospace Power Journal", Summer 2002, p. 62–63.

37 M. Franklin, *Unmanned combat air vehicles: Opportunities for the guided weapons industry?...*, Ed. cit., p. 11.

You can even assume that integrated electromagnetic heads of missiles similar to GAMS (GPS Aide Munitions) or JDAMs[38] will exist in the future. It is also expected that there will be new electronic warfare systems and jamming of air defence systems. Future systems of electronic warfare (jamming) will be even smaller than those currently used, but comparable to or with a greater ability to affect. It cannot be overlooked in the long term (after 2020) that the applicability of bundle weapons or laser weapons, which in the long term can be a great self-defense system, will be considered. On the basis of facts collected so far, it can be assumed that UAVs will have independence (autonomy) in the phase of the flight to the object of attack greater than they do now, while the decision for action with weapons remains in the hands of the operators on the ground who will be equipped with modern cockpits to guide such systems[39]. Combat platforms will be controlled by operators remotely, hundreds and even thousands of kilometres away from the theatre of operations. Along with the further development of unmanned aerial vehicles, it can be assumed that they will be so autonomous that human intervention (the operator) in their activities will be limited to a minimum or even completely eliminated[40]. It should be emphasised that the unmanned airborne vehicles will feature modern weapons, which will allow them to operate against stationary objects even heavily defended by air defence systems, fortified, and well-concealed in the urban area.

On the basis of forecasts of the development of means of air threat, one can assume that unmanned systems will be amongst the most technologically advanced measures to combat modern armed forces in the twenty-first century. Therefore, acceleration of work on the development of unmanned combat devices can be expected[41]. The basis for the formulation of such an idea can be the concepts already implemented. I have in mind the American future combat system (Future

38 A. Radomski, K. Dobija, *Podręcznik przeciwlotnika, National Defense University,* Warsaw 2010, p. 83-87.

39 *Unmanned Aircraft Systems Roadmap 2005–2030*, Office of the Secretary of Defense, 4 August 2005.

40 P. Krawczyk, *American unmanned, man. I. Proven in combat, "Aviation"* 2005, No. 3, p. 24.

41 J. Brzezina, Z. Dańko, *Unmanned aircraft and ASG as new challenges and threats in the air, "Overview of the Air Force,"* 2004, No. 8, p. 30.

Combat System - FCS)[42]. Similar programmes are found in China[43], Great Britain, Russia and India. It is predicted that these programmes will include, inter alia, the development and use of a new kind of means of combat, which includes unmanned air, sea and land systems.

In addition to these types of military means of air threat, the rocket winged maneuvering system is already a serious threat to Air Defence. They are unmanned, homing destruction weapons that can be fired from bomber aircrafts (ALCM - *Air Launched Cruise Missiles*), warships and submarines (SLCM - *Sea Launched Cruise Missiles*) and ground-based launchers (GLCM - *Ground Launched Cruise Missiles*).

Cruise Missiles usually bypass areas heavily defended by the Air Defence system, performing flights at low or high altitude[44]. Targeting cruise missiles can be carried out without entering the zone of action of active Air Defence systems. While overcoming the zone of air defence and actions from deeper targets, the main burden will be to take on the Air Defence systems arranged deep in the area of defence.

Ballistic missiles are today the most commonly reported and analysed threats. The basic condition for activating a ballistic missile is to give it a speed that will allow it to overcome gravity and output in the highest layers of the atmosphere, but less than the first cosmic velocity, which for Earth is 7.91 km / s[45].

Ballistic missiles can be deployed on different types of platforms. The dominant platforms are now underground silos which are also launchers in a particular state of readiness for missiles. Other platforms for ballistic missiles are mobile

42 *Future Combat System (FCS), or battlefield management system of the future, is part of a big project to transform the US military challenges in the twenty-first century. The whole system will cost approx. 230 billion. It performs 550 contractors and subcontractors from 41 US states. See. The Army's Future Combat Systems.Program and Alternative*, Congressional Budget Office, August 2006.

