

Safety management of formation flying in an aerobatic team

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Abstract: *The article is focused on explaining the notion of safety from the aspect of generally applicable standards established by the ICAO. It describes the role of human factor played by the pilot's personality in an aerobatic team by way of determining the individual traits of team members as pre-requisites of mastering formation flying.*

Key Words: *aerobatic team, human factor, pilot, safety management*

1. INTRODUCTION

Safety is a status, when protection of people and assets is at such a level that minimizes risk by way of a continuous process of risk identification and controlling the safety of risks. In terms of formation flying, safety is understood as a set of organizational measures resulting in successful handling of flight displays (of an aerobatic team).

2. FLIGHT SAFETY IN THE AEROBATIC TEAM

Depending on the point of view, the concept of safety in aviation can have several connotations, such as:

- No accidents (or serious incidents) – the view held by the majority of the participants to air displays.
- Exclusion of danger and risk, i.e. the factors, which generally may cause damages.
- Environment considered safe for the activities of aerobatic group members (the so-called „safe common culture“).
- Level of inherent (basic) risks in aviation is considered as „acceptable“.
- Process of identifying hazards and risk management.
- Control of losses (human, material, environmental) caused by accidents.

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3. THE RESPONSIBILITIES OF PILOTS FLYING IN FORMATION, BOTH LEADING AND THE LEAD ONE

The pilot in the lead of the team is held responsible for the successful and safe flight of the group. It is prohibited for him or her to fly into clouds (if not planned so) and fly under worse meteorological conditions as admitted by the levels of proficiency of the lead pilots!

He is liable to:

- Remain continuously in command of the formation (from starting to roll till landing).
- Know positions of aircraft in the formation and be in control of all the activities during the entire flight.
- Maintain modes of flight that enable the pilots to keep their position in the formation.
- Make no sudden changes in speed, direction and altitude of flying, especially when flying at low level or even at supersonic speeds.
- Monitor and assess the situation in the air and the meteorological conditions, requiring information from centers of command and take decisions based on the situation at hand.
- Perform orientation during the flight along the route, while complying with the flight plan and the advices of the ATC authorities.
- Have a performance reserve for the lead pilots when flying close to the operational ceiling of their aircraft. It is inevitable for maintaining one's position in the group and avoiding unnecessary and useless re-grouping and maneuvering.
- Assign a crew to accompany the aircraft leaving the formation if necessary.
- Check fuel amount status in the aircraft flown by all members of the team.
- Hand over command to his deputy in the group should his radio fails to operate.

The lead pilot is prohibited to join the formation or change his place in the group or leave the formation, except for the case of failure to his aircraft equipment, system or icing (formation of dew) on the cockpit canopy, when holding position in the formation is impossible. When flying in the group, the lead pilot **is liable to:**

- Continuously maintain his or her position in the group.
- Continuously monitor the aircraft in command, without losing it from sight.
- Join the leading aircraft in direct flight, only after having set the ordered distance at larger separation and with vertical separation (when flying above ground and at low altitudes with vertical separation), and then to take his due position.
- Pay attention to commands (signals) of the pilot in the lead and observe them exactly.
- Be continuously vigil thereby preventing dangerous closing-in to the rest of other aircraft in the formation and collision with obstacles when flying at CTG and low altitudes.
- Be knowledgeable of aircraft capabilities and make best use of them.
- Report immediately all technical failures of his aircraft to the leader of the team.
- Perform continuous orientation and be ready for independent navigation at any time.

If the leading aircraft is lost out of sight, the pilot of the lead aircraft is liable to:

- Immediately leave the group towards the free area and report it to the leader of the group.
 - ✓ Maintain straight-and-level flight at break away from it by gradually increasing lateral separation.

- ✓ When flying in a turn as the outer wingman, reduce banking and break away from the group. If flying as an internal wingman, increase banking and break away from the group. If the altitude makes it impossible to increase banking, break away towards the free space available.
- ✓ When in dive, recovery from dive is performed without changing the direction of flying.
- ✓ In pull-up, break-away from the group is made by gradually increasing the lateral separation and then it comes to reducing the angle of pull-up.

