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Analysis of Accidents Resulting from the Interaction of Air and Ground Vehicles at Airports

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Abstract

The analysis of the causes and consequences of accidents resulting from the interaction of air and ground vehicles at airports is presented in this paper. The data on accidents involving the following aircrafts were taken into account: airplanes, helicopters and unmanned aircrafts; the ground vehicles included: fuel tankers, cars, snow plows, pushback tractors and other vehicles operating at the airport. As a basis for the analysis, data on eleven such accidents that occurred at the airports of a number of countries in the period from 2000 to 2021 were used. The analysis of what types of ground and aircrafts were involved in the accidents is made. When studying the main and associated causes of accidents, the actions of all participants in traffic control at the airport (operators of ground vehicles, aircraft pilots and air traffic control officers) were analyzed. In addition, the impact of complex meteorological conditions (snow, fog, heavy rain, etc.) limiting visibility was analyzed. The classification of accidents is carried out in accordance with the level of danger of their consequences. At the final stage, possible ways to reduce the risk of such events in the future are discussed.

Keywords: Aircrafts; land vehicles; airport; interaction; accident

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1. Introduction

At modern airports, tens of thousands of air vehicles and hundreds of thousands of ground vehicles are constantly interacting. This interaction is primarily aimed at servicing aircrafts, including refueling, loading or unloading cargo (baggage), maintenance, security, delivery of passengers and crew to the aircraft, etc. The vehicles involved in this process are grouped in Table 1.

Table 1. Vehicles interacting at the airport. Source: Compiled by the author.

Ground vehicles	Air vehicles
Buses for the delivery of crew and passengers	Aircrafts
Aviation security vehicles	Helicopters
Pushback tractors	Unmanned aircraft (UA)
Special vehicle – self-propelled snow cutter	
Passenger boarding steps vehicle	
Tanker vehicles	
Water trucks	
Vehicles for transportation of baggage and cargo to airplanes (from airplanes)	
Belt loaders for loading baggage and cargo onto the plane	
Catering service vehicles	
Vehicles with devices for warming up / air conditioning the airplane while parked	
Fire trucks	
Ambulances	
Aircraft de-icing vehicles	
Mobile sources of electricity	

One of the main tasks in organizing the interaction of air and ground vehicles at airports is to ensure the safety of this process.

The safety of interaction between air and ground vehicles primarily implies protection against emergency collisions of air and ground vehicles (accidents), the consequence of which may be not only damage to vehicles, but also a plane crash. An example of such events is the plane crash on the runway of the Tomsk airport that occurred in 1984 (Airplane vs car, 2014). The landing plane collided with three snow plows on the runway. The crew, passengers and operators of ground vehicles died, the plane and three snow plows were completely destroyed. In total, 178 people died in this plane crash.

The consequences of collisions of air and ground vehicles should also include disruptions in the operation of the airport arising from such events. For example, according to the estimates presented in the work (Lykou et al., 2020), one hour of downtime for such an airport as Newark Airport in New Jersey is estimated at USD 1M per minute (Newark is one of the three main airports serving New York City and the surrounding region (Newark Airport Traffic, 2019)).

Also, the consequences of collisions between aircrafts and ground vehicles can be attributed to the violation of the traffic schedule of other aircrafts moving through the airport in which the accident occurred.

Significant losses for the airline may arise due to the damage to the airliner resulting from a collision with a ground vehicle at an airport that does not have a service (repair) infrastructure (base) capable of eliminating the damage. If the damage received in the accident does not allow the airliner to fly to the place of repair, the airline will have to organize ground transportation of the airliner to the place of repair, or organize the transportation of the necessary service (repair) infrastructure to the location of the airliner. For example, in accidents (PICTURES: El Al 747, 2007; Van comes off slightly, 2016), the engines of the airliners were damaged (Figure 1). In case of such damage, the airliner will no longer be able to perform an independent flight to the place of repair work.

Fig. 1. Accident at Gdansk airport (https://www.avianews.com/incidents/2021/01/08/wizzair_plane_car_collision_at_gdansk_airpor t/).

Accidents at airports involving air and ground vehicles as classified by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) fall into the following categories: Ground Safety (GS), Operational Damage (OD), and Runway Safety (RS).

ICAO and IATA periodically submit safety reports (ICAO Safety Report, 2020; Runway Safety Accident Analysis Report, 2020), including data for Ground Safety, Operational Damage, and Runway Safety. However, the data presented in the ICAO and IATA reports do not contain detailed information on how many accidents involving air and ground vehicles occurred. The presented data reflect the generalized statistics for the GS, OD and RS categories (Figure 2).