43 W. Minnick, *China Looks at Space Plane. Four Hypersonic Aircraft Concepts Unveiled at Airshow,* Defense News, 12.06.2010. http://minnickarticles.blogspot.com/2010_12_01_archive.html.

44 Frequently winged rockets use very small height (100-300 m) and the speed poddźwiętional to 2 Mach. A major problem in the detection of very small size effective reflection, which is about 0.01 m2. Winged rockets can perform maneuvers avoiding obstacles overload greater than 10 g.

45 http://www.fizykon.org/grawitacja/grawitacja_pierwsza_predkosc_kosmiczna.htm

platforms that exist in many variants, of which the most common are SLBM ballistic missile systems carried by atomic strategic submarines and ballistic systems on road mobile launchers.

The effectiveness of Air Defence depends on the type of missile fired. Short-range missiles do not leave the atmosphere and they fly at a relatively low speed. The intercept system is adapted to the characteristics of the flight. Missiles of medium and longer range move faster to leave the earth's atmosphere. A different type of defence system must be used to shoot them down. The difficulty in destroying ballistic missiles is also apparent from the fact that they are equipped with technical measures designed to penetrate enemy Air Defence systems. The most common form of devices that are designed to cheat the antimissile systems are measures that hinder the selection of the correct target, through the use of virtual heads and balloons. Another type of means of impeding the interception of the head is setting "clouds" of metal dipoles strongly reflecting radar waves, between which the correct head is not visible, and therefore difficult to trace, track, and ultimately to capture. Today, it is emphasised that the use of ballistic missiles is likely to increase, especially in the case of an uncontrolled proliferation of ballistic missiles in politically unstable countries or countries referred to as „rogue" with terrorist organisations. The threat from ballistic missiles with an intercontinental range should be extended to other countries several thousand kilometres away from Poland. In light of recent international events, particular attention should be paid to the states referred to as unstable such as Iran[46], North Korea[47], Syria and Pakistan. These countries have a relatively wide assortment of ballistic missiles with a range of up to several thousand kilometres. In this regard, it is expected that there will be a gradual increase to 10-13 thousand km.

46 S. A. Hildreth, *Iran's Ballistic Missile Programs: An Overview*, Congressional Research Service, February 4, 2009,p 4–5; A. Feickert, *Iran's Ballistic Missile Capabilitiess*, CRS Report for Congress, August 23, 2004, p. 1–6.

47 D.A. Pinkston, *The North Korean Ballistic Missile Program*, February 2008, p. 39–46; S. A. Hildreth, *North Korean Ballistic Missile Threat to the United States*, CRS Report for Congress, January 3, 2007, p. 3–6.

Since the 1970s, North Korea successfully continued its work on the development of rocket technology, making it (until the introduction of UN sanctions) one of the largest exporters of ballistic missiles and their components in the world[48].

Also noteworthy is the relatively high potential of ballistic missiles currently located in the arsenals of the Russian and Belarusian armed forces. The ballistic missiles of these countries have a range of destruction that includes many important targets on the territory of Poland.

The current Polish system OP is helpless to counteract these missile threats, expressed by the impossibility of destroying ballistic missiles with greater ranges, e.g. medium and intercontinental. Particularly dangerous for us might be an arrangement, for example, of „Iskander" missiles in Kaliningrad, near the Polish border. Based on analysis of the range of „Iskander" missiles, which is up to 500 km, it can be stated that they would destroy virtually all the important objects deployed on Polish territory[49].

To summarise, because of the threat from ballistic missiles, one can be tempted to formulate general ideas regarding development trends. According to this, one can predict: - increased progress on ballistic missiles for liquid fuel and constant efforts to increase their mobility, reliability and resilience:

- increased range of missiles, and thus the number of potential targets that they can strike;
- an increase in accuracy , which makes missiles more effective against targets;
- work on ways to overcome air defence, both technical and operational;
- work aimed at ensuring the protection of the starting positions of rockets against pre-emptive strikes (masking, disinformation and increasing the possibility of maneuvering platform boot) .