Basic safety requirements for formations at air displays are:

- Plan and perform displays so that the displaying aircraft is to fly along the line of performance at a safe distance from the visitors (over flight in direction of the viewers followed by a sudden turn performed close to the limits set for the display prohibited).
- Participate in the pre-flight briefing.
- Present if requested by the Director of the PAD the documents and the valid description of the performance.
- Adhere to the variant of performance determined by the Director of the PAD including all the limitations.
- Make sure that the aircraft are manned only by the crew named in the display description.
- Pay due respect to the hints of the Director of the PAD.
- Be exactly knowledgeable of and adhere to the appropriate limits (lines of demonstration performance).
- Pay due respect to the hints of the ATS.
- Participate of the Post flight analysis (if held).

4. HUMAN FACTOR IN THE SYSTEM OF FLIGHT SAFETY OF AEROBATIC FORMATION FLYING

The issue of human factor in aviation is primarily linked to pilots. It is about people, their lives and activities as performed in the surrounding environment, their relation to the facilities and equipment, with which they come into contact on a daily basis and about the relations to other people as well. [3]

Coping with the issue of "human factor" in aviation at the level of the current status of knowledge is of principal value for efficient utilization of the pilots' potential for formation flying in an aerobatic team.

Analyses of the causes of air accidents of aerobatic teams show that the share of human factor on the rate of accidents in this type of flying is the one, where further reduction is difficult to achieve.

4.1 Errors made by pilots

Pilots within the entire system of aviation, are on the other hand the most flexible, most adaptive and the most valuable element, which is unfortunately most apt to making errors.

Conclusions drawn from air accidents as much as a two-thirds share of the causes is attributed to error made by pilots.

The notion of "pilots' error" cannot be referred to in isolation when investigating air accidents. [11]

Sources of errors when flying can be traced back to improper perception, poor assessment of the situation, wrong choice of the procedures and incorrect performing of the aviation tasks. An ideal pilot is capable of:

- Maintaining full situational awareness before and during the entire flight.
- Maintaining the necessary level of vigilance, attention and decisiveness during the entire flight.
- Making timely definitions as to the variance from the required status and of executing proper corrections.
- Real risk assessment and finding optimal solution when in crisis or critical situation.
- Proper and right communication with other members of the group.
- Remaining not influenced by personal, family and workplace or other problems.

A real pilot should get as close to the ideal as close as possible.

Five most frequent causes of accidents caused by pilots in terms of occurrence:

1. Loss of control over direction of flight.
2. Erroneous judgment.
3. Not comply with the speed of flight.
4. Erroneous preflight preparation and preflight decision.
5. Not keeping the permission/prohibition from the ground traffic control.

Errors of pilots are not some kinds of abnormal behavior, but are of the natural by products of the complex air operation. Errors must be accepted as normal components of any system, where the pilot or technology is interacting components.

Errors of pilots can results from:

- Wrong methodological procedures.
- Insufficient ground, preliminary and preflight preparation.
- Training process out of order.

4.2 Requirements on pilots and air training

Aviation psychology describes requirements on pilots, whereas a modern pilot should press certain circles of psychological and psycho-physiological qualities.

Among others, they involve:

- Independence and speed in decision-making.
- Speed and critical thinking.
- Clear and substantial capability of perception and attentiveness.
- High level of emotional and mental stability.
- Sound special orientation and operational memory.
- Capability of rapid and flexible development of senso – motoric and mental competencies.
- Tolerance and resistivity to stress.
- High level of dependability.
- Socio-psychological qualities such as capability of good coordination of activities, social solidarity, feel for friendship.

In general, pilots are more realistically oriented, critically and emotionally more stable than the majority of other people. They are more extraverts, more calm and composed when under stress and capable of withstanding load attributed to their strong belief in their own performance and capabilities.

It is necessary for the pilots to rationally interlink their physical and mental capabilities.

