

## COMPREHENSIVE AVIATION SYSTEM OF FLYING CREW IMPROVING SAFETY IN THE AIRCRAFT OPERATION

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### Abstract

The article describes 10 known programmes of practical flight training in military aviation – specialization: Multi-Mission Tactical Jet Pilot, which is the highest level of military pilot training in all types of military and civil aviation – comparable only to the level of training and experience of the pilot-instructor of the Military Aviation School. The presented comparison was developed on the basis of literature research from the point of view of, among others, an aircraft operation engineer and a pilot-instructor.

**Keywords:** TS-11 “Iskra”, flight training, military pilot, flight safety.

### 1. INTRODUCTION

After a comparative study of several selected systems of practical aviation training occurring in military aviation, specialization: Multi-Mission Tactical Jet Pilot, a simple conclusion can be drawn that a country with an aviation industry,

- i.e.: aeronautical plants for the serial construction of gliders,
- aircraft airframe series construction plants,
- aircraft engine serial production plants,
- serial production plants for aviation equipment – including:
  - (a) avionics,
  - (b) radio-electronic equipment,
  - (c) hydraulic,
  - (d) pneumatic systems and equipment for such aircraft

and construction offices, headed by experienced constructors at these aircraft factories. and cyclical graduates of aviation faculties who, in accordance with the common interest, cooperate with aviation institutes, contributing to a flexible response to the needs of modification, cyclical modernization of the aircraft – glider, aircraft, aircraft engine, avionics, which results in a functioning system of

flight personnel training – pilots, generated and generates low cost and high flexibility of quotations. “Flexible instruments are those that follow economic development and related scientific progress and do not require constant and time-consuming revision“. [1] This is how the aviation industry functions, which absorbs and generates innovative solutions, enabling technological development, e.g. in the automotive industry or in the construction of ships and ships for the navy.

## 2. A FLIGHT TRAINING SYSTEM IN TERMS OF ECONOMICS AND FLIGHT SAFETY

Aviation safety, and in particular “flight safety” is related to the pilot as a subject in the dynamic system [2]. A new scientific approach taking into account the “human factor” as the main element of the safety of active systems [3] may bring an additional psychological element to the training of military pilots.

Analysing successively training systems of the Multi-Mission Tactical Jet Pilot, safe aviation training systems in terms of economy, i.e. low cost and high flexibility, are the air force aviation systems of the United States and Great Britain. This is due to the concern for national security. In the United States, if there is a need to supplement the training system with aircraft not built in the U.S. aviation industry, and it was chosen because of its aeronautical and tactical characteristics, it must be built from elements manufactured by U.S. companies in the United States (Fig.1/Table 1.). A similar philosophy prevails in Great Britain. An example is the licensed construction of a Swiss training aircraft PC-9 with a turboprop engine in the USA under the designation T-6A “Texan II”. In the United Kingdom, a Brazilian training aircraft the EMB-312 “Tucano” for the RAF under the designation “Short Tucano T.1”.

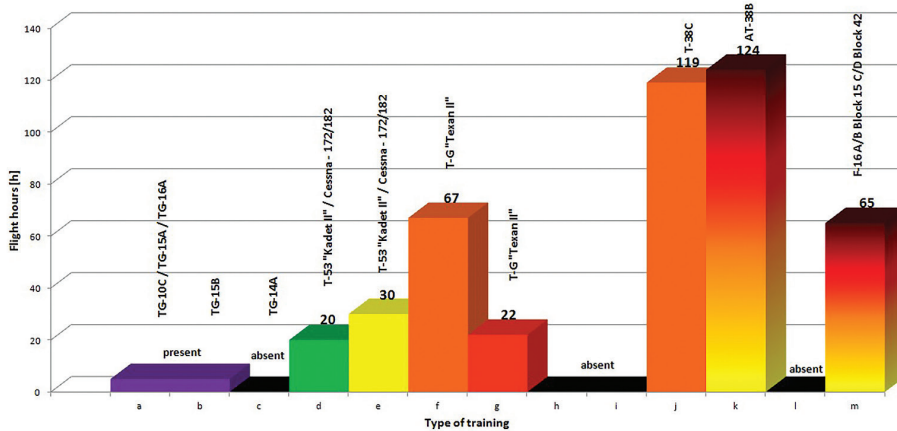


Fig. 1. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of learning to pilot aircraft and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the United States Air Force (USAF) (type of training – table 1) – own elaboration.

Countries that have an aerospace industry use their production potential, i.e. final products to create training systems with specialities: Multi-Mission Tactical Jet Pilot.

