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New technologies in the field of ensuring security for restricted and public areas at airports

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The paper refers to innovative solution of security at international Airports, taking specifically into consideration cur-rent challenges within secure processing of passengers and protection of critical and public spaces, in light of types of current major threats. One of the main reasons, why aviation being one of the most regulated means of transport in sense of security, is the fact of continues serious risk and vulnerability for terrorist attacks. Instead of continues implementation of strict security measures, the number of incidents and breaches within aviation international security environment, being updated almost at daily basis, all around the world. Therefore, the primary role of all aviation regulatory and professional stakeholders is to effectively protect and secure variety of aviation ecosystems such as airports and airlines. To meet the challenges of increased security regulations and growing number of passengers, and to keep up date on the latest antiterrorism strategies, airports are looking for tailor made solutions. Such solutions are primary based on electronic deployment of new types of equipment aiming to improve detection of threats materials with specific focus on explosives and CBRN threats. Within the scope of this paper, presented key technological elements supporting threats detection, as well as indicated main points referring to general perception amongst airport security systems.

Keywords: threats, advanced technology, security system.

Introduction

Air transport plays a significant role in the global economy. Safe air services are conducive to the development of trade, tourism and international politics [5]. By 2030, international air passenger traffic is expected to increase to 6 billion a year, with around 4.1 billion passengers present.

Air transport is exposed to terrorist attacks [9]. The object of a terrorist attack may be elements of airport infrastructure and airplanes, both at airports and during take-off and landing operations, as well as during flight. The threat of a terrorist attack at the airport is still a current threat. Terrorists, aiming at the destruction of airport infrastructure or aircraft (both on the ground and in the air), can bring explosive charges to the airport area and to airplanes. They may also seek to abduct a passenger plane to be used to attack from an air on an important, selected object (a government administration building, a large airport). They can also abduct a civilian aircraft, and then use it for a suicide attack on a passenger plane at the airport or in the air. The use of means of destruction to destroy (damage) the infrastructure of the airport or aircraft at the airport during take-off or landing is also not excluded [6].

In 2011–2016, 69 acts of unlawful interference in air transport in the world were recorded, which caused the death of 884 people. Frequently, improvised explosive devices are used to try to attack airport infrastructure, which is why security systems play a key role in containing and detecting threats. In addition, attacks targeting public zones have shown an increasing threat precisely to the places where passengers gather before departure. To reduce the risk of attack in public areas, as well as reduce the number of injuries and damage, many solutions can be applied.

The analysis of the literature and own research shows that the security systems used so far do not ensure consistent solving of problems in the scope of preventing new types of acts of unlawful interference aimed at airport infrastructure.

The subject of the research undertaken within paper refers to problematic related to the new resolution of the international airport security system. Due to new types of threats, that affects not only hard airport infrastructure, but also its soft components, such as departure halls, parking lots or airport hotels, it can be concluded that the security systems used so far, have not been able to effectively and consistently solve problems related to the prevention against new types of acts of unlawful interference against airport's infrastructure.

Airport security checks are no longer static, but dynamic, so that passengers subjected to them can adapt to them. When moving to the "dynamic review", make sure that no visible and static vulnerabilities arise. Therefore, a risk-based system should also contain unpredictable and deterrent elements.

The aim of this research was to analyze the innovative solution of the international airport security system (IASS), taking into account actual operational solutions, as well as current threats and those that may arise in the future, also in the field of new technology.

The research problem was formulated as follows: what is and what determines the security of an international airport?

In reference to the above-mentioned problem, the research hypothesis was defined as follows: the security of an international airport, which aims to ensure sterility of security restricted areas and the protection of public areas, depends mainly on professional competences of security personnel (PCSP), moreover from proper selection and technical condition of electronic assisting devices (TCEAD).

In the solving of mentioned research problem and proving hypotheses, the following research methods were applied: analogy, definition, analysis, synthesis, induction, deduction, modeling and diagnostic tests (interviews and anonymous surveys) amongst groups of aviation experts.

The research was carried out among experts from variety of international organizations, as well as based on anonymous survey taken within airport authorities and security services representatives specialists in Europe and abroad.

The research shows that the law is not always keeping up with the growing threat, and the measures are inadequate to today's risk maps. For this purpose, it is necessary to modify, depending on the needs, some selected infrastructural elements of the airport ecosystem, so that in the most effective and the least costly way (in operational and financial terms) to introduce methods and measures to minimize the possibility of a given threat.