Pilots prefer living their own way of life, which is remarkable for their sense of order on the one hand, organization and discipline on the other and also by independence and unconventionality. They do not show special understanding for their problems, though they do not like when criticized personally. Aptness to the feeling of guiltiness as a personal characteristic is very rare with the pilots. For them, social status is very important and they attribute special importance to activities, which could emphasize this status. Drive for acknowledgement is far less oriented on glory, but on how to maintain personal performance on the good level. They are sometimes characterized as an omnipotent elite group, which can be less related to the need to be important than to the fact that in this profession – more frequently than at any other professions – danger, risk, stress and high dementedness are part of the job.[1]

By determining the level of stress in aviation, we obtain information for the prediction of pilots' further activities, foreseeing the consequences on their health and taking efficient measures, inevitable for preventing undesired phenomena. However, determining the degree of stress is not that simple.

It is important to keep on mind that it is a literally psychological status to be lived up exclusively individually.

With external conditions unchanged, they can take not only different forms and different sizes at each pilot.

So, with the very same pilot, at changing the internal status (e.g. status of being threatened, taking over higher responsibility, high physical fatigue etc.) the level of stress can change.

Step one in reducing stress consists in identifying the moment when the normal stress limit has been passed by the pilot, but it still remains a rather personal assessment. Warning signals are such as tensions, feeling of stress, irritability, dryness in mouth and in the neck, fearfulness at random noises and situations, depressive attitude and loss of patience towards others. Many of these factors can be considered as symptoms of stress. However, stress is inevitable part of the profession of pilot, and in small grades it is necessary indeed. It is the natural way of keeping the pilot alert, and it can eventually lead to higher concentration and identifying (situations of) danger. [4]

On the other hand, however, external stress leads to external fear and fearfulness, and it can result in reduced capability of concentrating on what is dangerous. If stress perseveres, the organism is starting to adapt to the prevailing circumstances. It can lead to wrong judgment and decision-making, and if relaxation does not come, stress could result in illness and threats to life. [2]

5. INFLUENCE OF PERSONAL QUALITIES OF THE AIRCRAFT PILOTS ON THE ACTIVITIES OF AN AEROBATIC TEAM

In the world much attention is paid to the research of personal traits of pilots and the aircrew as well, proven by more or less sophisticated profiles of various aviation specialties. From the point of the pilot's profession, the issue of psychological selection is added by evaluating specific personal traits such as:

Structure of motivation.

- Structure of interests and aptitudes.
- Emotional resistivity (stability, even-mindedness).

- Capability of withstanding internal lead and stress.

Practice in aviation is proving that pilots of aerobatic team not being at different levels of Professional preparation and health status and certificate of health status behave differently in equally flight situations.

It appears to be conditioned by the structure and the peculiarities of the regulative functions of the pilot's personality. [5]

It is characterized by variability, which can be shaped by means of systematical air training

The most personal traits and capabilities of aerobatic team pilots involve:

- Knowledge and general faculties.
- Cooperation.
- Special orientation and movement coordination.
- Speed of perception.
- Readiness/alertness and resistivity to stress.
- Motivation/decisiveness and self-confidence.
- Self-control and courage.
- Awareness of responsibility/leadership qualities.

5.1 Psychological requirements on the personality of aerobatic team pilot

For the aerobatic team to operate properly and at a quality, every year, it is necessary add a minimum of one new pilot to the team, ideally two, and then have them involved into all activities of the aerobatic team. When selecting a new member of the aerobatic team, it is necessary to assess the following personal traits and capabilities of the pilot:

- Motivation and high level of interest in aviation activities related to flying in an aerobatic team, effort to improve one's art.
- Sufficiently high general education (general mental aptitude).
- Practical and operative type of thinking.
- Emotional stability.
- Sanguine temperament.
- Very good ability of dividing, transferring, high capacity and stability of attention.
- Good memory and readiness of recollection.
- High speed and precision of complex emotional reactions.
- Excellent motoric coordination, agility.
- Excellent special imagination and estimation of time.
- Sufficient volume, speed and precision of perceiving the depth, high, forms and dimensions, speed of movements.
- Capability of easy development and reworking motoric habits.
- Strength of will.
- Endurance, decisiveness, courage – as personal traits.
- Initiative, intelligence, self-criticism.
- Leadership traits.
- Socializing, openness, sense of humor.
- High self-confidence, resistance to factors of disorganization, capability of getting adequately mobilized when solving crisis situation.

