

SAFETY APPROACHES OF POPULATION PROTECTION DURING AIR SHOWS IN THE CZECH REPUBLIC

Kateřina TOMANOVÁ*, **Barbora KLUČKOVÁ**

Technical University of Ostrava, Faculty of Safety Engineering, Lumířova 630/13, 700 30 Ostrava-jih-Výškovice

Marek PILÁT, **Patrik ŠVÁB**, **Michaela TIRPÁKOVÁ**

Technical University of Košice, Faculty of Aeronautics, Rampová 7, 041 21, Košice

*Corresponding author. E-mail: katerina.tomanova@vsb.cz

Abstract. In recent years, organizing air shows is a very popular attraction. The proof is the high number of visitors. Examples are the NATO Days in Ostrava, where the number of visitors is around 200,000, or the CIAF in Hradec Králové, which will be attended by 40,000 visitors. The aim of the articles is to approach and analyse the approaches that ensure the safety of people during these events in the Czech Republic. Several legal regulations dealing with this issue were analysed and their content is focused on the obligations of the rescue system during air events. The contribution of the article can be information that can help ensure the safety of air shows abroad.

Keywords: population protection; air show; safety approaches; safety

1. INTRODUCTION

In recent years, air shows have become a popular destination for visitors and aviation enthusiasts, both at home and abroad. Air shows, public air performances or air days can be defined as the activity of preparing and conducting aircraft performances for spectators who are assembled for this purpose at a specified time at a designated airport or adjacent property [1]. However, a large number of people in one place can pose a great risk, which can have an impact on the health and lives of the participants. Examples include a plane crash during an airshow in Germany (Ramstein Air Base), a plane crash in Ukraine (Lviv) and many other accidents around the world [2,3]. These misfortunes must be taken into account. It is a resource that can be used for planning air events and their best security.

The article presents an overview of the available documents that regulate safety regulations, both from the point of view of the organizer and the requirements that are placed on the rescue forces. In this case, the emergency services are the main pillar for the eventual rescue of visitors and their participation in these events is essential to save health and lives. In order to ensure the safety of the participants, it is necessary for the emergency services to verify this preparedness. The aim of this paper is to highlight a possible approach for emergency services to verify preparedness and thus ensure greater safety of participants using established methods.

2. ACCIDENTS DURING AIR SHOWS

Accidents during air shows took place throughout their duration. These were both small accidents without a serious impact on the health and lives of the participants, as well as accidents that had catastrophic consequences. The reasons for accidents had various causes, from the human factor to the failure of technology [2,3]. Over time, it became the main priority of these shows, ensuring the highest possible protection for visitors. Trying to secure an air day is not an easy task, as shown by one of the deterrent cases - an accident during an air show at Ramstein Air Base [2].

On August 28, 1988, an air day was held at Ramstein Air Base (one of the largest USAF military bases outside the United States) in Germany. The grand finale of the whole performance was supposed to be the manoeuvre of the Italian pilots, the so-called "Pierced Heart", but only 4 minutes after the start of their performance, about 70 people died, about 1,000 were injured, of which 346 were seriously injured [4].

The poor manoeuvre caused an accident that claimed many lives. As one might expect, no one expected an accident that would have such major consequences. The whole event was provided with medical support, which included 15 doctors, 163 paramedics and 15 ambulances. However, about 300,000 spectators were present throughout the air show. Given the number of spectators and doctors on site, it is clear that in the event of a major accident, the medical staff is insufficient.

There was a lot of chaos after the incident at the scene of the accident. The whole incident lasted 7 seconds, so many spectators did not have a chance to save themselves. Chaos occurred during the rescue of spectators, firefighters arrived about two minutes after the incident, followed by the arrival of ambulances and helicopters. As the accident took place at the base, the Americans joined the rescue and began to transport the wounded, but did not cooperate with the Germans. Therefore, even after the hour of the accident, the Germans did not have an overview of the extent of the tragedy. The Americans had a different way of rescuing people by not treating them on the spot, but immediately evacuating the wounded from the scene of the accident. This resulted in overcrowding in nearby hospitals and unnecessary loss of life, when the wounded did not receive immediate assistance that could save their lives.