The training system in the Brazilian Air Force (FAB) is economically reasonable from the point of view of training methodology and is economically justifiable. Based on aircraft of their own design

Tab. 1. *Type of practical training in the air for student-pilot during the practical tasks in the air at successive progressive stages of learning to pilot aircraft and gaining air experience – own elaboration.*

No.	Description
a.	Primary glider training
b.	Basic glider training
c.	Motor glider training
d.	Primary training on a trainer aircraft with piston engine with a propeller drive
e.	Basic training on a trainer aircraft with piston engine with a propeller drive
f.	Primary training on a trainer aircraft with turbo-prop propulsion
g.	Basic training on a trainer aircraft with turbo-prop propulsion
h.	Advanced training on a trainer aircraft with turbo-prop propulsion
i.	Primary training on a trainer aircraft with turbojet engine
j.	Basic training on a trainer aircraft with turbojet engine
k.	Advanced training on a trainer aircraft with turbojet engine
l.	Training on advanced trainer aircraft with turbojet engine
m.	Training on a multi-mission tactical jet aircraft with turbojet engine

and production of T-25A/C, T-27 ‘Tucano’ and A-29 ‘Super Tucano’. And after acquiring aerial experience, the pilot officer switches to the AMX A-1 B/A or F-5 FM/EM fighter aircraft. A very important element of the FAB is a comprehensive modernization programme of these aircraft, in which the cabin architecture has been unified to the “Glass Cockpit” standard and a control system based on the HOTAS (Hands On Throttle And Stick) concept has been applied. Thanks to this modernization, the training program for further types of these aircraft is shorter [4-7].

Similar to the Brazilian system operated in the Air Force of the Armed Forces of the Republic of Poland. Aeroplanes: trainer the TS-8 “Bies” with propeller-powered piston engine, trainer the TS-11 “Iskra” with a turbojet engine, combat trainer the SBLim-2, combat Lim-2 and the Lim-5 with a turbojet engine had a similar cabin architecture. The same type of pilot-navigation devices, engine operation control, viewfinder, radio-navigation devices, ejection seats (on the TS-11 “Iskra”, the SBLim-2, the Lim-2, the Lim-5).

The Air Force of the Czech Republic is the next training system using its own potential of the aviation industry. It is used for primary and basic training, training aircraft the Zlin-142C/AF. The next stage is the performance of flights on a trainer with a turbojet engine L-39C. Then, on the L-39ZA combat trainer version with a built-up cannon and four wing hard points to carry unguided missiles, bombs and suspended tanks to increase the range of flight. The final stage of the training is the performance of flights on a training and combat plane with a reinforced structure of the entire L-159T1 “ALCA” airframe.

The training system in the Swiss Air Force is similarly designed. The training system is based only on Swiss construction and production aircraft with turboprop engine. These are the NCPC-7 and the PC-21. After the completion of the full training program on these planes, the officer pilot is trained as a supersonic aircraft F-18D/C in the fighter version.

Another challenge for the process of correct methodical aviation training is the example of the Croatian Air Force, which was created in the early 1990s. Croatia does not have an aviation industry, so it is forced to buy aircraft abroad. The system uses a Czech training/ tourist/sports aircraft with propeller-powered piston engine the Zlin-242L for primary and basic training. Then, in basic and advanced training, later in basic and advanced training the Swiss training aircraft the PC-9M with turboprop engine is used. After the completion of the whole program, a young pilot changes to a fighter aircraft, the MiG-21UMD/MiG-21bisD. The leap from the operating speed of the PC-9M aircraft in the instrument speed range  $V_p > 143 \text{ km/h} \div 593 \text{ km/h}$  in relation to the operating speed of the MiG-21UMD/bisD aircraft with a turbojet engine in the instrument speed range  $V_p > 310 \div 1200 \text{ km/h}$  is connected with high burden and psychophysical effort while piloting by a young pilot. Lack of experience, temporary distraction may result in the loss of  $V_p$ , which is associated with the loss of instrument height  $H_p$ . For example, two young pilots collided over the Slunj training ground on September 23, 2010. Both pilots were catapulted. The above fact indicates that pilots were focused on piloting the aircraft with the use of on-board instruments. Without conducting an eight-point observation while performing the task on the firing range. As Croatian experience shows that in order to increase the training level of combat aircraft pilots and at the same time to reduce the costs of this process, it is necessary to introduce into the training a combat trainer with a turbojet engine [8].

Analyzing the system of training of flying personnel – pilots specialization: Multi-Mission Tactical Jet Pilot in the French Air Force. In the years 1993-2009 the basic training took place on the Embraer EMB-312F “Tucano” turbo-propelled training aircraft. Due to savings, this type of aircraft was withdrawn from the training program. Replacing the older generation plane – training aircraft of the French design and production of the TB-30 “Epsilon” with a built-in piston engine. This is a proof of the fact that the purchase of an aircraft without the possibility of licensing production is too expensive a stage in the training process.

A positive development of the French and Belgian Air Force is the joint operation of the French “Alpha Jet E+” and Belgian “Alpha Jet 1B+” at the air base of the French Air Force in Cazaux. This decision brings tangible economic benefits, namely the joint maintenance of aircraft at this base, thanks to a phenomenon known as ‘economies of scale’ (the more aircraft to operate, the cheaper an aircraft). [9]

Analyzing the Multi-Mission Tactical Jet Pilot System in the Indian Air Force, we can conclude that the training process was based on aircraft of own design and production (trainer the HTT-40 BTA with turboprop propulsion and combat trainer the IJT-36 “Sitara” with turbojet propulsion is currently undergoing the process of flight tests and research) – trainer with turbojet engine the HTJ-16 “Kiran” Mk II and trainer Swiss aircraft with turboprop engine the PC-7 Mk II and built under British licence, combat trainer aircraft the “Hawk Mk 132”, which replaced the Polish training aircraft the TS-11 “Iskra”. All pilots, without exception, expressed themselves very positively about the pilot properties of the “Iskra”. The pilot training system is currently based on the program developed by the manufacturer of the “Hawks”, which safely allows the change to a multi-purpose aircraft the Su-30MKI [10,11].

