

2. NONMILITARY SECURITY

SELECTED ASPECTS OF HAZARD ANALYSIS IN THE AIR TRANSPORT OF HAZARDOUS MATERIALS

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ABSTRACT

While considering the issue of the air transport safety, special attention should be given to projects related to air transport of hazardous materials, which occupy an increasingly important position in the global air transport. The authors conducted the analysis of selected aspects of security aiming at the minimization of the risks occurring during transportation of hazardous materials. Nevertheless, the main subject of research is a human factor and its impact on the possibility of occurrence of flight events involving hazardous substances and objects. As a result of the analysis, the main reasons for flight events caused by air transport participants were presented and discussed. The examples illustrate the gaps and shortcomings in the transport procedures for these materials. These procedures should be updated from time to time by the knowledge acquired through the experience of the occurrence of bad or irregular shipments of hazardous goods.

KEY WORDS

Air transport, hazardous materials, human factor, incidents in air transport, ICAO Technical Instructions.

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Introduction

It should be noted that so far no one has tried to address the problems of air transportation of hazardous substances and items in the context of other phenomena and processes, such as the protection and defence of airport infrastructure, the sanitary – epidemiological conditions, technical design solutions and, above all, the location of threats caused by chemicals, radioactive substances and biological agents in the national security system. The main focus of the article is to fill this gap. In addition, it is

worth mentioning that so far in Poland, no one has developed the work discussing the conditions of air transportation of hazardous materials which would exceed the volume of the article [Kucharek, 2016, p. 31].

Significant limitations are also present within the existing regulations, used for the air transportation of dangerous goods. On the basis of the work carried out by international aviation authorities, regarding the safe transportation of hazardous materials, the Annex 18 to the Convention on Interna-

tional Civil Aviation (Chicago Convention, 1944) and the associated Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions) were prepared. Air carriers also apply the rules concerning the transport of dangerous goods in the international air transport (IATA Dangerous Goods Regulations), which are called ICAO Technical Instructions “field manual”, as they represent almost the exact translation. Hazardous materials are transported by air on the basis of one of the above statements, which only define the procedural provisions of carriage. Direct translation of voluminous (about 1200 pages) ICAO Technical Instructions from English language makes the regulations difficult to understand and expressions included are vague causing further blur of the essence of the rules contained. The most important drawback of the existing ICAO Technical instructions is their lack of adaptability and imprecision, in addition, the rules are not supported by the examples of their practical use in the transportation of hazardous materials. In many cases, it narrows down only to the technical indication of the applicable rules of conduct. For this reason, it was necessary to prepare a publication that discusses not only the issue of safety in transportation of hazardous substances and objects, but also containing an analysis of the existing solutions in terms of ensuring the safety of human life and health and the environment. Therefore, it become essential to investigate scientific and journalistic research and applicable laws, including legislative and non-legislative materials regarding the issues of transportation of hazardous materials. They allow for identifying a wider range of conditions leading to the creation of the rules, but they mainly indicate the level of the existing legal safeguards, as well as organizational, technical and procedural measures, designed to minimize the risks involved.

The main objective of research was to identify the risks in the air transportation of dangerous goods, which in extreme cases can destabilize national security. An important outcome of the study was the presentation of multiple factors of the greatest importance in determining the safety of air transportation of hazardous materials. The variety of existing threats and their evolution require from the national security system to be capable of immediate and comprehensive response to emerging threats. The response should include operations carried out both locally and throughout the country or even in the cross-border projects. Therefore, the existing security system must always be transformed in a way, which allows to monitor and accurately predict potential threats. If a problem occurs, it is essential to respond in prompt and adequate manner, creating further ability to remove the effects of its existence. The mentioned scope of the National Defence threats prevention should also include many air events involving hazardous materials. The occurrence of an air event as a result of which infectious biological agents, as well as radioactive substances or toxic chemicals escape into the environment, could lead to a crisis on a scale, which would require undertaking actions by the highest state organisations.

Analysis of the undertaken research subject revealed that technological progress in terms of the aircraft construction allows the transportation of a constantly increasing number of passengers and amount of cargo. Nowadays, the airspace creates specific conditions for flying, but by helping to increase air transport capabilities, it also becomes a place where dangerous air accidents can occur. Unfortunately, this happens in a situation when we are experiencing more and more threats that may affect the level of national security. Moreover, when considering the issue of ensuring

transport safety, the existence of specific threats related to air carriage of hazardous materials should be noted, as they occupy an increasingly important position in the global air transportation.

A human factor

Dangers involved in the transport of hazardous materials are a significant problem for cargo carriers. Frequently in the air transportation history the errors associated with human factors, in particular the failure to comply with procedures for the transport of hazardous materials, were followed by tragic plane crashes. One of many reasons that lead to unfortunate consequences is that uncontrolled chemical reactions during transport may occur. The list of hazardous materials include, for example, substances which, under favourable environmental conditions, e.g. by the release of oxygen, can contribute to the combustion of other material, automatically start a fire, and damage or destroy the transported cargo and means of transport. Despite introducing regular updates to procedures contained in the ICAO Technical Instructions, monitoring procedures of transportation and the introduction of better security systems used in the packaging, tragic accidents still occur from time to time.