The investigation of the accident, which was caused by a plane crash during the manoeuvre, also revealed how the whole event was not medically secured. There were no resuscitation devices in the whole area, minor injuries or, for example, food poisoning were expected. Another problem was the number of trained paramedics, which was only a fraction. The ambulances that were inside the complex were not sufficiently equipped, and the ambulances that came to the complex could not get there due to poorly parked cars.

A flight day at Ramstein has long been a bad example of how a flight day can turn into a disaster in a matter of seconds. The overall lack of security for the event, the lack of adequate medical care, the lack of communication at the scene of the accident and many other mistakes led to stricter measures during the following air days around the world. The accident at Ramstein Base was for a long time the most catastrophic air show, until 2002 [3].

In July 2002, an air show was held in Skyla, Ukraine, to celebrate the anniversary of the Ukrainian Air Force. Under normal circumstances, little would know about this flight day. Around 10,000 spectators came to the show. The performance was to include one of the most advanced fighters with high-tech hardware and was to demonstrate a vertical "vertical Charlie" manoeuvre. During the manoeuvre, there was a poor evaluation of the situation and subsequently a crash of the fighter and another aircraft that was standing on the ground. During the crash, the planes began to burn and the burning wreckage flew up to 100 meters. Spectators standing close to the flight line had no chance of survival. The accident killed 77 people and injured 543 people. The pilots managed to eject from the cockpit, but they could not prevent the accident [5].

During the accident investigation, several versions of the causes of the accident were used, such as a technical failure, a pilot error or an error in the planning, organization and location of spectators at the airport. The result of the investigation was determined as the cause of the accident poor organization, preparation for the organization of air shows. Furthermore, the error of the pilots was evaluated as an error in the performance of the manoeuvre, after which the pilots objected that their flight maps did not correspond to reality.

By comparing the two disasters during the air shows, a difference in spectator numbers can be seen, and yet the loss of life at both events is huge. The mentioned air days made major mistakes during the preparation and organization of the air days, as well as fundamental mistakes made by the pilots [3].

Based on these findings and a comparison of safety regulations in the Czech Republic, it can be stated that the Czech Republic approaches this issue very responsibly. However, all stakeholders involved in security also need to be taken into account. Failure of a single entity can lead to fatal

mistakes that could require casualties or injury to participants. It is therefore necessary to perceive the security of the event as a comprehensive approach to ensuring the protection of visitors.

3. SAFETY REGULATIONS FOR AIR SHOWS IN THE CZECH REPUBLIC

The Czech Republic hosts many air shows or air days. The size of these events is usually influenced by the number of performances, the presentation of aircraft and other accompanying programs. These facts affect the number of incoming viewers. One of the largest events of this type in the Czech Republic is the NATO Days in Ostrava. It is the largest security show in Europe. The aim of this event is to present to the public the widest possible range of resources available to the Czech Republic and its allies. It is a show of both ground forces, air forces and rescue equipment. An interesting part are also air manoeuvres, demonstrations of special units, etc. In such a large air show, it is necessary to ensure the safety of participants, using the rescue system, documentation, and other interested persons (security, etc.) who help them safety.

The organizers of the NATO Days are preparing a Security Study, which includes all aspects to successfully manage the event. This safety document includes both information about the event, an overview of legislation, transport security, risk analysis, fire protection, evacuation, medical security of the event and other points that provide comprehensive security of the event [9].

Other air days held in the Czech Republic have different numbers of participants depending on the venue and also the attractiveness or tradition. An important fact is that the number of participants is growing exponentially and thus the requirements for their security are also growing.

An overview of the largest flight days and the number of participants in the Czech Republic is given in Table 1.

Table 1 Overview of flight days in the Czech Republic [6-10]

<i>Event location</i>	<i>Number of visitors (year)</i>
<i>Airshow Plasy</i>	21 600 (2018)
<i>Přerov Airport Day</i>	12 500 (2016)
<i>CIAF Hradec Králové</i>	40 000 (2016), 25 000 (2019)
<i>NATO Days Ostrava</i>	220 000 (2018, 2019)
<i>Aviation pilgrimage Pardubice</i>	35 000 (2019)

Safety regulations are documents that impose obligations on the flight director and the organizer of the flight day, so as to ensure the safety of visitors. One of the very important documents for the holding of aviation days is the document entitled Conditions for the organization of public aviation performances CAA-SL-101-0-16 and Regulation L14.