### 3. A COMPREHENSIVE SYSTEM OF THEORETICAL PREPARATION FOR THE PERFORMANCE OF FLIGHTS BY STUDENT PILOTS

Analyzing training systems at the specialization: the Multi-Mission Tactical Jet Pilot System of the above mentioned countries, there are 3 systems of theoretical training preparing candidates for officers to start a multistage practical training in the air, the final stage of which is the training on a supersonic aircraft:

#### I. Theoretical training system:

1. Four-year higher education – specialization: the Multi-Mission Tactical Jet Pilot System at the Academia da Força Aérea (AFA) in Pirassunga, São Paulo,
2. Five-year university studies for cadets – specialization: the Multi-Mission Tactical Jet Pilot System at the Officer Air Force College (Wyższa Szkoła Oficerska Sił Powietrznych) in Dęblin.

#### II. Theoretical training system – is a graduation from an officer aviation school and promotion to second lieutenant – first officer's degree, and then referring to practical aviation training, e.g.:

1. Training of the Royal Danish Air Force officers for jet planes takes place in Sheppard AFB in Texas, on the basis of the 80th School Wing according to the NATO pilot training programme known as Euro-NATO Joint Jet Pilot Training (ENJPT) [12],
2. Graduate Officers of Colorado Springs Academy of Air Force begin practical training in the air on the Raytheon T-6A "Texan II" planes. [12].

#### III. Theoretical training system – these are graduates of civil universities who, before starting practical training in the air, pass an officer's course and for example:

1. All RAF pilots are officers and therefore the pilot training begins with the initial officer training which lasts 24 weeks. This is followed by Elementary Flying Training (EFT) [12,13],
2. A graduate of civil university studies starts their career in the US Air Force with a graduation from the Official School of Accession and Training subordinate to the University of Aviation at Maxwell AFB. After the officer training – second lieutenant begins further practical training in the air on the Raytheon T-6A "Texan II" planes. [12,14],
3. In the Indian Air Force, recruitment of candidates for the Air Force Academy in Hyderabad – specialisation – Multi-Mission Tactical Jet Pilot System, which takes place from three sources and these are:
  - The State Academy of Defense in Pune,
  - State Cadet Corps,
  - Civil universities. After the second stage, cadets trained on a turbojet-powered training plane are promoted to the first officer rank and awarded the military pilot badge [10].

A similar recruitment system as in the Indian Air Force and training operates in the Czech Republic Air Force, but the system of theoretical and practical air training is based on an external company, the so-called aviation training outsourcing. Since 2004 the basic training of pilots of the Air Force of the Czech Republic has been carried out by the Letecke Výcviku – CLV Centre in Pardubice, which is a part of the state enterprise LOM Praha (Letecke Opravovne Malecice) – this is a result of the decision of 2003, when the Czech government decided to introduce military pilot training through external companies [15] The training is intended only for graduates who have graduated from the Defence University in Brno and do not have aircraft piloting skills [16].

The UK Ministry of Defence in 2008, following the UK Strategic and Security Review, handed over jet training pilots of combat aircraft to Ascent Flight Training System, a joint venture between Lockheed Martin and Babcock International. It is a concept of aviation training, which assumes the outsourcing of the training, i.e. its transfer to the industry company with the support of the UK armed forces [17,18].

The Ministry of Defence of France is also following a similar route of training as the Czechs and British. In 2016, the French military purchasing agency (Direction Générale de l'Armement, DGA) concluded an agreement for the purchase of turboprop training aircraft the PC-21. According to this agreement, Pilatus Aircraft of Switzerland is a supplier of aircraft and ground training equipment of the FOMEDEC system for the main contractor – Babcock Mission Critical Services France (BMCSF – French branch of the British Babcock). FOMEDEC is to include new infrastructure, synthetic training equipment, post-mission planning and check-in devices and ground equipment for aircraft handling. The French Air Force is the owner of the FOMEDEC system's aircraft and training facilities. The annual total flying time of the French PC-21 is supposed to be between 11-13.5 thousand hours. FOMEDEC pilot training will take place at the BA120 base in Cazaux and the planes will be part of the EE 3/8 Côte d'Or school squadron. Under an agreement between the French Ministry of Defence and Babcock Mission Critical Services France, the PC-21 pilot training service will run for 11 years from 2018 [19].

It should be mentioned that the forerunner of the idea of practical training in the air, based on the so-called outsourcing of aviation training, was General Gew, a retired Head of Supply of the Israeli Military Aviation, who got the idea that his company would buy a few Polish turboprop advanced trainers the PZL-130 "Orlik" and will rent them to the Israeli Air Force to train military pilots on these planes, hired from his trading company. The PZL-130 "Orlik" underwent positive tests in Israel and received very good opinions from Israeli military pilots – fighters and flight school instructors and Israeli Air Force Commanders [20].

#### 4. PRACTICAL FLIGHT TRAINING SYSTEMS

Analyzing the total flying time of military aviation schools graduates, the above-described systems of practical flight training in the air, it should be stated that the safest system from the point of view of training methodology is the Royal Air Force system – RAF. Total flight time achieved by the graduate of Multi-Mission Tactical Jet Pilot System is  $\approx 432$  hours (Fig.2) flew in total on: a glider, a motor glider, a trainer aircraft with piston engine with a propeller drive, a trainer with a turboprop engine and a combat trainer with a turbojet engine. This allows to gain extensive aviation experience, which will translate into a safe and peaceful acquisition of experience.

