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Organisational Aspects of Air Show Safety and Security

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Abstract:

Every year, there are a dozen or so air shows organised in Poland. Their character varies from flying club shows, through air picnics, which are getting more and more popular, to big civil-military international air shows. Their organisation demands the involvement of many institutions and a close cooperation of them at every level, of the event planning and execution, as well as ensuring safety by maintaining operational readiness, of the resources engaged in the show. The character of the air show leads us to a conclusion that the whole security system (ensuring air and ground safety) needs to be organised in such a way that it will meet high safety standards at all stages of the process. The aim of this work is to develop a coherent concept of planning, organisation and implementation of an air show with all necessary safety regulations, as well as taking into consideration possible safety hazards and risks which may occur. To solve this problem, the author tries to answer the following question: What kind of factors needs to be taken into consideration during the air show preparation in order to maintain its required level of safety and security?

Keywords:

air show, health and safety, security, management

1. Introduction

Air shows, both national and international, have contributed to the calendar of events that every time attracts attention from a few thousand to tens of thousands of spectators. They are organized around the world to present flying machines, to the viewers and to the people associated with them by their passion, as well as their work and service that cannot be commonly seen by an average person. The first public demonstration of the capabilities of the Flyer III, the Wright Brothers' plane, took place at the French race track of Le Mans. The show met with so much interest that it was

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repeated several times a year in Italy, France, and the United States. The first static display of aircraft is believed to have been the presentation of the aviation section during the French motor show (*Salon de l'Automobile*). The exhibition caused a big stir in the world, which resulted in the organization of an international exhibition of airship transport (*Internationale Luftschifffahrt – Ausstellung – ILA*) in Germany in the same year, during which, in a dynamic show, Orville Wright made an appearance, along with an improved version of "Flyer I".

Another important date (25th July, 1909) for the air shows' history was the air race over the English Channel organized by the "Daily Mail" newspaper. The race was won by Louis Blériot at the controls of the "Blériot XI" aircraft. This event was, in turn, the beginning of the kind of show called "air race", consisting in planes racing along certain routes.

The first air show in Poland took place in 1909, on the Mokotów Fields, where Georges Legagneoux and Baron de Caters presented their machines flying in the presence of the audience. The year 1911 in turn witnessed a dynamic show of the first Polish aircraft produced by Count Michael Scipio del Campo, also on the Mokotów Fields [1].

As many people believe, an important breakthrough for the Polish aviation was the big Challenge in Berlin won by the Poles, Franciszek Żwirko and Stanisław Wigura. As the winners of the great air race, they were on everyone's lips [2]. It is worth pointing out that from 1927 on, national air competitions were organized on the Mokotów Fields, and they were the first cyclical aviation events in Poland, which continued until 1935.

On 2nd September, 1945, there was the first "air march" parade over Warsaw to mark the anniversary of the Polish renascence, which betokened the high rank of Polish aviation. The "air march" parades over Warsaw became a tradition, and from year to year it attracted growing crowds of audience and were an opportunity to present new air force units (in 1950, for the first time the squadron of Yak-17 in the formation flight was presented), which became very attractive. The first air show similar to today's Polish Air Shows was held in the Bemowo airfield in 1957, where the stunt flying, gliding, parachute demonstrations, and static display could be seen. The final show was an air parade of 75 machines used in the Polish Air Force. Air parades became an integral part of the celebrations of important anniversaries in Poland.

We could witness the return to the organization of international air shows in Poland in 1991 at the Poznań Ławica airfield during the Aviation Feast Day, where in addition to the Polish Air Force equipment, NATO aircraft were presented in dynamic shows, including F-16s, F-15s, Mirages 2000, and Tornados. During that show, the Polish Air Force aerobatic group of "White-Red Sparks", on the TS-11 Iskra, performed for the first time. The group now represents the Polish aviation all over the world. Currently there are up to even several dozen of air events in Poland every year. They are of various nature ranging from flying club shows through the increasingly popular air picnics, to large international civil-military air shows.

2. Organizational Assumptions of Air Events

In recent years there has been a steady increase in the number of air shows and the aircraft participating in them, see Tab. 1.

Tab. 1 Growing number of air shows in Poland [3]

2012	2013	2014
20 shows	45 shows	50 shows
364 aircrafts	924 aircrafts	719 aircrafts

As cultural and sports – or purely business as is the case with Air Salons – events, to reach the intended objectives, air shows must be conducted taking into consideration a certain security system created, which is a collection of interrelated elements, aimed at ensuring an acceptable safety level. Every year, air shows attract more and more spectators because for many they are the only opportunity to enjoy sports and military aviation.