3.1. Conditions for organizing air public performances

The document Conditions for Organizing Air Public Performances CAA-SL-101-0-16 (hereinafter "Conditions for APP"), defines air public performances ("APP"), as an air day or air promotion event [1]. The term aerial promotional event refers to the activity associated with the preparation and performance of performances for spectators, who are gathered for this purpose at a specified time at the airport. Promotional events can be both part of a sporting event and a social event. An aviation day is defined as an activity associated with the preparation and performance of aircraft performances for spectators who are assembled at a particular location in the airport or adjacent land. The document contains the requirements for the APP, ensuring communication, organization, location and management of the APP, safety requirements, safety measures and emergency procedures, conditions for approval of performances, rights, and obligations of performers. The content of the document is focused on the whole area of the APP [1].

Due to the nature of the article, which focuses on the protection of persons during APP, the document provides information that clearly describes approaches to ensuring the safety of persons during APP.

The protection of persons (spectators) is established for the flight director in the following manner, so that:

- there is no take-off or landing of aircraft over the place for spectators or parking for cars,
- to consider the appropriate choice of space for spectators and for car parking, which must be appropriately marked and demarcated so that the space provides constant supervision to the organizing service,
- barriers marking the spectator area and car parks must be located behind the public line in the direction from the performance limit,
- places that are not accessible to the public must also be properly marked and inspected by the organizing service,
- spectator areas and car parks must be located so that any part of the taxiing aircraft does not approach them at a distance of less than 15 m,
- spectator areas and car parks must not be less than 15 m from the permanent service station or less than 15 m from the aircraft filling point and the venting of aircraft fuel systems and filling equipment,
- the distance between the track centreline in use and the public line must be at least 75 m [1].

In addition, the document contains safety requirements, special safety precautions and emergency procedures that are characterised:

Ensuring safety by rescue services

The document Conditions for APP also includes the need to provide rescue services at the APP venue. The flight director must request the presence of the medical rescue service, the fire brigade or the Police of the Czech Republic in advance. The lead time must be such that the components are able to prepare sufficiently for the action. For both spectators and the operating area, a station must be located so that quick help can be provided. In the case of more than 500 spectators, a first aid room with appropriate equipment must be set up at the APP. This room must be properly marked and the arrival of medical vehicles must be ensured. In the event of leaving the APP venue, one of the rescue vehicles, the flight director must decide to continue the event. If the rescue vehicle leaves the action, this could disrupt or reduce any intervention [1].

Negotiations with rescue services

It is the responsibility of each flight director wishing to hold an APP to inform in advance:

- medical facilities,
- medical rescue service centre,
- the fire brigade,
- for the local service of the Police, or the Regional Directorate of the Police of the Czech Republic.

With these components, the flight director is obliged to develop measures to ensure the smooth running of the APP. The measure also includes the development of procedures that will be effective in the event of an emergency. It is essential for APP that there be a medical rescue service and a fire brigade at the venue. Contacting rescue services is derived according to the size of the event and the classification of the event. Based on these data, the deadline for contacting rescue services is set, see Table 2 [1].

Table 2 Recommended deadlines for contacting rescue services

<i>Event size</i>	<i>Event classification</i>	<i>Contact deadline (before the day of the event)</i>
<i>1–3 performing</i>	Small	2 months
<i>4–12 performers</i>	Medium	5 months
<i>12 and more performers</i>	Large	10 months

APP emergency plan

It is essential for each APP to draw up an emergency plan for which the flight director is responsible. The size of the event affects the scope of the emergency plan. The emergency plan must include a definition of the responsibilities of the persons involved or rescue services in the event of an emergency. Each person or component concerned must approve this plan and all persons involved in the APP must be familiar with this plan. The document Conditions for APP sets out the minimum details that an emergency plan must contain:

- the type of emergency (these may be air incidents, terrorist attacks, fire, etc.)
- persons or components included in the emergency plan,
- the responsibilities of each person or component included in the plan,
- a map that is detailed and has a grid showing emergency points, exits, access routes, control centres and other important points that are essential,
- the type of communication connection,
- names and contact details of the responsible authorities.