1. New Technology In The Field Of Security Control

1.1. Imaging with millimeter waves

The suspicion of an increased threat posed by the use of explosives and non-metallic weapons has led to the study of new passenger security screening technologies, including techniques for detecting trace amounts of chemical, biological and explosives, and imaging methods that x-ray garments. With each subsequent security system that will be created, you will also need to consider the requirements for additional space required to conduct security controls, equipment, labor costs and increased operational skills that these technologies impose on carriers and airports [2].

For now, several emerging technologies can detect metal and non-metal weapons, explosives and other types of smuggled materials hidden under many layers of clothing. These technologies create images that can distinguish these materials. Physical contact is not needed here [3].

Imaging technologies scan objects, looking for natural radiation that is emitted by the human body (passive imaging), or expose objects to a special type of radiation, reflected by the body (active imaging). In each of these cases, materials such as metal weapons or plastic explosives differ in the background image of the human body because they emit or reflect a different type of radiation than the human body [2].

The images are viewed by a trained operator who can identify the object that is a potential threat. Sometimes this happens with the help of image enhancement software that highlights unusual shapes or any other anomalies [10].

Although these technologies can not detect objects hidden in the body or sewn into the skin, they are considered to be used to perform security checks at airports, as carriers will be able to search passengers for more material than is possible with current systems.

1.2. Other technologies for detecting trace amounts of explosives

Technologies for detecting traces of explosives are based on direct chemical identification of explosives or vapors containing explosives. Thus, the presence of a dangerous object or bomb is inferred from the presence of solid particles or vapors.

The main difference between the technology of detecting traces of explosives and electromagnetic or imaging is that when detecting traces of explosives, a sample of the explosive must be transported to the instrument at a concentration that exceeds the detection limit.

Track detection technology can not be used to detect the presence of metal weapons or any other metal material commonly classified as forbidden to carry on board an aircraft.

Two important steps in detecting traces are collecting the sample and chemical identification. In order to determine the presence of explosives, both steps must work at the same time. The stage of collecting the sample in this procedure is the main point of contact between the technology and the objects being inspected.

Explosive substances can be transported from a given person to the detection device as fumes or solid particles. Originally, the technology of detecting traces of explosives focused on collecting fumes around a person or luggage. However, due to the fact that many modern explosives do not emit too much vapors at room temperature, attention has been paid to explosive particles on the skin and other surfaces. The methodology and technique of the sample preparation procedure is a key element in the effective detection of potential hazards.

In order to detect traces of explosives, they should be collected from the air sample (vapor technologies) or separated from the substrate (molecular technologies). In the case of a vapor test, large amounts of air should be collected, from which a small amount of the substance to be tested should be separated. In the case of a molecular test, the pieces of explosive should be removed from the surface to which they adhere [7].

Both ways of detecting trace amounts of explosives have their strengths and weaknesses, depending on the type of explosive we are looking for.

Vapor technologies are more effective in detecting explosives with high vapor pressure, while molecular technologies are better suited for explosives with low vapor pressure, such as plastic explosives used by the military.

Although the use of hand-held scanners is a potentially effective technique for collecting samples, it requires more work and takes more time than collecting samples using an automated system.

The optimal solution could be to connect a hand-held scanner to an automated system for detecting trace amounts of explosives in order to obtain an additional control system at a higher level.

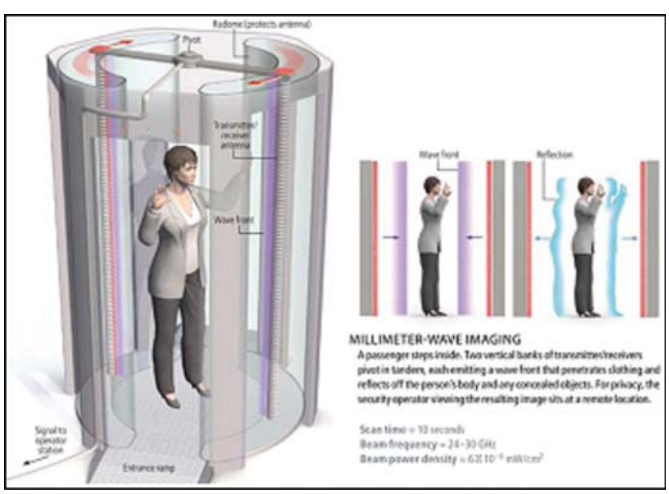

Fig. 1. *Diagram of the Transportation Safety Administration, explaining the basics of the millimeter imaging technology [4, 10]*

