



Protection of Air Transport Against Acts of Unlawful Interference – What's Next?

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Abstract

Air transport consists in moving people or goods by air. Aircrafts, known as the main means of air transport, can be divided into two categories: airplanes and helicopters. Such transport is the most modern and the most dynamically developing branch of transport. It is also considered to be the safest mode of transport, even though, for various reasons, aviation accidents still occur.

Security in aviation has various connotations. According to the International Civil Aviation Organization (ICAO), it is a state in which the possibility of damage to persons or property is minimized and is maintained as part of a continuous process of hazard identification and safety risk management at an acceptable level or below this acceptable level. Aviation security includes flight safety and aviation security against acts of unlawful interference. There is a significant difference between the meaning of "safety" and "security". The first of these concepts means preventing unintentional damage, while the second refers to the procedures undertaken in order to prevent deliberate damage resulting from an intentional act.

As it appears from the abovementioned information, the immovable part of aviation safety is aircraft protection, including the protection of civilian airports.

The aim of the article is to draw attention to the problems of air transport security, including the security of airports, related to the evolution of threats and the functioning of the airport security system.

The problem that the authors address is expressed in a question: in what directions should the current solutions in the field of air transport security be improved in order to effectively prevent acts of unlawful interference in the future?

Theoretical research methods, such as the analysis and synthesis of information contained in literature and source materials, inference, comparison, were used to develop the article.

Keywords: air transport, security, airport, security systems, technical security measures.

1. Introduction

It is widely believed that general aviation is one of the safest means of transport. The sense of security is quite relative, largely dependent on subjective feelings and difficult to describe in terms of procedures that ensure it.

Aviation safety has numerous connotations. According to the International Civil Aviation Organization (ICAO), it is a state in which the possibility of damage to persons or property is minimized and is maintained as part of a continuous process of identifying threats and managing safety risks at or below an acceptable level. More effective laws and procedures, resulting in a reduction of the number of incidents, increase the sense of security and, as a result, raise the number of passengers. This simple mental observation has become the basis of many efforts taken by airline companies, both those to deal with the transport of passengers and those to deal with the transport of goods. It also became the basis for research and analyses.

Aviation safety covers the problems of flight safety and aviation security against

acts of unlawful interference. There is a significant difference in meaning between "safety" and "security". The first of these terms means avoiding unintentional damage, while the second means avoiding intentional and culpable damage.

The aim of the article is to draw attention to the problems of air transport security, including the security of airports, related to the evolution of threats and the functioning of the airport security system.

The problem that its authors want to highlight is expressed by the question: in what directions should the current solutions in the field of air transport security be improved in order to effectively prevent acts of unlawful interference in the future?

The authors of this article make the following assumption: the protection of aircrafts and airports should be viewed in a systemic way. This means that the authorities, ministries and state services that can provide information about a potential threat and be used to naturalize it, should operate in one coherent system dedicated to civil aviation security, according to previously established rules. Currently, the protection of airports should be dynamic, maneuverable and related to the protection of its operational zone.

The theoretical research methods, such as analysis and synthesis of information

contained in the literature and source materials, inference and comparison, were used to develop this article.

An important source of information for the authors of this article come from the participation in anti-terrorist exercises at Chopin Airport in Warsaw.

2. Protection of air transport and its contemporary threats

Security in the light of Annex 17 to the Chicago Convention is understood as a combination of measures, and human and material resources intended to protect international civil aviation against acts of unlawful interference. In the traditional approach, the security of civil aviation against acts of unlawful interference is to prevent sneaking objects and dangerous materials onboard which pose a threat to the safety of passengers and aviation infrastructure. The issues related to the protection of civil aviation are particularly visible at an airport. The infiltration of people and hazardous materials onto the grounds of the airport results from a breach in the protection system, which is highly unlikely, especially in the Member States of the European Union, where high common standards for the protection of airports are established. They are related to the applied procedures, training and technical devices used by the security services of the airport.