It is also important for the flight director to consider other requirements when drawing up an emergency plan that could better handle emergencies. This includes, for example, finding out the characteristics of the largest aircraft that participates in APP, as well as studying the regulation L14, which deals with rescue and fire services. Or, for example, the possibility of setting up a dedicated, independent emergency services centre and staffing it. Another option may be to provide continuous video recording of the entire APP, which can then be used for emergency analysis.

To ensure a quality emergency plan, it is recommended to prepare an emergency plan in close cooperation with the individual rescue services. These components can be relied on in this regard due to their experience in dealing with emergencies [1].

Risk management

Risk management is a key element in the development of an emergency plan. A risk can be defined as an event that may occur during APP occurs, seriously threatens the successful implementation of the action. There are risks in hosting any public event that, if they occur, can cause serious personal injury or damage to property. These risks must be identified and minimised early. This can be achieved through an activity called 'risk management'. Risk management can be defined using three steps [1]:

- Identification and assessment of key risks, evaluation of its consequences,
- Planning appropriate interventions and applying preventive measures,
- Monitoring and continuous control.

The assessment of the likelihood of occurrence and the evaluation of the impact of the risk on the implementation and progress of the action can be very subjective and is based on personal experience or available statistically recorded values, etc. Risk management is based on probability and consequences. The result is a matrix that shows the individual outcomes with the possibility of risk reduction. If some risks are unacceptable, the flight director is obliged to reduce these risks using effective measures.

3.2 Other safety regulations to ensure safety

The criteria for ensuring the safety, regularity and economy of international air transport are set out in the L14 Airport Transcript Regulation [11]. It stipulates, among other things, the categories of fire safety, specifying the requirements for the provision of rescue and firefighting equipment and services. One of the mentioned areas is also ensuring safety at APP. In the case of APP, the organizer must provide assistance to the medical rescue service and fire protection units included in the area coverage of the region by fire protection units. This is at category 1 and 2 airports [11].

The air disasters that have occurred in the past have become a sad but important point for ensuring operational safety during today's APPs. It can therefore be assumed that, based on the available aviation regulations, quality safety measures can be derived and established during the APP.

3.3 Proposal for verifying the preparedness of emergency services during APP

As already mentioned in the introduction, the emergency services form the main pillar for the rescue of the participants. It is therefore necessary to think also about the preparation of the activities of the rescue services during an airborne event. None of the mentioned safety regulations for air shows address this issue. It is therefore a possible determination of the preparedness of rescue services to ensure the safety of participants during the air show. This can be achieved, for example, by using selected methods. In this case, both theoretical and practical methods can be used.

On the theoretical level, one can consider, for example, methods such as check list, expert estimation, or mathematical modelling [12]. The results of these methods can outline the bottlenecks that may compromise the preparedness of the emergency services for action, i.e. reveal weak points. The check list method is also used by the flight director [1], who is able to use this method to detect deficiencies or risks in the preparation, or weaknesses that may occur during the event. And based on these results, the flight director is able to react by reducing the risk by applying selected measures with respect to the risk.

On a practical level, the stress test method can be mentioned. The term stress test, or stress test, is a very widely used tool that has a very wide range of applications. These include applications in information technology, nuclear power plants, banking, healthcare, and even aviation [13].

The advantage of the use of stress tests is the applicability, both to the whole system and to individual parts, i.e. focusing for example on the use of resources of emergency services, communication between emergency services and the flight director, or cooperation between all components of the emergency system. Stress tests applied to a selected system can be used as a check whether the system is sufficiently prepared for emergencies that may occur during an air show.

This check takes the form of scenarios where requirements are placed on the selected situation. Increased load requirements on the selected system will reveal weak points. These locations can then be analysed and requirements can be determined that would eliminate these weak points [14].

However, it must also be stated that the use of the stress test method, is very challenging. Challenging both in terms of coordination of components, people, time and finances. However, practical examples can be drawn, for example, abroad, where stress tests are a widely used and proven method [14].

