



## Safety Management and Formation Flying of Aerobatic Team

### KEYWORDS

pilot, aerobatic team, display

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### ABSTRACT

The article is describing the issue of establishing the fundamental criteria for selecting pilots for aerobatic teams. It analyses the elements of piloting techniques and the critical phase of flights in view of the load to be borne by the pilots of the aerobatic team pilots in term of tem flight proficiency. Analyzing the fundamental criteria for the flight display of aerobatic teams It describes the elements of formation flying proficiency arranged into a display under normal meteorological conditions.

### INTRODUCTION

Human factor is the most important one to be taken into consideration in aviation. The interaction of pilot with aviation technology and the environment when flying in an aerobatic team is of very high importance. It is the place where human factor is taking the priority.

In aerobatic flights human capabilities of pilots are of decisive importance in creating new combinations of aerobatic forms, figures, which subsequently play a primary role in the safety of cooperation for the team as a whole. Human factor is not only of high importance in safety but also in handling dangerous tasks, those that might result in air accidents or even fatalities.

### SELECTION OF PILOTS INTO AEROPBATIC TEAMS

In view of the non-existence of research made so far, I performed made as questionnaire-based survey oriented on evaluating the criteria which must be met by pilots accepted for the screening for the position of the leader pilot, team member (between 2-6) and solo pilot (number 7) in the aerobatic team. Part two comprises a questionnaire investigation focused on the evaluation of the critical phases of piloting and flights of group flight proficiency in the aerobatic team. The investigation was concerned with team I have known personally. They have been pilots with high level of moral capabilities, whose answers have been supported by their Professional experiences.

- Criteria for the selection of pilots into the aerobatic team
- A. Basic criteria to be met by pilots accepted for the selection process for the leader pilot in the aerobatic team are as follows:
  - Optimal age, between 33-37 years.
  - Overall flight flown exceeding 2000 hrs of flights.
  - Minimal hrs flown on the given type of aircraft over 500 hrs.
  - Achieved level of military flight proficiency: Class 1.
  - Achieved civil qualification of the commercial pilot license of aircraft (CPL/A).
  - Language proficiency by ICAO NORMS at a minimum of „5” – validity of testing, 6 years.
  - Personality with high level of self-assurance and excellent organizational skills, for the ability of controlling the team both in terms of flying and emotional points of views.

As a rule, the leader of the aerobatic team is assigned to this

position only as having been the formal member of the team, wherein he has confirmed his extraordinary piloting skills and organizational capabilities.

- B. The fundamental criteria to be met by the pilots included into the selection process for the position of the aerobatic team member (numbers 2-6) are as follows:
  - Optimal age 30-35 years.
  - Overall number of hours flown exceeding 1000 flight hrs.
  - Minimal number of hours flown on the given type in excess of 300 flight hours.
  - Holder of the 1st Class of military flight proficiency.
  - Holder of the civil qualification of commercial pilot of aircraft (CPL/A).
  - Language proficiency as by ICAO standards at level „5” – validity of tests 6 years.

Establishing the appropriate criteria for pilots of aerobatic teams is the cornerstone of their successful functioning! This is the starting point, the alpha and omega, towards successful cooperation of group flying proficiency of an aerobatic team.

- C. Basic criteria to be met by pilots included into the selection process for the position of the solo pilot team member (number 7) on the aerobatic team are as follows:
  - Optimal age 30-35 years.
  - Overall number of hours flown in excess of 1000 flight hrs.
  - Minimal number of hours flown on the given type over 500 flight hours.
  - Holder of the 1st Class of military flight proficiency.
  - Holder of civil qualification for commercial pilots of aircraft (CPL/A).
  - Language proficiency certified to ICAO standards, minimally at level „5” – validity of tests 6 years.

As a rule, solo pilot in the aerobatic team is assigned to the given positions only following a period already having performed in the group and having confirmed piloting skills. One can say that the solo pilot is a superstructure of pilot positions in the aerobatic team. He must be capable of handling tight formation flying and within a very short period of time reorientation himself to high solo flights at close altitudes above the ground.

- D. Supplementary criteria to be met by the pilots included

in the selection process are the following:

- Minimal number of hours flown for the latest year in excess of 100 flight hours.
- Average number of hours flown for the recent period of three years in excess of 100 flight hours.
- Regular flying in groups with intervals not exceeding 1 month.
- Personality with excellent flying skills especially interested in flying in the aerobatic team.