As a phenomenon, terrorism is still increasing in terms of its impact and the use of modern technological solutions. This characteristic is due to its ideas that do not follow any legal standards of the civilized world and which is constantly changing to awe and raise fear in the increasingly immunized society.

Currently, the Acts of Unlawful Interference in civil aviation are actions or attempts to undertake measures that threaten the safety of civil aviation, including, among others (Annex 17 to the Convention on International Civil Aviation, 1974):

- unlawful seizure of aircraft;
- destruction of aircraft in use;
- hostage-taking on board an aircraft or at airports;
- seizure of an aircraft, unlawful interference on the premises of an airport or an airport facility;
- bringing on board the aircraft or onto the airport area a weapon or a dangerous device or a material used for criminal purposes;
- using an aircraft during its operation in order to cause death, serious injury or serious damage to property or the environment;
- transfer of incorrect information aimed to endanger an aircraft during a flight or on the ground, including its passengers, crew, ground staff or the general public, at the airport or an aviation facility.

Taking into account the adopted solutions with regard to the protection of civil aviation, traditional hijacking of an aircraft appears to be extremely difficult (Evans, 1969). Nowadays attempted acts of unlawful interference, either at the airport or in its proximity, are most likely to occur.

Currently, there is no need for criminal groups to physically infiltrate the system of airport security. The same effects can be achieved by using, for example, the so-called cyberspace, or open space of communication via computers and computer memories operating worldwide. The widespread storage of information in computer systems turns cyberspace into an interesting target for possible terrorist operations. Thus, it is possible to effectively manipulate the information, or even generate fake information, which threatens the security of civil aviation.

It should be assumed that terrorists will also take action in the so-called operational sector of the airport. This is understood by airport facilities and the surrounding area, in which airport services and other entities provide assistance to an endangered aircraft within the of radius 8,000 m - in the case of a certified airport, and 3,000 m - in

the case of an airport with limited certification or an airport for exclusive use - from the airport reference point. This is a vast space, giving considerable freedom of action for possible terrorist groups. In the operational zone of the airport, various assets may be used as acts of unlawful interference, e.g. small arms, man-portable air defense systems, wide-area mines and unmanned aerial vehicles.

Another threat, known for centuries, is also worth mentioning, namely the war.

In the classic approach, warfare is understood as the use of military force in international relations against the territorial integrity and political independence of other countries. The nature of warfare is changing and the so-called hybrid warfare has the potential to change a quite stable country into an arena of the most intense armed conflict within a few months, if not days. The role of political, economic, information operations as well as the role of mobile military formations operating in a uniform information space is on the increase. The combination of conventional operations ranges from guerrilla operations (diversion, sabotage, terrorist acts) to operations in cyberspace and exerting economic pressure. It is increasingly difficult to separate war from terrorism and in the military aspect, the phenomenon of war is losing its exclusive national character.

3. Airport – a specific protected facility

The airport is a network of interrelated elements, forming a coherent and harmonious structure. Above all, it is characterized by complexity and a multi-level character. It consists of such elements as a passenger terminal, control tower, radio equipment, runways, depots, parking lots and access roads surrounding the airport area. In general, the airport can be divided into two areas:

- airside - an area where aircraft are handled and air operations are executed,
- landside - an area designed for passenger traffic (Compa, 2013).

When using the airport services, in the first place, we enter the terminal. This is the facility connecting the general public sector with the airport area. It is primarily intended to handle passengers. It is composed of specially detached airport buildings, providing service for passengers. On the grounds, there are restaurants, cafes, shops and other services. In terminals, there are also different types of recreation places, VIP zones and facilities for children. Terminals fall under two categories: domestic and international.

Domestic terminals are much smaller in size compared to the international ones, due to the fact that international terminals require additional space for arranging check-in and customs clearance as well as passport control. In addition, there are duty-free shops here. Bigger airports, due to a large flow of passengers and goods, have got several terminals divided by category, for example the way it is organized at Fryderyk Chopin Airport in Warsaw. It should be noted that most European countries and several non-European countries belong to the Schengen Area. This is the area where there is no border control at the internal borders within this area. Therefore, it was necessary to create separate areas: Schengen Area and Non-Schengen Area. In the "Schengen Area" passengers cross the generally available and restricted border zone without the necessity of going through a passport control. On the other hand, in the Non-Schengen Area each passenger is obliged to pass through the border crossing and undergo passport control.