An air show is a specific type of a mass event which is defined by the law as Air Force flights in order to present the Air Force and its operators' skills to the public, with the exception of training / school flights and professional / commercial flights [4].

The specificity and uniqueness of the event should be taken into consideration due to the fact that in addition to regular dangers, the risks resulting from air operations may be even higher, as the organization of air shows is subject not only to the law on organizing mass events, but to aviation law as well. Air shows are given the status of a mass event if, in accordance with the applicable legislation, the show provides over 1 000 places for spectators. In accordance with the aviation law, air shows are organized as flights of aircraft in order to present the skills of pilots and aviation equipment to the public [4].

Pilot skills may not be presented if they are part of the training or professional development, and if they are related to commercial / professional objectives.

Three types of air shows are distinguished:

- shows for fewer than 1 000 spectators;
- shows for more than 1 000 spectators;
- shows in the form of an overflight.

Air shows organized in accordance with Article 4, 123 Paragraph 1(b), must be reported to the President of the Polish Civil Aviation Authority along with a set of documents containing:

- application for the permission to organize an air show;
- copies of the application for the permission to organize a mass event;
- air show schedule;
- application for the permission to reduce the altitude of aerobatic flights (submitted within 7 days before the planned demonstrations for domestic pilots, and within 4 days for foreign pilots);
- a statement of completion of a risk analysis and exercise plans for the air show;
- other [5].

Each air show which is classified as a mass event is additionally a subject to the Regulation of the Minister of Transport, Construction and Maritime Economy of 16th May, 2013, on test and aerobatic flights, and air shows. The regulation clearly specifies the information about the so-called "air shows". Their program must include the following data:

- the organizer of the show (first name, last name, address);

- the date and time of the show;
- clearly indicated place of take-off and landing operations, along with a chart of the site containing details about the show zone and its location;
- the procedures for performing the flights during the show;
- personal data (first and last names, and authorizations) of the Director of the Show, the Manager of the Air Show Program, and the *Director of Air Operations*;
- a detailed description of each program;
- the minimum meteorological conditions to hold a demonstration;
- the description of communication between Air Force crews and the *Director of Air Operations* [5].

In turn, taking into account the law on the "Mass Events Security", an air show is qualified as an artistic-entertainment or sports event where the organizer provides a significant number of places for spectators. To be considered as a mass outdoor event, places for more than 1 000 spectators must be provided.

Were such restrictive rules in effect in earlier years? Between 1945 and 1989, that is in the time of the People's Republic of Poland, air shows were considered, in principle, to be air parades, air crews shows and team flights, and as such were subject to the legal regulations of the applicable Ministry. Flights at air shows were limited to executing the tasks in the air.

With regard to Polish national law, regulations are very restrictive. In Poland, major events involving military aircraft are organized by the Air Force. The basis for their implementation is the decision of the competent institution expressing the will of their organisation and financing. In the case of a picnic held at an Air Force Base, it is the consent of the General Commander of the Armed Forces and, if foreign and civilian air crews are to participate, it is the decision of the Minister of National Defence. Two basic documents normalize the rules of the air show organization: Defence Standard NO-05-A014 2006 on the Essential Requirements of Shows and Exhibition of the Equipment, and the Regulation of the Minister of Transport, Construction and Maritime Economy of 16th May, 2013.

The scope of the Defence Standard NO-05-A014-2006 specifies the basic requirements for the procedures of the organization of shows in the air and the ground displays of aviation equipment. In its normative annexes, there are examples of options for the location of the spectators' space, depending on the configuration of the basic airfield components (Fig. 1 and Fig. 2) and the required minimum weather conditions in the air shows, see Tab. 2 [6].

The standard is applicable when the organizer of the event is a military authority. The relevant requirements of the standard also apply to military participants in air shows organized by the civil authority. The provisions contained in the Regulation of the Minister of Transport, Construction and Maritime Economy of 16th May, 2013, are applicable to all events combined with a public display, organized on the territory of the Republic of Poland, in accordance with the Regulation of the Minister of Infrastructure of 11th March, 2004, on detailed technical provisions of air traffic, and are secondary legislation to the Act of 22nd August, 1997, on the security of mass events to be used during these shows. The need for the application of these two documents is

due to the participation of both civilian and military air crews in air shows. The provisions that are more restrictive are to be used, in principle, whenever there might be different approaches to contentious issues.

