

5. SECURITY STUDIES

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

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ABSTRACT

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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 of this article undertook the analysis of selected aspects of security aiming at 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 dangerous substances and objects. As a result of the analysis the main causes of flight events caused by air transport participants were indicated 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 dangerous goods.

KEY WORDS

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

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Introduction

It should also be noted that so far no one tried to grasp the problems of air transportation of dangerous substances and items in the context of other phenomena and processes, such as 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 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 International 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. Air transport of hazardous materials are conducted 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 existing ICAO Technical instructions, is their lack of adaptability and imprecision, in addition the rules are not supported by 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 treats not only about the issue of safety in transportation of dangerous 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 researches and applicable laws, including legislative and non-legislative materials regarding the issues of transportation of hazardous materials. They allow to identify a wider range of conditions leading to creation of the rules, but 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 the research was to diagnose 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, comprehensive response to emerging threats. The response should include operations carried out both in the local and all over the country scope or even 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. In case of problems occurrence, it is essential to respond in prompt and adequate manner, creating further ability to remove the effects of its' existence. Mentioned scope of the National Defence threats prevention, should also include many air events involving hazardous materials. Occurrence of an air event as a result of which infectious biological agents, as well as radioactive substances or toxic chemicals will escape into the environment, could lead to a crisis on a scale, which would require undertaking an actions by the highest state organisations.

Analysis of the undertaken research subject revealed that technological progress in terms of the aircraft construction allows transportation of 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 have a bearing on 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 a result of occupying an increasingly important position in the global air transportation.

The human factor

Danger involved in the transport of hazardous materials is 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 with tragic plane crashes. One of the many reasons that lead to unfortunate consequences, is the possibility of occurrence of uncontrolled chemical reactions during transport. 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, the tragic accident still occurs 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 institutions involved in the operation of air transport, are 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 use of specific procedures in transportation may be neglected by some, nevertheless the usefulness of them can be confirmed by highlighted some of the air plane crashes occurred in the past, which causes were associated with transportation of hazardous materials on board. Few examples from the aviation history (some of them included casualties) can be presented in order to confirm existence and types of threats [Air Accident, 2005, p. 204].

Firstly, in November 1973 years Boeing 707-321C, Pan American World Airways airline transported from New York to Glasgow 24 tons of cargo, 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 he crashed during landing approach. The direct cause of the crash, which killed three pilots, was most probably leaking 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 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 shipping company UPS, on a flight to Philadelphia. During the approach to land, 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 shipping company UPS, flying from Dubai to Cologne, has 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. As a result of the investigation found that the direct cause of the disaster were large amounts of lithium-ion batteries, transported together with other flammable materials [Air Accident, 2010, p. 204].

Table 1. Number of events which causes were associated with transportation of hazardous materials on board in 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
Railtransport	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, belong to the most tragic 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, are presented in the Table above. They cover all air events that took place in the period 1990-2012. As a result of documenting all incidents regarding different means of transportation, conducted by the US Department of Transportation (DOT), an overall upward trend in the number of incidents experienced 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 numbers of incidents in the transport of hazardous materials cannot be explained solely by expansion of carrying capacity and number of freight planes, which transport hazardous substances and

objects. The biggest impact on the number of recorded incidents have stringent obligations imposed on operators that require them to inform the institutions responsible for the safety of air transport, about even the small 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 undergone rapid changes (see Table). This is confirmed by The UK Civil Aviation Authority, which claims constant number of incidents reported in the UK. Observed changes occur only between the causes that directly affect the occurrence of incidents. On the basis of recorded notifications, the fundamental causes of incidents in air transport 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 causes of the events in the transport of hazardous materials by air, the investigation of areas of responsibility was also carried. It should of course be noted that the above listed 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 indicate 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 an incidents, only present their important role in organizing the transportation of hazardous materials. The shippers are responsible for the proper preparation of cargo for transport. This involves: using packaging appropriate to the threat posed by cargo, marking the package (packaging, transport container), organization of cargo protection and preparation of transport documents. High responsibility leads to possibility of committing errors, 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 of passengers, 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 which properties create 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 high possibility of packages, packaging or transport containers (used for transport

tation 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 aircrafts. 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 the "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. 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 detected technical faults were removed. However, the usage of similar aircraft for the transport of hazardous materials creates higher probability of air events occurrence. By analysing the events including the airplanes freshly introduced into

service, I have highlighted additional risks for the transport of dangerous substances and objects. They are caused by 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 this article, the author pointed out the cause of the error committed by the human factor, in terms of total actions taken to reduce the number of flight events involving hazardous materials. Among the reasons that may occur, it is human error, which has the greatest influence on the formation of threats and lead 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. What is more, terrorist attacks using chemical, radioactive or biological infectious agents has a significant influence on events in aviation. Therefore, despite 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 raising, should be aimed at increasing the skills, awareness and competence of the human factor.

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