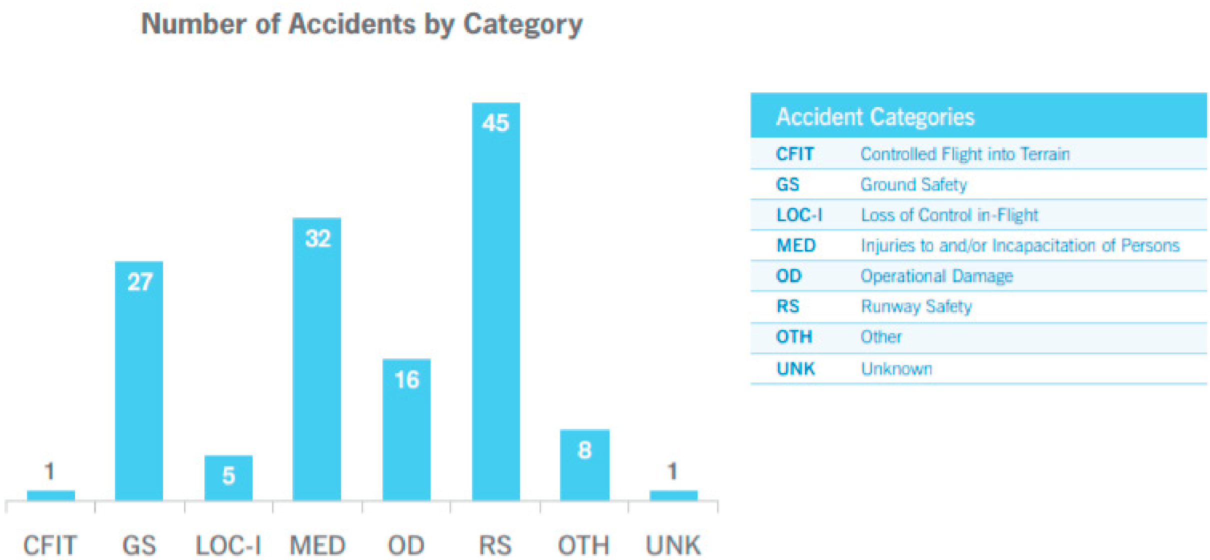

Fig. 2. Breakdown of accidents by harmonized category (ICAO Safety Report, 2020).

For the analyzed period of time, only a few references concerning the problem of accidents involving air and ground vehicles were found in the well-known scientific databases (Scopus, Web of Science), specifically (Alomar and Tolujevs, 2017; D'yachenkova et al. 2020; Wilke et al., 2014; Calle-Alonso et al., 2019; Price & Forrest, 2016). Basic information about such incidents is presented in Internet resources (Boeing, 2017; The information, 2021). It can be concluded that a detailed analysis of the causes and consequences of accidents resulting from the interaction of air and ground vehicles at airports will mostly fill this gap.

2. Analysis of the causes and consequences of accidents involving air and ground vehicles

To analyze the causes and consequences of accidents involving air and ground vehicles, data on eleven accidents that occurred during the interaction of passenger aircraft and ground vehicles at airports in different countries of the world in the period 2000-2021 were used (table 2).

It should be noted that data on similar accidents involving helicopters and unmanned aircrafts for the specified period of time were not found in open information sources. At the same time, in the works (Shvetsova and Shvetsov, 2020; Barrado et al., 2020; Shvetsova and Shvetsov, 2021; Pérez-Castán et al., 2019; Huttunen, 2019; Davies et al., 2021), a high potential threat of accidents involving unmanned aircrafts and ground vehicles is noted in the future, when UAs are allowed to fly at civil airports. Nowadays, UAs flights over the territory of airports are still prohibited in most countries of the world.

Table 2. Airport accidents involving ground and aircrafts. Source: Compiled by the author.

Aircraft type	Ground vehicle type	Year	Airport	Vehicle damage	Injured /Dead	Airport disruptions
Airbus A320	Water transport vehicle	2021	Gdansk airport (Poland)	The plane and the tanker were damaged.		
Airbus A321	Fuel tanker	2020	Sheremetyevo airport (Moscow, Russia)	The plane and the tanker were damaged.		
Airbus A320	Pushback tractor	2017	Dublin Airport (Sweden)	The right engine of the aircraft was damaged. The pushback tractor received damage to the body.		Yes
Airbus A320	Aviation security vehicles	2017	Alicante airport (Spain)	The right engine of the aircraft was damaged. The body of the ground vehicle was significantly damaged.		Yes
Boeing 767	Pushback tractor	2017	Bangkok Airport (Thailand)	The right engine of the aircraft was damaged. The pushback tractor received damage to the body.		Yes
Airbus A330	Catering service vehicles	2016	Hong Kong airport (China)	The left engine of the aircraft was damaged. The ground vehicle was completely destroyed.	1/0	Yes
Airbus A320	Aviation security vehicles	2015	King Abdulaziz Int ernational Airport (Jeddah, Saudi Arabia)	The right engine of the aircraft was damaged. The ground vehicle was completely destroyed.	2/0	Yes
Falcon 50EX	Special vehicle – self-propelled snow cutter	2014	Vnukovo airport (Moscow, Russia)	The plane was completely destroyed. The ground vehicle was completely destroyed.	0/4	Yes