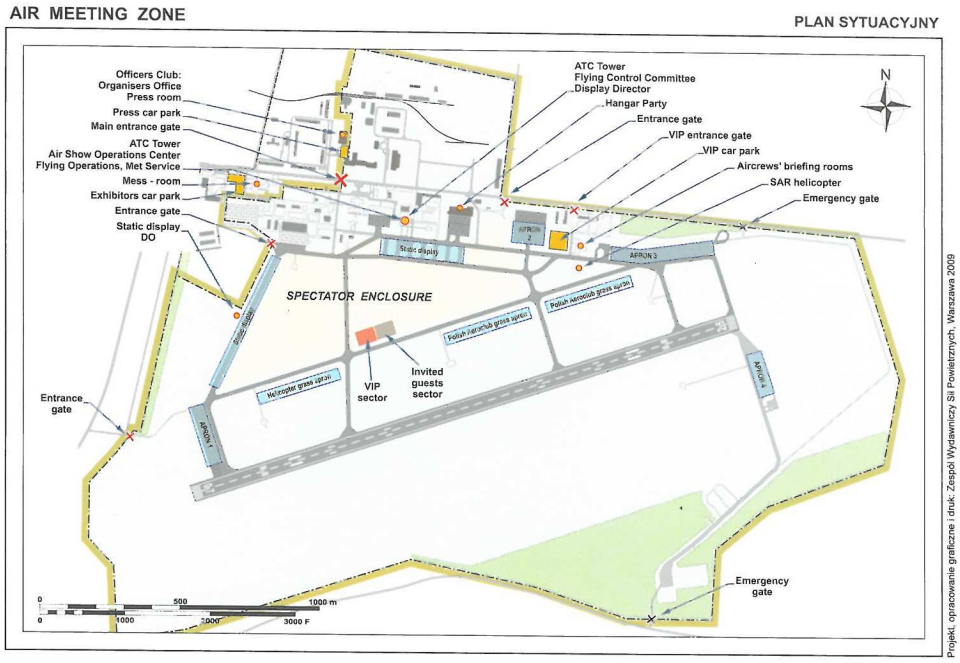

Fig. 1 Location of the basic airport elements during the Air Show in Radom, 2009 [6, 7]

3. Safety Aspects of Air Shows

Aviation safety includes problems of air traffic safety (operational safety) and problems of measures taken to protect air transport assets and aviation infrastructure against acts of unlawful interference (security). Before the issuance of the Safety Management Systems Aviation (SMS) by the International Civil Aviation Organization (ICAO), operational safety (safety) and the protection of aviation operations (security) had been treated together.

This definition of security also refers to threats: "Security is a condition in which the risk for people or the risk of property destruction is reduced or maintained at acceptable levels through an ongoing process of identifying risks, and risk management" [8]. On the other hand, the risk in relation to aviation operations is a state or a potential source of negative consequences, such as e.g. destruction of aircraft or the injury of the air personnel.

Due to their nature, air shows are exposed to threats unusual to other mass events, as they may occur both on the ground and in the air. In addition, in 21st century air force became an attractive target for asymmetric action, i.e. terrorism, due to the scope of the damage which it could cause.