It is assumed that the stress test method and its use for checking the readiness of emergency services will be the subject of further research. During this process it will be necessary to establish criteria and requirements that would make the whole procedure more specific and lead to accurate results. This could lead to the applicability of this method to different types of mass events, as well as applicability to different safety sectors. This could help to better ensure the protection of people from different perspectives. The approach to ensuring preparedness can be illustrated by the following Figure 1:

The aim of Figure 1 is to present an approach to enhance the preparedness of emergency services at air events. It is a simple process that is dependent on the type of event, safety approaches and methods chosen. Thus, the type of event is an air show, which is dependent on the safety regulations that are established. These regulations make it possible to determine the safety approaches of the emergency

services and other stakeholders see chapter 3. These safety approaches can be controlled by an appropriate method. Based on the results of the chosen methods, it is necessary to determine whether the preparedness of the emergency services is sufficient or not. Otherwise, other appropriate measures must be identified to enhance preparedness.

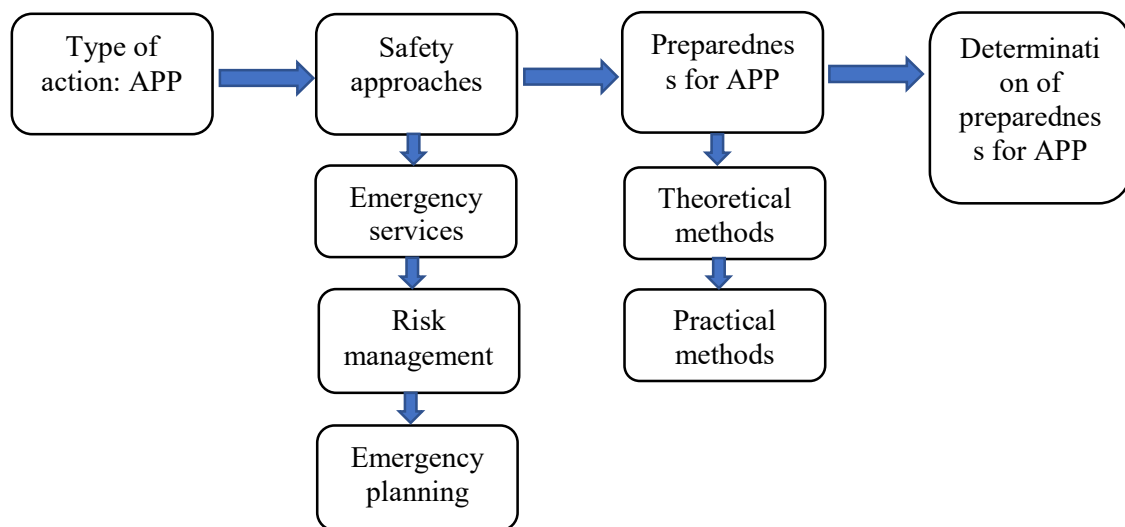


Figure 1 Verification of the readiness of emergency services during APP (own elaboration)

The contribution of this theoretical model is the extension of the possibility of verifying the preparedness of emergency services during air shows using the selected methods. As already mentioned, this is a theoretical model which needs to be verified in practice by exercises. This may be the subject of further investigation.

4. CONCLUSION

In most cases, the holding of flight days is considered a large event, which is attended by many spectators. These events bring a lot of fun attractions, air shows (acrobatics), aircraft shows, or other accompanying program that attract participants. As the number of spectators grows, so does the obligation to ensure their safety. This involves a large number of measures that must be complied with. These are the purposes of aviation regulations, which contain obligations and regulations for both the flight director and the organizer.

It is always a challenging task to make the flight day as safe as possible. However, with hindsight and the events that have happened, it is possible to learn from these mistakes. It is important to remember that there is always risk at these events. Therefore, regulations need to be properly and carefully followed so that disaster and unnecessary loss of life is avoided. The aviation regulations contain requirements for ensuring safety by emergency services. The article shows the responsibilities for the rescue services and how big a role the services play on air days. The availability of emergency services at large events such as air days is crucial. Mainly from the provision of rapid medical assistance on site and rapid intervention by the units. Therefore, it is also important to control these requirements. Whether the emergency services are at all prepared for such large events, so that they can respond to emergencies in time and to provide first aid in time so that there is no unnecessary loss of life.