A large number of projects, which should be carried out in connection with the transportation of hazardous materials, may increase the likelihood of flight events involving dangerous substances and materials. In the above situation, it is necessary to conduct systematic research, in order to analyse the functioning of air transport in terms of conditions related to the transport of hazardous materials. What is more, ensuring the safety of air transport is the most crucial objective of flight performed in the airspace. For this reason, all the institu-

tions involved in the operation of air transport aiming at achieving and maintaining a high level of safety regardless of the existing economic, environmental or social conditions [Kucharek, 2014, p. 116].

The necessity of using specific procedures in transportation may be neglected by some, nevertheless their usefulness can be proven by some air plane crashes in the past, the reasons for which were associated with the transportation of hazardous materials on board. A few examples from the aviation history (some of them included casualties) can be presented in order to confirm an existence and types of threats [Air Accident, 2005, p. 204].

Firstly, in November 1973 Boeing 707-321C, Pan American World Airways airline transported 24 tons of cargo from New York to Glasgow, of which nearly 7 tons were chemicals. During the flight, pilots felt smoke in the cockpit, which thickened, preventing the crew from operating the aircraft. The plane was sent to the airport in Boston, where it crashed during the landing approach. The direct cause of the crash, which killed three pilots, was most probably the leak of nitric acid.

Another incident which took place in May 1996 was one of the most tragic of aviation accidents recorded ever. The disaster, which caused the death of 110 passengers and crew members, was associated with the transportation of dangerous goods by passenger plane. The accident occurred shortly after take-off from the airport in Miami. The crew lost the ability to control the aircraft due to lack of power supply necessary for on-board equipment. DC9 aircraft owned by ValuJet Airlines, crashed in the swamps near the airport. The investigation revealed that the cause of the accident was a fire that damaged electric installations in the luggage compartment of the aircraft. Ignition of the fire was due

to improper security of oxygen generators belonging to the ValuJet Airlines [Paquette, 2011, p. 2].

In February 2006, just as in the previous example, the accident occurred at the board of freight plane DC8 belonging to the UPS shipping company during a flight to Philadelphia. During the landing approach, crew reported smoke and fire in the cargo compartment. Fortunately, a short distance from the airport and the small size of the fire saved the plane. The crew managed to land and emergency services immediately took charge of extinguishing the fire. The investigation presented no clear causes of the fire, although the evidence indicated that a fire could occur as a result of a chemical reaction that occurred in lithium-ion batteries carried on that plane.

In September 2007, Boeing 747 (cargo) owned by the UPS shipping company, flying from Dubai to Cologne crashed. The first signs of danger occurred shortly after take-off when the pilots received a signal from the smoke detectors about the appearance of smoke in the cargo space. The plane immediately turned around, however, about 17 km from Dubai International Airport, the machine hit the ground. The crash killed two crew members. The investigation found that the direct cause of the disaster was a large number of lithium-ion batteries, transported together with other flammable materials [Air Accident, 2010, p. 204].

Table 1. Number of events whose causes were associated with transportation of hazardous materials on board in the USA between 1990 and 2012

	1990	2000	2010	2011	2012
Air Transport	297	1 419	1 294	1 400	1 460
Road transport	7 296	15 063	12 652	12 810	13 241
Rail transport	1 279	1 058	749	745	662
Water transport	7	17	105	71	70
Total	8 879	17 557	14 800	15 026	15 433

Source: Freight Facts and Figures 2012, US Department of Transportation, Washington 2013, p. 65.

The cases of unfortunate aircraft events mentioned above are some of the most tragic accidents in the last half-century. Nevertheless, air accidents are rare, despite the growing number of aircraft carrying hazardous materials. Instead, the incidents and serious incidents are more frequent and least dangerous. Information on the number of incidents in the transport of hazardous materials is presented in Table 1. They cover all air events that took place in the period between 1990 and 2012. As all incidents regarding different means of transportation were documented by the US Department of Transportation (DOT), an overall upward trend in the number of incidents occurred in the transportation of hazardous materials can be seen. In the years 1990-2012 the number of incidents with hazardous materials nearly doubled. According to the data contained in the table, most of the incidents and their largest gain in absolute terms, was in road transport. This situation is undoubtedly an outcome of enormous quantities of hazardous materials transported by road vehicles.