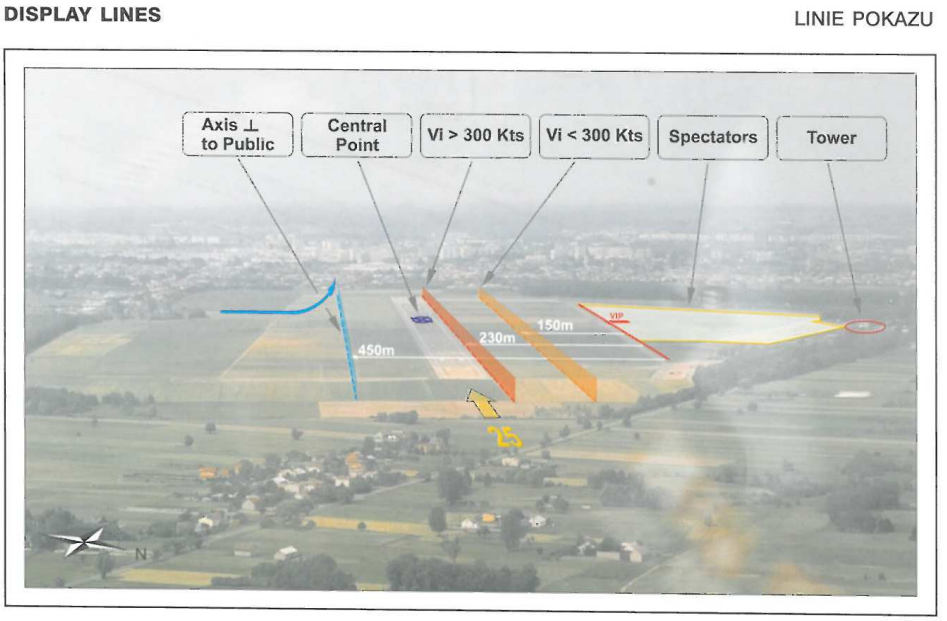

Fig. 2 Air operation boundaries (thick lines) during the Air Show in Radom, 2009 [6, 7]

Tab. 2 Minimum weather conditions in the area of air shows [6]

Manoeuvre type	Number of aircraft	Helicopters		Short take-off and landing (STOL) aircraft		Other aircraft	
		VIS[(a)]	BASE[(b)]	VIS[(a)]	BASE[(b)]	VIS[(a)]	BASE[(b)]
Straight and level flight	1	1.5	200	1.5	300	3.7	1 000
	from 2 to 6	1.5	300	3.7	1 000	3.7	1 000
	from 7 to 16	1.5	300	3.7	1 500	3.7	1 500
	over 16	1.5	300	8.0	2 000	8.0	2 000
Manoeuvres in the horizontal plane without vertical manoeuvres	1	3.7	1 000	3.7	1 000	3.7	1 000
	from 2 to 6	3.7	1 000	3.7	1 000	3.7	1 000
	from 7 to 16	3.7	1 000	3.7	1 500	3.7	1 500
Unlimited aerobatic manoeuvres	According to the order on the organisation of demonstrations issued by the Air Show Director						

[(a)] Visibility in miles.
[(b)] The base of the clouds, in feet, above, with shade 5/8 and larger.
NOTE the foot (ft) is a unit of measurement not belonging to the SI. Valid: 1 foot = 0.3048 m.

At the planning stage of the shows, a directory of common threats that may arise during the course of this type of event should be created. Such a directory may contain, inter alia:

- air show airspace incursion by aircraft uninvolved in the event;
- air accident;
- sudden weather deterioration;
- chemical or biological contamination caused by the aircraft malfunction, or the third party activity;
- asymmetric action;
- aircraft fire in the static display;
- breaking the safety rules by the air crew during dynamic display;
- road collisions near the site shows;
- panic in the public zones [9].

Consequences of the threats may be the adverse air events that are classified as:

- air incident defined as "any event other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operations" [10];
- air accident defined as an event associated with the use of aircraft, which took place from the time when anyone enters the deck with the intention of flight execution, until all the people leave the board, and in which anybody has suffered personal injury or the death, or injury was caused as a result the aircraft suffered: damage, defragmentation of construction, missing in an unknown location, in an inaccessible place or the access to it is absolutely impossible.

Analyzing the modern theories of safety is worthwhile, as they are useful in the risk assessment and Safety Risk Management (SRM). In the area of security, on the other hand, it is important to analyze the legal, procedural and technical aspects of the ground protection of the area dedicated to carry out the show, its infrastructure, and the participants. What should also be taken into consideration is how to prepare the entire system for the smooth conduct of the event, as well as maintaining readiness for immediate, correct response in the event of an emergency or crisis situation.

The analysis of literature, such as normative and planning documents, of the air shows indicates that until the introduction of the Aviation Law Act, the organizers, following the existing documents of a rank lesser than an act, treated the problem selectively, excluding multiple items within the area of security, for example, the number of protective / law enforcement personnel during the Air Show at the Radom airport in 2003 amounted to only about 380 people, 150 of whom belonged to external services, Tab. 3 [11].

4. Accident Rate Contribution to Negative Image of Mass Events Involving Aviation

Air accidents and incidents are adverse events occurring during the use of the aircraft, in connection with the entry of the aircraft in excessive critical flight parameter values, causing the destruction of aerial objects and ground facilities, the environment, and often also involving fatalities [11].