Boeing 747	Pushback tractor	2010	JFK Airport (New Jersey, USA)	The plane was damaged. The pushback tractor was significantly damaged.		
Boeing 737	Special vehicle – self-propelled snow cutter	2007	Henri Coanda Inter national Airport (Bucharest, Romania)	The plane was completely destroyed. The ground vehicle was completely destroyed.	3/0	Yes
Boeing 747	Pushback tractor	2007	Paris Charles de Gaulle airport (France)	The right engine of the aircraft was damaged. The body of the pushback tractor was significantly damaged.		Yes

Analysis of the causes of collisions (Table 2) is presented in Table 3.

Table 3. Causes of collisions. Source: Compiled by the author.

Airport accidents	**Erroneous actions (inaction) of the air traffic control officer**	**Erroneous actions (inaction) of the airline pilot**	**Erroneous actions (inaction) of the ground vehicle operator**	**Difficult meteorological conditions (snow, fog, heavyrain, etc.) limiting visibility**
Gdansk airport (Poland)			•	
Sheremetyevo airport (Moscow, Russia)			•	
Dublin Airport (Sweden)		•		
Alicante airport (Spain)		•		
Bangkok Airport (Thailand)			•	
Hong Kong airport (China)		•		
King Abdulaziz International Airport (Jeddah, Saudi Arabia)		•		
Vnukovo airport (Moscow, Russia)	•		•	•
JFK Airport (New Jersey, USA)		•		
Henri Coanda International Airport (Romania)	•	•	•	•
Paris Charles de Gaulle airport (France)		•		

The analysis of which vehicles are most often involved in accidents is carried out in Figure 3.

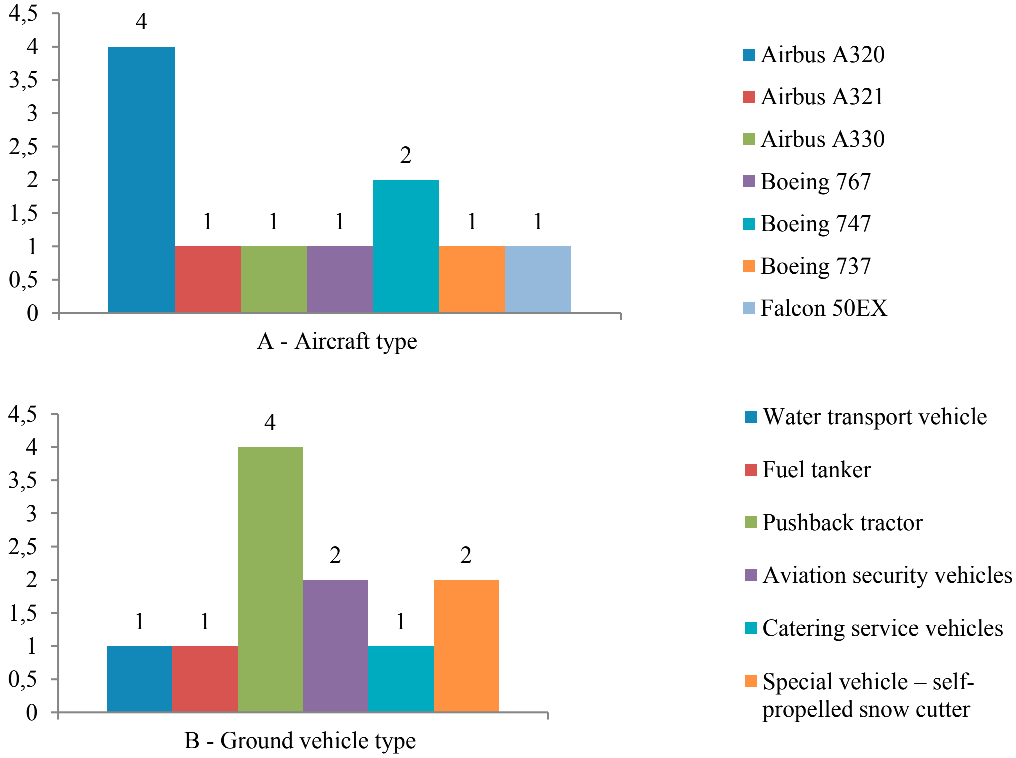

Fig. 3. Frequency of vehicle involvement in accidents: A – Aircraft type; B – Ground vehicle type. Source: Compiled by the author.