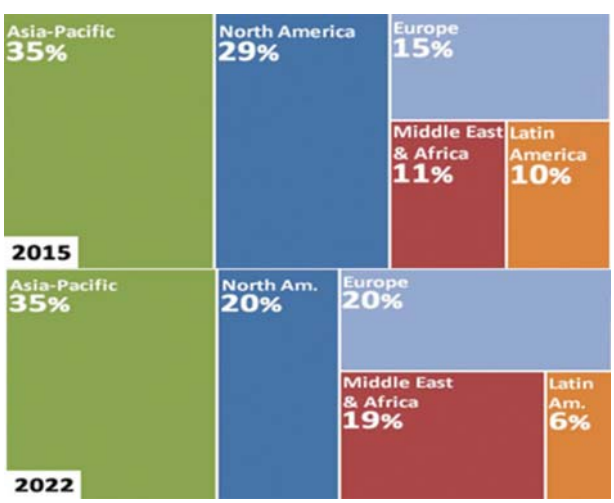

Fig. 2. *Percentage of technology used to detect explosives and drugs using ETD equipment in individual region [8]*

After the terrorist attacks that took place in January 2015 in Paris, it was predictable that the demand for electronic explosive detection systems (ETD - Explosives trace detectors). will increase in the European aviation sector and in the security of public transport, protected buildings, in the group of first-aiders and the public safety sector [8].

2. Results Of Own Empirical Researches

As regards technical equipment of the security control points, the majority of respondents within anonymous survey stated that they are equipped in a good manner, adequate to the existing threats. However, the group of responses also included opinions indicating a certain degree of the lack of adequacy of the technical equipment used to effectively detect current threats.

Four categories of answers were distinguished, of which three clearly indicated the imperfections of the technical equipment. The service malfunctions in new types of equipment and the degree of its modernity have been largely accentuated. In addition, comments that highlighted the financial issues related to the purchase of modern technical solutions and which some airports could not cope with, were not without significance.

Analyzing the results of research in the field of employee competencies, in the light of the effectiveness of explosives detection, it can be concluded that generally given ratings indicated as high and medium level of effectiveness almost equally (Table 1, 2).

Analyzing the problem of detection effectiveness more deeply, research activities were focused on the specification of the same parameter in the context of CBRN threats. The results of the study confirmed low marks for the effectiveness of detecting such threats.

Certainly, the use of modern technologies to detect potential threats is a very important element of the airport security system.

Similarly, elements of technical efficiency of equipment have been assessed as highly important for the correct functioning of the applied technical solutions (Table 4).

The effectiveness of the detection of explosives by the used elements of technical equipment has been determined at a high level, thus giving indications of a high degree of efficiency in the detection of explosives (Table 5).

Analyzing in a more detailed way the specific type of CBRN threats, the respondents rated the elements of the security control points equipment in electronic devices supporting detection, at much lower level.

Table 1. Technical equipment for security control points at international airport

	Possible answer	No	%
1	It is fully adequate to the existing threats	11	9,3
2	It is rather adequate to the existing threats	**88**	**74,6**
3	It is rather inadequate to existing threats	19	16,1
4	It is completely inadequate to existing threats	–	–

Source: own study results.

Table 2. The effectiveness for explosive detection

	Possible answer	No	%
1	High	53	44,9
2	Medium	**54**	**45,8**
3	Low	11	9,3

Source: own study results.

In the author's opinion, currently available technological solutions can radically help in increasing the capacity of control points and optimize the efficiency of personnel, through appropriate use of resources and space, to meet the growing number of passengers and the enlarging terrorist threat.

Table 3. The effectiveness of CBRN threat detection

	Possible answer	No	%
1	High	29	24,6
2	Medium	34	28,8
3	Low	**48**	**40,7**
4	No answer	7	5,9

Source: own study results.

Table 4. The use of the latest technology

Possible answer 1 means the lowest grade, and 5 – the highest rating	No	%
1 The lowest	7	5,9
2 Low	7	5,9
3 Medium	28	23,7
4 High	**52**	**44,1**
5 The highest	20	16,9
No answer	4	3,4

Source: own study results.