However, a large increase in the number of incidents in air transport should be highlighted, as in the analysed period, it raised from 297 in 1990 to 1 460 in 2012. A significant increase in the number of incidents in the transport of hazardous materials cannot be explained solely by the expansion of carrying capacity and number of freight planes, which transport hazardous substances and objects. The number of recorded incidents is largely influenced by stringent obligations imposed on operators that require them to inform the institutions responsible for the safety of air transport about even the smallest event. For example, according to the ICAO Technical Instructions, the operator must inform the competent authorities of any finding of undeclared or incorrectly declared dangerous

goods in cargo or mail. The operator must also report any cases of detection of hazardous materials in the check in luggage or baggage located in the close surrounding of the passengers or crew members [Technical Instructions, 2014, p. 7-4-4].

Nevertheless, in recent years, the number of events recorded in aviation has not changed rapidly (see. Table 1). This is confirmed by The UK Civil Aviation Authority, which claims constant number of incidents reported in the UK. Observed changes occur only in the causes that directly affect the occurrence of incidents. On the basis of recorded notifications, the fundamental causes of incidents in the air transport of hazardous materials were categorised. In percentage terms, they are as follows [International Fire]:

- undeclared/misdeclared - 40%
- packaging errors - 10%
- spillages/leakages - 10%
- mishandling/misleading - 15%
- passenger originating - 25%

Following the analysis regarding the causes of the events in the transport of hazardous materials by air, the areas of responsibility were also examined. It should, of course, be noted that the above reasons for the occurrence of incidents resulted mostly from the mistakes made by the human factor. This statement is supported by the results, which clearly indicated that the recorded air events, in percentage terms, were caused by:

- shippers - 50%
- operators - 25%
- passengers - 25%

Conducted analysis indicates the causes of incidents and present areas of responsibility, clearly illustrating that the lack of a declaration for transporting dangerous materials was the most common reason for the occurrence of incidents. On the other hand, the fact that shippers were mainly

responsible for incidents only shows their important role in organizing the transportation of hazardous materials. Shippers are responsible for the proper preparation of cargo for transport. This involves using packaging appropriate to a threat posed by cargo, marking the package (packaging, transport container), the organization of cargo protection and preparation of transport documents. High responsibility leads to a possibility of making mistakes, which are then classified as airline incidents. Moreover, the significant role of passengers in initiating situations should be noted. Such accidents are also classified as incidents involving hazardous materials. High overall impact of passengers is a direct result of their huge number, combined with low awareness of the risks involved, and sometimes even disregard of the applicable procedures.

Conclusion

The analysis of the causes of the events in the transport of hazardous materials, allows for a more complex visualization of conditions influencing the occurrence of hazards in air transport. For substances whose properties pose a threat to human health and life, as well as the environment, transport provides opportunities for uncontrolled discharge into the surrounding. During the transportation of hazardous materials, a high probability of packages, packaging or transport containers (used for transportation of chemical, biological or radioactive materials) leakage might occur. As a result of the analysis of the factors which have the greatest impact on the safety of air transport of hazardous materials, it is possible to find a wide range of threats that may contribute to the occurrence of aviation events.

For example, they can cause structural defects of aircraft. The solution may be

extending the period of trial operation for structures used for air transport of hazardous materials. Design imperfections are the basic structural flaws of the aircraft, what is more, they have a direct impact on the safe performance of the flights. Most construction errors are removed at the testing stage, nevertheless "young designs" are often characterized by a high faults frequency, even in the time of its commercial exploitation. An example of a high failure rate of newly constructed aircraft, affecting the safety of passengers and freight, was the implementation of the Boeing 787 Dreamliner. The first Dreamliners commercial flights often ended with long delays or forced machines replacements both caused by technical failures. In the initial phase of their operation, most of the problems resulted from the failure of the system power supply, especially problems with batteries. Although the aircraft underwent constant technical inspections conducted by the producers, they did not solve existing problems. A significant threat to the safety of passengers was presented during an event in September 2013, when a failure of identification system occurred. Boeing 787, flying from Canada to Poland, had to make an emergency landing in Glasgow, where technical faults detected were removed. However, the usage of similar aircraft for the transport of hazardous materials creates a higher probability of air events occurrence. By analyzing the events including the airplanes freshly introduced into service, additional risks for the transport of dangerous substances and objects were highlighted. They are caused by a combination of at least two reasons, namely the essence of transportation of hazardous materials and high faulty ratio of aircraft just introduced to the operation.

Referring to the overall content of the analysis in the article, the authors showed

the cause of the error made by people, in terms of total actions taken to reduce the number of flight events involving hazardous materials. Reasons that may occur include a human error, which has the greatest influence on the formation of threats and leads to incidents or even accidents involving hazardous materials. This refers to the unintentional behaviour of flight crew and passengers, as well as the people responsible for the safety of flight operations and people operating in the field of aviation security. Moreover, terrorist attacks using chemical, radioactive or biological infectious agents have a significant influence on events in aviation. Therefore, despite the technological development of airplanes and packaging used for transportation of hazardous materials, the main action as a result of which the level of air transport safety will be systematically rising, should be aimed at increasing the skills, awareness and competence of people.

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