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HUMAN FACTORS IN ACCIDENTS OF AIRSHIPS

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Abstract Airships represent a type of transport vehicle possessing great potential for the development of various branches of industry. They can provide probably the greatest comfort in transporting passengers in relation to all other means of transport, which makes them particularly suitable for different tourist arrangements. However, today the use of airships is almost inversely proportional to their capabilities and the potential they have. One of the reasons for such a situation is certainly the safety aspect of airships. The unfortunate cases from the past have largely affected the demand for this type of transport. This paper aims to investigate to what extent the human factor was the reason for the occurrence of accidents with airships. Based on the insight into the literature and documentation related to accidents of airships, it can be concluded that the human factor did not have a large share in the occurrence of accidents involving this means of transport. However, the prevention of accidents in the future requires a more complex ergonomic analysis that should include a segment of human factors in all parts of the system that are related to the design, use, driving, control and testing of airships and their personnel.

Keywords: Human factors; airship; zeppelins; blimps; accidents.

1. INTRODUCTION

An airship is a large lighter-than-air aircraft, which can be steered by using engine-driven propellers [1]. In addition, the airship can stay in the air without expending engine power, like a balloon [2]. Airships are means of transport with a very long history [3-5]. The first serious attempt to create an airship was made by two Swiss, John Pauly and Dun Egg, who at that time lived in England. In 1816-1817 these two men constructed an airship with an envelope of dolphin shape, built from gold-beater's skin and equipped with a ballonet [6]. In 1852, a French engineer Henri Giffard built the first practical airship. It was filled with hydrogen gas and driven by a 3 hp steam engine [7].

There are three main types of airships [7-8]:
1. Non-rigid airship (blimp), consisting of an envelope, whose shape and stiffness is maintained by the lifting gas (usually helium), whose pressure is above the ambient pressure.
2. Semi-rigid airship is an airship whose shape is maintained by gas whose pressure is above the ambient pressure, and which has a stiff keel or truss supporting the main envelope along its length.
3. Rigid airship, where the lifting gas is contained within one or more gas cells, and which has an internal (metal) frame to maintain the envelope's shape.
This study refers to all three aforementioned types of airships.

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The possibilities of using airships are extremely high. They can be used for tourist purposes, research purposes, as well as for advertising (Figure 1). They were also used in military operations. These aircrafts can offer extremely high comfort to passengers. For example, the Hindenburg airship owned: a big dining room, a passenger lounge with carefuly designed furniture and a piano, a writing room, 34 passenger cabins for sliping, male and female toilets, a shower, promenades with seating areas and large windows which could be opened in flight, a smoking room, a bar, etc.

Figure 1. An example of the use of airships.

2. PROBLEM

Although the scope of the use of airships is wide and has the potential for progress, over time, instead of expansion, there has been stagnation, or even declining of supply and demand for this means of transport. There may be several reasons for this. One of them is certainly related to the safety aspect of this type of aircraft.

As with other means of transport, there have also been unfortunate cases connected with airships in the past. The critical point that probably contributed most to the reduction of interest in this means of transport was the accident of the aforementioned Hindenburg airship from 1937 (Figure 2). The circumstances surrounding this disaster are described in detail in [9, 10]. At that time, all airships outside the U.S. used hydrogen gas to make their airships float. Although hydrogen gas is lighter than air, it is highly flammable. One spark could start an explosion. As a consequence of that, in just 37 seconds from the onset of the first flame, Hindenburg was on the ground in a huge flame. Of 97 passengers and crew members, 35 did not survive the accident.

Until the occurrence of this disaster, airships were used to transport long-distance passengers. There were regular overseas lines. However, after the disaster of the Hindenburg, passengers are no longer transported on long distances with airships. The accident of the Hindenburg stopped transatlantic airship travel.

However, the aforementioned accident was not the only accident involving this means of transport. Although gas hydrogen was replaced by non-flammable gas helium, after Hindenburg there were still accidents of airships. So, on the one hand, we have a very comfortable means of transport, and on the other hand, we have a potentially unsafe means of transport. Therefore, one can ask the question, how

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safe is to fly by the airships? In connection with this, one can ask the question, to what extent the human factor was the cause of the emergence of accidents with airships? This paper aims to investigate the influence of human factors on the occurrence of accidental cases with airships.

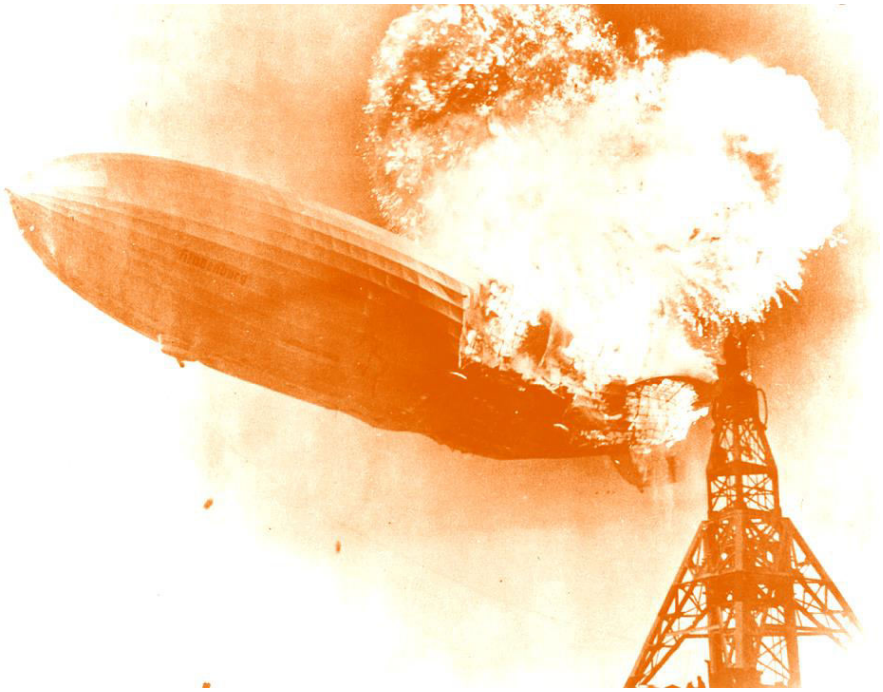

Figure 2. The Hindenburg accident.