Another important element facilitating the use of airport services is parking lots. Travelers beginning a longer trip can use a car park adjacent to an airport. They are usually paid as well as fenced, with 24/7 protection, and are located close to a terminal.

In the operational zone of an airport, aprons (Chicago Convention, 1944) are designated for various types of aircraft. The apron is a separate area at the airport tarmac for aircraft parking. Aprons are provided for passengers getting on and off a plane, loading and offloading of cargo, luggage or mail as well as aircraft servicing. The overall dimensions of an apron area are determined by the size of the airplanes expected to serve the aerodrome and to permit expeditious handling of airplane movements and the volume of traffic anticipated for the aerodrome. The dimensions of an apron are adapted to the aircraft size (min. wingspan) and derive directly from the airport reference code.

In addition, based on ICAO Annex 14, it is necessary to enclose an isolated apron, which might have become the subject of an act of unlawful interference, or due to other reasons it is necessary to isolate the aircraft from the normal activities of the airport. The apron should possibly be in the most remote part of the airport, no closer than 100 m from other parking positions, buildings or the general public area. It is also important that the apron location does not interfere with the aerodrome systems of supply installations such as gas, fuel, energy or telecommunications (Annex 14 to the Convention on International Civil Aviation, 1974).

Every modern airport possesses radio technical devices. These devices facilitate and enable the aircraft to perform flight operations. They indicate the parameters necessary for the proper performance of take-offs or landings especially in conditions of limited visibility. The devices need to be certified and are subject to periodic tests on the ground and in the air. They must have a continuous energy supply so as not to disrupt the continuity of their operation. Radio technical devices include radio navigation aids, radars and radio communication equipment.

The air traffic control tower is an important part of the airport. Its main function is to control the area of an airport and its airspace, as well as issuing commands

and instructions relating to performed flight operations. It is usually a high structure towering over airport buildings, and also equipped with a glazed observation point, which enables an observation of aircraft maneuvers. The large international airports, air traffic control towers are open 24/7. Moreover, they are manned by several air traffic controllers, including technical maintenance and support personnel. They receive all the necessary information to be provided to pilots, including meteorological conditions, disruptions at the airport, delays and any other circumstances that affect the ability to perform procedures of flight operations. In addition, information is provided on the condition and suitability of navigation aids and lighting.

An integral part of an airport is various types of airport warehouses, composed of building complexes, halls localized at the airport or outside. In practice, larger airports make investments not just in ordinary warehouses, but in modern logistics centers that meet the requirements of the 21st century. In this way, the logistics center for Krakow Balice Airport was created, named The Krakow Airport Logistics Centre, localized approximately seven kilometers from the airport. These buildings are designed for the storage and distribution of cargo and light production, sharing regular warehouse space or one that is equipped with offices and social areas.

The warehouses located on the grounds of the airport additionally offer comprehensive services with regard to air cargo handling at the international airport. This service includes warehouse temporary storage and inspection of cargo safety (The service of conducting safety inspections is possible after the granting of Regulated Agent status by the Civil Aviation Authority (Regulation (EC) No 300/2008).

The additional elements of the airport infrastructure are all types of systems responsible for the functioning of the facility from the purely technical side, i.e. mainly such issues as the energy supply, sanitary and IT systems.

The energy system can be compared to the bloodstream of a living organism. All machines, equipment, light conveyor belts, navigational aids, alarm systems, monitoring systems and other are dependent on an energy supply. The system is vitally important since the quality of the electricity supply affects the security of the entire airport area. When designing the airport, it is important to ensure that the sources of energy supply are checked. Typically, several sources of energy are used for an uninterrupted power supply. The system should also be provided with an alternate power supply to ensure a safe execution of air operations and to transfer information both for pilots and airport workers, in the event of a failure. Power units which generate energy from the combustion of fuels or from alternative sources of renewable energy, such as solar or wind power are exploited for this purpose. Due to the significance of this system, it is necessary to use special protection, which minimize the risk for unwanted interference of third parties. The buildings contain the devices responsible for the transfer of energy are encoded. The power cables used for the delivery of energy to different parts of the airport are located underground, under the tarmac.