Tab. 3 Security forces of the Air Show 2003 in Radom [11]

	Number of facilities	Airfield security personnel	Military Police personnel	Police personnel	Fire Brigade personnel	Security Agency personnel	City Guard personnel
Gates, traffic security	3	30	45	–	–	18	–
Area protection	–	100	–	–	13 squads	18	–
VIP protection	2	–	–	–	–	–	–
Routine patrols	–	30	–	20	–	–	8
Parking security	3	20	–	–	–	–	–
Temporary children's shelter	1	5	–	2	–	–	–
Short-term detention center	1	–	–	3	–	–	–
Additional guard posts	–	15	–	–	–	–	–
Cash convoy	–	–	–	–	–	4	–
TOTAL	10	200	45	25	13 squads	40	8

According to the statistical data and analyses of the air accidents in the past accident investigation reports, the weakest element of the security system was the aircraft. Structural problems and the strength of the materials used in the construction cause the technology to be the most frequently occurring cause of air accidents. The operator, the pilot, could lead to overstressing the aircraft structure without exceeding their physical capabilities. Along with the growing opportunities in the field of design of fixed- and rotary-wing aircraft, achieving better and better performance in terms of speed, altitude and manoeuvrability, the man became increasingly fallible. More and more air accidents were caused by air crews.

In the 1970s, by making extensive research into the causes of air accidents, it was found out that human error remains at the forefront cause of air accidents. The studies also showed that a common accident cause was the improper management in aviation. Many experts showed the impact on flight safety exerted by the management and organizers of aviation activities, in addition to the abovementioned causes, such as equipment failure and human error, which are still present. Changes in the views on the sources of safety threats in aviation are shown in Fig. 3 [11].

Since the second half of the 20th century on, it has been difficult to make a full analysis of air accidents due to the lack of materials from the Eastern Europe, especially from the Soviet Union. Unfortunately, the knowledge of air accidents at air shows in the Western world is, even today, much wider than that of the events in the East. It was only the participation in international air shows and air salons in the West by the Soviet aircraft, which allowed gathering the data on the rates of accidents involving the aircraft from that region.

In our country, there are known accidents which occurred during preparations for the parades: UT-2 of 2nd September, 1945, Il-28 of 1st August, 1957, SM-1 helicopter of 3rd June, 1966, or the loss of two MiGs-19PM in the summer of 1966.

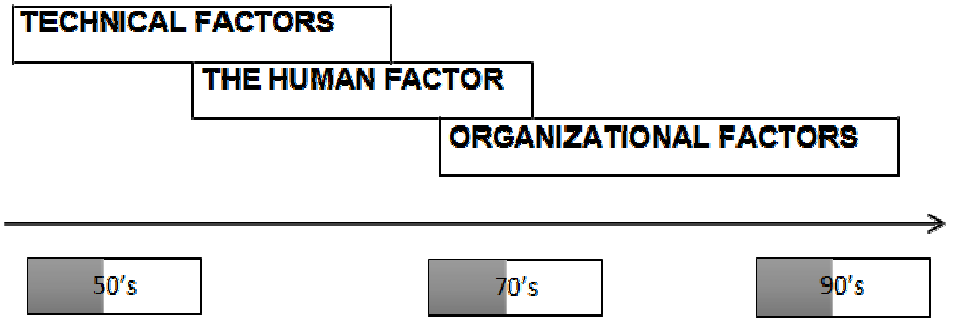

Fig. 3 Changes in the views on the sources of safety threats in aviation [9]

The end of the 1980's was the starting point of the increased participation of the military combat aircraft in air shows, which not only attracted thousands of viewers, but also caused spectacular crashes involving fatalities and property losses:

- air crash on the Ramstein base (preceded by a tragic accident of an American CH-47C in Mannheim in 1982);
- air crash of the Italian Tricolori which caused not only the death of 70 people, but also hundreds of injuries;
- collision of two fighter aircraft in Fairford;
- ejection of Vyacheslav Avierianov and Vladimir Szendrik out of a prototype of Su-30MKI in Paris shortly after hitting the runway;
- air accident of a Su-27 in Lviv with over 80 fatalities in the audience.

Over the past three decades there were at least 9 accidents during air shows, in which the air force from the Eastern Europe has lost 11 of their aircraft, 9 Russian and 2 other from the air forces of Ukraine and Belarus. In the same period, Americans lost 8 military aircraft during air shows. These are just some examples of accidents during large air events [14].

During the author's supervision of the air shows in 2014, the following particular risks were found in relation to all identified risks:

- flights over the audience by aircraft participating in the air show;
- flights across the public zone by aircraft non-participating in the air show;
- allowing creation of "wild", uncontrolled, public zones;
- presence of unauthorized persons in the pre-flight preparation of aircraft;
- presence of objects filled with a gas lighter than air in the public zone.