Table 5. Technical efficiency status

Possible answer 1 means the lowest grade, and 5 - the highest rating	No	%
1 The lowest	6	5,1
2 Low	6	5,1
3 Medium	17	14,4
4 High	**57**	**48,3**
5 The highest	32	27,1

Source: own study results.

Table 6. The effectiveness of explosive detection

Possible answer 1 means the lowest grade, and 5 – the highest rating	Number	%
1 The lowest	7	5,9
2 Low	9	7,6
3 Medium	23	19,5
4 High	37	31,4
5 The highest	**41**	**34,7**
No answer	1	0,8

Source: own study results.

Table 7. The effectiveness of CBRN threats detection

Possible answer 1 means the lowest grade, and 5 – the highest rating	No	%
1 The lowest	15	12,7
2 Low	30	25,4
3 Medium	**33**	**28,0**
4 High	15	12,7
5 The highest	19	16,1
No answer	6	5,1

Source: own study results.

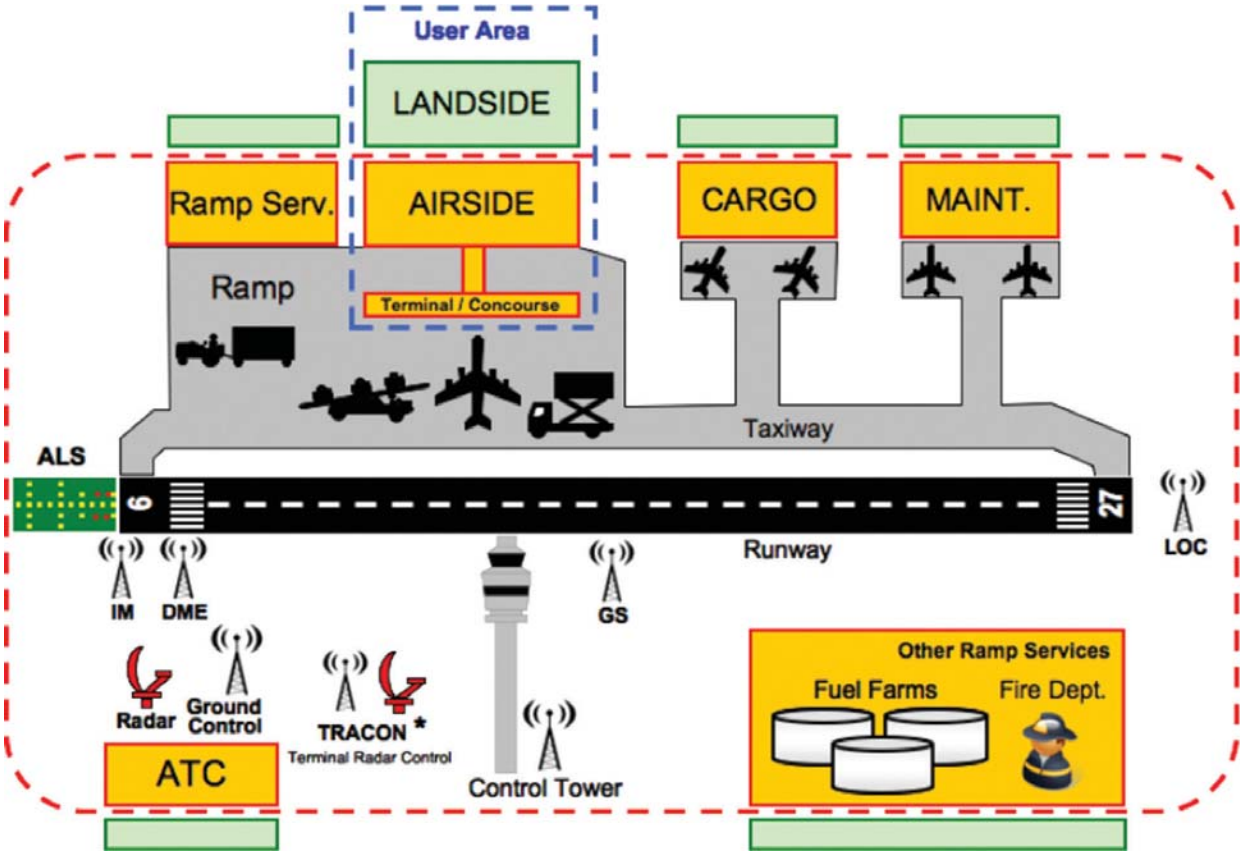

Fig. 3. *The basic layout of airport airside and landside areas [1]*

3. Innovative Solution Of Iass

The following figures very schematically outlined the security concept of an international airport, focusing both on public and restricted areas, as well as on selected elements of technical and personal solutions that can be used, depending on the location of potential threats.

