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**ДОПУСТИТИ ДО ЗАХИСТУ**

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В.Ю. Ларін

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**ДИПЛОМНА РОБОТА**

**(ПОЯСНЮВАЛЬНА ЗАПИСКА)**

випускника ОСВІТНЬОГО СТУПЕНЯ МАГІСТРА

За освітньо-професійною програмою

«обслуговування ПОВІТРЯНОГО РУХУ»

**Тема: «Використання авіаційних тренажерів у підготовці фахівців з обслуговування повітряного руху (комплексна)»**

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**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

**NATIONAL AVIATION UNIVERSITY**

**FACULTY OF AIR NAVIGATION, ELECTRONICS AND TELECOMMUNICATIONS**

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**"\_\_\_\_\_" \_\_\_\_\_\_ 2020**

**MASTER’S THESIS**

**ON THE EDUCATIONAL PROFESSIONAL PROGRAM**

**"AIR TRAFFIC SERVICE"**

(EXPLANOTARY NOTE)

**Theme: "****Usage of aviation simulator in a process of ATS officers training (complex)"**

**Performed by:**   **A.R.German**

**Supervisor: assistant professor\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ M.M. Bogunenko**

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**KYIV 2020**

**NATIONAL AVIATION UNIVERSITY**

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Educational degree: *Master \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

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“\_\_\_\_”\_\_\_\_\_\_\_\_\_\_\_\_\_2019

**Master’s Thesis Assignment**

**Student`s name: German Alina Ruslanivna**

1. The thesis theme: “***Usage of aviation simulator in a process of ATS officers training”***

approved by the Rector’s order *of “24” October 2019 № 2476*

2. The thesis should be performed from :  *14.10.2019 to 09.02.2019*

3. Initial data: *Training experience as a student of ANS department.*

4. The content of the explanatory note (the list of problems to be considered): *Analysis of ATCO simulator system requirements and the process of skills training. The usage of proposed ATCO training system.*

5. The list of mandatory graphic materials*: research details, principal layouts.*

*Power Point should be used to provide graphic support and presentation.*

6. Calendar Schedule of Performing the Master’s thesis.

|  |  |  |
| --- | --- | --- |
| Tasks | Period of works execution | execution note |
| Preparation of Chapter 1:  “REQUIREMENTS TO SIMULATOR TRANING OF ATS PERSONNEL” | 14.10.19 – 23.10.19 | Complete |
| Preparation of Chapter 2:  “FORMATION OF PROFESSIONAL SKILLS” | 2.11.19 – 30.11.19 | Complete |
| Preparation of Chapter 3: “THE PROCESS OF GAINING THE SKILLS OR ROLE OF HUMAN FACTOR IN AVIATION” | 10.12.19-20.12.19 | Complete |
| Preparation of Chapter 4: “GENERAL REVIEW OF AERONAUTICAL VOICE COMMUNICATION SIMULATOR” | 22.12.19-31.12.19 | Complete |
| Preparation of principal layouts | 03.01.20 -10.01.20 | Complete |
| Preparation of report and graphic materials | 15.01.20 –24.01.20 | Complete |

7. Date of issue: «\_\_\_»\_\_\_\_\_\_\_\_\_\_\_\_ 2019.

Supervisor of master’s thesis \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ M.M. Bogunenko

Excepted the task \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name, surname)

**ABSTRACT**

Explanatory note to a graduate work “**Usage of aviation simulator in a process of ATS officers training (complex)**”: 90 pages, 6 figures, 10 references.

**The aim of this graduate thesis -** Analysis of existing training system, the process of simulator skills acquiring and development of new training communication system.

**Means of improvement** – Analysis of work experience on training systems.

**The object of improvement** – Simulation training system improvement.

**The subject of improvement** – Simulator training of ATCOs.

Simulation training of aviation personnel is a universal method of practicing skills connecting theoretical and practical parts of studying. The direction of research is to analyze the existing training process and focus on the new cheap and effective training system for obtaining radio usage skills.

AIR TRAFFIC CONTROL OFFICER, ATCO SIMULATOR TRAINING, ATCO TRAINING SISTEM, VOICE COMMUNICATION MODULE, VOICE COMMUNACATION MODULE IMPLEMENTTION.

**РЕФЕРАТ**

Пояснювальна записка до дипломної роботи «**Використання авіаційних тренажерів у підготовці фахівців з обслуговування повітряного руху**».

90 сторінки, 6 рисунків, 10 використаних джерел.

**Мета дипломної роботи** – аналіз існуючої системи тренувань, процесу отримання навичок на тренажері та розробка нової навчальної системи зв’язку.

**Засоби досягнення –** аналіз досвіду роботи з системами тренувань.

**Об’єкт дослідження** – покращення системи тренажерної підготовки.

**Предмет дослідження** – тренажерна підготовка фахівців з управління повітряним рухом.

Тренажерна підготовка авіаційного персоналу - це універсальний метод отримання практичних навичок, що поєднує теоретичні та практичні знання. Напрям дослідження полягає в аналізі існуючого навчального процесу та розробці нової дешевої та ефективної системи тренування для отримання навичок роботи з радіостанцією.

ОБСЛУГОВУВАННЯ ПОВІТРЯНОГО РУХУ, АВТОМАТИЗОВАНА СИСТЕМА УПРАВЛІННЯ ПОВІТРЯНИМ РУХОМ, СИСТЕМА ТРЕНУВАННЯ, СИСТЕМА ГОЛОСОВОГО ЗВ'ЯЗКУ.

**COMMENT SHEET**

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**DEFINITIONS**

**Aerodrome.** A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

**Aerodrome control service.** Air traffic control service for aerodrome traffic.

**Aerodrome control tower.** A unit established to provide air traffic control service to aerodrome traffic.

**Aerodrome traffic.** All traffic on the maneuvering area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.

**Aeronautical Information Publication (AIP).** A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

**Aircraft.** Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth’s surface.

**Air-ground communication**. Two-way communication between aircraft and stations or locations on the surface of the earth.

**Air traffic.** All aircraft in flight or operating on the manoeuvring area of an aerodrome.

**Air traffic control clearance.** Authorization for an aircraft to proceed under conditions specified by an air traffic control unit.

**Air traffic control service.** A service provided for the purpose of:

a) preventing collisions:

1) between aircraft, and

2) on the manoeuvring area between aircraft and obstructions; and

b) expediting and maintaining an orderly flow of air traffic.

**Air traffic control unit.** A generic term meaning variously, area control centre, approach control unit or aerodrome control tower.

**Air traffic service (ATS).** A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

**Air traffic management (ATM).** The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.

**Airway**. A control area or portion thereof established in the form of a corridor.

**Approach control service.** Air traffic control service for arriving or departing controlled flights.

**Approach control unit.** A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

**Area control centre (ACC).** A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

**Area control service.** Air traffic control service for controlled flights in control areas.

**ATS route.** A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

**Control area.** A controlled airspace extending upwards from a specified limit above the earth.

**Control zone.** A controlled airspace extending upwards from the surface of the earth to a specified upper limit.  **Cruising level.** A level maintained during a significant portion of a flight.

**Flight level.** A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

**Flight plan.** Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

**Terminal control area (TMA).** A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

**ABBREVIATIONS**

AIP Aeronautical Information Publication

ATCS Air traffic control service

ATCU Air traffic control unit

ATC Air traffic control

ACC Area control centre

ADF Automatic direction finder

ANSP Air Navigation Services Provider  
ATCO Air traffic controller officer

ATCS Air traffic control service

FL Flight level

ATM Air traffic management

ATS Air traffic service

CP Communication panel

CTA Control area

CTR Control zone

HF High frequency

IDE Integrated development environment

PCS Potential conflict situation

PIC Pilot in command

PTT Push to talk

SARU Search and rescue unit

TCU Traffic control unit

TG Training group

TM Training management

TWR Tower

VHF Very high frequency

TMA Terminal control area

ICAO International Civil Aviation Organization

**INTRODUCTION**

Aviation is a sphere where voice communication system plays a great role. Proficiency in English is a key tool for an air traffic controller and phraseology of radio exchange has a number of specific features. Air traffic controller’s work includes maintaining an orderly flow of air traffic, servicing of an aircraft and control of safe movement on the ground and in the airspace. The only way to communicate with the pilot is a radio communication, which takes place in a real-time operation and requires maximum attention from the specialist.

Among the below overviewed means and methods of training, a special place is taken by simulator training, which has the closest connection with the formation of ATCO's high competence and confidence. For this purpose, the existing training systems and theoretical approach foe studying was analyzed. Training simulators allow the formation of knowledge, skills and abilities, as well as professionally important qualities.

The main purpose of this work is to present the device that can be used for aviation personal training, as well as in different directions.

**The aim of this graduate thesis** is an investigation of existing training system for an ATCO, its components and training simulators to be used for a specialist preparation and creation of new simulator for aviation personnel training.

**The following tasks** have to get accomplished:

1. Analyze general process of aviation personnel simulator training;
2. Analyze the process of professional skills formation;
3. Analyze human factor affects and its reduction due to skills training;
4. Overview of new simulator system and its usage.

# CHAPTER 1. REQUIREMENTS TO SIMULATOR TRANING OF ATS PERSONNEL

## 1.1 Qualification training

Technological practice on simulators forms the basic skills for an air traffic control specialists, necessary for achievement of a controller’s certificate, training and adaptation to the workplace and for subsequent work as a traffic controller. It’s significance forms from the basis of modern methods of formalization the activities of the human operator in the control systems to explain the processes of direct control of the aircraft movement in various air traffic control areas and at the aerodrome using existing air traffic control and civil aviation rules of flight as well as to coach the usage of the engineering methods of analysis, evaluation and optimization of technological processes of the ATC.

To develop a Qualification training and assessment system, a systematic approach is used: setting the qualification requirements and related criteria effectiveness, the training course, the developed methodology for evaluating the results. Practice is based on the natural-scientific, technical, special, historical and social disciplines.

Annex 1 to the Convention on International Civil Aviation Organization (ICAO) “Personnel licensing” International Standards and Recommended Practices includes six categories of the air traffic controller ratings that may be approved on an air traffic controller license [5]. They are:

a) Aerodrome control (ADC) rating;

b) Approach control procedural rating (APP);

c) Approach control surveillance rating (APS);

d) Area control procedural rating (ACP);

e) Area control surveillance rating (ACS); and

f) Approach precision radar control rating (APRC).

Annex 1 state that before a person can get an air traffic control license, there are a number of criteria that to be met. Some of these criteria closely connected to the training of an air traffic controller. These include the knowledge, skills and practical experience requirements for all controllers and then the specific requirements for each above mentioned [5].

In addition, Annex 1 says, that the applicants have to complete an approved training course in an approved training organization and have taken on-the-job training for at least three months. Skill is an ability to present an action. This ability is also the result of the training [5].

Training plays the great role at the Air Traffic Service (ATS) System. From the Doc 10056 “Manual on Air Traffic Controller (ATCO) Competency-based Training and Assessment”, an air traffic controller training has been divided into three phases, illustrated in the diagram below [6]:

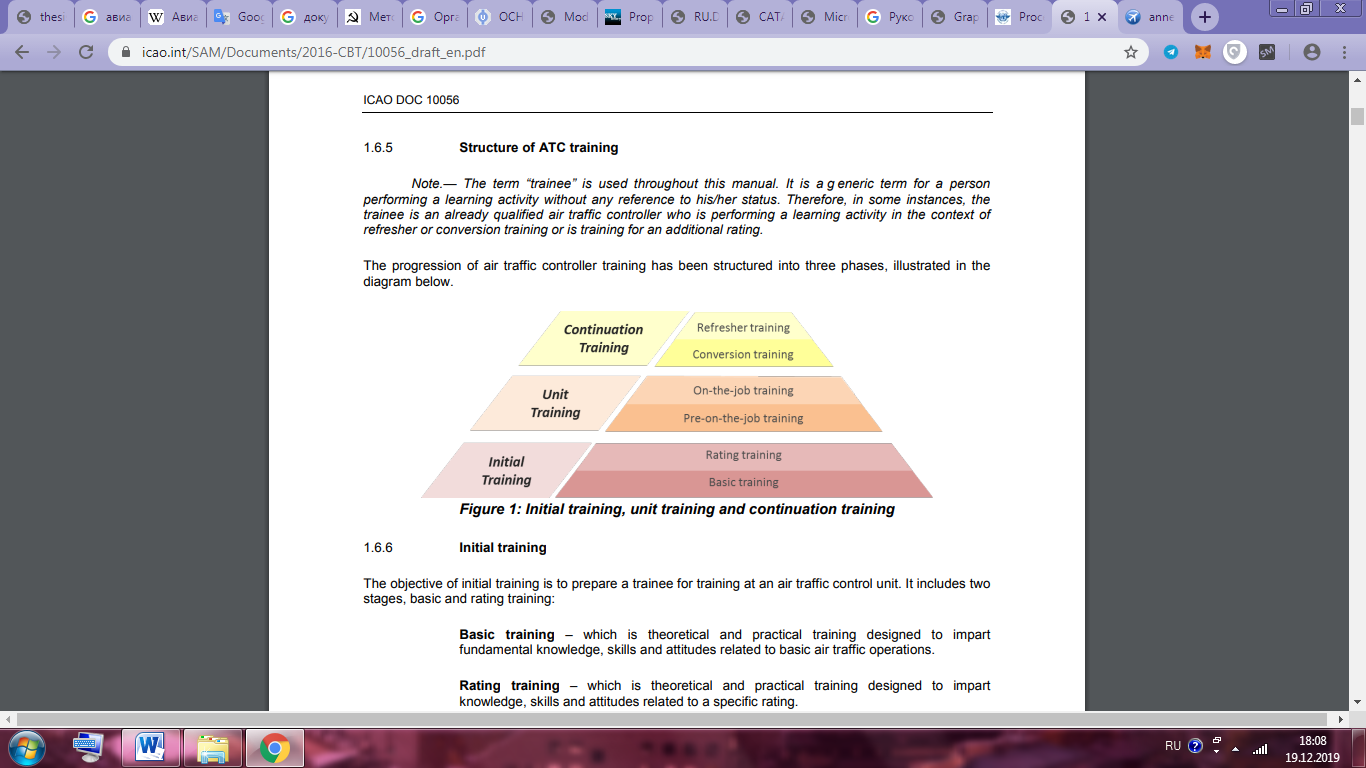


Figure 1.1 –Initial, Unit and Continuation training

First Phase includes two stages, basic knowledge related to basic air traffic operations, both theoretical and practical parts and its rating.