It is difficult to imagine the operation of an airport without any computer system or the use of network technology. The reliance on information technology has good and bad sides. On the one hand, it allows efficient management, on the other hand, the so-called cyberspace is the interest of criminal groups and even rogue states which are hostile to western democracy. The protection of airports also entails the protection of cyberspace that these ports use.

The qualities that may expose an airport to a terrorist attack include the following:

- a large area, which is extremely difficult to isolate and control;
- a large number of personnel;
- a massive flow of people and baggage from different destinations, steady and high concentration of people;

- dependence of air traffic safety on technology, safety equipment and power supply;
- storage of a massive amount of explosives and easiness of planting an explosive in the landside, which can be reached without passing through any control.

4. Airport security system

Rankings state that the largest airport in the world is King Fahd airport located in Saudi Arabia near the city of Ad-Dammam. The airport in question was built on a grand scale. It has a four-kilometer long runway and seven terminals (including one luxury Royal Terminal, designed to handle the Saudi royal family and their guests). The airport complex houses a mosque that can accommodate even two thousand worshippers. The airport comprises an astonishing 780 hectares surface area (Kubisa, 2017). By comparison, the surface area of London Heathrow Airport equals 1227 hectares and the largest Polish national airport Okęcie is an area of approximately 830 hectares. There is only one conclusion - the area that needs to be protected is vast and the task should be approached best through the prism of a security system.

One of the definitions describes the system as a deliberately defined set of elements and a set of linkages among them, which together determine the characteristics as a whole. Defining the system consists in extracting the elements of the system environment, significant couplings between system components and relevant system feedbacks with all its surroundings (Sillitto et al., 2017). The system of airport security is a deliberate link between the human being and technical assets.

Ensuring airport security is mostly the responsibility of Airport Security (Guard) Services. This security also comprises Border Guard, Police, Customs Service and the

operational services of the airport. The protection system is designed to prevent any act of unlawful interference on its territory.

The organization and functioning of the protection system of individual airports in Poland results from the implementation of the rules of international aviation law, including that of the EU, into national documents. One should bear in mind that the indicated documents are updated from time to time.

In the system of airport security, the following subsystems can be observed:

- the legal and organizational subsystem, including the division of an airport into zones;
- the technical subsystem;
- the subsystem of the security service personnel and other.

5. The legal and organizational subsystem

It is created by laws relating to civil aviation security, and their effects, namely issues relating to the organization of this protection. The records of these documents also enable a clear understanding of the basic concepts related to the protection of civil aviation. The following international documents are worth mentioning:

- The Annex 17 to the Convention on International Civil Aviation, "Protection of international civil aviation against acts of unlawful interference";
- Regulation of the European Parliament and of the Council of 11 March 2008 on common rules in the field of civil aviation security and repealing Regulation (EC) No 2320/2002;
- Commission Regulation (EU) no 18/2010 of 8 January 2010, amending Regulation (EC) No 300/2008 of the European Parliament and of the Council as far as specifications for national quality control programmed in the field of civil aviation security;

The national documents include:

- Aviation Law Act of 2002, Part IX. Aviation Security;
- Regulation of the Minister of Transport, Construction and Maritime Economy of 31 July 2012. On the National Civil Aviation Security Program (Annex to the notice of the Minister of Infrastructure of 6 March 2018. / Item 631/);
- Regulation of the Minister of Transport, Construction and Maritime Economy of 25 July 2013 on the National Quality Control Program in the field of civil aviation security (Appendix to the notice of the Minister of Infrastructure and Construction dated 25 August 2016/ item 1497/);
- Regulation of the Minister of Transport, Construction and Maritime Economy of 20 September 2013 on the National Training Program in the field of civil aviation security (Appendix to the notice of the Minister of Infrastructure and Construction dated 27 October 2016/ item 1852/).

