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**O.M. PAPCHENKO, A.V. GUSEV**

***National Transport University, Ukraine***

# ANALYSIS OF COCKPIT ECOLOGY AND ITS INFLUENCE ON OPERATOR AND TRANSPORT SAFETY

The influence of hazardous substances and materials present in the working environment on operator safety and transport safety is considered. The principles of the problems are stipulated. The classification of negative factors of pilot's working environment is proposed.

**operator, operator safety, transport safety, hazardous materials, physical and chemical factors, psycho-physiological parameters, negative influence, working environment**

## Introduction

The importance of transport safety is underlined by recent accidents and crashes statistics and by scores of publications concerning the anticipated topic.

The operator (i.e. pilot, driver, train operator, etc.) is considered responsible for up to 80% of all accidents. The purpose of the presented article is to analyze the influence of hazardous factors on operator (pilot) and its farther implication on aviation safety.

## Principles of the problem

The problem of securing safety in transport is complex and multi-factor. The following major factors lead to accidents and/or crashes:

– human factors (operator's psychophysiology, erroneous and/or untimely perception of the situation (including visual perception), level of professional skills, types and efficiency of operator training (controlling), influence of medicine and other foreign substances etc.) [1];

– runways factor (the widths, lengths, runway pavement type and conditions etc.);

– aircraft (vehicle) factor (technical conditions, visibility, concentration of fumes and evaporations in the cockpit, environment and working environment conditions etc.);

– weather conditions;

– etc.

In accordance with chosen direction of investigation the in-depth analysis of working environment and its influence on operator's psychophysiology (specifically, the influence of hazardous substances on pilot or driver) and thus its would be negative influence on transport safety was made.

The main aim of research is enhancement of safety in transport (it should be noted that similar factors influence the safety of automobile and railway transport) by implementing the measures allowing to eliminate or minimize the negative influence of working environment on operator; the other aim is the development of methods for assessment of such hazardous factors on operator's (pilot's) professional activities.

While accessing the influence of working (cockpit) environment on transport safety one should define the main factors the operator is exposed to; the proper classification of the later factors should also be done. In general all factors are divided in two separate groups.

### Group 1. Physical Factors

*1. Meteorological Factors (Microclimate):*

a) internal air temperature;

b) humidity;

c) air movement;

d) infrared radiation.

*2. Radiation:*

a) ionizing;

b) ultraviolet;

c) light;

d) high-frequency.

*3. Oscillation and Vibration:*

a) Acoustical Vibrations (noise);

b) Mechanical Vibrations (overall and local vibrations and oscillations and jolting).

*4. Air Dust Content (Dusting).*

**Group 2**. **Chemical Factors**

*1. Technical Solvents.*

*2. Synthetic Polymers.*

*3. Carbon Dioxide.*

*4. Other non-organic gases and evaporations.*

*5. Metals and its compounds.*

*6. Fuels and Combustible Materials.*

*7. Motor oils, Lubricants and Cooling Liquids.*

*8. Organic Substances, which are being used, for example, in Agricultural Aviation.*

The methods of assessment of working environment influence on human should be based on:

– measurement and assessment of separate (specific) factor's intensity (levels of concentration);

– comparison of obtained results with existing norms (standards);

– assessment of changes in operator's psychophysiological parameters under the influence of specific working environment's hazardous factor (being studied) and under the influence of working environment as a whole.

One more aim of the presented research is the development of specific norms (standards) (sanitary norms) and recommendations and development of technical means allowing to adhere to proposed recommendations.

It should be noted that the sanitary norms (occupational hygiene) are quantitative indexes, which characterize the accordance of working environment with physical needs of human body.

Table 1

Factors, which influence the operator

| Parameter | Comfort zone | Allowed values |
|---|---|---|
| Carbon Dioxide, mg/l | 0 – 0,016 | 0,4 |
| Oxygen, % | 15 – 60 | > 60 |
| Air velocity, м/s | 0,39 – 0,57 | <0,14 >1,4 |
| Humidity, %(*) | 30 – 70 | <10 > 90 |
| Temperature, $^{o}$C (*) | 17 – 24 | <12 > 38 |
| Acceleration, m/s$^2$ | 0 – 0.1 | >1,0 |
| Current, mA (at 50 hertz) | 0 – 1 | >10 |
| Illumination, lux | 200 – 1000 | 100000 |
| Noise, decibel (permanent silence is prohibited) | 0 – 85 | > 94 |
| Frequency of Vibration, hertz | 0 – 1 | 10 |
| Other factors | Should be studied | Should be studied |

*) *interrelated parameters*

## The decision of a problem

Microclimate is defined by the combination of temperature, humidity and air velocity. The optimal temperature (OT) allows to provide the highest working capacity and dependability of operator. The changes of temperature relative to OT (especially for extended periods) leads to increase in operator response, fatigue and as the result – leads to decrease of safety levels.

The humidity and air velocity significantly influence the body heat regulation. For example, low temperature and high humidity leads to increase of body heat emission and thus results in intensive cooling of body. The high temperature and high humidity leads termination of body heat emission and thus results in overheating of body.

The air velocity in the cockpit (cabin) also significantly influences the human.

For initial practical purposes the following equation could be recommended [2]:

$$S = 7{,}8 - 0{,}12t_a - 0{,}09t_e - 0{,}04p + ...$$

$$... + 0{,}03(37{,}8 - t_a) \cdot v^{1/2},$$

where $S$ – "comfortable state of the operator" index;

$t_a$ – air temperature;

$t_e$ – average temperature of surrounding objects and hull (average environment temperature);

$v$ – air velocity (measured in several locations of cockpit);

$p$ – water evaporation pressure.

The above equation allows to subdivide cockpit environment conditions into quality groups.

In the view of the authors, currently existing list of hazardous materials influencing the pilot safety is insufficient.

The major hazardous substances are in accordance with Table 1. It can be seen that a lot of the factors (presented in the classification) are not anticipated and taken into account.

The current statistics show that concentration some potentially hazardous substances present in cockpit (especially in newly manufactured vehicles) is many times above allowed (above norms).

In several cases hazardous fumes led to extensive allergies, to severe fatigue and even loss of consciousness by the operator.

All the potential hazardous material and their sources and their influence on pilot safety should be studied.

Intensity and character of noise and vibration influence depends on their type, source and the levels.

For example, the sources of noise and vibration in vehicle are:

- engines;
- hydraulics system;
- elements of the hull.

Noise leads to:

- increase of operator's response time;
- deterioration of operator's visual apparatus performance;
- deterioration of operator's movement coordination;
- deterioration of operator's vestibular apparatus.

## The conclusions

As shown above the substantial changes of operator's psycho-physiological parameters caused by working environment lead to significant decrease of operator safety and to according decrease of transport safety. All the presented hazardous factors should be studied and taken into account (in accordance with the classification proposed by the authors of the article).

The further research of aviation safety are directed at research of:

- defining all possible negative factors, which influence the pilot (operator);
- defining hazardous substances and their sources;
- determine the relation of aviation safety and action of hazardous materials (working environment) on pilot (operator);
- development of measures and technical means (devices) to eliminate the influence of above negative factors on pilot.

## References

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**Рецензент:** д-р техн. наук, проф. Н.Н. Дмитриев, Национальный транспортный университет, Киев.