5.2 Personality requirements – for the leading pilot of the aerobatic team

In the forefront of the requirements traits established for the leader pilot of the aerobatic team are characteristics that can be related to, capability of influencing and persuading, cooperative behavior, self-control, awareness of responsibility, honesty and endurance.

The leader selected is usually the most experienced pilot with a large view and moral authority. Personal traits of the leader pilot of the aerobatic team also termed as “leadership qualities” involve:[9]

- High level of self-confidence backed by perfect preparation.
- Capability of controlling a team both from emotional and piloting point of view.
- Capability of maintaining a good overview throughout the entire flight and exercising control until the successful ending.
- Capability of intuitive and solving non-standard situation.
- Capability of demonstrating good judgment and make good decisions which will ultimately gain the consent of the team.
- Capability of separating facts from emotions.
- Capability of communication.
- Capability of listening in terms of accepting others' opinions.
- Capability of clearly applying and transferring aspects and opinions.
- Capability of cultivating and developing trust in others.
- Capability of delegating the tasks and the responsibility onto others.
- Capability of understanding and empathy to others,
- Capability of friendly communication.
- Capability of establishing priorities.
- Capability of performing a quality based analysis (briefing).

Requirements established for the position of the leader pilot in the aerobatic team:[8]

- High speed in perceiving the concrete situation.
- Resistance to external stress.
- Reliability in activities and communication in the course of acquiring various types of information.
- Initiative.
- Reliability.
- Readiness to operation.
- Leadership (managerial) qualities.

5.3 Personality requirements – for members of the aerobatic team

Personal profile of pilots in this category involve, apart from specific capabilities (intellectual/motoric), also factors of the traits, which enable their psychological activities and the required performance under stress and under higher workload. Here, adequate motivation and self-activation (excitation) appropriate to psychological load is needed. Internal tranquility and even-mindedness are inevitable pre-requisites.

Apart from the necessary capabilities for the flight operation the functions of perception are also required.

These functions must enable processing of information under high time stress and being capable of withstanding short-term high physical and psychological load.

- The position of the aerobatic team pilot requires:[10]

- High speed of speed in perception.
- Excellent orientation capabilities.
- Capability of concentrating and transferring attention.
- Remarkable discernment of the eyes for close and distant objects.
- Capability of calculating time and readiness to reaction.
- Decisiveness.
- Initiative.
- Readiness to withstand extreme risk. [6]

Developing a generally applicable model of the aerobatic team pilot's personal traits is a task rather complicated.

Therefore, the forefront is taken by the need to have a sophisticated and quality-based selection of the members of the aerobatic team.

The entire issue is becoming complicated even more, because there is a large group of pilots, who despite of unsuitable individual-psychological personal traits are successfully adapted to the condition of air operations. [7]

For these reasons, the given issue makes it necessary to ensure continuous and intensive monitoring of the selected pilots, which pays off, for sure. Human errors can be reduced by means of introducing new technologies, perfect organization of both the theoretical and practical training and optimization of regulative measures.

6. CONCLUSION

Safety is a status in which the risk of occurrence of damage or destruction is limited to an acceptable level. Placing safety into hazard generates risks and may become evident by way of violations of safety ultimately leading to air accidents or incidents. It can be identified by official safety checks well before an event harming safety occurs. However, when identifying the hazard to safety it is important that the accompanying risks are simultaneously estimated. Arriving at the essence of risks is followed by the stage of decision on its acceptability, which along with those unacceptable ones must be handled by taking appropriate measures to eliminate them.

Interaction of the pilot with the aviation equipment and the environment in formation flying is of high importance and it is here that human factor is coming to the forefront. For formation flying in an aerobatic team, human capabilities of the pilots are decisive in making up new combinations of aerobatic elements, which subsequently play a vital role in flight safety of the team as a whole. Human factor is of high importance not only in ensuring safe flight tasks, but also in knowing those dangerous ones – which result in air accidents.

Safety management is focused on systematic approaches of identifying risk hazards, in order to minimize losses on human lives, damages to assets, financial, social and environmental losses.

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