The second phase is the basis for issuing an air traffic controller license and corresponding rating (s) for a specific unit. During the preliminary phase, special simulations can be used to complete the intern in the unit for a real work environment. The use of simulation during this training is highly recommended for units that are often faced with difficult traffic situations. The stage at the workplace is designed so that the student can combine certain procedures and module procedures under the supervision of a qualified instructor. And, the third one Phase- Continuation is directed to the enhancement of knowledge. The main difference is that the Conversion training is provided for changes in the operational procedures and Systems.

Figure 1.2 shows how the ATC training process is related to the various phases and stages of training. It also includes an additional phase, development training, for career advancement, for instructing, for example.

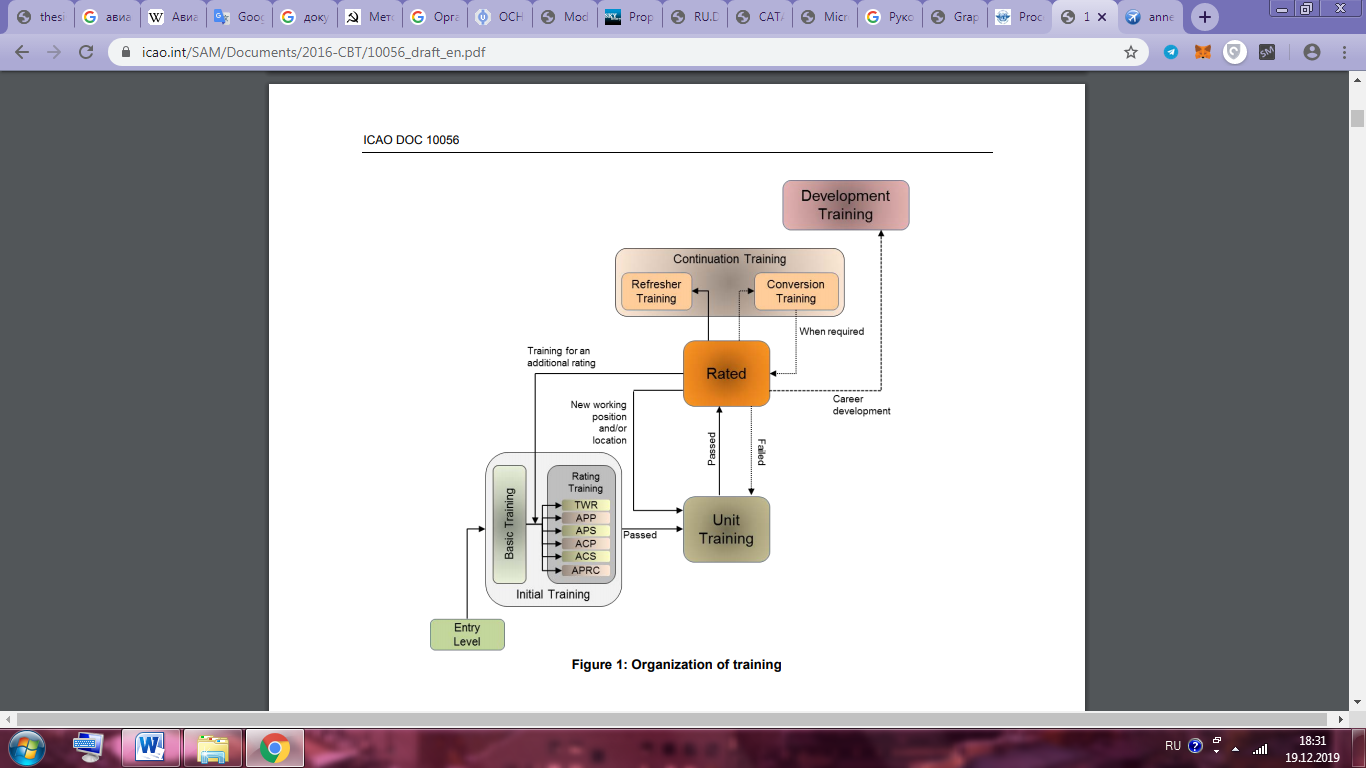


Figure 1.2 - Organization of training

Also, in the “Manual on Air Traffic Controller Competency-based Training and Assessment” book included the list the simulation requirements, needed to achieve the training outcome:

a) Part-task trainer; and

b) Minimum of 180° aerodrome simulator [6].

Teamwork includes the possible variations in situations in the individually conducted Simulator.

## 1.2. Analysis of research and publications

The studies shows, that simulators can be the effective tool for a comprehensive approach to staff training, which allows the formation of knowledge, skills and professionally important qualities and competencies of air traffic controllers [1].

R. Makarov in collaboration with scientists established, that the essence of simulator training itself consists in solving three types of tasks (procedural, decisive and preceptual motor): procedural task includes a control of the communication system, work with equipment and control of the air situation. Decisive one includes the flight planning, actions in extreme situations, determining the order of operations and distribution of responsibilities between control units. Preceptual-motor tasks are: spatial orientation, communications, hazard identification and action [1].

According to B. Kemalov combination of a technical, economic and scientific nature factors determined the formation of simulator training as a relatively independent scientific field. The most important condition for the effective use of simulator training is the availability of methodological, software and hardware systems that meets the intellectual level of simulator technologies development [2].

It should be noted that the main focus of modern research is on the development of automated training systems.

In the work of V. Zheltukhin is emphasized the need to improve the methods and means of training through the use of analytical and monitoring programs based on a personal computer as part of the independent training of future operators [3].

However, today the issues of error analysis in the process of simulator training of students are still not sufficiently developed. The main requirement for such analysis is the systematization of working process and the identification of errors made by students in order to control the formed competencies of an operator on the one hand and to optimize the educational process of training future pilots on the other.

Preparation programs in educational institutions carrying a classic character but at the same time, with all the positive qualities, they have a number of significant drawbacks. One of such drawbacks is the analysis of errors in the training process for students, which, as a rule, is performed exclusively by evaluating the mistakes in the training center. It is important to note that such an assessment is subjective and is based on criteria developed without taking into account the characteristics of the working process using modern equipment and the interaction between an adjustment centers.

In civil aviation, the processing of all necessary information for a flight plays an important role in improving the airspace and the efficiency of air transport. Flight information in some cases is the only objective source of information about the crew’s activities throughout the flight. Therefore, the systematic monitoring and assessment of crew’s flight activity based on the processing of flight information and provides a significant increase in the level of operator’s training.

In turn, ground processing of flight information plays a leading role in solving one of the main tasks of civil aviation - improving flight safety. Disadvantages of such flight information processing systems are the high complexity and duration of processing, as well as the low reliability of the information received.

As part of the safety management system, airline companies carry out an analysis of flight information due to the documentation of the results in graphical, digital and electronic form.

Among the means of professional training of aviation personnel, simulator training, conducted during the classes has a special place. It plays a great role in the successful, safe flight and the formation of an orderly flow of air traffic.

## 1.3. Classes’ structure

Classes are conducted under the guidance of instructors in accordance with the thematic content of the program, given guidelines and are based on the problem-programmed training principle application, which includes:

- Clearly defined goals at each stage of training;

- Training material on the stages of training;

- The presence of indicative, basic and control exercises (classes) at each stage of training;

- Taking into account the individual characteristics of students;

- Interactive teaching methods (role-playing games in control classes and emergency situations’ solving as a method of increasing the activity of cadets).

Distribution and retention of instructors should be carried out through the group training period, while it is necessary to take into account the uniformity of the instructors’ load.

Training consists of three stages, each of which is built on the principle of following from simple to complex that ensures the integration of theory and practice.

The first stage of training is pre-training. At this stage, students study the Instructions for the conduction of flights in the simulated zone, the equipment of the control panels (its operation) and get acquainted with the general ATC technological processes on the simulator with a reference material, used in the workplace.

The second stage of training (modular) is implemented using the separate technical elements and simple operations in order to form the initial skills for the air traffic control specialist with the subsequent integrated use of all ATC facilities in the modular mode with a predominance of the demonstration of knowledge got in the classes, where the instructor performs technological operations.

Besides, at the second stage, the technology of work and the phraseology of radio exchange during the departure of the aircraft are worked out. Testing of students' skills is carried out during the classes with an assessment of their actions in separate elements of training. If the results are positive, next stage is the development of the technology of work and phraseology of radio exchange during the arrival of the aircraft.

In the case of difficulties in the process of mastering the algorithm of actions during the aircraft departure, instructor can use an extra time to fix the skills on the elements that present difficulties. Development of ATC skills during the aircraft arrival and departure is carried out similarly.

The intensity of the aircraft movement in the second stage have to be adjusted taking into account the assimilation by the student of the planned volume of the technological operations and phraseology of radio exchange, but with the condition of working with only one aircraft, so that the technological operations and radio exchanges’ phraseology with one aircraft do not “overlay” with the next aircraft and was practiced from the start to finish without any additional interference.

At the final stage of the modular training in the preparation and implementation of control and test exercises, it is recommended the integrated use of all modules in the circuit of work out the interaction of all control stages with the goal of the effective and smooth transition from the modular to the integrated learning phase.

Note. If at the second stage of preparation is not possible the usage of different training modules or training is done on a different type of a simulator, the duration of the student’s training should be increased due to the additional training time at a workplaces of a simulated model of an automated system.

The third stage of the training is based on the integrated use of all available technical equipment of the simulator, as well as on the application and fixing the knowledge of students on the phraseology of radio exchange in English.

It includes the development of skills for working with an increasing an air traffic flows up to 15-18 aircraft per hour for the one workplace, with the gradual entry of aircraft intersections at the same height and in the intersecting routes and with a variable flight profile, using the special conditions and flight route cases.

Exercises should be performed strictly according to the goal:

- Intensity from 4 aircraft per hour with a gradual increase of the intensity up to 18 aircraft per hour;

- Development of the intersection of an aircraft trajectory - intensity from 2 aircrafts with a gradual increase of the intensity;

- Interaction of a lower speed aircraft with higher speed aircraft- the intensity starts from 2 aircraft with a gradual increase of the intensity at the each workplace;

- Simulation of failures of the ground-based facilities;

- Entering the special flight conditions;

This is the example of the technique is designed for simulator training in the amount of 524 hours.

The training is based on:

- Work programs of specialized disciplines of the State standard of higher professional education;

- Generalization of the experience of educational institutions and airlines, as well as analysis of relevant International Civil Aviation Organization (ICAO) materials.

Classes should be held after studying the relevant sections and topics of the disciplines "Air Traffic Control Theory", "Organization of an Air Traffic Control System" and "Air Traffic Control Technology".

This methodology is designed to conduct classes in the presence of simple simulators including all Air Traffic Controllers’ workplaces limitations.

At all stages of training, it is necessary to develop attentiveness, independence, among students, as well as a creative approach in solving different tasks.

## 1.4. Detailed principles of trainings

At the initial stages, the programmed teaching principle prevails with constant monitoring and instructor’s correction of the wrong actions of students. After the practicing in simplest skills, procedural control and interaction with ground facilities should be done.

A variety of options can be achieved, for example, by changing in the system the simulated types of an aircraft, time and levels of entry into the zone, changing the situations that are different from the previous one, but saved by schematic exercises.

During the initial development of one or another element, students must complete as many similar tasks as are necessary for the error-free execution of the exercise. Typically, this amount varies from three to five.

Thus, the frequent change of simulator workplaces is impractical during one lesson, but can be done in practicing new exercises. However, it is necessary at the final stages of training, when it is required to maintain acquired skills at a given level at a various workplaces.

Before the exercises in which the radio exchange with the crews is carried out in English, students need to undergo a preliminary training in the language classes. Conduction of such exercises on pilot-operator simulators must also be proficient in English radio phraseology.

Breaks between training sessions at the initial stages of training should not exceed 2-3 days. In the final stages are permissible breaks in 1-2 weeks.

According to the Instructions for the organization and conduct of simulator training for ATS personnel, the time for performing exercises on the simulator is 3 hours, the distribution of which by type of activity is as follows:

-Instructions - 20 minutes;

- Preparation for the exercise - 10 minutes;

- Exercise - 120 minutes;

- Analysis - 30 minutes.

Besides, in order to increase the efficiency of the simulator training process, in addition to complex, procedural simulators and language classes, also there exist the following visual and methodological materials:

- Flight procedures in the take-off and landing zone, the area of the aerodrome and in routes;

- Location schemes of radio navigation and landing equipment;

- Tactical and technical characteristics of radar stations, for example it’s range;

- Methods for determining and recalculating the transition level and the minimum safe altitude along the routes depending on pressure;

- Aircraft movement graphs;

- Rules for filling the stripes;

- Information about the methods to be used for solving potential conflict situations;

- Recorder of radio exchange;

- The layout of the base airfield with an aircraft models;

- Instructions for the production of flights;

- Organization of an air traffic control at the Local airlines (connecting regional centers within a radius of 500-1000 km);

- Instructions for the organization of air traffic control at the Local airlines;

- Phraseology of radio exchange for each control zone and area, including special cases and flight conditions should be conducted in Russian and English;

- Technology of work at every workplace;

- Technological tables of operations of operators in special cases and flight conditions for each control center;

- Reference and visual aids explaining individual technological elements, air traffic services (ATS) procedures, ground, airborne navigation and landing systems;

- Changes to previously developed methodological documentation in accordance with the requirements of new documents, new technical means or new ATS procedures.

### 1.4.1 Structure of training

Preliminary preparation is carried out in a methodical audience on the start of a new exercise.

At the preliminary training, an instructor is obliged to inform the students of the following:

- The purpose of the exercise;

- The order of the exercise;

- Conditions for the exercise;

- An example of solving specific problems;

- Traffic intensity and air situation in the simulated area.

Instructions consist of two parts. The first part coincides with the provision of an air traffic service. The second includes the organization of the exercises.

Briefing should be considered and used not only as a way of transmission of the necessary information to the students, but also as a method of developing their knowledge in a special discipline.

### 1.4.2 Conducting of classes

The main responsibilities of instructors during the exercise are:

1) Operational management of the learning process (explanation of issues arising during the air traffic control process, choice of methods for solving problems, assistance in a difficult situation, etc.);

2) Collection of information on the degree of preparedness of students with the recording of comments in the instructor's journal (the number of errors by type, air traffic control efficiency, stiffness during air traffic control, etc.);

3) Operational interaction with the leaders of training to regulate the level of student load (if the instructor believes that the future operator can solve more complex problems with an additional number of goals and vice versa);

4) The organization of the learning process, which consists in the timely movement of students into workplace in accordance with a predetermined plan;

5) Collection of information about characteristic errors in the group for subsequent analysis, identifying their causes and eliminating them.