The U.S. Air Force's practical flight training system is also safe and user-friendly for the trainee pilot. The total flight time during the training is  $\approx 382$  hours flew on a glider, a training aircraft with a propeller-powered piston engine, a trainer with a turboprop engine, an advanced trainer with a turbojet engine – considering the total flying time of an officer-graduate of the Academy of Air Force Colorado Springs + total flying time = 65 hours on the target aircraft in a combat trainer version and then on a combat aircraft. This gives a general air raid on a young officer pilot  $\approx 447$  hours (Fig.1). As mentioned earlier, the British and American systems are based on aircraft built by national aviation companies on the territory of these countries.

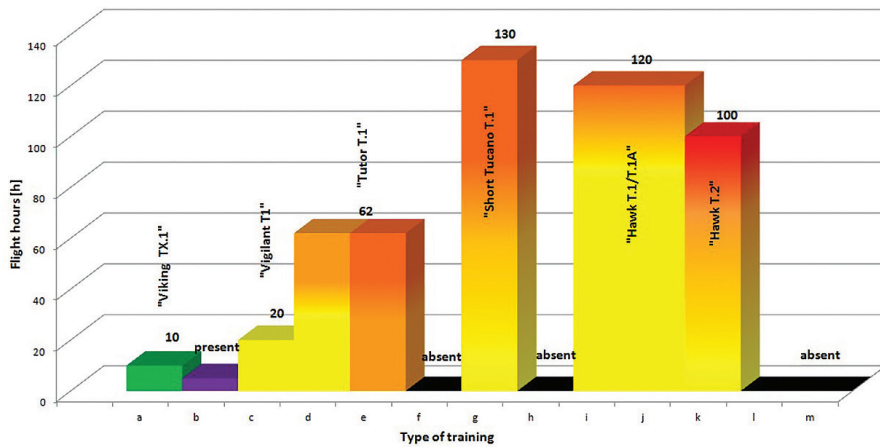


Fig. 2. An hourly flight plan for student-pilot during practical tasks in the air at successive progressive stages of training for an aircraft pilot and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Royal Air Force (RAF) (type of training – Table 1) – own elaboration

- a system of practical training in the air of the Czech Republic Air Force, which uses for primary and basic trainer with a piston engine with a propeller drive, reaching the total flying time of 50 hours per student pilot. After that basic training begins and then advanced on a monotype – a turbo-jet aircraft in a trainer version, combat trainer version and a combat trainer version with a reinforced airframe structure with architectures I and II cabin in the “Glass Cockpit” standard and a control system based on the HOTAS concept with a built-in American engine F-124-GA-100 applied. The trained officer reaches the total flying time  $\approx 400 \div 450$  hours (Fig.4.)

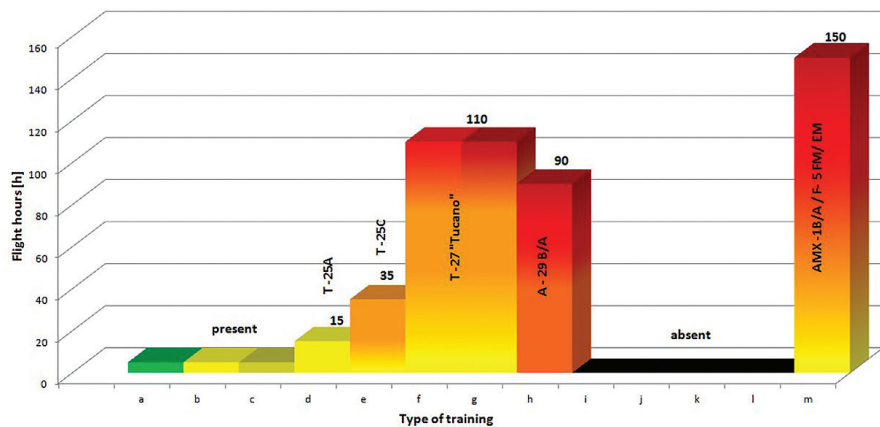
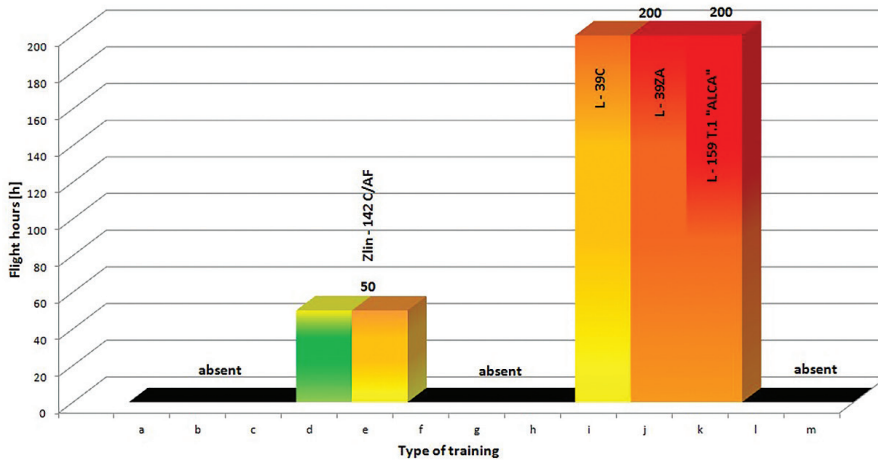