**ELEMENTS OF PILOTING TECHNIQUES CRITICAL FOR AEROBATIC GROUP FLYING PROFICIENCY**

The elements of piloting in group flying of aerobatic teams can be divided into four groups:

- Special elements of high level of piloting technique for individual pilots in the aerobatic team:
  - Inverted position flight,
  - „hops on the goat“ (regrouping within the group using rolls),
  - Rolls around the groups,
  - Breaking from and rejoining the group (fan, umbrella).
- Special elements of piloting techniques and those of higher piloting techniques related to changing position within the whole aerobatic group as a whole:
  - Barrel roll,
  - „Snake/Spiral“ roll
  - Landing as a group,
  - Loops for changing position-snake dragon, rajah, swan, vixen, oscar,
  - Takeoff as a group.
- Standard elements of higher techniques of piloting in the aerobatic team:
  - Horizontal turn with bank angle of  $\approx 60^\circ$ ,
  - Loop without changing position in the climb turned by  $90^\circ$ ,
  - Slant loop with bank angle of  $\approx 30^\circ$ ,
  - Loop without changing position in descent turned by  $90^\circ$ ,
  - Loop without changing position,
  - Steep climb at an angle of  $60^\circ$ ,
  - Dive at an angle of  $60^\circ$ ,
  - Combat turn.
- Standard elements of piloting technique in the aerobatic team:
  - Break away before landing,
  - Landing individually with one minute interval in the group,
  - Takeoff individually with one minute interval in the group.

The most demanding elements of piloting techniques listed above are inverted flight, „hopping the goat“ (regrouping within the group using roll), rolls around the group, break-away from and rejoining the group (fan, umbrella).

**CRITICAL PHASES OF AEROBATIC GROUP FLYING PROFICIENCY**

According to the pilots, flying in clouds in a tight formation is considered the most critical, mostly during over flights to air shows. Even under rather complex meteorological conditions, pilots were to maintain tight formation during entire flight. This is where illusion of flights started to develop quite often. On having passed not more than 10 minutes of flying in the clouds, pilots flying on the right side were having the feeling of making steep turns to the left and pilots flying on the left side were feeling to make steep turn to the right, while pilots flying in the rear were having the illusion of being still involved in loops. This illusion at flight could be eliminated only by the pilots realizing their proper position and looking at the artificial horizon. As further critical phases of flying in the aerobatic teams were attributed to the **technique of flying in the area of operation and over flights to other airports.**

**SAFETY REQUIREMENTS FOR AIR DISPLAY**

The fundamental safety requirements for air display are established in compliance with the methodological guidelines of the Slovak Civil Aviation Authorities No. 3/2004 „CAA requirements for organizing public air events (PAE)“. Participants to such public air events are liable to:

- Plan and perform their own display so that the display aircraft will fly along the line of display at a safe distance from the public (flights in direction of the visitors followed by steep turns close to that borderline are prohibited),
- Participate in the preflight briefing,
- If demanded, present the required documents and the valid description of the display to the director of the PAE,
- Keep to the variant of air display approved by the PAE director, observing all the limitations,
- Make sure the aircraft are manned only by the persons named in the display description,
- Pay maximum respect to the orders of the PAE director,
- Know exactly and maintain oneself within the given boundaries of display (lines of display)),
- Pay respect to the order of ATS and
- Take part in the post-flight briefing (if held).

Minimal altitude of climb to the precisely defined zone over free area must correspond to the individual capabilities and experiences of the flight crews and must not be smaller than it is outlined in TABLE - 1. [1] [2]

**TABLE - 1**  
**Minimal altitude at maneuvers other than over flights on the PAE**

Maneuvers	Aircraft(ft)
Horizontal turns $60^\circ$	300
Vertical maneuvers	500
Other maneuvers	500

The line of demonstration is the one clearly visible for the pilot (axis or the side-line of the runway) which cannot be overflow by the pilot under no circumstances. Such line of presentation can also be specially marked for this purpose. In view of the differences in the speed of aircraft and experiences of pilots, there may be defined more than one line of demonstration in the program. The minimal distances between the demonstration from the spectators are given in TABLE - 2. [1] [2]

**TABLE - 2**  
**Minimal distance of the demonstration borderline from the visitors and car park**

Maximal speed of aircraft during demonstration (km.h <sup>-1</sup> )	Flying over (m)	Aerobatic element (m)
less than 100	30	100
100 up to 200	50	100
200 up to 400	100	150
400 up to 600	150	200
more than 600	200	230

**DESIGNING THE FLIGHT CONFIGURATION**

Flight configuration for a 7-member aerobatic group for normal meteorological conditions - „variant A“ is assuming cloud base at 3 900 ft and minimal visibility of 4 km. The time of flying from takeoff to landing 25 minutes. By standard, the group is taking off in the configuration of 3+3+1 aircraft with the intervals of 5 seconds. If meteorological conditions are worse, if strong crosswind disables takeoff in formation, so the aircraft are doing it one-by-one. Then, after takeoff a rendezvous is made for the entire 7-member team into the „VIXEN“ formation. The sequence of the aerobatic elements to be performed is as follows:

- Display section One

## 1. LOOP

Performed in „VIXEN“ formation – right after the rendezvous into the „vixen“ formation, the leader is making a turn to the right with a followed by aligning into the direction of arrival at an angle of 45° to the line of display. Then comes the loop without changing position of any of the team-members, then in descent the loop is turned at 45° to the left. Then again a climbing turn to the left with transition into the „SWAN“ followed by alignment into the direction of arrival at an angle of 45° to the line of display.

