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Results of assessing work capacity and fatigue levels of air traffic control dispatchers during their professional activities

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Abstract:

The article analyzes scientific research conducted by foreign, local, and CIS scientists and specialists on improving occupational safety for operator-dispatchers working in various economic sectors. Based on the research results, legal, organizational-technical, and sanitary-hygienic measures aimed at improving the working conditions of air traffic controllers have been proposed. However, it has been determined that the impact levels of production environment factors and work process factors on air traffic controllers operating within the air traffic control service have not been sufficiently studied. Furthermore, specific methods, technical means, and practical-technological solutions aimed at reducing these factors have not been developed. Within the scope of the research, changes in fatigue levels and work performance of air traffic controllers throughout their work shifts were quantified in percentage values using the integral scoring assessment method.

Keywords:

air traffic controllers, workplace, working conditions and safety, integral scoring assessment method, factors of the labor process and production environment

1. Introduction

In recent years, the civil aviation sector in the Republic of Uzbekistan has been actively developing, with numerous infrastructure and investment projects being implemented across the country. In accordance with state programs and development strategies, existing airports are being modernized, and new airfield complexes and air navigation facilities are being put into operation. These processes have enhanced the efficiency of the country's airspace utilization, ensured flight safety, and expanded the capacity to provide services that meet international aviation standards.

Currently, an air traffic control system has been established in the Republic of Uzbekistan within the Tashkent FIR (Flight Information Region), where the central air traffic control center in Tashkent city and regional and airfield control points operate as part of a unified system. Airfield control towers (TOWER), approach control units (ADP/AYDP), as well as area and terminal control centers (RM, KDP, SDP) are operational at the international airports of Tashkent, Samarkand, Bukhara, Urgench, Nukus, Karshi, Termez, Fergana, Andijan, and Namangan.

The operational dispatch service of the Air Traffic Service (ATS) within the State Unitary Enterprise "Uzaeronavigation Center" system ensures reliable and efficient operation of the air traffic control system. This includes centralized operational management of flight planning, aircraft movement coordination, and airspace utilization processes. The operational dispatch service of the SUE "Uzaeronavigation Center" employs over 200 air traffic controllers (for upper and lower airspace) who perform crucial tasks across all major airports and airspaces of the republic. These tasks include ensuring flight safety, monitoring and analyzing air situations, preventing and managing emergencies, and establishing cooperation with civil and military aviation structures.

2. Research methodology

The organization of the operational dispatch service in 2 shifts with extended working hours (12 hours) necessitates the implementation of measures to ensure the safety, health, and work capacity of air traffic controllers. Otherwise, such conditions will lead to a sharp increase in the risk of occupational diseases among air traffic controllers. Therefore, studying the working conditions of air traffic controllers and developing and implementing organizational, technical, and sanitary-hygienic solutions to ensure full compliance of the workplace with sanitary and hygienic requirements enhances the practical significance of various tasks. These tasks include: safe and continuous control of aircraft movement, maintaining a balance between flight flow and airspace utilization, monitoring and analyzing real-time weather data, preventing and addressing emergencies and accidents, coordinating activities of dispatch points and aviation services at various levels, as well as ensuring the optimal operation of the entire air traffic control system in accordance with international and national aviation safety standards.

In numerous instances, all necessary operations are performed under severe time constraints. During extreme situations, multiple operations must be carried out simultaneously, demanding strain on visual and auditory analyzers, significant concentration of attention, and the utilization of both short-term and long-term memory. The work of air traffic controllers is directly influenced by various factors in the production environment, such as the reliability of technical equipment, quality of communication systems, workplace ergonomics, microclimate, and levels of lighting and noise. Therefore, ensuring that air traffic controllers' working conditions fully comply with hygienic requirements significantly guarantees the safe execution of tasks performed during their work activities and holds practical importance.

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Numerous studies on improving occupational safety for air traffic controllers and dispatchers in related fields have been conducted by scientists and specialists from various countries. Local and international scientists and researchers have carried out scientific investigations aimed at analyzing and enhancing the working conditions of air traffic controllers and dispatchers in related industries, developing a range of noteworthy practical solutions and recommendations. Legal, organizational-technical, and sanitary-hygienic requirements for the working conditions of air traffic controllers and dispatchers in related fields have been established and implemented. Many authors have examined the development and practical application of scientifically-based organizational, technical, and social measures aimed at improving working conditions by applying these requirements to enhance occupational safety [1-27].