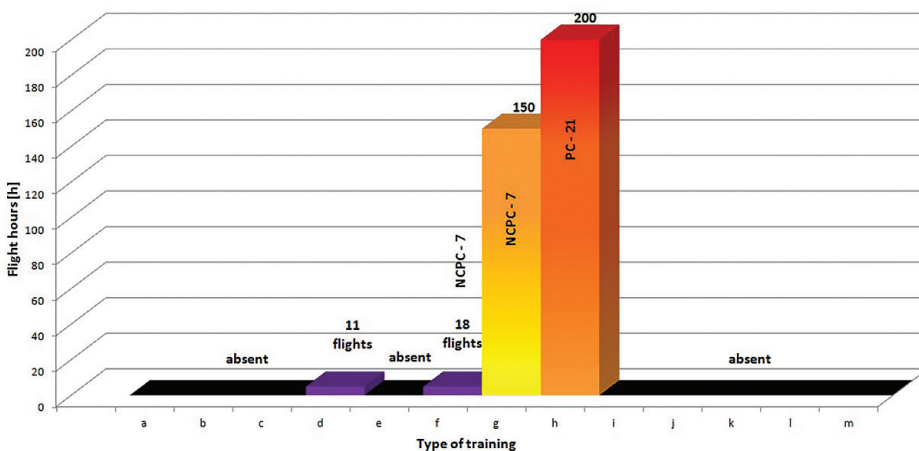
Fig. 3. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of pilot training and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Força Aérea Brasileira (FAB) (type of training – Table 1) – own elaboration.

- on the above mentioned monotype, then to move to one of the two tactical flight squadrons equipped with a combat aircraft the L-159 “ALCA” or a supersonic multi-mission tactical combat aircraft Saab JAS 39 C/D “Gripen”.



*Fig. 4.* An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of pilot training and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Vzdušné síly Armády České republiky (type of training – Table 1) – own elaboration.

- the Swiss Air Force practical training system begins with the 11 test flights for the Swiss Air Force Pilots School in Locarno-Magadino on a civil trainer with a piston engine and airscrew propulsion and 6 flights on a flight simulator of a training aircraft NCPC-7, and then 18 flights on a training aircraft with a turboprop engine NCPC-7. After successful completion of this elimination path and 3 years of studies at ZHAW (Zürcher Hochschule für Angewandte Wissenschaften), the student pilot cadet begins 2 years of practical flight training. 1. year – basic training on the above-mentioned the NCPC-7 aircraft, reaching a total flying time of 150 hours (Fig.5). During the second year – basic and advanced training on the PC-21 turboprop advanced trainer, with increased take-off power by 766 kW (1042 hp) compared to the NCPC-7, reaching the total flying time of 200 hours.



*Fig. 5.* An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of pilot training and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Schweizer Luftwaffe/ Forces Aériennes Suisses/ Forze Aeree Svizzere/ Aviatica Militara Svizra (type of training – Table 1) – own elaboration.



After completion of the training with the total flying time of more than 350 hours, only on piston-engine and propeller-powered turbine advancer trainers, the officer pilot is directed for further training to one of the three units equipped with a supersonic multi-mission tactical combat aircraft the F-18C/D (for the Swiss Air Force, the said aircraft was delivered in accordance with the specification – in the fighter’s version). [21]

- a practical training system for the Royal Danish Air Force, which starts the primary practical training in the air, on a piston-powered Swedish construction and production the Saab T-17 “Sup-porter” training aircraft. The student pilot reaches the total flying time of 27 hours.

Further training takes place in the 80th School Wing in Sheppard AFB in Texas according to the NATO pilot training programme – Euro-NATO Joint Jet Pilot Training (ENJJPT). The basic training takes place on the T-6A “Texan II” turbo-propeller training plane, where the student pilot reaches 125 hours of flying time. He then continues his primary and basic training on a T-38C turbojet engine training plane, reaching 135 hours of flying time. At the end of the training, the pilot-officer has the total flying time of 287 hours. After returning to Denmark, he has trained on the F-16BM/AM combat trainer/combat in 662. School Air Force, reaching 120 hours of flying time (Fig.6) [12].

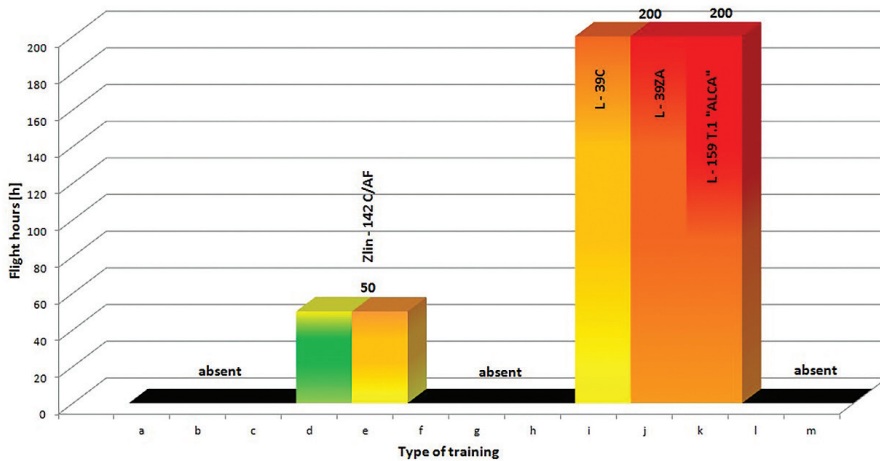


Fig. 6. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of pilot training and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Flyvevåbnet (type of training – Table 1) – own elaboration.