As far as forecasting air threats, one cannot ignore the risks arising from acts of aviation terrorism, particularly in the context of the possibility of its development in the twenty-first century. From facts and conclusions gathered within the forecast

48 W. Wątor, *North Korea's nuclear program*, „Przegląd Wojsk Lądowych" 2010, No 10, p. 45.

49 http://defense-update.com/products/i/iskander.htm.

changes in the Air Defence system, we have no doubt that aviation terrorism will be further developed in relation to both the form and the means.

These attacks can be carried out by individuals or organisations in order to achieve certain benefits (propaganda, psychological, financial, etc.), or to intimidate the international community. This form of terrorism should be seen as particularly dangerous, which can create a large number of victims[50]. Targets that are particularly vulnerable to air terrorism include:

- objects whose disposal may be difficult or impossible from land or sea;
- protected targets that are difficult or impossible to reach by land;
- targets that are at large distances from the actions of terrorist groups;
- targets with a large surface area;
- major sports events (Olympic Games, World and European Championships in football, economic (EXPO), or political (state tops the G-8, NATO and others).

Experts point out that future air terrorism will be much more dangerous that outside commercial planes from civil aviation used as Renegades[51] will use different types of aircraft, manned and unmanned.

One of the main advantages of using this type of aircraft by terrorists is their ability to travel long distances at very low altitudes, thus avoiding detection by ground-based radar systems. Micro light aircraft can use both concrete and grassy runways, as well as short sections of road. Small jet aircraft, such as Lear, whose impact can largely destroy the layer of concrete surrounding the nuclear reactor, can also be hijacked by terrorists. In addition to nuclear power plants, they can be a big threat to the tanks and processing of radioactive waste, which are very vulnerable to attacks from the air[52]. One cannot exclude the use by terrorists of other aircraft e.g. planes for agricultural spraying. These aircraft, through specially mounted tanks and spray systems, could become an ideal tool to spread to a large area of non-conventional toxic chemicals or biological agents. Another dangerous tool in the hands of terrorists may be still other constructions sites. They include

50 E. Masnikov, *Threat of terrorism using Unmanned Serial Vehicles*, Moscow 2005, p. 8.
51 Study future air forces - ground air defense systems. Forecast of development up to 2025, ed. S. Zajas. AON, Warsaw 2005, p. 11.
52 K. Shoot, objects threatened by terrorism, aviation ground [in] the state Responding to threats of terrorism aerospace, ed. A. Glen, AON, Warsaw 2010, pp. 48-49.

unmanned, radio-controlled flying apparatus and models[53] - RCA (Radio-Control Aircrafts)[54]. These structures are independently powered flying machines that can move autonomously after the planned route of flight or be controlled remotely by one or more operators[55]. These devices are capable of carrying combat loads, which are able severely to damage the target even with a low-volume. An alternative could be terrorist radio-controlled model airplanes, RCA (Radio Controlled Aircrafts)[56]. This is mainly due to the projected development of aviation technology, including miniaturisation of radio and electronic control systems, the introduction of composite materials, the practical use of RCA as a terrorist tool able to be fully realistic in the near future[57]. RCA can be easily adapted to carry a conventional load and different types of trays, including chemical or biological agents. Due to its small size, it will be very difficult to detect and destroy airborne. Thus, their application to perform precision bombings over large distances seems to be highly probable[58]. In addition, firepower can be increased for these measures, using „swarm tactics", i.e. attacking the object simultaneously by a dozen or so RCA from different directions[59]. Therefore, the features of lightweight unmanned aircraft and RCA, and above all, their development trends allows one to allocate them to the aircraft which are particularly predisposed to be used by terrorists in the twenty-first century. Taking into account an estimate of the risks generated in the airspace of the twenty-first century, one can conclude that air terrorism may constitute one of the most dangerous sources of destabilisation of aviation security, both in the regional dimension as well as in the international. This means civilian aircraft will not only be the fastest means of communication but also a very interesting and effective tool in the hands of terrorists[60].