### 1.4.3 Workout Analysis

At this stage in the simulator system, should be installed the additional recorders for better analysis. Human factor exist at each stage of training. To solve all problems appeared during this educational process and minimize it, high-quality complex training system should be used.

Analysis of training includes:

- An individual analysis of the actions of each student with an indication and analysis of his mistakes;

- A group analysis for all practicing involved in the training process, during which special attention is paid to cases of violation of air traffic control rules that create a potential threat to flight safety.

The effectiveness of the analysis and quality of training increases with the use of objective control tools (audio and video recordings of the course), that are used in the process of analysis. Based on its results, the instructor makes a decision on the continuation of the training process, taking into account the individual approach.

The analysis is carried out by the training leader or instructor according to the data received from all the instructors involved in the exercise.

The analysis of preparedness should be based on quantitative and individual assessments of instructors.

The analysis criterion is based on:

1. Preparedness and ability to check the working place and achieved information by the student;
2. Determining of an aircraft position (up to 5km);
3. Level of radio exchange ( up to 4 remarks);
4. Quick reaction on different situations (up to 4 remarks);
5. Correctness and timeliness of commands (up to 4 remarks);
6. Interaction with crew members;
7. Schedule management (up to 4 remarks);
8. Interaction with an adjacent centers and areas (up to 4 remarks);
9. Information Transfer and it’s correctness;
10. Violation of the boundaries of transmission of an air traffic control service;
11. Mistakes in defining of the intervals between the aircrafts and dangerous weather conditions (up to 3 remarks);
12. Alarm of the system (up to 2 remarks);
13. Collision of an aircraft (up to 1 remark).

Table 1.4.2.1- Student error assumption during the training classes

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Analysis criteria number | Rating (number of remarks) | | | | | | | |
| excellent | | good | | satisfactory | | unsatisfactory | |
| 3 course | 4-5 course | 3 course | 4-5 course | 3 course | 4-5 course | 3 course | 4-5 course |
| 1 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 2 | 3km/3° | 2km/2° | 4km/4° | 3km/3° | 5km/5° | 4km/4° | 4km/4° | 3km/3° |
| 3 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 4 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 5 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 6 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 7 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 8 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 9 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 10 | 1 | 0 | 2 | 1 | 3 | 2 | 4 | 3 |
| 11 | 0 | 0 | 1 | 0 | 2 | 1 | 3 | 2 |
| 12 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

Students who have successfully completed the exercise should note in their workbooks the instructor's comments and the questions necessary for repetition, with the obligatory indication of the period for their verification.

In addition, instructor gives directions and tasks to prepare for the next exercise.

Students who have received an unsatisfactory grade for an exercise should re-examine the conditions for its implementation and undergo preliminary training.

### 1.4.4 Training classes

Throughout the entire period of training, the instructors are constantly monitoring the actions of students. Depending on the stage of preparation, the methods and form of presentation of its results are different. So, at the initial stages of training with the introduction of new elements into the exercise, tight control and adjustment of the actions of students by the instructor exist.

In the course of the exercises, operators are making frequently repeated mistakes inherent in a particular workplace, which can lead to violations of air traffic control rules and airspace usage rules.

The observations showed that about 50% of students make mistakes in determining and predicting actions with dangerous proximity in flight, 92% violate the phraseology of radio communications, 78% make mistakes in deciding on the organization of a dynamic air situation with dangerous proximity, 21% violate the boundaries of reception - transmission of operational messages. This information confirms the importance of the simulating systems usage in order to avoid such mistakes.

Depending on the workplace, all the mistakes are divided into several groups:

1. Mistakes made in planning and providing air traffic:

* Transmission of flight plans for approval and provision in violation of the deadlines established by the Timetable of messages and the Timetable of intra-airport information;
* Untimely re-provision of the amended air traffic plan;
* Violation of the flight schedule and flights outside the schedule without notifying the production and air traffic service;
* Planning and transferring of flight plans carried out according to Visual flight rules (VFR), to ensure the violation of the requirements;
* Permits of controller for flights under the VFR in the absence of relevant weather conditions;
* Violation of the Timetable of messages and the Timesheet of intra-airport information.

1. Errors made during the ground operations:

* Permission for a start, towing without the permission of the airdrome control unit;
* Violation of the established phraseology;
* Ineffective control or its lack for an aircraft movement in the taxiway;
* Untimely information (its absence) about the status of taxiways and potential dangerous obstacles on the route of taxiing;
* Lack of information to crews about changes in weather conditions or forecast received from Meteorological Station;
* Violation of the Timesheet of intra-airport information and technology;
* Violation of interaction with related control centers;
* Intervals less than specified by the Flight Instructions;
* Permission to take off and land without the situation awareness;
* Permission for taking-off in weather below the established minimum;
* Lack of information about the changing weather conditions;
* Permission for taking-off and landing in the presence of obstacles on the taxiway;
* Permission for taking-off and landing with a co-efficient of adhesion <0.3 at the runway if the strength of the soil (snow) on the runway is less than that established;
* Violation of the phraseology of radio communication between air traffic controllers and an aircraft crews;

1. Errors made during the area operations:

* Failure to comply with established intervals and separation rules;
* Untimely informing the aircraft crews about the presence of restricted and dangerous areas;
* Violation of the radio communication phraseology;
* Lack of continuous radar checking;
* Careless fulfilling of the schedule of movement of an aircraft (stripes);
* Permission to maneuver with the intersection of occupied flight levels without defining safe intervals;
* Untimely notification of air defense authorities on changes in flight routes, about deviations of the aircraft.

As we can see, a lot of mistakes can be done on the working place, prevention measures if which is testing the actions of the controller on the backup workstation or simulator after it’s occurrence.

### 1.4.5 Simulated exercises requirements

When completing the training program on simulators, the simulated air zone can reflect either real-world air traffic control zones or a training zone that is not tied to specific conditions.

1. While creating the exercises for the simulator at the final stages, it is necessary to model the following elements for an air traffic control operators:

* “peak” loads, that is, a sharp transition from low intensity to high and vice versa;
* Simultaneous control of several aircraft with different flight characteristics;
* ATC in special cases and flight conditions;
* ATC during unstable operation of the radar, interference and "clogged" communication.

2. In the Control Area:

* Dangerous En- route situations;
* Aircraft entry into the “prohibited” zone;
* Fling beyond the control area.

3. In the Terminal Area:

* Conflict situations;
* Aircraft deviation beyond the corridor and approach procedures;
* Change in heading;
* Rapid change of the weather conditions without paying any attention;
* Entrance to the zone of two aircraft at different altitudes with the same distance and azimuth;
* The presence of runway obstacles;
* Control in conditions when two or three different types of descending aircraft meet several aircraft that are ready to take off.

### 1.4.6 Preliminary classes

Objectives:

1) To study the features of the organization of flights and air traffic control at the training aerodrome;

2) To get acquainted with the workplaces on the simulator and documentation at workplaces.

The students, under the guidance of an instructor have to get acquainted with the description and characteristics of the training aerodrome, with schemes for leaving the area of ​​the aerodrome and landing.

Also, at the workplaces, students have to study the equipment and documentation of control centers, the channels of interaction between control centers and services that provide and coordinate flights.

As a result of studying the topic, students should know:

* Instructions for the control of flights at the training aerodrome;
* Equipment and documentation of control zones;
* Rules for interaction between control centers and with other services.
* Theoretical check is carried out on knowledge:
* Normative documents closely connected with the area of knowledge;
* Airspace structure in the management area;
* Rules and procedures for the Air traffic controller tasks;
* Features of work in the air traffic system.

### 1.4.7 Practical training of students

In the course of training, real radar information is supplied to each control panel of the system. It is displayed on the corresponding workplace of the control desk also the data from radio exchanges and information from current flight plans is received.

Observing the air situation and listening to the radio exchange of the instructor controlling the air traffic, students perform the functions for each aircraft in accordance with the instructions given for these aircraft. In addition, they record changes in the current air situation.

Students under the guidance of instructors get to know new working places of operators in the automated system, practice skills on the use of air traffic controllers’ equipment, operations for entering information into the system, adapt to the new location of the display tools and controls, master the procedure for turning on, off and preparing the equipment and remote control equipment for work.

Instructors should strictly monitor how correctly students who carry out radar control receive the air situation in a simulator form from the radar system. At the same time, the skills of analysis and assessment of the current air situation, as well as the correct determination of its development, should be processed. To solve this problem, instructors should pay attention of students to the fullest use the capabilities of the system, which allows you to get additional information about the movement of an aircraft using the functions "quick view", "extrapolation" in its and adjacent sectors, "vector", as well as functions for receiving a weather data.

Future operators, who carry out procedural control during the exercise, practice the skills of the correct perception and evaluation of information about flight plans displayed on control panels.

The aim of first exercises is the elements of the technology of work that are directed to control of the movement of an individual aircraft, as indicated by instructors, where the intensity of air traffic is limited. This is due to the fact that with the help of training there may exist cases when the information displayed on the indicators may exceed the ability of students to perceive it, as well as to develop elements of the technology of work for all aircraft included in the air traffic control sector.

Therefore, it is advisable that the instructor, on the basis of the student’s preparedness level, in each case determine to them a quantity of aircraft per exercise, which ensures full training of the operations and approvals.

In the future, elements of operational procedures for all aircraft under the control of the operator of this sector should be worked out with the students. The first lessons in these exercises are conducted in conditions of low air traffic intensity, but with a time, the exercises become more complicated. The elements of the technology for the work of operators are worked out under the conditions of failures of individual units of the system: the failures in the operation of the corresponding simulated equipment (unit of equipment) or the information is removed from the display for a certain period. The failure of the equipment, which for technical reasons cannot be switched off autonomously, is simulated by the corresponding information.

During the training, it is also important to learn how to perform the preliminary and current planning, for which lists of flight plans are ready, and analysis of the errors in messages received to air traffic control and the necessary actions are taken to eliminate these errors using remote control operations.

## 1.5 Qualification approaches to the training and assessment system

Qualification Document 9868 “Procedures for Air Navigation Services - Training” includes the section of the effective communication, the qualifying elements if which, during the trainings are: the choice of suitable communication mode and demonstration of the effective speech skills [4].

To develop a qualification system for training and assessment, a systematic approach is used, providing for the establishment of qualification requirements and related performance criteria. Training course is based on established qualification requirements, the developed methodology for assessing results. A qualification training and assessment system can be used by a training organization or air navigation service provider (ANSP), or both in combination. When introducing a qualification system for training and assessment, the following characteristics must be observed.

Qualification approaches to the training and assessment system include at least the following aspects:

* Grounding of the need for training with the use of system analysis;
* Determination of the criteria to be used in assessing;
* The use of different methods of analysis and tasks to determine the performance standards, the conditions in which this work is carried out, the importance of tasks and a list of requirements for skills, knowledge and attitudes;
* Determination of the characteristic features of the trained contingent;
* Determination of training objectives based on the analysis of tasks and their formulation in a form that allows their observation and measurement;
* Development of a performance-oriented testing system;
* The development of the principles of adult education that are aimed to provide an optimal method for achieving the required level of qualification;
* The development of a special training course (as opposed to instructor-dependent training);
* Use of the evaluation process to ensure the effectiveness of training and its relevance in the context of real production processes;
* Selection and description of training forms for examiners within the framework of the qualification system;
* Examination of the effectiveness criteria by the examiner in assessing each skill level;
* Grading guide (necessary information) applicable to all assessments within the qualification system.

The training process involves filling in the gaps between the existing skill level and by preparing and demonstrating the results in the assessment process.

The authorities develop and / or approve, as appropriate, the assessment process, which includes guidance on the assessment (objective data), a set of variable factors and the standards of knowledge and skills required to approve the candidates. The certificate of an air traffic controller meets the requirements of the approved program of the qualification training system and is subject to assessment in accordance with the approved process.

All programs of the ATCO qualification training system are developed using a systemic methodology, for example, the Training Management System or its equivalents. The ATCO qualification training program includes teaching theoretical subjects and developing practical skills.

The ATCO qualification training program provides the classes acceptable to the authority. During an assessment, it must be ensured that:

* The qualifications acquired and the results of the training are relevant from the point of view of the work of the air traffic controller in the specific context and the specific conditions in which he / she may be sent after the training;
* Students get the required qualifications in a gradual and satisfactory manner;
* Actions are taken to correct deficiencies if their necessity is determined by the results of evaluations during preparation or upon its completion.

The introduction of a qualification training system requires a combination of different types of training (theoretical and practical) using technical training tools (classroom teaching, simulation tools of various levels and training at the workplace). An approved training program should demonstrate the ability to achieve training goals using a variety of training parts.

For the first experimental ATCO qualification program at an Air Navigation Services Provider (ANSP), approval should be preliminary and only confirmed if the first training courses and an experience gained at its implementation is satisfactory.

The ATCO Qualification Framework describes the qualification blocks, qualification elements and performance criteria that are transformed in the operational environment of air navigation service providers, taking into account applicable air traffic control qualification marks and the required skill levels to obtain such marks.

Approved training organizations or air navigation services providers use the ATCO qualifications framework as the basis for developing their own training and assessment programs, which should be adapted to the operational and organizational conditions of the ATCO. The competent authority should use the ATCO qualifications framework accounting the conditions of evaluating the approval of ATCO training programs. The use of such a qualification framework is not mandatory, but it is recommended to achieve the best results in preparing the ATCO.

The qualifications framework is a high-level structure for determining the qualifications of ATSOs. They can be specified using general categories of qualification marks - area, approach and an aerodrome. The framework does not depend on the type of equipment used or on the main areas of application (on the route, during approach, etc.) or on the distribution of tasks at the operator’s workplace. Some skill levels may refer to specific air traffic control functions, as determined by local organizational conditions. Aspects of management, cooperative decision-making, and the functions of organization of an air traffic flows are not included into the ATCO qualification framework.

The framework is general in nature and must be adapted to the work environment and organizational conditions, as well as the professional experience of the ATCO. They do not consider specific definitions of job responsibilities, assignment of tasks, qualifications and levels of training adopted by the organization. Local application of this framework includes the selection of skill levels that are most suitable for local conditions. Errors should be integrated in the development of programs for the qualification training system.

Qualification block includes:

Situational awareness, qualification elements of which are:

* Observation of the operational environment;
* Understanding of the operational environment;
* Anticipation of possible situation;
* Recognition of decreased situational awareness.