At the level of an airport, a program and a protection plan are developed, which obviously are classified documents.

The overall organization of protection at an airport is imposed by the National Civil Aviation Security Program. The contents of this document are the implementation of ICAO and EU documents, relating to civil aviation security.

Chapter 1 "General provisions" of this document indicates which institutions are to cooperate with each other in the implementation of the provisions of this document. In the opinion of the authors' team, this is a good solution because this cooperation is essential in the dynamically changing security environment

This article presents only some of the provisions of this document, those which are the most visible to people who use airport services. First of all, when entering the premises of an airport, a division into zones can be noticed, i.e.:

- (landside) the general open public area, which is not part of the operational part of the airport;
- (airside) the operational part of the airport, which refers to the movement area of an airport, adjacent terrain and buildings or portions, to which access is restricted;
- security restricted area, which refers to the airside where, apart from restricted access, also other aviation security norms are applied;

The boundary between landside and airside shall be a physical obstruction that is clearly visible to the general public and which denies a person unauthorized access.

6. Security bodies (services) at airports

Polish Act of 22 August 1997 on the protection of people and property describes an airport as an area, an important object in the protection of economic interests of the state (Ustawa o ochronie osób i mienia, 1997). In accordance with the legislator, apart from the use of technical security assets, physical security in the form of Internal Security Services or Professional Uniformed Security Formations will also be used to protect an airport. These two forms constitute the Airport Security Service (ASS). The established service is the managing airport body, constituting the Internal Security Services and operating under the authorization of the competent Provincial Police Commander. In the event that it is outsourced to a business entity that provides services for the airport, as a Specialist Uniformed Security Formation, it must have an adequate concession, which specifies the scope and form of the provided services. Regardless of the type of organiza-

tions that can create ASS, they are composed of employees which are registered on a list of well-qualified security personnel (Biernacki, 2014).

ASS performs the following tasks in the field of airport management:

- conducting security check-ups;
- conducting access control to airport restricted areas;
- inspecting passes issued by the airport manager;
- detention and handover of a person (passenger) breaching the safety conditions at the airport to the Police or Border Guard.

By 15 January 2011, Border Guard was responsible for conducting security checks of passengers in domestic flights at Chopin Airport. After this period, this task was taken over by the Airport Security Service.

Other services which are involved in the protection of the airport are the Police, Border Guard and Customs Service. Due to the authorities possessed by the ASS, the service which in an emergency situation is linked with airport security, must cooperate closely with the ASS.

Compliance with stringent norms of airport security make the penetration of people and hazardous materials into the restricted airport area,¹ extremely difficult. The airport security system should prevent such cases. It needs to be remembered, however, that humans are the inherent component of this system - security guard personnel who can commit an error.

Human error is an integral part of human nature, and it cannot be "eradicated." Professor James Reason stated that an error occurs in a situation, in which an undertaken action or an accepted way of thinking have not led to the intended result.

The most common types of errors committed by people arise from:

¹ The security restricted area refers to the operational airport zone, in which, apart from a restricted access, other aviation security norms are also applied.

- an undetected stimulus and lack of response;
- no reaction despite a detection of a stimulus;
- improper identification of a stimulus;
- abnormal response to a stimulus;
- making a wrong decision;
- delayed decision (with a deficit of time) about an action.

The fight against human errors is possible due to an optimal protection strategy, which should be based on a specific sequence of barriers which constitute: an effective system of training and quality, trained staff, information about threats and execution of tasks in accordance with procedures and quality control in the field of civil aviation security.