53 E. Miasnikov, *Threat of Terrorist Unmanned Aerial Vehicles: Technical Aspects,* Center for Arms Control, Energy and Environmental Studies at MIPT, June 2004, pp. 1–8.

54 Arab terrorists groups Hezbollah used the three UAVs Ababil against Israel (these cameras have a remote range of the order of 240 km and explosives weighing 40 kg).

55 J. Gotowała, *Anxiety in the air*, „Przegląd Wojsk Lotniczych i OP" 2003, No 1, pp. 7–8.

56 P. Makowski, A. Radomyski, K. Dobija, *The share of defense forces in counter-terrorism air,* National Defense University, Warsaw 2008, p. 35.

57 J. Adamski, New technologies in the service of terrorists, Ed. Trio, Warsaw 2007, p. 49.

58 Dennis M. Gormley, *Unmanned Air Vehicles as Terror Weapons: Real or Imagined?*, Center for Nonproliferation Studies (CNS), Monterey Institute of International Studies, July 2005.

59 Ibid, p. 37.

60 J. Karpowicz, E. Klich, *Flight safety and aviation security against attacks of unlawful interference,* National Defense University, Warsaw 2004, p. 7.

Summary

On the basis of the vision for the development of combat aircraft which are an essential determinant of the development of the Air Defence system, one can see the most important aspects that will conditon its future and the desired technical and organisational state. In this respect, the efficiency of Air Defence systems in the twenty-first century will be largely dependent on the capabilities of processing and using information about the threat. In this regard, an interdisciplinary approach to creating a future Air Defence system, which will go beyond the existing framework of interest mainly among the military, is desirable[61]. At this point, the question arises: how do we do it? The answer is not simple, if only due to the fact that the implementation of Air Defence was, is and will probably remain, difficult and complex. The basis for this assessment is the fact that Air Defence is always moving among unexpected events and it is difficult to quantify, but real , occurring randomly in a multidimensional space in an extraordinarily short time. General Czeslaw Dęga wrote in the 1990s: „(...) from the point of view of probability forecasting in the area of air defence is far more difficult than in other types of combat military operations"[62]. Therefore, there is nothing else but the doctrine of probability during the transformation of the Air Defence system. In this regard, the predicted phenomena, events, processes should be seen to solve the key problem: how to use them in shaping the desired future of Air Defence?

The ability to transform Air Defence will also depend on the level of involvement of the armed forces in international operations under the auspices of NATO or the UN. In this respect, there is no doubt that the issue of international security is an important issue for Poland, but it can cause weakening of the defence capability of the territory of one's own country. Especially in recent years, Poland can be seen unfavourably from the viewpoint of the Air Defence changes in the armed forces, which were intended to create light expeditionary forces prepared for operations outside the country. With regard to Air Defence, this trend is very unfavourable, if only because of the fact that it is a military system with highly defensive characteristics. Air Defence should be able to concentrate its effort in

61 http://www.defenselink.mil/.
62 Cz. Dęga, *Weapons and battlefield army until 2020,* Warsaw 1995.

the fight against military aircraft in a particular place and time. This involves the coordination and efficient organisation of its activities both in war and in peace. Effectiveness in the fight against enemy aircraft is to focus effort at the right time in covering the most important (priority) military facilities and non-military. This is demonstrated by the conclusions and experiences of armed conflict. Based on this, it can be concluded that in every country there are such centres of gravity on which their efficiency depends. Their destruction or incapacitation is often a key factor in success. Hence, in future war, mass destruction is not as important as the time of (phase of the campaign or operation) destruction of the centre of gravity, which can result in the functioning of the whole country being incapacitated. In this aspect, it seems reasonable to conclude that the success of the Air Defence system will decide the possibility of preventing the elimination of these targets by means of a potential enemy air threat.

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