To pass the effectiveness criteria of this framework operators have to:

* Carry out monitoring of air traffic in the area of ​​responsibility and adjacent airspace;
* Monitor weather conditions that affect their own area of ​​responsibility and the adjacent airspace;
* Monitor the status of an air traffic control systems and equipment;
* Monitor operational activities in adjustment sectors to anticipate possible change of situation in his area;
* Receive information from the observation systems and flight data, meteorological data, electronic data indicators and any other available means;
* Receive a complete picture based on information obtained from tracking and searching;
* Analyze the actual situation on the basis of information obtained as a result of observation;
* Assess the situation based on the results of the analysis;
* Predict the future development of the operational environment;
* Detect potentially dangerous situations (for example, the distance to other aircraft, objects, airspace and land, the effects of weather conditions);
* Check the accuracy of information and the correctness of assumptions;
* Use available tools to monitor, search, understand and predict the operational situation.

Air traffic and capacity management, qualification elements of which are:

* Organization of safe traffic;
* Transmission of flight information;
* Providing basic traffic and weather information.

To pass the effectiveness criteria of this framework operators have to:

* Organize the movement of arriving, departing aircraft and / or aircraft on the route using established procedures;
* Take into account the characteristics of an aircraft issuing operator permits and instructions;
* Use a variety of methods for efficient organization of movement (for example, assigning speed, vectoring, order of movement, assigning to climb speed / descent speed);
* Take actions to prevent the excess of sector capacity if necessary;
* Keep focus at movement;
* React appropriately in situations that may affect the flight;
* Give permits to flight crews to facilitate an economical and efficient traffic flow;
* Give appropriate permissions and instructions;
* Issue the permits and instructions in time;
* Use available tools to reduce delays and optimize air traffic flow;
* Provide flight information in time;
* Transmit warnings of danger to pilot in time;
* Transmit accurate and timely information about nearby aircraft to crews;
* Transmit meteorological information to flight crews if necessary.

Separation and conflict situations’ solving, qualification elements of which are:

* Identification of potential conflict situations in traffic;
* Solving of conflict situations;
* Ensuring aircraft separation;
* Ensuring a safe distance between aircraft, land and obstacles.

To pass the effectiveness criteria of this framework operators have to:

* Recognize conflict situations;
* Select the most suitable separation method;
* Apply appropriate separation;
* Issue permits and instructions to ensure that proper separation intervals are maintained;
* Issue permits and instructions, taking into account the characteristics of an aircraft, obstacles on the ground, airspace restrictions and weather conditions;
* Transmit permits and instructions for resolving a conflict situation;
* Solve conflict situations coordinating with an adjustment sectors;
* Monitor the actions after the instructions to ensure separation;
* If necessary, correct actions to maintain separation intervals.

Connection and its qualification elements:

* Selection of the appropriate communication mode;
* Demonstration of effective radio communication skills;
* Demonstration of effective writing skills and other types of non-speech communication.

To pass the effectiveness criteria of this framework operators have to:

* Use proper vocabulary and expressions for radio exchange;
* Use standard radiotelephony phraseology;
* Demonstrate active listening skills by asking relevant questions and providing the required information;
* Check the accuracy of the reverse transmission of instructions and, if necessary, correct it;
* In appropriate cases, use visual contact;
* Write or enter the messages according to the protocol;
* Report related issues and intentions.

Coordination and its qualification elements:

* Determination of the need for coordination;
* Choosing the right coordination method;
* Implementation of coordination.

To pass the effectiveness criteria of this framework operators have to:

* Coordinate with the staff at other workplaces and other adjustment centers in time;
* Select a coordination method, taking into account the circumstances, including the urgency of the coordination, condition of systems and prescribed procedures;
* Coordinate with the change in state of operating facilities, including equipment and systems;
* Coordinate changes in the airspace status;
* Use clear phraseology for speech coordination;
* Use standard Air traffic service message formats and protocols for non-speech coordination;
* Transferring control at the workplace, conduct an effective briefing.

Coordination in emergency cases and its qualification elements:

* Management in the emergency and unusual situations related to aircraft operations;
* Management in conditions of limited functionality of the Air traffic service system.

To pass the effectiveness criteria of this framework operators have to:

* Recognize based on available information the presence of an emergency or unusual situation;
* Determine the nature of the emergency;
* Determine the way of action taking into account level of dangerous situation;
* Choose optimal assistance actions;
* Follow established emergency communications and coordination procedures;
* If necessary, provide assistance and take measures to ensure the safety of an aircraft in the area of ​​responsibility;
* Detect change in the performance of an Air traffic service systems and / or equipment;
* Evaluate the effects of functionality limitations;
* Follow the established procedures for management, coordination and communication in the case of system functionality limitation;
* In the absence of a procedure, determine the options for responding actions in the emergency situations.

Problem Solving and Decision Making and its qualification elements:

* Identification of possible solutions in the identified problem;
* Effective prioritization;
* Effective risk management.

To pass the effectiveness criteria of this framework operators have to:

* Takes into account existing rules and operating procedures when determining possible solutions to a problem
* Implement a proper solution to the problem;
* Determine the situations that require the most urgent action;
* Organize tasks in accordance with the proper order of priorities;
* Take appropriate measures to minimize the effects of identified hazards;
* Provide operation in the presence of problems without influences on the flight safety;
* Making decisions taking into account factors of timeliness.

Demonstration of personal qualities that contribute to improving work efficiency and its elements:

* Self-assessment in order to increase the efficiency;
* Usage of the feedback to increase efficiency;
* If necessary, adaptation to the characteristics of the situation;
* Continuous self-development efforts.

To pass the effectiveness criteria of this framework operators have to:

* Take responsibility for his work and correct his mistakes;
* Accept feedback in order to improve the performance;
* Do not lose self-control in any situation and work normally in adverse conditions;
* Change approaches and take the necessary actions for a changing situation;
* On a personal initiative, maintain an appropriate level of awareness of the development and achievements in aviation;
* Participate in training events (production meetings, briefings and training sessions).

Workload management and its elements:

* Adaptation to change in work conditions;
* Determining the place and the time for the provision of the required assistance;
* Effective use of working time;
* Effective and efficient use of ATS equipment.

To pass the effectiveness criteria of this framework operators have to:

* Effectively perform the tasks in the current and future workload;
* Determine the need for support based on workload;
* If necessary, delegate problem solving to reduce workload;
* If necessary, accept the help;
* With an increase in workload accelerate the speed of work;
* Select appropriate facilities, equipment and resources for ensuring the effective performance of tasks;
* Use automated capabilities of ATS equipment to increase work efficiency.

Teamwork and its elements:

* Creating an atmosphere of open communication;
* Encouraging the participation and cooperation of team members;
* Use of feedback to increase the overall efficiency of the team.

To pass the effectiveness criteria of this framework operators have to:

* In a constructive spirit give positive and negative feedback;
* Objectively perceive positive and negative reviews;
* Respect and tolerate other people;
* Perform actions and responsibilities, guided by the spirit of collectivism;
* To strengthen the spirit of collectivism, participate in the resolution of interpersonal conflicts;
* Use the negotiation and problem solving methods to resolve inevitable conflict situations when they arise;
* Anticipate the needs of other employees and respond appropriately to them;
* Share the experiences to further improvement.

The program of the qualification system of a personnel training should provide a sufficient amount of practical training to ensure the achievement of the required level of qualification.

## Conclusion to Chapter 1

The main goal of developing a training system for ATCO controllers is to promote the standardization of operational efficiency with the use of existing practices in the preparation and evaluation of ATCOs.

From the huge amount of plans for training, the most popular mistake of training is evaluating mistakes during classes. Also, the system proposes 524 hours on Simulator Training. It means that for training should exist at least one classroom that have to be free most period of time, if take into account only ATCO students. The best idea to solve this question –is to set up movable station for trainee work that can be used in every free classroom for working out the radio exchange communication skills and phraseology.

Besides, the level of training should correspond to job requirements. Such practical training should be supervised by an instructor with qualification and professional knowledge in the technical. In case if practical training is carried out at the workplace and instructor have qualification and professional knowledge in the technical field, training should be carried out as part of the management system of the appropriate air navigation service provider with an approved lessons’ plan.

# CHAPTER 2. FORMATION OF PROFESSIONAL SKILLS

## 2.1. Necessity of the formation of professional readiness of future air traffic controllers for radio exchange.

In recent years, Ukraine's aviation system has undergone changes aimed at adapting to the relevant standards and recommendations of the International Civil Aviation Organization, the European Organization for the Safety of Air Navigation and other international regional aviation organizations. In accordance with international requirements, aviation education reform is underway in Ukraine, which is part of a pan-European educational transformation, which envisages eliminating the deficiencies in the aviation education system of previous years, in particular the training of future aviation controllers.

The effectiveness of the process of preparation for radio exchange, both in normal and in extreme flight conditions, directly affects the reliability of the professional skills of future air traffic controllers, although it is not considered to be the only prerequisite for achieving this level of reliability. Insufficient reliability of professional radio communication skills is one of the reasons for a number of aviation catastrophes of the past years, so the search for ways and mechanisms for constant improvement of the training of future aviation specialists for radio exchange, improvement of the culture of professional communication of aviation controllers, improvement of their level of reliability actual problems for higher flying schools that prepare future aviators. In view of this endeavor, the use of state-of-the-art pedagogical science to shape the readiness of future air traffic controllers to conduct radio exchanges in standard and non-standard situations should become one of the main activities in the educational process.

Communication is one of the main means of accomplishing professional tasks. Today, the society needs aviation specialists, namely air traffic controllers, who, in addition to a complex of specialized knowledge, must be able to navigate well in various communication situations, choose adequate means of communication, actively perceive and analyze information, clearly, logically and convincingly express their thoughts, establish and express their thoughts, overcome communication barriers, organize cooperation. Effective work of the control unit requires a relaxed atmosphere of communication, a clear understanding of all the tasks of the team, respect for the views of others, resolving conflicts without pressure, by weighing the evidence of the parties and making a group decision. It is communication skills that provide communication, is an essential means of carrying out any professional activity, including professional activity of the air traffic controller.

Not only the activity but also the life of the communication participants depends on the level of professional communication skills. In our case, it is the communication between the operator and the pilot. It is from the understanding of each other that the participants of this interaction determine the safety of the flight. Thus, for the successful implementation of professional activity, air traffic controllers need to be able to communicate effectively in the mode of "pilot - pilot". It is also necessary to communicate in monosocial groups such as "air traffic control services", "air traffic controllers" and the like. Therefore, professional communication of future air traffic controllers will be effective if it is based on knowledge of professionally oriented disciplines and provided the necessary communication skills necessary for successful communication and information exchange.

Formation of communication skills of future operators during training is an active educational process due to the need of society for professional training of qualified aviation specialists.

## 2.2 Methodology of preparation of ATCO personnel in civil aviation.

Over the past 20 years, the training of the ATCO has been constantly changing and attempts to reform the training methodology have been noted. In this regard, there are some negative changes in the initial training, internship and, naturally, in work.

The study of these problems is due to the growing role in the aviation industry of specialists in air traffic control (air traffic controllers). Air traffic intensity has a clear growth trend not only on domestic airlines, but also on international air routes. Air transport has become a truly massive and the only regularly operating mode of communication.

In this regard, it is necessary to understand that the training of highly qualified aviation personnel is one of the main tasks for ensuring flight safety.

But a future specialist who enters an educational institution to receive an education in a specialty obviously becomes a hostage to an imperfect training structure for an air traffic controller. After graduating from the educational institution, the young specialist is brought to the so-called enterprise, in conditions of intense uneven movement, where gaps in theoretical training come out into the white light.

According to numerous observations, about 50% of young professionals do not understand at all how and what they will do in the future. Not to mention how the aircraft is piloted, and what difficulties are associated with this.

Many instructions are being developed on the organization and conduct of simulator training for ATS personnel, instructions on internships and verification of air traffic control personnel at workplaces that help in the future with the professional growth of operators.

On October 20, 1961, the International Federation of Air Traffic Controllers Associations (IFATCA) was created in Amsterdam. This event was a significant milestone in the history of the development of air transport.

Since its inception, the number of IFATCA member associations has grown to 133; they are represented by 50 thousand air traffic controllers around the world. There is a rule among air traffic controllers — work must be carried out regardless of any circumstances and working conditions.

Air traffic controllers have a huge responsibility and the highest demands are placed on their professionalism. ICAO pays great attention to the study of teaching methods. These studies were launched by the Air Navigation Committee in June 1946 and continued during the first, second, fourth and several subsequent sessions of the ICAO Assembly.

The Air Navigation Commission also pays close attention to various aspects of the ICAO training program, which has long been developed as a source of information and guidance for States.

Since ICAO, as one of the specialized agencies of the United Nations, is currently participating in the implementation of the UN expanded program of technical assistance for economic development.

The goal of ICAO training is to ensure uniform application of these technical requirements. It aims to achieve a high level of professional training in general, and is published in the form of information and guidance material for contracting states.

The needs of the industry with regard to the selection of candidates, their training, advanced training and maintaining the appropriate level of professional training of personnel have changed, and the recommendations proposed in the Training Manual have lost their relevance.

In order to overcome these difficulties in the training of specialists, ICAO constantly makes adjustments to the training programs for specialists responsible for people's lives.

Experience has shown that the training of individuals whose activities are related to aviation is perhaps one of the most important factors contributing to aviation security.

Quality training can only be carried out by qualified teachers. Others rarely realize that learning, like teaching, is an art that requires a special technique, the implementation of any other activity related to the observance of well-defined rules and procedures.

In fact, even with such rules and procedures, training is a more complex process than most other types of human activity, since it is a matter of human material, and the differences between individual students are often much wider and more complex.

Quality teaching is an active process that involves active thinking or student participation.

In many ways, education lays a large strong stone in the foundation of a young specialist. In the future, during training and work, all the knowledge that a student or entrant receives, like a chain, link by link, his knowledge platform will be built.

There are a number of sciences that need to be studied and understood. This is a very important moment in the formation of a young student as a future specialist. But today there are a number of gaps in the training of movement service specialists in educational institutions. In some places, training methods are "laming" and lagging.

There are a number of disciplines that are currently not paying much attention, but they are very important in understanding the listener of the importance and specificity of the chosen profession.

There is a great need to revise the methodology of the educational program and training specialists in educational institutions. It is necessary to place a great emphasis not only on the so-called control science, but also on the disciplines taught to future pilots.

Preparation of ATS personnel for independent work begins at the training center, at the direct enterprise, where a young specialist begins his work.

When undergoing training in a training center, a specialist uses the necessary teaching aids. The purpose of training manuals is to improve the quality of training; throughout the history of mankind there has been a natural tendency to use illustrations or models in the learning process for demonstration to students. Classical teaching methods (blackboard, teacher, textbook) often forced to memorize unimportant facts, reducing the real quality of training. The latter depends entirely on the students, however, in the course of practical experiments it was found that the most effective training takes place when the student is an active participant in this process.