- a system of practical training of the French Air Force, in which a training and training aircraft with a propeller-powered piston engine is used for primary training in the air, manufactured by the German Grob G-120A, on which the student pilot reaches the total number of flying hours of 27 hours and 30 minutes. The basic training takes place on a training aircraft with propeller-powered piston engine, French design and production of the TB-30 “Epsilon”. The student pilot reaches 127 hours of the total flying time. The next stage is basic and then advanced fighter training – on a combat trainer with a turbojet engine, designed and produced in cooperation with the Franco-German Alpha Jet E+. The pilot-officer’s total number of flying hours at the basic fighter’s stage of the training is 100 hours and 100 hours of total number of flying hours at the advanced fighter’s – multi-mission tactical stage of the training. The pilot-officer achieves a total number of 354 flying hours (Fig.7). TB-30 “Epsilon” and Alpha Jet E+ planes are no longer built [12, 22-24].

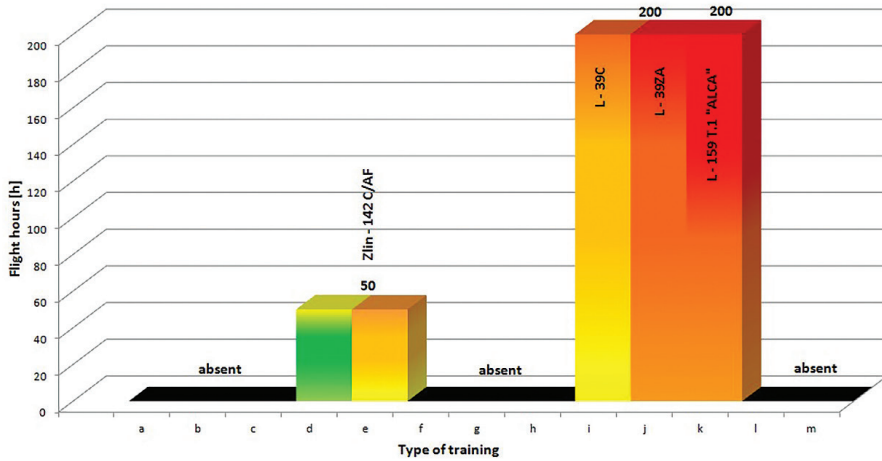


Fig. 7. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of pilot training and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Armée de l'air (type of training – Table 1) – own elaboration.

- The system of practical training of Croatian Air Force is based on a trainer, touring – sports aircraft with a piston engine powered by a Czechoslovakian construction and Czech production of the Zlin-242L. Used in the primary and basic phase of practical training in the air. Next, the training takes place on a training aircraft with a turboprop engine PC-9M, on which it is possible to hang on pylons under the wings: shooting weapons, NPR unguided missiles containers and bombs. In the system of practical training in the air, there is no link, which is a an advanced trainer/ combat trainer with a turbojet engine. In order to safely introduce the student pilot training process, i.e. flying on the MiG-21UMD/MiG-21bisD fighter aircraft, which requires very good theoretical preparation for each flight, as well as concentration and concentration during the performance of each task in the air.

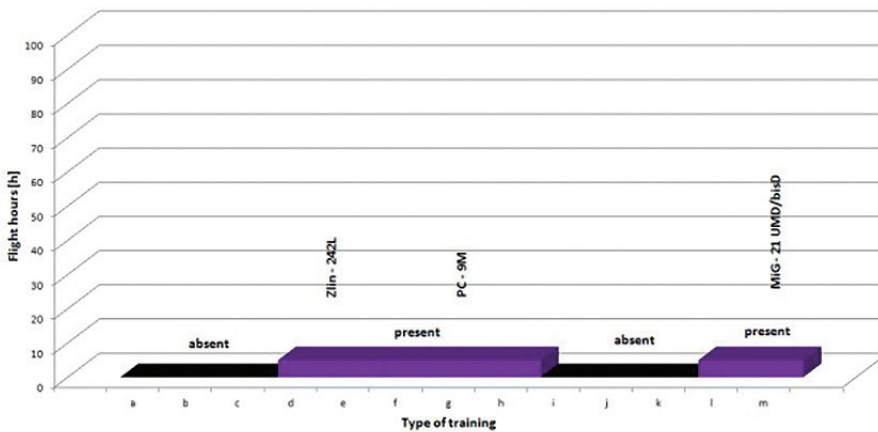


Fig. 8. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of learning to pilot aircraft and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Hrvatsko Ratno Zrakoplovstvo i Protuzračna Obrana (HRZiPZO) (type of training – Table 1) – own elaboration.