5. Modern Approach to Air Show Organization

The results of analyzing the justification of the present paper's subject matter have led us to searching for answers to the basic question: What factors should be taken into account in the organization of air shows to maintain their required safety level?

The answer to this question is possible by analysing:

- the level of safety factors implemented until now in the air show – analysis of selected representative mass events (air shows);
- the impact of the factors decisive from the perspective of the level of safety at the air shows, with particular reference to international and national air regulations;
- the role of various components of the aviation system (man-machine-environment-organisation) in the process of achieving and maintaining an acceptable level of safety at air shows.

The results of the analysis of the literature carried out so far suggest that both the legislation and its application, and also the organization of the mass air events, reveal a number of shortcomings which have a decisive influence on the safety level. They indicate that there are policies and projects possible to implement in order to raise the safety of air shows to a higher level. With regards to the above-mentioned factors, it is necessary to develop comprehensive policies and measures aimed at harmonizing the preparation and conduct of mass air shows in different dimensions, both local and international, i.e.:

- to continue analysing the threats and experiences from the air shows carried out so far;
- to establish clear rules, taking into account the current legal status of the shows;
- to carry out analyses in terms of needs and measures to be taken in order to protect the event, having regard to the study of potential threats;
- to create organizational and management teams in charge of various safety system components in a well-thought out way, based on the developed algorithm way;
- to prepare and carry out the decision-making simulation involving the individual elements of the organisational system, with exercises and training to coordinate the entire safety system, using appropriate forces and safety measures;
- to formulate the conclusions from each edition of the show in order to implement them in the subsequent air shows.

Based on the anticipated objective of the show and the risk analysis, the basic tasks of the air show safety system are:

- ensuring safe aircraft movement on the ground and in the air;
- analysis of meteorological conditions for the execution of the tasks in the air;
- search and rescue;
- preventive action regarding public order;
- coordination of road traffic and the flow of spectators;
- fire protection;
- medical services;
- support for public event notifications – thefts, robberies, losses;
- readiness for crisis-response operations;
- in the event of an emergency: isolation of risk locations, taking the appropriate action, preventing panic, and dealing with the consequences of the emergencies.

As defined above, the tasks of the safety system allow one to select appropriate services and coordinate their cooperation which is necessary to ensure safety. In air shows, we must bear in mind two locations that can be at safety risk, i.e. air space of the show, i.e. the airport, and its vicinity within 9.3 km radius. Vastness of the area of activities require to establish of two safety teams: Air Show Management responsible for safety in the air, and Ground Safety Team responsible for safety on the ground[1].

The analysis of the organizational documents concerning subsequent International Air Shows in Poland, as well as local shows organized by the Polish Air Force, shows a very important and effective element of the show, i.e. a practical coordination training involving all components of the safety system. It is an integral part of the final stage of preparations for each edition of the air shows. This is done by verifying communications between the system components, and training security services with the use of a special group simulating real threats (Tab. 4), as well as evaluating the performance of the security services by means of a team review.

Note: The detailed actions at the accident site are performed by all services (fire brigade, police, military police, Government Protection Bureau, special services) according to their own procedures depending on the development of a crisis situation.

A set of events that can occur in the mass event of such a scale and nature that is included in Tab. 4 above allows, through a simulated execution, to practice Standard Operational Procedures of individual services, to connect all the links of the safety system, and to show the possible vulnerabilities in the system.

An extremely important factor, and sometimes the decisive one for the success of air shows, is the weather conditions, as the dynamics of air shows is largely dependent on them. Changing weather conditions require a full cooperation of the teams responsible for ensuring the safety in the air during the dynamic demonstrations. Such weather conditions require a special focus and flexibility on the part of the show Management and air crews engaged in piloting the aircraft; the Air Show Director may be required to take difficult decisions including an earlier than planned termination of the show on the particular day.

Another very important factor influencing the safety is the coordination of the departments in the use of airspace, aircraft movement on the ground, and restoring combat readiness of the aircraft. On the other hand, continuous analysis of weather forecasts guarantees correct decisions as to the further implementation of the show's schedule (possible interruption, sequence change, termination). This is essential, because the economic aspect (the event should not bring about financial losses) can cause a pressure exerted by the organizers on the Air Show Director to reduce the safety requirements.