Learning is a process under the influence of which the reaction and the resulting behavior of an individual change. It is no coincidence that the individual textbooks discussed below are intended for visual and auditory perception, since vision and hearing are the two most important cognitive tools.

Vision, i.e. visual perception of current events is the best teacher. However, not everything can be perceived or learned through direct visual contact, so there is a need to develop teaching methods and materials that properly replace direct participation and direct experience.

Audiovisual learning is an expression used to refer to a commonly used specific teaching practice. The materials pertaining specifically to audiovisual media include all kinds of models, maps, posters, tape recordings, slides, illustrations and movies.

The proper use of audiovisual tools can significantly increase the effectiveness of listeners. This helps to improve the quality of training, the assimilation of certain elements of knowledge and in the presence of a capable and qualified teacher saves time.

The mentioned conclusions are confirmed by statistical data. The critical importance of individual learning is not in doubt as it fits into “Twin” training and certain types of training in the workplace.

Such tools, especially if they represent the material in a logical sequence, develop the discipline of thinking. This allows you to save the most important elements of basic knowledge on any particular problem in an active form. The student gets the opportunity to understand for himself the details of what the teacher gives only in a descriptive form.

These tools limit the amount of detailing of knowledge communicated to the listener per unit of time, making it possible to focus on the main thing. It is because of this that they contribute to a deeper assimilation of the material and give practical experience that is not so easy to acquire in another way. As a rule, dynamic learning tools, such as movies or television programs, stimulate the rapid development of students' abilities.

Thanks to the use of good teaching aids, this can be achieved much faster and better than even with direct work with the studied object. Training programs focused on the scrupulous and ubiquitous use of such tools have proven their practical suitability in all areas of knowledge and for all age groups of students.

Plans and methodologies for training and internships have been developed both on the simulator and directly at the workplace.

For each enterprise, depending on the complexity of the zone, traffic intensity and other related factors of controller’s work, the necessary procedures have been developed for internships and further professional development of an ATS specialist.

The internship consists of two parts: theoretical and practical. According to some observations, we may notice that there are also imperfect internship methods. This is especially evident when a careful examination of teaching aids, instructions for organizing and conducting training and internships for ATS personnel. The theoretical part includes testing knowledge after an educational institution, studying the necessary materials related to the features of a particular zone and further developing any exercises on simulators in the training center. In the future, after going through all this part, the specialist is allowed to practice internships, i.e. direct ATC with an instructor.

This is where two questions meet - ignorance of some important disciplines and the specifics of piloting an aircraft with imperfect technology for internships and personnel training at the enterprise. As a result, it is possible not only not to understand the young specialist what they want from him, but also to dissuade this specialist from the correct choice of profession.

After all, if he understood from the very beginning of his studies what operator’s work was, and upon arrival at the enterprise, the young specialist was brought not old information in the form of instructions that had not been processed since the Soviet era, but a new revised methodology for training and internship of ATS personnel, there would be no such results.

Therefore, in the preparation and training of controllers, it is necessary to reintroduce flights or flight simulators so that students can understand what is happening and how beyond the radar, at the other end of the radio communications. So that there is no ambiguity in understanding what the operator says and what the pilot is doing at this time. It is necessary to strengthen and modernize not only the training methodology, but also the technical basis of training, so that the training and internship methodology of the air traffic control personnel acquires more and more solutions to problems in the training of a young specialist.

## 2.3 Methods for teaching future air traffic controllers in professional English language.

An analysis of aviation accidents and their prerequisites showed that in recent decades the problem of the human factor has become aggravated in international civil aviation, and in particular, the problem of reliable radio communication in professional English between pilots and air traffic controllers of non-English speaking countries.

According to the International Civil Aviation Organization (ICAO), the cause of this problem is an insufficient level of English proficiency by pilots and air traffic controllers. However, an analysis of the materials of the investigation of aviation accidents showed that the problem is not just an insufficient level of language knowledge, skills and abilities of pilots and air traffic controllers, but the inability to apply this knowledge, skills and abilities in extreme situations.

It has been suggested that the reason for this phenomenon lies in the discrepancy between the quality of language training and the requirements for the modern operator of particularly complex control systems. Based on this, an analysis was made of the existing system of teaching English the professional orientation of future air traffic controllers on international air routes.

The analysis revealed a number of significant shortcomings and, in particular:

-priority of the informative side of training and the underestimation of the procedural, which contributes to the assimilation of ready knowledge by students and the inability to independently acquire and quickly use it for professional purposes;

- lack of scientific substantiation of specific requirements for the application of problematic teaching and modeling methods problem situations, which are an effective means of consolidating theoretical knowledge and building skills of reliable radio communication in professional English in conditions as close as possible to real ones.

The analysis of modern achievements in the field of psychology and pedagogy made it possible to formulate a research problem, that is determined by the contradiction between the growing role of sustainable proficiency in professional English language, as a necessary component of the reliability of the air traffic controller on international air routes, and the lack of theoretical and practical development of psychological and pedagogical foundations for teaching professional English in the system of their professional training.

 It is established that at present there is no methodology for training future air traffic controllers in professional English based on the analysis of aircraft accidents. The components of the methodology and, in particular, the methods and forms of training organization are not scientifically substantiated or developed.

Studies have shown that the objectives of the training methodology for future air traffic controllers in professional English based on the analysis of aircraft accidents should include the formation of:

- motivation to carry out professional activities, highly motivated to analyze special and critical situations during air traffic control;

-emotional stability in extreme conditions of professional activity;

- the ability to perceive and retain in memory the spatial-temporal characteristics of flight, to recreate a model of a dynamic air situation according to information transmitted by aircraft crews in professional English; and sustainable skills in analyzing alternative models, making and implementing non-standard decisions in the form of instructions to aircraft pilots in professional English in extreme conditions of professional activity;

- reliable knowledge and skills in professional English in expected and special situations: with increased emotional stress, tension of mental and perceptual functions, frequent access to long-term memory and chronic overload of RAM, intense load on the attention function;

- the ability to analyze emergency situations on air traffic control and the ability to predict the development of the situation and anticipate the result of activities.

The above tasks determined the choice of teaching methods, including reproductive (information-receptive and reproductive), productive (partially search and research) teaching methods and problem statement methods.

The use of the information-receptive teaching method is due to the fact that, being one of the fastest ways of transferring experience, it will allow the formation of knowledge that will provide the basis for the development of skills and the formation of skills necessary for future air traffic controllers in their professional activities.

The reproductive method will allow the formation of future air traffic controller’s ability to use the knowledge gained in future practice. It consists in the repeated reproduction of acquired knowledge by performing training exercises and in the process of various forms of control and self-control.

Both of these methods contribute to the formation of students' knowledge, skills and abilities, the formation of basic mental operations (analysis, synthesis, generalization, classification, etc.), but they do not guarantee the development of students' creative abilities. By definition, reproductive methods “appear in the process of theoretical as well as other types of training as the basic basis for the use of more active methods that ensure the development of search and creative abilities. Creative thinking is only possible in conjunction with reproductive.

Since air traffic controllers must have strictly defined techniques (algorithms) for reasoning and actions for conducting radio communications in air traffic control, the use of programmed-algorithmic methods is of great importance in teaching students how to exchange radio in standard situations. However, as the analysis of aviation accidents showed, standard phraseology does not cover all the situations that the air traffic controller encounters in his professional activity, and, accordingly, programmed-algorithmic methods cannot ensure their reliability in non-standard conditions.

In order to teach future operators of particularly complex control systems to independently find a solution to the problem, productive training methods should be applied - partial search (or heuristic) and research. They are aimed at the development of creative thinking and cognitive activity, they teach future air traffic controllers not only to solve, but also to see new tasks for themselves, to be able to independently set them and master the elements of scientific knowledge (to recognize the problem, put forward a hypothesis, build plan for its verification, draw conclusions, etc.).

Productive teaching methods for training future air traffic controllers are aimed at: improving adaptation mechanisms to non-standard situations; formation of structural units of anticipatory reflection (probabilistic forecasting, anticipatory synthesis); formation of independence in decision making and implementation in special and critical situations; analysis of emergency situations and disasters; modeling of situational tasks for the analysis of air crashes, and the prerequisites for them; the formation of emotional stability when performing speech actions in the face of interference; the formation of the stability of mnemonic and mental activity (short-term, operational, long-term memory), probabilistic forecasting, comprehension; the formation of the ability to perform speech actions in a time limit and lack of time.

Productive teaching methods are characterized by the maximum independence of students' actions. Independent work skills are very important for future air traffic controllers because, upon graduation, at the request of ICAO, they are required to periodically confirm their level of proficiency in professional English and take advanced training courses. Considering the fact that the funds allocated by airlines for teaching English to pilots and air traffic controllers, and the possibility of separating them from their professional activities, are extremely limited, further training of specialists is carried out mostly independently, which requires the availability of relevant skills.

The features of the professional activity of the air traffic controller and, in particular, the high probability of the occurrence of problem situations, necessitated the use of problem training methods:

1. General:

* Monological;
* Exponential;
* Dialogic;
* Heuristic;
* Research;
* Algorithmic;
* Programmed.

1. Binary:
2. Teaching methods:

* Informative;
* Explanatory;
* Stimulating;
* Prompting;
* Instructive.

1. Learning methods:

* Executive;
* Partial search;
* Search;
* Practical.

To achieve the unified programmed goal of training future air traffic controllers at international air routes, it is necessary to use specific methods based on specific training principles. These include:

* method of strict regulation and temporary limitation of mastered actions;
* method of additional psychophysiological load against the background of the main activity;
* method of rhythmic increase in psychophysiological load;
* method of complex formation of psychophysiological qualities.

The use of theories of developmental and problem-based learning for the scientific justification of the experimental methodology for training future air traffic controllers in professional English based on the analysis of aircraft accidents led to the use of active learning methods, among which special attention should be paid to role-playing games.

Active learning methods create conditions that motivate students to independent, proactive and creative assimilation of educational material in the process of their cognitive activity. At the same time, four types of activity are distinguished: thinking, action, speech and emotional-personal perception of information. The degree of activation of students is determined depending on which and how many of these types of student activity are manifested in the lesson.

If thinking and, first of all, memory is used in a lecture, thinking and acting in a practical lesson, thinking, speaking and sometimes emotionally personal perception in a discussion, then in a business game all kinds of activity are used, and the training material is learned in the best way.

This led to the fact that in the experimental methodology for training future air traffic controllers in professional English based on the investigation of air crashes and special attention was paid to business games. Their goals are: the formation of decision-making skills in a specific situation; the formation of motivation for learning; the development of cognitive and search activity of students in working with materials for investigation of aircraft accidents and incidents; the formation of skills in the scientific analysis of aviation accidents and incidents; the formation of the ability to conduct scientific research, compose messages and state them in professional English against the background of the impact of emotional factors in the process of conducting a business game; the formation of the ability to express one’s point of view and argued for it in professional English.

By the nature of educational and cognitive activity, methods of active learning are divided into two main groups: imitation methods based on imitation of professional activity, and non-imitation. Simulation, in turn, is divided into gaming (namely: business games, didactic games, game situations and gaming techniques and procedures) and non-gaming (for example, analysis of specific situations). The most typical game situations are educational role-playing games and discussion sessions.

Particular interest for this training methodology for future air traffic controllers in professional English based on the analysis of aviation disasters are audio-visual-kinesthetic training methods, involving the demonstration of instructional videos and films and working with computer-based training programs. In this case, information is recorded on all channels of perception. Accident and incident investigation materials contain all types of training material that allow for the wide and effective use of these training methods.

According to ICAO requirements, the assessment of the level of proficiency in professional English should be carried out by means of an interview or may be based on recordings of a real radio exchange. This can be audio and video recordings, which are an important component of materials for investigation of aircraft accidents and incidents. In this case, not only videos should be used, but also fragments from television news programs recorded from television channels broadcasting in English. The use of different channels of information (auditory, visual, motor perception) contributes to the strong memorization of the material and increase cognitive activity.

Since the English language is a combined activity against the background of the main one in the professional activity of the air traffic controller, it is required mainly for radio communication with aircraft crews, one of the main tasks of their language training is the development of dialogue skills: requesting the necessary informationa and responding to messages pilots (its accuracy, information contentand speed).

An important element of the training methodology for future air traffic controllers in professional English based on the investigation of air crashes is the creation of problematic situations. To create a problematic situation, contradictions should be identified that need to be explained. The content of each problem situation is a training problem. A task or question is a training problem when there is a contradiction between knowledge and ignorance, the content indicates the direction of the search and there is enough basic knowledge to solve the problem.

Role-playing games conducted in the form of air traffic control fragments on international air routes are not only the leading method for assessing the readiness of future air traffic controllers to conduct reliable radio communications in professional English in extreme situations for which standard radio phraseology is not provided so that language activity does not prevented the implementation of the basic professional, but also the most important method of training, as at the stage of theoretical preparation, they allow you to maximize bring the learning process to the conditions of professional activity.

It is important to note that the plots of business and role-playing games should be based on materials of real aviation disasters as the most reliable source of knowledge of the language behavior of the air traffic controller in extreme conditions of professional activity.

The most important method for the formation of future air traffic controller’s reliability of professional radio communication in professional English in extreme situations is the analysis of aircraft accidents. Situations that are selected for analysis can be divided into two groups: the first group is extreme situations caused by technical malfunctions on board the aircraft and communication problems arose due to the fact that under the influence of stress or any other reasons, the air traffic controller could not recreate the model of the flight image, anticipate the development of the situation or realize the degree of its extremeness due to the inability to obtain all the necessary information for this; the second group is situations that were caused by language errors that the controller could not recognize and eliminate.

In the first case, when analyzing the causes of the disaster, special attention is paid to analyzing the behavior of the air traffic controller in an extreme situation, the degree of his emotional stress, the level of motivation to resolve the problem and assessing his professionally important qualities that appeared in a difficult situation. In the course of such an analysis, factors that determined the occurrence of an extreme situation are identified; the course of development of the situation is analyzed; conclusions are drawn about the causes of the disaster based on the construction and analysis of a model of cause-effect relationships of factors that led to the disaster; analyzes all the communication errors and behavior in an emergency situation of the operator and crew members who were negotiating. In the second case, the main attention is paid to finding the error itself, which led to the disaster and the analysis of its nature and causes.

Thus, modern achievements in the field of general and aviation pedagogy make it possible to scientifically substantiate the components of the experimental methodology for training future air traffic controllers in professional English and, in particular, teaching methods. Studies have shown that the most effective method of forming the ability of future air traffic controllers to conduct reliable radio communications with aircraft crews on professional English in extreme situations on international air routes is an analysis of aircraft accidents.