3. METHOD

Hindenburg was not the first accident with airships. However, at the time, forensic engineering and investigations were at a lower level than it is today. In addition, control means such as flight data recorder (FDR) and cockpit voice recorder (CVR) were not used at the time. Although most of the accidents were investigated, the findings of these investigations were often not unambiguous. Even for Hindenburg's accident there is no definite attitude about the cause of the accident.

However, taking into account the time distance associated with the occurrence of accidents, formal reports, records and publications on these reports represent at this time the only possible global source of information, on the basis of which it is possible to draw a conclusion on the influence of the human factor on the occurrence of accidents with airships. For this reason, records and reports about accidents of airships are the main sources of data that are used in this study.

This survey includes accidents with airships from 1901 to 2012. The subject of this study were accidents with the following airships:

Pax
Unknown 1
LEABUDY PATRIE
Morrell
La Republique

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ERBSLOH
HMA No.1
AKRON
IMPERIAL GERMAN NAVY L1 (Zeppelin LZ 14)
IMPERIAL GERMAN NAVY L 2 (Zeppelin LZ 18)
LZ 40
SCHUTTE-LANZ SL6
N.S.11
Wingfoot Air Express
R38
ROMA
DIXMUDE
TC2
USS Shenandoah (ZR-1)
Italia
R 101
ZRS 4 – Akron
Macon
SSSR V7
Hindenburg
SSSR V6
SSSR V10
G-1
L-2
L-8
K-133
K-5
K-14
K-53
K-111
K-34
Unknown 2
Pobeda
ZZPG – 2
ZPG-3W
EA-1
Heli – Stat 97-34J
Bigfoot
N760AB
Goodyear GZ-22
Goodyear
Hood
Sky ship 600
Goodyear
Sky Dragon

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4. RESULTS AND ANALYSIS

Of all the aforementioned airships, in only 3 accidents, a human factor is mentioned as a potential cause of an accident. These are accidents with the airships USSR V6, K-14 and EA-1. In Tables 1, 2 and 3, on the basis of the available data from the literature [11-16] relating to the aforementioned airships, the basic information on these aircrafts and the causes of their accidents are presented in a compact form.

Table 1. SSSR V6 airship accident.

Date of accident	February 5, 1938
Name of the airship	SSSR V6 (semi-rigid airship)
Location of the accident	Near Kandalaksha
Number of flights before the accident	Unknown
Total number of passengers and crew members at the time of the accident	19 people
Number of survivors	6
Number of injured	Unknown
Number of fatalities	13
Types of injuries	Unknown
The cause of the accident	According to the official version of the accident, a "pre-revolutionary" chart was used with the wrong altitude marked on it. An unofficial version suggests, instead, that the crash was jointly due to the human error, poor visibility, and the old charts. Commander of the airship ordered raising the airship to 800 meters, but it was too late, and the airship struck the mountain nearly at the 300-meter mark.

Table 2. K-14 airship accident.

Date of accident	July 2, 1944
Name of the airship	K-14 (non-rigid airship)
Location of the accident	Gulf of Maine
Number of flights before the accident	Unknown
Total number of passengers and crew members at the time of the accident	10 people
Number of survivors	4
Number of injured	Unknown
Number of fatalities	6
Types of injuries	Unknown
The cause of the accident	According to the U.S. Navy's reports, the cause of the crash was a pilot error. An unofficial version suggests, that the crash was the result of machine gun fire from a U-boat.

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Table 3. EA-1 airship accident.

Date of accident	October 8, 1980
Name of the airship	EA-1 (non-rigid airship)
Location of the accident	Naval Air Engineering Station Lakehurst, New Jersey
Number of flights before the accident	0
Total number of passengers and crew members at the time of the accident	1
Number of survivors	1
Number of injured	0
Number of fatalities	0
Types of injuries	There were no injuries.
The cause of the accident	The airship on its first flight reached 600 feet altitude before beginning an unplanned right descending turn. The airship collided with trees. According to NTSB report, the pilot was inexperienced, with zero hours of flight with airships. The additional cause of the accident was the poor design of the airship.

Based on the data presented, it can be noted that the human factor was the potential cause of accidents in only 6% of airships, of the total number of airships that participated in the incident situations (which were the subject of the analysis). In addition, it can be observed that rigid airships did not participate in events where the human factor appears as a potential cause of accidents related to this type of aircrafts.

5. CONCLUSION

Of all the analyzed accidents with airships, only in one official report, the human factor is mentioned as the cause of the accident. The human factor (jointly with other circumstances) is mentioned in two more unfortunate cases, as a potential cause of accidents with airships. Bearing this in mind, and that the analysis carried out included a time interval of over 100 years, it can be concluded that the human factor had a small share in the occurrence of accidents with airships. However, when it comes to airships, this does not mean that the situation regarding the human factors is ideal or close to the ideal one. In order to prevent accidents in the future, a more complex ergonomic analysis should include a segment of human factors in all parts of the system that are related to the design, use, driving, control and testing of airships and their personnel.

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