If humans, in the airport security system, commit an error, they will act inappropriately in such a situation. His action will cause a situation of unlawful interference, although avoiding such a situation was possible. As a rule, in such a situation one usually wonders about the reason for the failure: lack of information about a threat, training, equipment, inadequate control, etc. There may be a range of hypothetical reasons, however it is necessary to indicate one of them - the lack of proper security awareness. "Awareness" is an integral part of a human being. Awareness is a concept which is difficult to define, referring to the sense of experiencing specific mental states (mental phenomena). Owing to perception, the human being is aware of the surrounding environment. He adapts his activities to the relevance of events. Also, he is aware of the contents of own mental experiences (experiencing one's own "Self") and the very fact of their cognition (PWN, 2020).

The personnel of airport security should have a high level of "security awareness". This means that they should possess the ability to perceive hazards, maintaining awareness of things which pose the greatest threat in the near and further environment, and at the same time, they need to be able to take action to minimize these threats. At

the same time, they should be able to anticipate the consequences of their own actions.

7. Direct aviation security systems

There are a number of measures and aircraft protection systems against the most common MANPADS attacks. They differ in the mode of operation, the possibility of using them, degree of complexity and obviously the price, which undoubtedly is one of the key issues when making a decision on the purchase and the application of a given asset by an air carrier.

MANPADS – Man Portable Air Defense System is a portable anti-aircraft missile intended to fight visually observable air targets, including planes, helicopters and other objects emitting radiation in the infrared spectral range. Due to the risks involved with this type of a weapon, its possession as well as international sales are tightly controlled. In addition, too much attention is placed on terrorist attacks and an international trade, also in view of the threat of terrorist attacks using anti-aircraft rocket sets. The advances of techniques and technology had made it possible to construct portable anti-aircraft missile sets, operated on the battlefield by one soldier. They are now used at all levels of air defense. They are capable of fighting objects at distances ranging from several hundred meters to several kilometers and altitudes between several meters to tens of kilometers. Thus, there is no doubt that anti-aircraft sets which remain in the hands of terrorists and accidental persons, pose a threat to civil aircraft.

MANPADS systems are mostly intended to be used by a single soldier. They have been frequently used in various armed conflicts since 1969, i.e. since the Egyptian-Israeli border clashes. The main element of MANPADS is an anti-aircraft missile, placed in a tubular launcher, which guides itself to the most intense source of thermal

radiation, which is the aircraft engine. By assumption, it is designed to be an inexpensive system, which is why its construction is simplified. For example, the same rocket does not have a proximity fuse, but an impact one, hence the eruption occurs at a time when it directly hits the warmest place of the aircraft. In addition, generally external detection systems are not used, and the detection itself is made by using a rocket homing warhead, in-built in the launcher tube. Additionally, the launch device is switched off and can be reused after replacing the used launcher.

The simplicity of design of MANPADS translates into an easiness of its use. It does not have any special calibration, testing and aiming systems. Everything is quite tough and rough as well as "idiot-proof". The shooting procedure in the case of terrorist activities only consists in mounting the trigger mechanism and the coolant tank on the launch pad, removing covers, placing it on the shoulder and aiming into the direction of an aircraft. The engagement of a target is signaled to the operator by a light signal or a sound signal. Firing is done only by pressing the trigger. Next, an empty launch tube is disposed of, obviously after removing the trigger mechanism, which can be later reused. It is clear that firing from MANPADS does not need a well-trained specialist, which was proved by Russians in Afghanistan. Often illiterate Taliban launched attacks on them. Currently government aviation in Syria is frequently attacked by rebels.

The simplicity of the system does not mean that it is ineffective. Initially, the most effective were easily accessible Russian rockets. Terrorists act primarily using the surprise element, i.e. in an environment where no one is expecting an attack and where prevention is absent. Moreover, a terrorist does not act under the pressure that he will die if he does not shoot. He is the one to select the time and place of an attack.

The availability, mobility and possibility to hide MANPADS make this weapon one of the most frequent tools to carry out

terrorist attacks. The attacks which occurred several years ago by means of short range infrared homing missiles led to a situation that aircraft developers and supervisory bodies began to consider equipping commercial aircraft with anti-missile defense systems. The idea was considered to be too expensive, unreliable and ultimately too dangerous for airlines. Various surface-to-air missiles require different defense systems, which creates a number of opportunities for their producers and also would fundamentally change the role of commercial pilots. Equipping aircraft in anti-missile systems would cost enormous amounts of money and would turn the pilot's work into a real nightmare. Additionally, new safety issues would arise because of the equipment itself: lasers are harmful to eyesight, other means of defense may be poisonous (Radomyski, and Bernat, 2018; Radomyski, 2019).