## 2.4 Peculiarities of professional communication of air traffic controllers as a basis for completing exercises in a professionally-oriented English language.

Teaching professionally-oriented English to air traffic controllers requires the use of exercises that reflect the characteristics of their professional communication — radio exchange, which, in turn, makes it necessary to study the characteristics of this type of communication from a methodological point of view. In the scientific literature there are a number of studies of the professional discourse of air traffic controllers, but none of them set the task of taking into account the characteristics of their professional communication in the preparation of exercises. Indirectly, this problem is touched upon and determines the methodology of teaching speaking and listening, taking into account the psychophysiological difficulties of working in the “live” radio exchange mode, however, their studies concern only certain aspects of the professional communication of air traffic controllers.

In the theory of communicative learning, the principle of composing exercises based on the simulation of real communication has been used for a long time, including in professionally oriented training.

For an air traffic controller whose job is to service aircraft and monitor their efficient and safe movement on the ground and in the air, radio communication is the only means of communication with the pilot. This is the process of verbal interaction "pilot-operator" through radiotelephone communication channels. Being a process of remote communication, it has a number of its own specific stages of flow:

1) the perception of information about the objects of management and environmental parameters and the system itself (detection, decoding, allocation of significant information, detection of changes);

2) information processing, i.e., bringing it to a form suitable for decision making (highlighting problem situations, comparing them, highlighting critical objects and situations, lining up for service);

3) making decisions on the necessary actions based on data obtained in the process of analyzing the information model and contained in a conceptual model that reflects the result of the formation of mental processes in operators such as knowledge, skills and abilities;

4) the transfer of information about the decision or the implementation of management actions;

5) control of the crew acceptance of the transmitted information / team, control of crew management actions;

6) coordination of controlled actions of the crew.

Since the operational information intended to solve a specific problem is sent to the operator via radar channels, most often the first stage - the perception stage - falls under the influence of a number of factors of a different nature and, accordingly, slows down the quality of the subsequent actions.

The main factor that cannot be controlled, but determines the entire course of the development of radio exchange, is the lack of time, which is formed by the size and structure of the controller’s area of ​​responsibility and air traffic characteristics (aircraft speed, maneuverability, etc.). Together they compose indicators of workload and tension of the area of ​​responsibility. When the moderator operates at moderate power for more than 30 minutes, the quality of information perception and processing decreases, the redistribution and switching of attention deteriorates, and the RAM also decreases. This regularity must be taken into account when planning and organizing the communicative activity of students in foreign language lessons. This means that the exercises should be aimed at the formation of auditory-speech “endurance” of future air traffic controllers.

A specific feature of the operational work of the operator is the mental advance of incoming information. Two circumstances - the rapid development of the dynamic environment and the reflection of only actual data on the screen - force the operator to predict the development of spatial-temporal relations between managed objects in order to be able to outline the sequence of occurrence and resolution of potentially conflict situations. This skill plays a major role in the controller’s decision -making in operational procedures. So, in busy airports during peak hours, when up to 6 different boards can get in touch within a minute, and when the service time of each of them should not exceed 10 seconds, it is precisely the course of events that has been thought out in advance that allows the operator to quickly cope with the situation. This circumstance

It requires, on the one hand, the training of operator in scenarios for deploying situations and, on the other hand, in radio communication with a gradual increase in the rate of development of the situation.

The ability to predict the development of the air environment is inextricably linked with the ability to distribute attention to changing visible information, instantly evaluate it and save it in operative memory. These abilities are especially clearly necessary in the event of loss of radar contact with the aircraft or in the event of a complete failure of the radar system, which forces air traffic controllers to work blindly. The probability of occurrence of such situations requires the operator to be able to memorize the call signs of at least six aircraft issued to them by heights, and to correctly build their trajectories, despite the screen. Of course, these requirements should also be taken into account when drawing up communication exercises.

Other factors turn out to be relevant when we touch on the specifics of receiving and processing audio information. Despite the fact that this type of information makes up only 15% of the operative data (from the above mentioned), it is he who allows the operator to pass successfully all the selected stages of information exchange in the process of air traffic control. On the one hand, these are the information and command components confirmed by the pilot that are duplicated on the screen (call sign, responder code, altitude, etc.). On the other hand, this is completely new information, not yet reflected anywhere, but already forcibly used for flight safety, for example, in the case of emergency or urgent messages, therefore, when developing exercises for listening, it is necessary to include messages with poor quality of intelligibility of perceived information due to man-made interference (noise, overlays, etc.) and non-standard language design, for example:

1. Distracting even at the stage of perception, the individual characteristics of the speaker’s speech. As a rule, this is emphasis, inadequate speech response of the participant in the radio exchange, speech rate, and pause, intensity of the speech signal and features of the speaker's diction;

2. Violations of the norms of the language code of the radio message, creating difficulties in its decoding. These violations cover language errors in the field of standard phraseology and spoken language and violation of the discipline of radio exchange.

You should also take into account secondary reasons for the distraction of the operator and incomplete or inaccurate perception and decoding of incoming information:

1. Factor of surprise. Since over 90% of radio exchange situations are realized in a well-known context, within the framework of established templates of procedures and language, it is precisely an unexpected turn of events and / or dialogue that can create a stressful situation for the air traffic controller. In this case, the success of decoding a message will directly depend on the level of its mental stability and analytical thinking;

2. Logical errors detected in the message;

3. Simultaneous use of Russian and English languages ​​on the same frequency.

As a rule, the development of exercises of this nature implies the possibility of training on the basis of a training supervisory simulator, which allows you to visualize all managed objects, set the necessary characteristics for them (speed, direction, etc.) and simultaneously develops the required communication skills. However, within the framework of a professionally-oriented language training course, this opportunity is far from always possible due to a number of technical and organizational reasons. To teachers often it is necessary to simulate conditions close to the workers directly in the foreign language lessons using classical teaching aids (textbook, audio player, etc.). It is for such cases in order to prepare for the features of professional communication, we can recommend the following types of exercises, presented below:

1. For the development of auditory skills:

- a phonetic dictation, which is an audio cut from call signs, speeds, heights, etc., reported by pilots of different nationalities;

- listening to the negotiations "pilot-controller" in order to identify the correctness of the confirmation of the pilot issued to him commands;

- listening to “pilot- controller” negotiations in order to compare the incoming audio information with the proposed visual support (map, flight path diagram, telegram, scenario) and identify inconsistencies.

2. To develop a spatial representation of the air situation in a specific area of ​​responsibility, students are invited to listen to the pilot's report and the “pilot- controller” talks:

- for the purpose of the written fixation of elements of navigation information (type (s) of aircraft, speed, altitude, courses, maneuvers, time, point names, etc.);

- for the purpose of graphically plotting the aircraft trajectory in a longitudinal or vertical profile;

- for the purpose of analyzing potential capabilities in the management of this aircraft based on the proposed scheme of the area of ​​responsibility, issued weather conditions, restrictions, etc.

3. For the development of memory:

- an oral account in the mind. The teacher reads an example, students should give an answer, for example: “Four plus seven minus three makes ...?” (4 + 7–3 =?). Students must answer “eight” (8);

- the game "snowball". Students must describe the aviation event or picture in a chain, or transmit the pilot’s report in the following order: the first student speaks only one idea (within the framework of one sentence), the second repeats what was said before him and adds his own phrase, the third repeats the sentences of the first and second students and adds a third idea, etc. .;

- listening to multicomponent reports of pilots, “pilot- controller” negotiations in order to confirm the received information or retelling without written recording of audio information.

4. For the development of communication skills, communication strategies:

- a raffle of the situation. For example, “Confirm receipt of the Airfrance 1153 report on the failure of the right engine and check if the pilots can withstand the current level for 5 minutes”;

- the game "crocodile". One student, without naming an object or object, describes it, the task of the listener (them) is to guess this object or object by asking clarifying questions;

- listening to the pilot's message and responding to it within 10 seconds;

- listening to an excerpt from the pilot- controller talks without the initial and final remarks of the pilot and the operator in order to restore the situation - what was / could be said before and after. Play the restored situation by roles.

However, the general principles for working with each exercise will be reduced to the following principles.

1. The organization of the work itself with each exercise involves completing a task, discussing the results in a group, pairs and individually, if there are discrepancies in the answers of students - motivating them to use communicative strategies to determine the correct answer (re-asking, clarifying, requesting confirmation, requesting to replay the audio fragment, please rephrase the pilot’s message, etc.), student error analysis and help finding optimal ways to avoid them;
2. Monitoring of the implementation of exercises should be subject to international requirements for the language of radio exchange. According to Doc 9835 “Manual on the Implementation of ICAO Language Proficiency Requirements” [7], the language of aeronautical radiotelephone communication is based on the alternate functioning of two language registers: standard ICAO phraseology and spoken language. Regardless of the language register chosen, in order to ensure air traffic safety, the following requirements must be met:

a) the language used should include clarity, directness, relevance, unambiguity and brevity;

b) the standard stipulated by document 9835 on the need to use spoken language in radiotelephone communications should in no case be construed as permission to ignore protocols that determine the use of standard phraseology.

Given this, when performing the proposed types of exercises, the teacher should monitor the compliance of students' answers with ICAO requirements.

3. Each of the proposed exercises should be based on real radio examples.

4. The composition of each exercise is determined taking into account the principles of accessibility and following from simple to complex. So, the same kind of exercise can vary:

* by the number of information elements included for the aircraft being served (only altitude, altitude and course, altitude, course and pressure, etc.);
* by the number of aircraft served;
* on the quality of communication (playing exercises with techno genic interference, individual characteristics of the pilot’s speech, violations of the language of the message code, inclusion of fragments of communication in Russian);
* on connecting visual support;
* by connecting a factor of surprise (for example, an exercise is lost without first removing the difficulties, recording the student’s response to the recorder, with an unexpected time limit for the exercise, etc.);
* by the amount of presentation of the audio recording for the exercise;
* by the time allocated for the exercise.

The practice of using these exercises shows that the proposed approach to their modeling allows accelerating the preparation of future operators for the real difficulties of professional communication.

## Models of assessment of an air traffic controllers

Implementation of state-of-the-art automated air traffic control (CRC) systems and the latest communications, navigation and surveillance (CNS / ATM) technologies, development of the air traffic management system, application of new air traffic management techniques and procedures against the background of significant increase in flight intensity , place increasing demands on air traffic controllers. The Air Traffic Management Authorities (ATMs) are tasked with ensuring the continuous effective air traffic management (management) and flight safety.

Successful completion of these tasks by the air traffic controller largely depends on their acquired level of professional knowledge, skills and competences (OHS) and their actual implementation in the workplace. Therefore, the development of a method and models for evaluating the actions of air traffic controllers with a view to applying them to control the level of their professional training, both on ATR simulators and at the enterprise, plays a very important role. One of the most important tasks of assessing the level of competence of air traffic controllers is to obtain reliable and valid training results. The current system of evaluating the actions of air traffic controllers at ATR simulators and at workplaces, based on the conclusions of instructors (experts), is not sufficiently objective because it depends on the level of their professionalism, experience, moral qualities and psychophysiological characteristics.

The second problem is the lack of a clear, detailed one and a comprehensive system of criteria for assessing the actions of air traffic controllers, which would characterize the activity of air traffic controllers at different levels of the technological structure of their activity (at the level of technological procedures, operations and elements) are quantitatively represented.

Human Reliability Assessment (HRA) was given much attention in the 1970s and 1980s when many different HRA methods emerged (Stager & Hameluck, Rouse & Rouse, Rasmussen, Reason, Embrey, Norman, Jones & Endsley, Williams & Munley, etc.).

The new HRA method proposed by Eurocontrol includes the use of a set of interrelated models, by means of which it is possible to identify and classify errors that allow air traffic controllers during the exercise on the URF simulator. A key model for identifying and classifying errors in their method is the Operator Choice Model (OCM). OCM consistently describes what specific events may occur during the exercise on the simulator. This model encompasses both solutions: right and "wrong" to record how errors occur, propagate and correct.

From the analysis of these methods, it becomes clear that most of them are either not intended specifically for modeling the activities and errors of air traffic controllers, and therefore do not adequately identify errors during the ATR, or are too general and not sufficiently developed at the level of models and algorithms to implement the appropriate evaluation programs. Most of the methods considered do not allow determining the causes and patterns of errors during the URP, to establish causal relationships between the errors and the corresponding events. In addition, many existing methods are characterized by a narrow consideration of the parties and the parameters of the air traffic controller's activity, ie0 there is no integrated approach to analyze and evaluate them.

To reduce the impact of the human factor on the results of the assessment of air traffic controllers' air traffic controllers. This is made possible by providing a simulator (expert) instructor with a documented report containing the results of the initial analysis of the actions of the air traffic controllers. Taking into account the totality of quantitative indicators of the activity of the air traffic controller provided by the automated system, and making his own observations, the instructor (expert) makes a final qualitative assessment of the actions of the UPS operator.

Thus, the purpose of this study is to improve the effectiveness of the training of UPS operators by improving the system of evaluation criteria, the development of models, methods and algorithms for evaluating their actions.

In its work, the air traffic controller is guided by job and operating instructions, which regulate the conditions and the sequence of technological operations as part of the relevant technological procedures for solving various situations in air traffic. In doing so, the air traffic controller performs roosters’ professional tasks that specify the purpose of his professional activity in the form of general directions of his work: provision of appropriate types of air traffic service, airspace usage management, organization of air traffic flows, etc. The problem situation encountered during provision is in accordance with a certain technological procedure and acts as a "starting mechanism" for applying appropriate measures to the air traffic controller to solve it. A problematic situation is a set of circumstances (conditions) that violate the specified functioning of the managed system, and require the air traffic controller to make a decision to normalize the situation.

So, to determine the typical technological units of activity, that are subject to registration, analysis and evaluation, we first developed a three-level hierarchical model of activity of the air traffic controller, which is built on the principle of the metronyms of typical technological units, namely:

1. Technological procedures (TP) - an orderly set of technological operations, the execution of which solves a certain typical situation in air traffic (including, the situation of a problematic nature). The TA serves as a structural and functional unit of a professional task of a certain type, that is, the realization of the corresponding TA by the air traffic controller ensures the solution of a certain professional task.

2. Technological operations (TO) -are separate permits, instructions, blocks of information elements, coordination messages that are part of the corresponding technological procedure.