Figure 3 presents the basic layout of landside and airside zones. In addition, the diagram includes the standard distribution of around-aircraft infrastructure such as cargo terminal, ground handling terminal and ATC. Location of main service buildings, including the air terminal is located exactly on the border of the restricted area. Taking the above into account, it is necessary to introduce additional security control procedures in all listed locations - depending on the object of the inspection (passengers, employees, cargo, airport supplies, on-board supplies, etc.). The diagram also includes the approximate arrangement of access control points located inside and outside the terminal.

The presented scheme also includes an element of additional protection of the aircraft, resulting from the Community regulations or individual requirements of an air carrier at a given airport.

Figure 4, in a general way, captures the four most important components of a properly constructed airport security system for public areas. According to the author, the key element is the training and awareness, among all those working within the airport's ecosystem. In addition, the elements related to infrastructure assumptions, video monitoring vehicle and people flow control system are key components affecting the security of airports in the era of today's threats.

In addition, the author of the dissertation undertook to visualize the technical measures used to secure restricted areas (Figure 5).

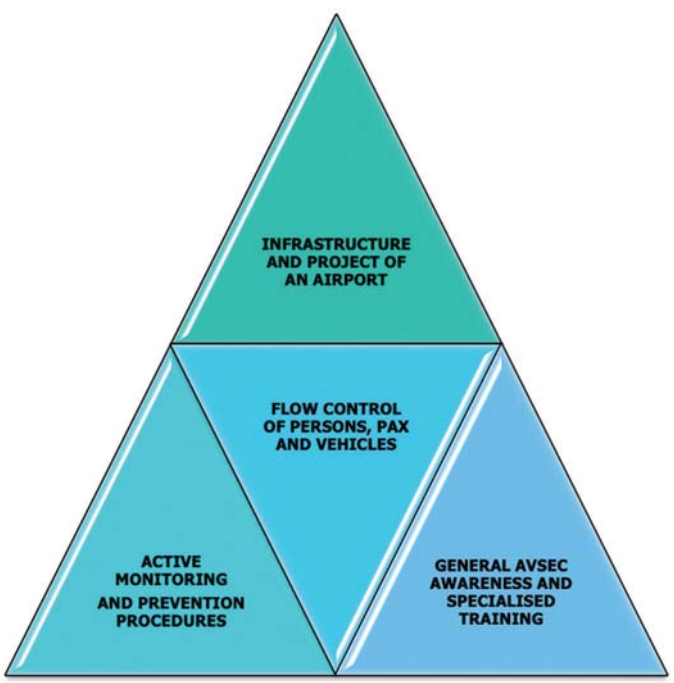

Fig. 4. *Main pillars of the security system of public areas*
Source: own study research graph.

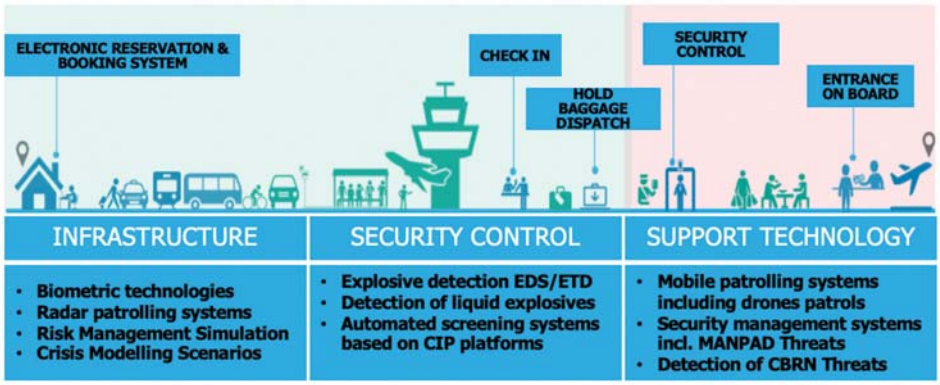

Fig. 5. *Summary of the analysis of technical measures used to secure critical and restricted zones*
Source: own study research graph.