## 2. LOOP

Performed in the „SWAN“ formation with transition to the „RAJAH“ –followed by a complete loop with member positions changing when climbing into „RAJAH“, in descent the loop is turned to the right at an angle of 45°. There comes a climbing turn to the right with transition into „APOLLO“ with a subsequent alignment into the direction of arrival at an angle of 45° to the line of display.

## 3. LOOP

Performed in the „APOLLO“ formation with transition into „VIXEN“ with solo pilot break away – then comes a complete loop with member positions changing while climbing into „VIXEN“ formation, in descent the solo-pilot is breaking away, the loop is turned at an angle of 45° to the left. There follows a climb turn to the left with transition into „YPSILON“ (roof) followed by alignment into the direction of arrival at an angle of 45° to the line of display.

## 4. ROOF

Over flight in the „YPSILON“ formation with the solo pilot flying under it – horizontal flight of the group holding the „YPSILON“ formation extended into roof and the subsequent solo pilot is flying under in the opposite direction. The follows a climb turn to the right with transition into the „DRAGON“ with subsequent alignment into the direction of arrival at an angle of 45° to the line of display. The solo pilot is making a combat turn to the left in the meantime.

## CONCLUSIONS

The main cause to the majority of fair accidents occurred to aerobatic teams were attributed to the error of pilots. Consequently, the primary task of aerobatic flight safety management consists in eliminating the failures related to the human factor present in the aerobatic team. This is to be foregone by proper selection of the personality of the pilot to be involved in the selection for the aerobatic team.

Establishing the criteria for the aerobatic team is the elementary precondition of the success to the flight of the entire aerobatic team. Any of such group will be capable of flying to the level of its weakest link. Among the follow-up problems to be handled are those of identifying the most critical phases of flights and elements of piloting techniques of group flying proficiency in order to establish the sequence of aerobatic group pilot training.

The culmination of the art of piloting for an aerobatic team is a display performed on a Air show. The given display configuration is a set of individual elements of both basic and higher piloting/aerobatics of groups and elements of higher aerobatics on the part of the solo pilot, all that compiled into a single unit. When designing such a display program, factors related to the human, technical and organizational aspects of flying are taken into consideration. Due respect is to be paid to the individual capabilities proficiencies of pilots for the given elements of the program in handling the given elements of the program for the aerobatic group team, as well as to the flight characteristics of the aircraft and the potentials in the ground and flight training of the pilots.

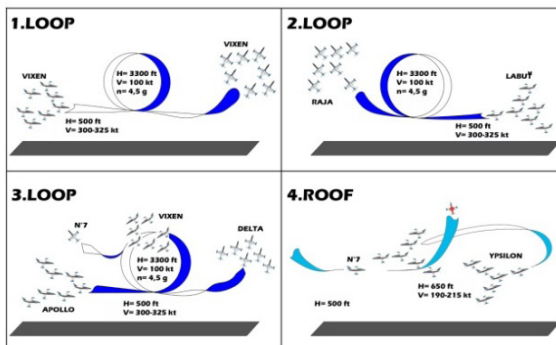


Figure 1: display section One

## REFERENCE

- [1]STANAG 3533 FS (EDITION 7) – Flying and Static Displays | [2]Methodological guidelines of the Slovak Civil Aviation Authorities No. 3/2004 | [3]Rozenberg, R. "Zvyšovanie bezpečnosti v skupinovej zlietanosti v akrobatickej skupine". Košice. 2013 | [4]Szabo, S., Sim, M. and Saloň, M.: "Future and transfer of technology in armament". In: Acta Avionica. roč. 9, č. 14 (2007), s. 123-125, ISSN 1335-9479. | [5]Szabo, S., Kandrač, P.: "Slovenské letectvo včera, dnes a zajtra". In: Euro-atlantic quarterly. roč. 1, č. 3 (2006), s. 18-19, ISSN 1336-8763. | [6]Rozenberg, R., Szabo, S.: "Letecká terminológia a frazeológia - 1. vyd", Košice : TU, LF - 2012. - 147 s. ISBN 978-80-553-0843-2. | [7]Szabo, S., Uherik, L. : "The research and development direction of the special technology for needs of the armed forces of the Slovak republic: Special Technology 2008". Trenčín : Alexander Dubček University of Trenčín, 2008 S. 79-82. ISBN 9788080753245.