Moreover, an air show organizer should bear in mind that in real life, such events are limited and shaped by site-airport, aprons, spaces for general public, cars parking, arriving roads, etc. Then the safety and security are applied to organization intentions.

[1] Apart from the organizers' representatives (functionaries from the airbase who are supervising to separate forces and autonomous resources), representatives of external institutions responsible for their subordinate activities and coordination are also included in the teams.

Tab. 4 Assumptions for the coordination training

No.	Time	Simulation scenario	Information source	Standard Operational Procedures (SOP) to be followed in the initial response stage by the Chief of the Security Response Team
1	09:05 a.m.	The crew coming from weather air reconnaissance informs Air Traffic Controller (ATC) about braking problems with the plane stops 100 meters from the end of the runway blocking it.	The TWR (tower) Air Traffic Controller	• notify the representative of the Fire Brigade; • announce the fire alarm; • collect information to take further decision; • monitor the course of action;
2	09:30 a.m.	Group of about 10 aggressively behaving individuals' attempt to access the airport at the main gate	Manager of the Pass Office	• notify the Air Show Director, representatives of the police, military police, fire; • brigade fire and the closest patrol; • call the reserve units of the Voivodship Police Command; • collect information to take further decision; • monitor the course of action;
3	10:00 a.m.	Found a pack of unknown origin in the area around the VIP (Very Important Person) bleachers	Official Government Protection Bureau	• notify the Air Show Director, a representative of the police, military police, and fire brigade; • decide to evacuate the affected site; • collect information to take further decision; Monitor the course of action;
4	11:30 a.m.	Smoke noticed, coming out of the An-28 airplane cabin in the central part of the display	Static display Manager	• notify the Air Show Director, a representative of the police, military police, fire brigade; • announce the fire alarm; • decide to evacuate the affected site; • collect information to take further decisions; • monitor the course of rescue;
5	12:45 a.m.	F-16 aircraft executing demonstration struck the audience	Air Show Director	• initiate the rescue action; • notify the crisis management Centre and hospitals in Radom; • secure the accident site and call the police, military police, and fire brigade; • secure the passage of vehicles for a post-disaster recovery to designated hospitals; • monitor the course of rescue.

6. Directions of Changes in Organization and Conduct of Air Shows from the respective of Participants' Safety

The International Air Shows in Radom, air picnics, and local air meets at Air Force Bases have confirmed that the adoption of the ground and air safety system model presented in the previous section proved to be efficient. This model was tested in practice during the 2009 Air Show in Radom, following an emergency situation caused by an accident of the Su-27 belonging to the Belarus Air Force on the second day of the show. Despite the death of the air crew, the implementation of the entire safety system during the rescue operation and after an earlier–than–planned end of the show, was given a positive evaluation by the institutions explaining the causes of the accident. This of course does not mean that we should not continuously try to improve the legal basis for the air show organization, organizational foundations, or procedures. Any action to increase the safety of people participating in mass events related to aviation is legitimate and necessary, given the extremely high popularity of such events.

7. Enhancing Emergency Response System Capabilities During Air Shows

Preventive action does not always completely eliminate the risk of adverse events. There are too many factors that could affect the air shows which are independent from organisational and systemic efforts. Therefore, the reaction is the response to the existing situation in order to control it and minimize its negative impact. Systems that simulate various events that may occur in different organization phases of an event and in its course are very helpful. Creation of checklists may be preceded by a simulation game that demonstrates weaknesses and which will prepare the individual components of the safety system for proper operation. Each simulation should undergo an external audit to determine the weak points of the system and it should be discussed upon completion. Training should be carried out until the weak points of the system disappear or their impact is reduced to an acceptable level. Simulation and repair process of the system is time-consuming and costly, but due to its relevance it cannot be ignored in any way. The organizers should make all efforts in order to reduce the effects of any potential adverse events to a minimum level. With the changing world and technology, there are new threats and, as a result, the response plans should be changed on a regular basis and before each subsequent air show, coordination trainings should be made mandatory for all employees and training services.

An ideal tool for the continuous process of the improvement of emergency response plans can be a modification of the PDCA (*Plan-Do-Check-Act*) cycle also known as the Deming Cycle [14], the idea of which is to create a flow chart representing the sequence of actions shown in Fig. 4.

The process described by the "Deming's Wheel" begins with the determination of the current state and detection of the problems. Once their causes are recognized, a plan should be developed to improve the process and its implementation. However, this is not the final step. It becomes necessary to review the results of the checks carried out, and then further streamline subsequent processes.