3. Technology Elements (TEs) - the elemental indivisible component of any technological operation, represents the lowest level of activity of the air traffic controller. These are subject to direct registration. Depending on the mode of action (language instruction or interaction of the air traffic controller with the items), the following technological elements should be distinguished:

- information TE - phraseological elements, which consist of any permits and instructions, advisory, information and coordination messages;

- behavioral TE - basic practical acts in the interaction of the air traffic controller with the CRC AU, in particular with the planned information subsystem.

The highest place in the decomposition of air traffic control is occupied by technological procedures associated with typical air traffic situations, each of which is a set of technological operations, arranged in sequence of their execution. Each operation consists of an ordered set of standard information elements of messages and elementary acts for entering data into the system. It is the technological elements as indivisible units of the lowest decomposition level of the air traffic controller's activity that are subject to direct registration. Assessment of the TE performance by the relevant criteria is the basis for the conclusion of the final assessment of the exercise by the air traffic controller.

An analysis of the actions of air traffic controllers under this approach covers such aspects of the activity of the air traffic controller as:

- reaction to the problem situation;

- prioritization of addressing simultaneously existing problems in air traffic;

- making a decision to solve a problem situation;

- implementation of actions to resolve the problem situation (the procedural, technological and phraseological correctness of actions at the appropriate levels of the structure of activity of the air traffic controller are analyzed); implementation of the chosen management strategy.

The obtained data contribute to the conclusion of a reliable final assessment of the actions of the air traffic controller and make it possible to form, on their basis, a more accurate and detailed forecast of the dynamics of changes in the level of development of specific skill groups of the air traffic controller according to the relevant technological procedures and operations. For the structured view of the evaluation criteria and their relationship with the appropriate levels of action of the air traffic controller uses a system of interconnected frames that form a logical semantic network. Based on the basic evaluation criteria, a set of partial criteria is formed, which is inherent in the corresponding technological procedure, operation, and element.

Detection of errors of air traffic controllers is performed by comparing the model of "actual actions of the air traffic controller" with the formed model of "errors" or model of "optimal actions" (depending on the type of evaluation criterion). If there is a discrepancy between these models, the assumption by the air traffic controller of a certain type is fixed.

Models for evaluating the activity of air traffic controllers by three evaluation criteria. For the identification of errors of air traffic controllers are used "models of errors", which help to determine the error detection of problem situations, timely response to them by the air traffic controller and the results of their solution from the point of view of flight safety.

Improved models for assessing the actions of air traffic controllers are based on a common cause and effect risk model. Its use makes it possible to determine the cause and effect relationships between an error (a chain of errors) made by an air traffic controller during an ATR and an aviation event. Unlike the existing ones, which are used to analyze the possibilities of reducing the level of risk in the aviation transport system, the proposed models are used precisely to identify the mistakes made by the air traffic controller during the ATR. The air traffic control error detection models developed consist of event and error tree diagrams using the relevant evaluation criteria. The sequence of events is different scenarios of aviation events at the most general level of models as well

Error trees associate air traffic controller errors with key aviation events that triggered them. The error tree decomposes the errors of the air traffic controllers with a clear definition of the conditions of their identification and provides an opportunity to trace the paths of error assumption.

Thus, the assessment of the actions of the air traffic controller is carried out at 3 levels of the hierarchy of technological units of activity in accordance with the evaluation criteria, which reflect the characteristic characteristics of a certain level. At each level of activity, an appropriate set of assessment criteria is applied; each of the lower levels reveals the meaningful elements (concepts) of the upper level of activity.

## Conclusion to Chapter 2

Based on the above observations, it can be concluded that virtually all methodology for training and internships of aviation staff should be revised and presented in another, more modernized version.

For this purpose, we have an example of the World Organization of ICAO, where modern methods are used in the preparation and internship of aviation staff, many documents related to the methodology of training aviation staff is constantly being improved and processed.

Training plans for pilots and air traffic controllers should be included both a course in radiotelephony phraseology and aviation English. Using appropriate pedagogical strategies is one of them the most important factors that ensure high learning outcomes.

# CHAPTER 3. THE PROCESS OF GAINING THE SKILLS OR ROLE OF HUMAN FACTOR IN AVIATION

## 3.1 Incoming data for development of training radio communication system

There is no absolutely safe human activity, like a risk-free activity. It has been proven many times that aviation is the safest type of transport for now. But it is impossible to avoid completely the risk in aviation, while errors in this sphere of human activity are the most critical, as they can often lead to human losses. Flights must be safe, regular, and cost effective. Herewith the safety is the main factor in flight operations.

Federal Aviation Administration (FAA) annually publishes reports. According to the reports, in the 1960s, more than 60% of accidents were caused by the pilot and air traffic controllers’ mistakes and less than 21% of accidents were caused by equipment failures. At the moment, accident statistics due to the fault of the pilot (human factor) are still at the same level.

One of the factors ensuring the maintenance of not only an acceptable level of flight safety, but also the successful implementation of air traffic, is the high-quality interaction of the Air traffic service components. Visual demonstration of the system "SHELL" is a simplified basic model of human interaction with all aspects in Air traffic control environment (pic):

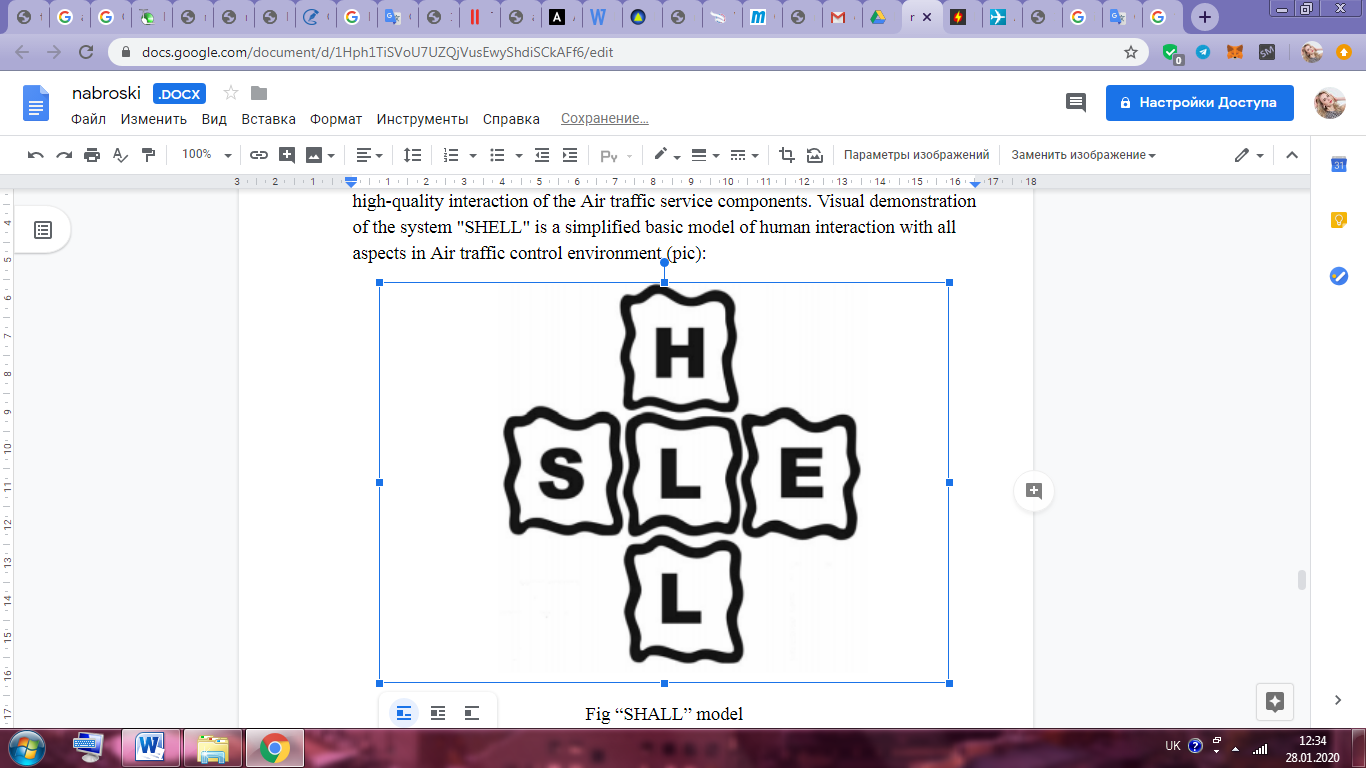


Figure 3.1- SHALL model

The presented model consists of four main blocks:

Subject - L (Liveware) is an aviation staff, from management to aircraft workers;

Object - H (Hardware) is a technical part of the system -equipment;

Procedures - S (Software) - documentation, rules, preparation, training;

Environment - E (Environment) - influencing conditions at workplaces, where other elements of the model L, H, S interact.

In the center of the model is subject - L - the person, the main connection of the aviation system. This person directly interacts with other elements of the system, presented in the form of blocks.

An accident develops as a result of errors arising from the interactions: "Subject - object (L - H)" (protective equipment), “Subject - procedures (L - S)” (organization), “Subject - environment (L - E)” (workplace), “Subject - subject (L - L)” (team). Operator plays the role of the central link of all elements.

The main way to minimize the factors, acting the human is a good practicing and preparedness to difficult situations. It can be gained with the help of trainee lessons and work on simulator.

Practical exercises in simulators are an integral part of the educational process, the most important stage of training the students with a goal of consolidation and deepening of their theoretical knowledge.

## 3.2 Practical exercises

### 3.2.1. Topic 1. Planning

During the air traffic planning, an instructor and students process the current schedule changes. These changes are laid out in the order of entry into action. List of information about the schedule for the next day are placed in the appropriate field in the tables. If there are errors in the application that do not allow making the conclusions about the flight through the controlled sectors of the ATC make a request for a repeat and clarification of the application.

Also, students should compare hourly load sectors with standards. With an increase in capacity standards, the sector should be unloaded by transferring part of the flights from a given hour interval. After that they inform an Air Traffic Management Center about the expected hourly load of the air traffic control sectors.

2. Flight control

Objectives:

1) To develop air traffic control skills during the departure and arrival of one aircraft, to fix the knowledge of the technology of work and phraseology of radio communication;

2) To gain the ability to determine the position of the aircraft relative to the CTA, Aerodrome control point, the ability to maintain a schedule of flight;

3) To develop the initial skills of working with the equipment on the working place.

Exercise 1. Air traffic control during departure

Purpose: to work out the ATC procedure in the area of the aerodrome during departure.

After turning on the simulator, the students check the speakerphone and adjust the indicators. The instructor, making sure the students are ready, indicates the start time of the exercise.

Students conduct radio exchanges, work out the procedure for interaction between control centers during air traffic control, and fill the control documents that at the example of conducted at air traffic control points.

In the process of doing exercises, tasks are developed containing the following elements:

* Maintaining the boundaries of an air traffic control and flight routes of an aircraft upon leaving the aerodrome zone on route, climb procedures, compliance with the correct understanding of information from aircraft crews;
* Determining the location of an aircraft, monitoring its movement on the maneuverable area of the airfield and in the air;
* Maintaining time intervals during departure;
* Maintaining a schedule of an aircraft;
* Transmission of departure time of the aircraft;
* Rules and phraseology of radio communication during flight operations and air traffic control;
* The procedure of the transmitted information (its order and information) to related control centers.

Instructor monitors phraseology of radio exchange between the crew and the operators, monitors the adherence to established patterns of climb and exit from the aerodrome area. At the end of the practical lesson, he analyzes the main shortcomings noted during the exercise, and gives the task of additional training in order to eliminate them.

As a result of the exercise, students should be able to:

Conduct radio communications with an aircraft crews during the departure;

Interact with control centers and authorities that provide, control and coordinate the flights;

Know the capabilities of the training equipment.

Exercise 2. Air traffic control on approach.

Purpose: to work out the order of an air traffic control service in the area of the aerodrome during the arrival of an aircraft.

During this exercise the students should get acquainted with the purpose of the exercise, analyze the rules of descent and approach and repeat the rules for filling the air traffic plans upon the arrival of an aircraft.

Also, students work out the technology of work and phraseology of radio exchange during the arrival of an aircraft in compliance with the established longitudinal separation intervals.

As a result of the exercise, students should be able to:

* Give exact commands according to the established descent and approach schemes;
* Maintain the longitudinal separation between taking-off and landing aircraft in the area of the aerodrome;
* Act in accordance with the technology of work and phraseology of radio communication during the arrival of an aircraft.

Exercise 3. Air traffic control in the area of the aerodrome during departure, arrival and transition flight of an aircraft.

Purpose: to work out the technology of an air traffic control during the service of an aircraft on crossing routes in the area of the aerodrome.

During the exercise, instructor reminds the students about the features of air traffic control in the presence of crossing traffic of an aircraft, the order of their vertical, longitudinal and lateral separation using the intervals, introduces to students the peculiarities of fulfilling the plan for a various types of an aircraft, reminds with the students the schemes for climbing aircraft, the rules for fulfilling an air traffic plan for departures, descent and landing procedures.

In these practical classes, students perform an ATC for departing, arriving and transition flight for different types of an aircraft. Air traffic intensity is determined for each lesson in this exercise taking into account the level of preparedness of the students.

In the air traffic control process, students develop skills to determine safe intervals issuing permits for climbing or for descending with the intersection of the oncoming or passing occupied level, monitor the maintenance of safe intervals in the approach area and in the take-off and landing zone.

As a result of the exercise, students should be able to:

* To separate the movement of an aircraft following on the opposite and same direction, using the established separation standards;
* Correctly apply the technology of work and phraseology of radio communication with the crews of the aircraft.
* At the end of the practical classes on that topic, a final lesson is conducted with an assessment and an instructor makes a conclusion about the degree of preparedness of the students.

### 3.2.2 Topic 2. Intersecting routes

Exercise 4. Air traffic control service on local routes and airways

Objectives:

To develop the procedure for an air traffic control on the airway and Local Air Lines and to teach students to maintain a schedule of an aircraft;

To control the movement of an aircraft at the intersection of busy flight levels and airways.

The head of classes (instructor) acquaints students with the features of the implementation of the flight plan, providing the need for existing flight levels intersection, recalls the importance of using the tables and a schedule of movement of an aircraft. He also explains the technology of working with the schedule, after which the students put on the lines of movement of the aircraft, conventional signs for the designation of weather and air conditions, determine the time and place of the crossing tracks of an aircraft, safe intervals at the intersection of flight levels and aircrafts, the possibility or impossibility of crossing the flight level by an aircraft at a certain point in certain time, and also interact with adjacent control centers and bodies controlling and coordinating flights.