The technical measures for the individual protection of military aircraft include: devices warning about radar or laser radiation, warning devices about incoming missiles, jamming and deception devices, devices of active infrared interference, stations of active radio interference and electronic devices, anti-radiation missiles and passive infrared interference systems, as well as radio electric dipoles.

Undoubtedly, these days it is necessary to undertake actions with regard to the protection of passenger aircraft as terrorist attacks and hijacks are becoming more common. The incident of 28 November 2002 in Mombasa, when there was an unsuccessful attack on a Boeing 757, forced the Israeli government to develop an innovative project. In accordance with the governmental Sky Shield programmed, jet aircraft belonging to the national carrier El Al Israel Airlines, Arkia Israel Airlines and Israir Airlines are equipped with such equipment, which is manufactured by the local company Elbit Systems. The position of Israel was that the benefits outweigh costs and insecurity. The lowest level of security against terrorist attacks pertains to Israeli airlines and therefore they are considered

to be the most dangerous ones. Therefore, Elbit company decided to develop a system named Commercial Multi-Spectral Infrared Countermeasures (C-MUSIC), which introduces a revolutionary concept in fighting ballistic missiles and rockets. A pod, which is installed under an aircraft fuselage, has got a strong laser (jamming the operation of a missile head) and a guidance system. In this way, in a matter of seconds, the system is capable of destroying a dangerous incoming threat. What is more, it can engage a missile using a thermal camera (it detects a threat by heat seeking). Next, it “fires” into its navigation system to change its trajectory and avoid a crash. This system largely reflects military anti-missile systems designed to counter ballistic missiles, yet on a smaller scale. C-MUSIC is already mounted under the fuselage of the Boeing 737-800 belonging to the El Al Israeli airline. The system is fixed in the lower rear part of the fuselage of a passenger aircraft (Fig. 1).



Figure 1. El Al’s Boeing 757-800 equipped with C-MUSIC system. Adopted from: (Altair, 2014).

This system is one of the most desirable security systems in the world since the current level of threat from missiles and ballistic missiles is very high. It gives hope for both civil aviation and military aviation due to a breakthrough in the field of security. In the foreseeable future, all passenger aircraft in Israel are to be equipped with C-MUSIC systems in order to improve their

level of security (Ogonowski, and Bogusz, 2018).

In 2016, the Elbit Systems company completed testing the system, consisting of three main subsystems that facilitate a reduction of the danger that exists mainly from Man Portable Air Defense Systems (MANPADS). The subsystem of detectors is designed to detect and locate an incoming missile. After a positive identification of the autonomous control system, an optical system, placed in a special copula, guides the head of the anti-aircraft rocket, using a laser beam. In this way, the thermal matrix of a projectile is blinded, and finally the projectile goes astray, exploding at a safe distance from an aircraft (Fig. 2).



Figure 2. Components of the C-MUSIC system and their distribution in the pod. Adopted from: (Opli, 2012).

The aircraft used by the President and Prime Minister of the French Republic has been equipped with the Israeli defense anti-aircraft infrared guided missile system - “surface-to-air.” The French decided to assemble this system of self-defense, due to more frequent visits of the president and prime minister in the countries of central Africa, where there is a very high risk of terrorist attacks using MANPADS. The Israeli solution was chosen since the country has vast experience in the fight against this type of threats, gaining it for decades.

The majority of anti-missile systems, designed for aircraft and helicopters, are to counter short-range and shoulder-launched missiles. The USA has equipped most of its military transport units with such protective devices, similarly to the

United Kingdom and Australia. The systems manufactured by Northrop Grumman are in service with the heads of states, for example, the Air Force One carrying the President of the United States as well as the German aircraft transporting the Chancellor.