8. Conclusion

The analysis of adverse events at air shows points out to the fact that, most frequently, the human being still remains the weakest link in the security system. From this

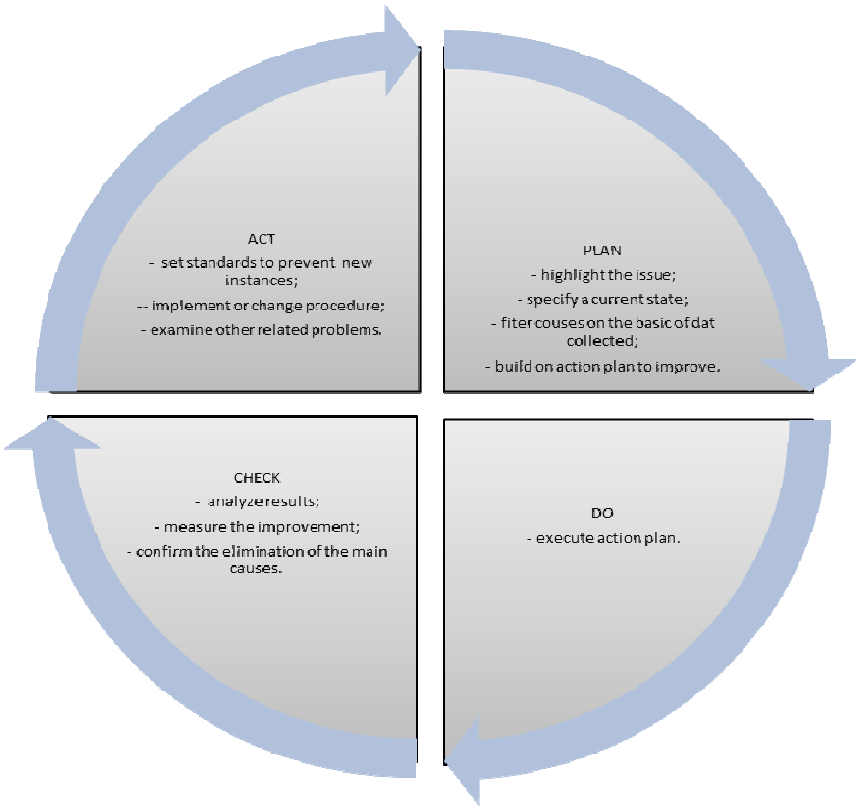

Fig. 4 PDCA Improvement Cycle by Deming [14]

perspective, any action of the organizers and security services should be subject to safety assessments each time upon the completion of the event, among the leadership of the institution providing the resources for its implementation. It should be stressed that the essential condition for the safe execution of such a mass event type as an air show is not only a strict adherence to the rules at every stage of its course, but also the use of previous experience (lessons learned). Consequently, there are some guidelines to be taken into consideration during the planning and implementation of air shows:

- to assess the capacity of the airport and the city in terms of airspace protection, disposable airport infrastructure, access and parking options for the city, and the emergency response systems;
- to estimate the momentum of the show for the purpose of planning the amount of forces and means necessary for its safety;
- in connection with the three stages of air shows, to include in the planning the rational use of forces dedicated to security (build-up of forces, full readiness for action, maintaining the necessary forces to secure the departure of crews);
- Security Plan should always include elements such as flight safety conditions, static display safety conditions, organization and conditions of audience evacuation, search and rescue, standard operational procedures for crisis situations typical of the air shows;

- training of the security system preceded by the inspection of the entire communication system should be an integral part of the preparation;
- forecasting the weather conditions should be based on the use of all available tools, and monitoring the current weather conditions should be continuous. Forecast and monitoring should be included in the route of the aircraft arrivals with their home bases;
- upon completion of the preparations, a briefing of the Air Show Management Team and Ground Safety Team should be held with the organizers in order to familiarize them with the weather forecasts and provide feedback on the training, as well as to present the minimum conditions at which air show should be interrupted;
- prior to the commencement of the show, conduct a briefing with the accredited media on security issues and the potential use of their photographic or video materials in the event of a crisis;
- the rotation of the various positions due to the long duration of the event needs to be taken into account;
- to interrupt the show immediately if an air crew violates safety conditions;
- to keep an extra airport crew on standby No. 2 in the Search And Rescue (SAR) helicopter during dynamic presentations in the air.

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