Using the examples, instructor shows to students how to determine safe intervals. Then he selects on the radar screen two or more marks from the aircraft following on the same or crossing tracks and sets the task to determine the moment of giving the crews the command to change the flight level.

After that, the instructor shows the students the procedure for determining safe intervals at crossing route on example.

Then, choosing the mark of an aircraft on the radar screen that should cross the busy route, Instructor poses the task of determining the safe interval for this intersection.

Students performing the functions of a radar control operator conduct radio communications with an aircraft crews, providing safe movement intervals and timely issuing commands to lower or gain a given flight level. After each lesson, students perform the functions of a change their working places.

As a result of the exercise, students should be able to:

* Determine safe intervals using a graph, tables and issue the permissions to cross a busy flight level for an aircraft following on the same or crossing tracks;
* Determine the possibility of a safe crossing of occupied level;
* Put on the chart signs about the air and weather conditions during the flights;
* Carry out Air traffic control service and conduct radio communication with an aircraft crews.

At the end of the training for this exercise, a final lesson is conducted to check the consolidation of skills in maintaining the aircraft schedule and competent air traffic control service at the intersection of occupied flight levels, airways and in the restricted areas.

Exercise 5. Air traffic control in the area of local control center and its airlines

Purpose: to work out the technology of work and phraseology of the radio communication exchange of an air traffic controllers with an aircraft crews.

At the classes, students have to get acquainted with the an air traffic plan and the rules for its implementation, the instructor reminds the organization of an air traffic control for 4th-class aircraft and helicopters in the take-off and landing zone, as well as at the assigned airfields of the Local airways, and familiarizes with the necessary information concerning Visual flight rules, checks knowledge of the students on an air traffic controllers and crews’ responsibilities and conditions for its provision, submits an air traffic plan for consideration and talks about the features of an air traffic control service during various types of aviation operations, which include flights and transition of an aircraft along the Local airways or off-route flights through the temporary closed airfields.

The movement of the aircraft should be organized:

* On separated local air lines with a lateral interval of at least 5 km;
* On separated routes within the width of local air lines.

In the process of air traffic control, students should learn:

* The technology of the service on the local control center of local airlines;
* The technology of operation during an air traffic control on local airlines during visual flights according to the rules, providing a daily flight plan in accordance with the requirements;
* The technology of work and the phraseology of the radio communication exchange of the operators at the control center.
* The technology of work and the phraseology of the radio exchange of an operator of the control tower of the local air lines of the assigned airfield;
* Methods of an aircraft movement monitoring and reports of the aircraft crews;
* Procedure for interaction with adjacent control centers;
* The principles of interaction between Units;
* Procedure of transmitting information about flight mode, weather information and other necessary information.
* During the lessons, instructor monitors compliance with the technology of work and phraseology of radio exchange.
* As a result of the exercise, students should be able to:
* Carry out an air traffic control in accordance with the technologies of work of operators;
* Systems’ correctly usage in the air traffic control and crew reports during the assessing of the current air situation;
* Comply with the rules of radio communication and established phraseology of radio exchange;
* Control of the aircraft movement at the airspace under the Visual flight rules outside the routes in the area of ​​aviation operations;
* Competently use the devices for an air traffic control and crew reports to determine the location of an aircraft during flights below the lower flight level;
* Timely inform the aircraft crews about the weather conditions along the routes and in the areas of aviation operations and it’s transmission for the crews and services the necessary information;
* Provide a daily air traffic plan for various types of aviation operations.

In the end of the practical classes on this topic, a final lesson is conducted with an assessment and instructor makes a conclusion about the degree of preparedness of each student.

### 3.2.3 Topic 3. Air traffic control in emergency

Exercise 6. Air traffic control during the flights in the icing zone, thunderstorms, dust storm, heavy turbulence and a wind shear.

Purpose: to work out the actions of an operator in dangerous weather conditions.

At the beginning of the lessons, during the briefing, students have to get acquainted with the air traffic plan, the actual and forecasted meteorological situation in the region, zone and at alternate aerodromes. Then, at the workplace, under the guidance of an instructor, the actual meteorological situation in the area of ​​responsibility and at alternate aerodromes is studied, after which the instructor, together with the students, analyzes the expected meteorological situation, noting the start time and the end of a meteorological event. He also outlines measures to prevent aircraft from entering dangerous weather zones, routes to pass these zones, taking into account the expected air situation. Analyzing the meteorological situation student selects and accommodates with an alternate aerodromes.

Instructor explains (if possible shows) how to determine zones with weather-hazardous weather phenomena (thunderstorm, powerful cumulus clouds, rainfall, etc.), the direction and speed of their movement with the use of radar. Instructor  together with the student analyzes the meteorological situation in the air traffic control area and selects the most favorable flight level as well as the most convenient routes for passing these zones with dangerous weather conditions and recommends it to crews, receiving the information from the crews about the observed flight conditions at given altitudes along the routes.

During the exercise, a storm warning is received at the control rooms, indicating the begging of a thunderstorm, and when it occurs, a dust storm and a wind shear.

The students inform the crews about the meteorological situation, the nature of the clouds and the direction of the thunderstorm displacement, receive messages from them about getting into icing zones, thunderstorms or heavy bumps and, using a radar, take the aircraft out of these zones or give a command to pass dangerous weather phenomena, observing the established intervals taking into account it’s displacement.

As a result of the exercise, students should be able to:

* To carry out an Air traffic control during an aircraft flight in special conditions in the compliance with the technology of work and established phraseology of radio communication;
* Correctly weigh up the prevailing air and weather conditions;
* Inform the crews about the presence of dangerous situation and give recommendations on how to avoid them;
* Timely inform an aircraft crews before takeoff and aircraft crews approaching about the presence of wind shear in the surface layer;
* Timely inform the adjacent control centers about the meteorological situation in their area of ​​responsibility and about the change in given flight levels and flight routes.

Exercise 7. Air traffic control service in situations when the aircraft is entering zone with dangerous weather conditions

Purpose: to work out an operator actions when an aircraft enters an area with dangerous weather conditions.

Instructor have to familiarize the students with an air traffic plan, remains meteorological conditions that are dangerous and it that can lead to untimely informing aircraft by the operators to crews preparing for departure, in flight or landing.

During the exercise, hazardous weather conditions should be introduced at all stages of the flight. Also, particular attention should be paid to working out the actions of operators in an aircraft approaching in the conditions of fog, sand or dust storm, limited visibility, blizzards, thunderstorms, strong winds and other dangerous weather conditions that can complicate or make impossible landing at this airfield.

In the presence of zones with dangerous weather conditions or flocks of birds, an instructor shows how to find out it on the radar screen. Then he explains and illustrates a specific example of the procedure for determining the direction and speed of movement of zones with dangerous weather conditions or flocks of birds. To consolidate this exercise, instructor sets the task of determining such zones, the direction and speed of their movement.

As a result of the exercise, students should be able to:

* Timely inform the crews of the aircraft and an instructor about the occurrence of dangerous weather conditions;
* Make a timely decision on the termination of the reception or release of aircraft;
* Act in the prevailing weather conditions in accordance with the technology of work;
* Operatively interact with control centers and neighboring airports for the transmission of n air traffic control and weather information.

Exercise 8. Air traffic control in dangerous cases of flight

Purpose: to work out the actions of operators when they receive a message from an aircraft crew about engine failure, fire, cabin depressurization, injury or sudden alerts of an injury of crew members, and passengers. During the classes, students receive information about the special cases that needs to be processed at the first moment after receiving a message from the crew or receiving a distress signal. In the process of practicing, instructor monitors the correctness of the of students action in a given situation, the timeliness of recommendations in order to assist the crews in distress. If a student loss in choosing a solution, the instructor explains how to act in the current situation.

As a result of the exercise, students should be able to:

* Act correspondingly receiving a message from the crew about the occurrence of a particular special case or receiving a distress signal;
* Provide timely assistance when the crew makes a decision to continue the flight, emergency change of flight level, landing at the alternate aerodrome or out the aerodrome;
* Inform the relevant authorities about a special case and measures taken, conducting continuous radar monitoring of the aircraft data;
* Interact with other control centers along the flight route of an aircraft and accurately confirm to them the nature of dangerous situations.

## Conclusion to Chapter 3

All exercises mentioned above, covers necessary topics that can be met during the ATCO work. Both, theoretical and practical parts play a great role in preparing the specialists for increasing the efficient, economic and orderly flow of air traffic.

In order to create situations that are close to real, introductory materials are developed on the basis of material on students preparations, with the addition of various complications, as well as on the basis of experiments conducted in research laboratories.

It came clear, that combination of human factor and practical part in one topic it is not a coincidence. Each rule is written after an error. Each exercise is the result of human’s error research. It underlines the main factors that affect during ATCO work execution. As it was mentioned before, operator plays the role of the central link of all elements.

# CHAPTER 4. GENERAL REVIEW OF AERONAUTICAL VOICE COMMUNICATION SIMULATOR

## 4.1 Information about device

The most important condition for the development of civil aviation is constantly growing requirements for ensuring flight safety. It is obvious that one of the main ways to reduce the number of aviation incidents due to the fault of flight personnel is an individual (taking into account the real capabilities of the pilot and ATCO) approach to training students and constant monitoring of the formation of their professionally important qualities. Training during the classes contributed the idea about possible improvements of communication system. After airdrome tower visit, it was found that there are some differences in the operation of existing systems for training ATCOs and real aerodrome communication facilities. After analysis of current communication training systems and its training program, it was decided to create a communication device for training and developing communication skills and working off phraseology.

This Simulator has the same PTT (Push to Talk) button as on the Air traffic controller’s working place. Very High Frequency (VHF) devise uses analogue data transmission method and its usage is much closer to real VHF radio then software-based solution. It can be used as the part of complex or modular simulator either a standalone module. Besides due to the analogue work flow of the system the voice distortion sounds like in a real VHF radio.

## Device application

Usage of the device can vary from the area of its application. The main idea was to use it in training direction for a future ATCO and pilots. But at the same way it can be used for a maritime aims and also for future specialists training. Besides it is a movable device so that students can take it to any free classrooms for conducting the classes.

This communication device can also actively be used in business. Here are some spheres where it is simply possible to use: supermarkets, security services, industrial areas, storehouse, restaurants, cafes and hotels, service centers, service stations, builders, installers and so on.

The system of “preventive measures” aimed at the decreasing of emergencies is a comprehensive mechanism that affects all elements of studying. Operators accumulate a huge experience in the process of work, which after a thorough analysis can be summarized and presented in the form of training material that accumulates all the typical sequences of events that potentially can lead to emergencies.

Training staff in behavior in such scenarios and subsequent certification can significantly reduce the risk of their negative development. As well as a quantitative and high-quality refinement of phraseology, this in the future will help to develop the skill of the correct speech reaction to the development of a situation that meets the requirements of the regulation.

## 4.3 Advantage and disadvantage of the simulator

The main idea was to make an analogue that will be closer to real pilot-ATCO communication. As was mentioned above, in this simulator PTT (Push to Talk) communication button is used. In this case during the training classes, student can face to shortened or cut phrases during radio contact, but can work out this defect in practical exercises. Besides, in the case of using this connection for entertainment purposes on the simulator of the cockpit of an aircraft, non-advanced users can use duplex communication, when the buttons of both participants are pressed, they can hear each other and speak at the same time. Also, this system need no any additional software-based solutions and can be used immediately.

As for disadvantages, this device is not suitable for long distance use. The problem of switching the frequencies is also in production now. This will allow students to switch the previously set channel frequencies to change an air traffic control area.

Low-amplify coefficient can also lead to low-level sound. At maximum amplifier settings can also cause the distortions.

## Conclusion to Chapter 4

During this research it was underlined all work process and gained knowledge to apply it to a new system and understand its usage and ability to change the training system.

The world experience in the development and implementation of computer simulators for training TP operators indicates about a constant trend to unify the system part of simulators (software and hardware platform). Under these conditions, the development of a specific training project and its construction has been done, that can allow maintaining market competitiveness.

The simplicity of use without add-ons, high-quality communication system approximate to the real one, availability of a push to turn button make the device eye-catching at the market. Also it is being used for 2 years by the Virtual Flight School enterprise without any complications and failures.

# GENERAL CONCLUSION

In this work was made overview of the studying process on Simulator and systems that already used for this purpose. It helped to realize the market demand of existing systems for training, both, educational and technical. An analog of this device is already settled into the simulators MIG-21 BIS and A-22 Aeroprakt in the Virtual Flight School (VFS) in Kiev. It is a universal system that can be used both in the system and separately. It is also portable and inexpensive in contrast to the existing parts of the trainee communication system.

The use of interactive speech simulators for the deepening knowledge in the phraseology of radio exchange, and aviation in general, is an extremely important and relevant tool for training and preparing future specialists for real working conditions. In order to increase its efficiency 524 hours of training classes should be passed by the students. In addition, simulator allows checking the level of preparation of the student during the classes.

**REFERENCES**

1. Макаров Р. Н. Теоретические основы профессиональной авиационной педагогики /[Макаров Р. Н., Герасименко Л. В., Нидзий Н. А, Стрелец И. В.]. – М.: МАПЧАК, 2000. – 325 с.
2. Казачкин Б. И. Авиационные тренажеры как связующее звено между наземной и летной подготовкой / Б. И. Казачкин. – Монино , 1999. – 160 с.
3. Желтухин В. В. Автоматизированные обучающие системы в сфере управления профессиональной подготовкой летного состава. Роль предтренажерной подготовки. // Межвузовский сборник научных трудов. СПб., Академия гражданской авиации, 1999. Т. IV. – С. 192–200.
4. Doc 9868 “Procedures for Air Navigation – Training”
5. Annex 1 to the Convention on International Civil Aviation Organization (ICAO) “Personnel licensing”
6. Doc 10056 “Manual on Air Traffic Controller (ATCO) Competency-based Training and Assessment”
7. Doc 9835 “Manual on the Implementation of ICAO Language Proficiency Requirements”
8. Типові вимоги до автоматизованих систем керування повітряним рухом (наказ Украероруху від 15.03. 2011 року № 87)
9. Bogunenko M.M. Implementation of the pilot common project into Ukrainian airspace/ Bogunenko M., Luppo О., Alekseev О., Kolesnyk T.// Системи обробки інформації Харків, - 3 (149) 2017 – P. 121-126,
10. Argunov G.F. Принципы построения и использования интеллектуальных тренажёров управления воздушным движением / Г.Ф. Аргунов, В. П. Харченко, О. С.Ерёменко // Тренажерні комплекси та системи: зб. наук. пр. – К.: Інститут проблем моделювання в енергетиці ім. Г. Є. Пухова, 2005. – Том 2. – С. 107-112.