Lack of concentration during the flight may result in a rapid loss of instrument speed, resulting in a large loss of altitude. Therefore, when starting the training on the above-mentioned the MiG-21UMD/bisD aircraft, the student pilot must have a general total flying time on a trainer with a piston engine/turbot propeller engine of 400÷600 hours (Fig.8). Currently, the Croatian Air Force is analysing the purchase of a multi-mission tactical jet aircraft in order to replace the MiG-21UMD/bisD aircraft, whose hourly and time resurrection is coming to an end [8,25].

- the Indian Air Force practical training system was supported by the purchase of a training and training aircraft with a turboprop engine of the Swiss design and production of the PC-7 Mk II. The aeroplane is used for primary and basic training in the air, on which the cadet student pilot reaches the total flying time of 60 hours (Fig.9). After the promotion, the pilot-officer continues the primary and basic training on a turbojet-powered trainer of the native construction and production of the HJT-16 “Kiran” Mk II and obtains 72 hours of the total flying time. Before the introduction of the “Hawk Mk132 combat trainer into the training system, the advanced training was conducted on the above-mentioned the HJT-16 “Kiran” Mk II aircraft or on a training and training aircraft with a turbojet engine of the Polish design and production of the TS-11 “Iskra”. The total flying time was 40 hours. The total flying time obtained in this training system is 172 hours.

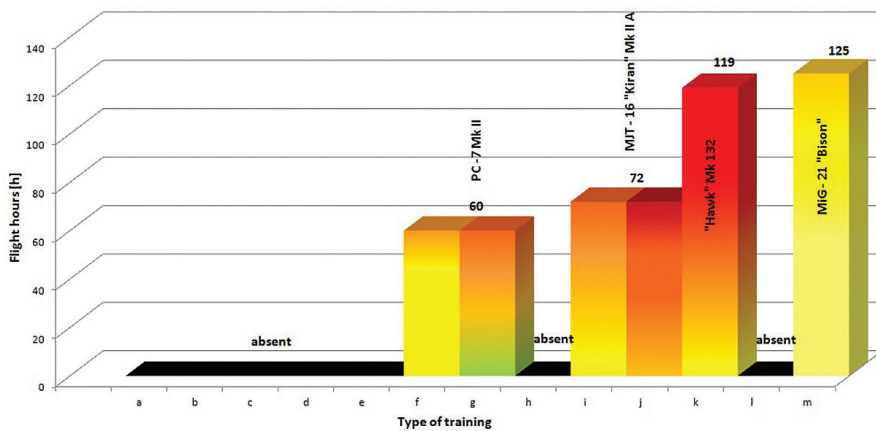


Fig. 9. An hourly flight plan for student-pilot during the practical tasks in the air at successive progressive stages of learning to pilot aircraft and gaining air experience in the system of continuous training of the multi-mission tactical jet aircraft pilot at the Indian Air Force (IAF)/ Bhartiya Vāyu Senā (type of training – table 1) – own elaboration.

The trained pilots on the TS-11 “Iskra” praised the smooth process of training on the MiG-21 aircraft. This was due to the fact that the TS-11 “Iskra” was equipped, among others, with the same type of artificial horizon of AGD-1 as on all versions of the MiG-21, operated by the Indian Air Force. Difficulties in training on the MiG-21 had groups of officer pilots trained only on HJT-16 “Kiran” Mk I and II. Unfortunately, the general air raid of 172 hours of an officer pilot, starting the training on the MiG-21 plane, was and is still lethal.

The reason for this is too small aviation experience in relation to the very demanding piloting technique related to the aerodynamic construction of the airframe and operation of the MiG-21 airplane power unit. Therefore, since 2012, flights on the MiG-21 planes have been performed only by the most experienced pilots of IAF [26] Since the beginning of IAF’s operation of the MiG-21 planes of different versions, 50% of the evidential status of the above mentioned aircraft has been lost in

accidents and catastrophes, and since the beginning of IAF's operation of the MiG-21 planes, only the most experienced pilots have been flying the MiG-21 planes [26]. Since 2010, the and combat trainer with a turbojet engine of British design and production BAE "Hawk Mk 132", built under license in Hindustan Aeronautics Limited in Bangalore, replaces in the process of advanced training HJT-16 "Kiran" Mk II. At this stage of training, the officer pilot in accordance with the training programme proposed by the British manufacturer – reaches 119 hours of the total flying time and the total number of flying hours since the beginning of the training is 251. This makes it possible to start the training on the MiG-21 or Su-30MKI. The total flying time which the trained pilot obtains is 125 hours on the MiG-21 and the total of 376 hours [27].

- The system of practical training in Aviation of the Armed Forces of the Republic of Poland was based until 1989 on a very well-functioning programme of theoretical and practical training in the air. This was the result of a vision, a comprehensive training of the Jet Pilot (PSO). The system was based on Lotnicze Przynsposobienie Wojskowe – 1. stopnia – LPW-1. degree – glider training, Lotnicze Przynsposobienie Wojskowe-2. stopnia – LPW-2. degree – aircraft training, which allowed to start first degree studies at the "School of Eagles" - specialization: Jet Pilot. Continuing basic practical training in the air on the school and training aircraft with turbojet engine the TS-11 "Iskra" – in the second year of studies. Basic training on the SBLim-2/Lim-2/Lim-5 or Lim-6 bis combat trainer with a turbojet engine – in the third year of studies. Advanced training on a SBLim-2/Lim-2/Lim-2/Lim-5/Lim-6 bis combat trainer/combat to reach the 2nd class pilot level in fighter aviation - in the 4th year of studies with the total flying time of 255 hours on planes with a turbojet engine at Wyższa Oficerska Szkoła Lotnicza, Dęblin. This level of cadet- officer training – the specialty: Jet pilot was achieved in 1986. Promoting to the rank of second lieutenant the first in the history of the "School of Eaglets", a group of officer pilots with the 2nd class of pilot in fighter aviation (with the total flying time  $\approx$  300. hours on turbo-jet-powered aircraft) [12].