The scheme (Figure 5) proposes a breakdown into security measures and methods used:
- towards the airport's external infrastructure,
- in relation to security control points and,
- for new types of threats such as drones or CBRN threats.

Summarize

The airport terminal condition will change essentially in the coming years. Joined with developing traveler desires and the need to enhance security execution despite a changing worldwide danger, this new environment will prompt a change in numerous strategies. Security will turn into a streamlined procedure dependent on collaboration and information trade.

In the course of the conducted research, it was found that the professional competencies of security personnel are one of the most important elements of the international airport security system and are generally positively assessed by the respondents. In a similar way, the issues of proper selection and technical condition of assistive devices and rescue equipment were positively verified. In the light of the research carried out, it appears that the most important and most difficult elements are still the issues of forecasting and detecting threats. Due to its complexity and unpredictability, this problem still leaves a wide margin for improvement and increasing their effectiveness.

The methodology of the conducted research made it possible to take a much deeper look at the issue of professional competences of employees and the elements related to the proper selection of devices supporting new threats in the world.

The results of the research showed that with regard to CBRN threats, the technical equipment of security control points does not allow for effective detection of such threats. This is an important piece of information for building security control systems, both in relation to critical areas of airports and public areas.

Bibliography:

1. A Morphological Approach for Proactive Risk Management in Civil Aviation Security - 47th AIAA Aerospace Sciences Meeting, At Orlando, FL, January 2009.
2. Air Transport IT Review, All Change at the airport, October 2017.
3. Browne, M., *In search of security: radar scanners that undress people*, The New York Times. May 5, 2014.
4. Concept of future technology in CCTV cameras that detects criminal and terrorist attacks. Gotrend Technologies International. March 12, 2016 by Prasad.
5. Director general's report on the global air transport industry. IATA, 5 June, 2017.
6. Dolnik, A., *Understanding Terrorist Innovation: Technology, Tactics and Global Trends*, June 26, 2009 by Routledge.
7. Elias, B., *Airport and Aviation Security: U.S. Policy and Strategy in the Age of Global Terrorism*, September 14, 2009 by Auerbach Publications.
8. ETD Market Size, Share and Trends Analysis Report, March 2018, Grand View Research.
9. Nowacki G., Olejnik K, Woźniak G., *Analiza zagrożeń terrorystycznych dla sektora transportu lotniczego*, „Logistyka" 2015, nr 4.
10. Working Knowledge: Body Scanners – Weapons Revealed, Scientific America 2017.

Nowe technologie w zakresie zapewnienia bezpieczeństwa dla stref zastrzeżonych i ogólnodostępnych na lotniskach

Artykuł dotyczy zastosowania nowych technologii w zakresie bezpieczeństwa na międzynarodowych lotniskach, biorąc pod uwagę aktualne wyzwania związane z odprawą pasażerów, ochroną krytycznych i ogólnodostępnych stref, w świetle aktualnych poważnych zagrożeń. Jednym z głównych powodów, dla których lotnictwo jest jednym z najbardziej uregulowanych środków transportu w sensie bezpieczeństwa, jest fakt, że nadal występują poważne zagrożenia i podatność na ataki terrorystyczne. Liczba incydentów i naruszeń w międzynarodowym środowisku bezpieczeństwa lotniczego, aktualizowana jest niemal codziennie, na całym świecie. Dlatego główną rolą wszystkich podmiotów regulacyjnych i zawodowych w lotnictwie, jest skuteczna ochrona różnorodnych ekosystemów lotniczych, takich jak lotniska i linie lotnicze. Aby sprostać wyzwaniom związanym z restrykcyjnymi przepisami w zakresie bezpieczeństwa i rosnącą liczbą pasażerów, a także aby być na bieżąco z najnowszymi strategiami antyterrorystycznymi, lotniska poszukują nowych rozwiązań w tym zakresie. Takie rozwiązania opierają się przede wszystkim na elektronicznym wdrażaniu nowych rodzajów urządzeń mających na celu poprawę wykrywania materiałów stanowiących zagrożenie, ze szczególnym uwzględnieniem materiałów wybuchowych i zagrożeń CBRN. W ramach tego artykułu zaprezentowano kluczowe elementy technologiczne wspierające wykrywanie zagrożeń, a także wskazano główne punkty odnoszące się do ogólnej percepcji wśród systemów bezpieczeństwa lotnisk.

Słowa kluczowe: zagrożenia, zaawansowana technologia, system bezpieczeństwa.

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