The article gave an insight into the aviation safety regulations that ensure the safety of spectators during air days. It also brought out the possibility of using methods to verify the preparedness of the emergency services that ensure the safety of people attending air shows.

Acknowledgement

The article arose from the output of an internship abroad, funded by the Visegrad Fund.

References

- [1] Civil Aviation Authority. Conditions for organizing air public performances CAA-SL-101-0-16. 2020. Prague.
- [2] Austrian Wings. Ramstein 1988: Death falling from the clear blue sky. [online] 2018. [cit. 2021-01-03]. Available from: <https://www.austrianwings.info/2018/08/ramstein-1988-death-falling-from-the-clear-sky/>
- [3] Fusco, P. The Crowd pleasers. A history of airshow misfortuens from 1910 to the Present. 2018. ISBN: 978-1-5107-2818-9.
- [4] Terry, M. The Ramstein Disaster. Journal of the Royal Army Medical Corps R Army Med Corps 1990; 136: 19-26. DOI: 10.1136.
- [5] 112 UA. Terminated Flight: Sknyliv air show. [online] 2016. [cit. 2021-02-03]. Available from: <https://112.international/article/terminated-flight-sknyliv-air-show-7714.html>
- [6] Plzeň.cz. The aviation day in Plasy broke records, at řonka et al. 21,600 people came. [online] 2018. [cit. 2021-03-05]. Available from: <https://www.plzen.cz/letecky-den-v-plasich-trhal-rekordy-na-sonku-a-spol-prislo-21-600-lidi/>
- [7] řerov. A RECORD NUMBER OF VISITORS VISIT THE AIRPORT TO řEROV ON THE DAY. [online] 2016. [cit. 2021-02-01] Available from: <https://prerov.nejlepsi-adresa.cz/index.php?ref=titulka&rpge=zpravy&uname=Rekordni-pocet-navstevniku-zavital-na-Den-letiste-do-Prerova-15612>
- [8] Hradec Krlov daily. IAF 2019: Attendance is growing, but so is criticism. [online] 2019. [cited 2021-02-02]. Available from: https://hradecky.denik.cz/zpravy_region/ciaf-2019-roste-navstevnost-ale-i-kritika-20190903.html
- [9] NATO Days. NATO DAYS IN OSTRAVA & ACR DAYS ACR 2019. [online] 2019. [cit. 2021-015-01] Available from: <https://www.natodays.cz/uplynule-rocniky>
- [10] IDNES.cz. The aviation pilgrimage reports record interest, with elite pilots attracting 35,000 people. [online] 2019. [cit. 2021-23-02] Available from: https://www.idnes.cz/pardubice/zpravy/aviaticka-pout-show-letadla-letiste-pardubice.A190602_094645_pardubice-zpravy_zdo
- [11] MINISTRY OF TRANSPORT OF THE CZECH REPUBLIC. Civil Aviation Authority. Aviation regulation of airport L14. 2020. Prague
- [12] ADAMEC, V.: Study of the possibilities of determining the level of civil emergency preparedness of territorial units. [Habilitation thesis]. Ostrava: VřB- Technical University Ostrava, Faculty of Security Engineering, 2008.
- [13] European Commission. Stress tests. [online]. 2011 [cited 15 March 2019]. Available from: <https://ec.europa.eu/energy/en/topics/nuclear-energy/nuclearsafety/stress-tests>
- [14] Risikoanalyse im Bevlkerungsschutz - Ein Stresstest fr die Allgemeine Gefahrenabwehr und den Katastrophenschutz. Praxis im Bevlkerungsschutz Band 16, Bundesamt fr Bevlkerungsschutz und Katastrophenhilfe, Bonn, 2015, 156 pages, ISBN 3-939347-67-, Available from: http://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/Publikationen/Praxis_Bevoelkerungsschutz/Band_16_Risikoanalyse_im_BS.pdf?__blob=publicationFile

Received 10, 2021, accepted 12, 2021



Article is licensed under a Creative Commons Attribution 4.0 International License