Accidents at airports involving air and ground vehicles can be classified according to the severity of their consequences (Figure 4).

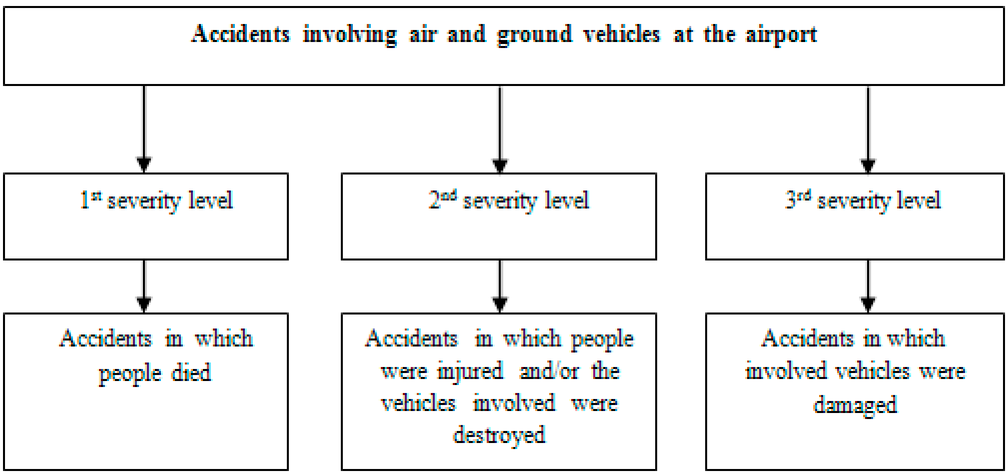

Fig. 4. Accident severity levels. Source: Compiled by the author.

Accidents at airports (Table 2) are distributed according to the severity level of their consequences as follows (Table 4).

Table 4. Distribution of accidents involving air and ground vehicles at airports by the severity level of their consequences. Source: Compiled by the author.

Airport accidents	1st severity level	2nd severity level	3rd severity level
Gdansk airport (Poland)			•
Sheremetyevo airport (Moscow, Russia)			•
Dublin Airport (Sweden)			•
Alicante airport (Spain)			•
Bangkok Airport (Thailand)			•
Hong Kong airport (China)		•	
King Abdulaziz International Airport (Jeddah, Saudi Arabia)		•	
Vnukovo airport (Moscow, Russia)	•		
JFK Airport (New Jersey, USA)			•
Henri Coanda International Airport (Romania)		•	
Paris Charles de Gaulle airport (France)			•

3. Discussion and Conclusion

This paper analyzes of accidents resulting from the interaction of air and ground vehicles at airports.

The data presented in Table 2 indicate that accidents occur regularly in different countries and on different continents.

Considering that the consequences of such accidents are not only damage to vehicles, but also plane crashes, this problem needs a comprehensive study in order to develop solutions that will prevent such events in the future.

According to the analysis carried out in this work, the main reasons for 100% of considered accidents (Table 3) were erroneous actions of traffic control participants at the airport, including 45% due to of the actions of operators of ground vehicles, 77% due to of the actions of airline pilots, and 18% due to of the actions of air traffic control officers. The associated causes of 18% of the accidents were difficult meteorological conditions: snow, fog and high speed of aircrafts at the time of collision

Analyzing which ground vehicles became participants in accidents (Figure 3), we see that a tanker, a tractor, a self-propelled snow cutter and other vehicles were involved in collisions.

Considering possible ways to reduce the risk of accidents, we can conclude that one of the possible ways to reduce the risk of such events in the future, primarily collisions of an aircraft in a state of takeoff and landing with a ground vehicle, is to block the possibility of unauthorized entry of the ground vehicle to the runway. For example, due to the use of blocking devices that rise at the time when exit is prohibited.

A way to reduce the risk of an accident when maneuvering an aircraft and a ground vehicle in one place (point) is to inform the pilot/operator about the approach to a ground vehicle/aircraft outside of its view (in the blind zone). One of the possible ways to solve this problem may be the development and equipping of aircraft and ground vehicles with an integrated computer vision system that implements the function of monitoring blind spots and informing the pilot/operator about the beginning of the approach and its parameters (distance in meters/centimeters between vehicles).

Considering the practical applicability of the data presented in this work, we can say that it can be used in the development of methods, as well as technical means and systems for ensuring traffic safety at the airport.

The data of this study may also be of interest to decision-makers in the field of organization and management of traffic at airports, as well as in the field of flight safety and aviation security.

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