The most important effect of mounting the system of self-protection on board an aircraft is to enhance the situational awareness for pilots, who are being informed about possible risks from anti-aircraft infrared guided missiles. The main aim of the kit is to defend against terrorists', militants' or various rebels' weapons, i.e. against portable anti-aircraft short range missile systems, MANPADS-type.

The aircraft protection against IR guided missiles is one of the priorities in the present time. The reason is very high effectiveness of such missiles. Recent war experiences show that approximately 90% of all aircrafts shot down in armed conflicts are destroyed by infrared guided missiles.

The protection of aircraft against MANPADS-type missiles is usually ensured by creating false thermal targets by means of thermal or optical active electronic jamming systems. The operation of the electronic-optical active jamming systems is based on the principle of modular jamming of infrared radiation.

8. Conclusions

This article deals with the protection of air transport against acts of unlawful interference with an indication of trends that are likely to occur in the future. The aim of this article is to focus on the problems of air transport security at airports, associated with the evolution of threats and the functioning of an airport security system.

The problem that the authors wished to signal was expressed by a question - what are the directions of improving the current solutions in the field of air transport security in order to effectively prevent future

acts of unlawful interference? This is a difficult question, since the challenges and threats are variable in their nature, and in practice it is difficult to follow them.

The authors are of the opinion that, in the first place, it is essential to change the perception of airport security. A modern airport might be compared to a fortress guarded by various services and various types of technical systems. Using military terminology, the defense is fairly static, important, however it is only one of its elements. Areas, objects and devices which are important for the defense, economic interest, public safety and other important state interests must be protected. An airport combines all of these attributes. One should realize that airports will not only be the scope of interest of criminal organizations, but also of countries which do not exclude conducting the so-called hybrid warfare. Therefore, it can be argued that airports, as communications centers, are exposed not only to criminal organizations, but also reconnaissance or saboteur groups, detached from armed forces of other countries. The forces will be well-equipped and mentally prepared for such an operation. The question remains whether the threat, however real, is included in various scenarios of services that are responsible for airport security?

The presented modern technologies are essential to significantly strengthen the protection of airports and other critical infrastructure installations. They facilitate an instant detection of threats and often shorten the response time of airport security and emergency services. New technology significantly supports the protection within the airport perimeter area and in the very buildings. The awareness of using these devices is a "psychological barrier", which, in a preventive manner, often deters potential perpetrators. The latest trends in the development of technical measures used in protection are closely related to biometrics. The biometric systems are already used in practice and will be further developed.

The law and technology applied in protecting airports prove insufficient. The actual level of airport security rests with those working in the services. If someone in the airport security system, commits an error, he/she will act inappropriately in such a situation. Actions taken will cause an unlawful interference, even though avoiding such a situation was possible. As a rule, in such a situation one usually wonders about the reason for the failure: lack of information about a threat, training, equipment, inadequate control, etc. There may be a range of hypothetical reasons, however it is necessary to indicate one of them - the lack of proper security awareness. "Awareness" is an integral part of a human being. Awareness is a concept which is difficult to define, referring to the sense of experiencing specific mental states (mental phenomena). Owing human perception, one has a sense of orientation in the environment that adapts operation to the relevance of events. One is also aware of the content of own psychic experiences (by experiences own "Self") and the very fact of experiencing them.

Airport security personnel should have a high level of "security awareness". This means that they should possess the ability to perceive hazards, maintaining awareness of things which pose the greatest threat in the near and further environment, and at the same time, they need to be able to undertake action to minimize these threats. At the same time, they should be able to anticipate the consequences of their own actions.

One final conclusion - the security of a facility should be approached in a systematic manner. This means that authorities, departments, state services, which can provide information about a potential threat and can be used for its naturalization, should act in one coherent system of civil aviation security, in compliance with predetermined rules. In practice, the protection of airports should be given a dynamic, maneuverable character, associated with the protection of its operational zone.

In the opinion of the authors of this article, the working hypothesis adopted in the introduction has been positively verified.

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