## 5. CONCLUSIONS

To sum up, the general analysis of the aviation training systems described above, it should be noted that all training systems (with the exception of the jet pilot training system of the Armed Forces of the Republic of Poland in the period from 3 January 1957 to 15 October 1989) share a common characteristic, namely:

1. They are based on the aviation training system used during the 'W' period – wars, from the beginning of World War II to the present day. This system generates only a high cost of practical training in the air, due to the use in the primary and basic training, aircraft with piston engine, turboprop, or immediately training in a trainer, combat trainer and combat aircraft with turbojet propulsion.

2. Glider training is included in the practical flight training systems described. However, when reading the literature, one can only deduce that the glider training program is limited to the training of the student pilot in a circuit with the use of a winch. Obtaining the total flying time of about 8 hours, which means reaching the third class of glider according to FAI regulations, out of the 10 described systems, only in 3 of the above mentioned ones, glider training is conducted. There was no training for glider class II in literature studies. Although the training units or military aeroclubs of RAF, US Air Force and FAB are equipped with school gliders and only a small number of training gliders, on which the conditions for the Silver Glider Badge can be reached and those willing to participate in the second class glider can be trained.

3. Two of the ten aviation training systems described above are motor gliders, i.e. RAF and FAB. It is probably used, among other things, to perform familiarization navigation flights and radio navigation flights of student pilots qualified for training on a piston-powered propeller-powered training aircraft in order to obtain a Private Pilot Licence. This applies to persons who have received a scholarship from aviation institutions bound by trade agreements with the Ministry of Defence of Great Britain and Northern Ireland.

4. A characteristic feature of all systems described is that the primary and basic training takes place in a 'side-by-side' propeller piston engine training aeroplane. This cabin system for further training of a student pilot changing to a tandem cabin training plane with a turboprop engine causes a change in the habits of proper division of attention during individual phases, e.g. flight in a circuit. The layout of the cabin "next to each other" limits the observation of the upper right side and rear semi-sphere – the pilot sitting on the left seat, especially when returning from the pilotage area or route, entering the airfield circuit. Eight-seat observation is also hindered by the presence of an instructor pilot on the right seat. Discomfort also occurs during the flight with poor vertical, slanting and horizontal visibility.

5. The "W" period flight training system creates high cost intensity and low flexibility for countries without an aviation industry of their own. It generates low cost-intensiveness and high flexibility for countries with their own aeronautical industry which allows for the creation of a properly functioning aviation training system, provided that State budget managers listen to the expectations of aviation training providers. For the trained student pilot, the system limits his creative invention to independent decision making by performing only those elements of flight training which are recorded in the ground theoretical preparation for flights and controlled after the completion of the task – on the ground, with the help of a flight data recorder.

## 6. GENERAL SUMMARY

The financial resources expended by the state for a quick, intensive and short-term process of practical training in the air – student pilot, on an expensive, high-failure aircraft – in the period of "childhood" bought abroad, in trace amounts in order to quickly train a new generation of jet pilot – multi-mission tactical aircraft, will only prolong the training process, inter alia, by weather conditions which will generate additional training costs.

What is needed is a comprehensive system of training of flying personnel – pilots, spread over a period of at least six years. This time will allow for methodical, calm, systematic, rhythmic and progressive training of flight personnel – pilots-instructors, who after graduation from aviation faculties of universities will be the personnel base in military, civil and sport aviation.

An additional element raising the level of training is the student internship in the aircraft design, construction and operation departments [28].

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## KOMPLEKSOWY SYSTEM KSZTAŁCENIA PERSONELU LATAJĄCEGO PODNOSZĄCY BEZPIECZEŃSTWO W EKSPLOATACJI STATKÓW POWIETRZNYCH

### Streszczenie

W artykule *Kompleksowy system kształcenia personelu latającego podnoszący bezpieczeństwo w eksploatacji statków powietrznych* opisano 10 systemów praktycznego szkolenia lotniczego występujących w świecie lotnictwa wojskowego – specjalność: Pilot Samolotu Odrzutowego – Wielozadaniowego (PSO-W) – jest to najwyższy poziom wyszkolenia pilota wojskowego ze wszystkich rodzajów lotnictwa wojskowego i cywilnego – porównywalny jedynie z poziomem wyszkolenia i doświadczenia pilota-instruktora Wojskowej Szkoły Lotniczej) na podstawie badań literaturowych z punktu widzenia m.in. inżyniera eksploatacji statków powietrznych i pilota-instruktora.

Słowa kluczowe: TS-11 “Iskra”, szkolenie lotnicze, pilot wojskowy, bezpieczeństwo lotów.