3. Results and discussions

The results of the conducted research and the recommendations presented in them are of great importance. However, the recommendations given by these authors are of a specific nature, and their direct application to improve the working conditions of air traffic controllers in the system of the SUE "Uzaeronavigation" Center does not yield the expected results in enhancing working conditions. Nevertheless, it is advisable to use the methodology of these studies, taking a creative approach, when examining the working conditions of air traffic controllers in the dispatch service. In this regard, to continue the research work, an analysis was conducted on the results of assessing the compliance of working conditions with hygienic standards, taking into account the workplaces, types and volumes of work performed by air traffic controllers operating at airports and air traffic control centers of the Republic of Uzbekistan.

Based on the analysis of the results assessing the compliance of working conditions for air traffic controllers in the air traffic control service with hygienic standards, the evaluation results of harmful factors in the production environment and work process have been included in the general assessment table of working conditions by degree of harmfulness and danger. Subsequently, the assessment of harmful factors was carried out in the following cases: by the highest level and degree of harmfulness; under conditions where the overall assessment of working conditions corresponds to class 3.2; in situations with the combined effect of 3 or more factors belonging to class 3.1; and in cases where 2 or more harmful factors belong to classes 3.2, 3.3, or 3.4. In these circumstances, the working conditions were assessed as one level higher, respectively [28].

Analysis of the assessment results regarding the compliance of working conditions for air traffic controllers in the SUE "Uzaeronavigation" Center with hygienic standards revealed the following: their working conditions belong to class 2.0 based on actual concentrations of harmful substances in the workplace; class 3.1 for levels of noise, infrasound, ultrasound, and vibration; class 2.0 for levels of non-ionizing electromagnetic radiation; class 3.2 for the severity of the work process; and class 3.2 for the impact of work process load. The overall assessment of the air traffic controllers' working conditions in compliance with hygienic standards corresponded to class 3.4.

In accordance with the Regulations on the Procedure for Certification of Workplaces for Working Conditions and Equipment Injury Hazards, appropriate guarantees and preferences have been established for air traffic controllers of the operational dispatch service working in hazardous conditions (class 3.4). The duration of the annual additional leave for air traffic controllers should be 13 to 18 days. Their position is included in the 2nd list of occupations that entitle them to retire 10 years earlier than the generally established age, provided they have the required general and specialized work experience [28].

Based on the analysis of assessing the compliance of aviation dispatchers' working conditions with hygienic standards at their workplaces, the degree of fatigue and decreased work capacity during the entire shift were determined using the integral point assessment method. This assessment was made through evaluating each factor of the existing production environment and work process at their workplace. For factors of the production environment and labor process belonging to classes 3.1 and 3.2, scores were established taking into account the duration of each factor's influence. The following points were assigned: 4 points for exceeding the permissible noise level in the workplace, 4 points for vibration level, 3 points for uncomfortable body position during the shift, 3 points for intellectual load (i.e., work content), 4 points for receiving and assessing signals (information), 4 points for task complexity, 4 points for dimensions of object observation, 4 points for duration of continuous work during the shift, and 3 points for shift work [29].

The coefficient of the duration of influence of production environment and labor process factors of classes 3.1 and 3.2 at the workplace of air traffic controllers during the work shift (day) was determined using the following formula:

$$K_{16} = \frac{t_i}{t_s(t_k)} = 0,83$$

t_i $t_s(t_k)$ – where - duration of exposure time to production environment and labor process factors (taken from the certification conclusion of the workplace working conditions map), in minutes; duration of work shift (day), in minutes.

The comparative value of the point assessment for production environment and labor process factors at air traffic controllers' workplaces was determined using the following formula:

$$\sum_{i=1}^n x_i = x_{16} \cdot K_{16} = 37,35 \cdot 0,83 = 31 \text{ ball}$$

$x_{16} K_{16}$ – where - the sum of points assigned to factors belonging to classes 3.1 and 3.2 of the production environment and labor process, in points; coefficient of the actual exposure duration to production environment and labor process factors during the work shift (day).

$\sum_{i=1}^n x_i = 31$ Based on the total sum of points assigned to each factor of the production environment and labor process, it is possible to determine the numerical value of air traffic controllers' fatigue during the shift as a percentage. In this case, it is advisable to use the empirical formula developed by researchers [30]:

$$Ch = \frac{\sum_{i=1}^n x_i - 15,6}{0,64} = \frac{31 - 15,6}{0,64} \approx 24 \%$$

where: 15.6 and 0.64 are regression coefficients.

According to the calculations, the fatigue level of air traffic controllers during the shift is 44%. Using the numerical value of fatigue, the work capacity of air traffic controllers during the shift, expressed as a percentage, was determined using the following formula:

$$I_q = 100 - Ch = 100 - 24 = 76 \%$$

Chwhere: 100% - work capacity under favorable working conditions, in percent; - fatigue level, in percent.

The work capacity of air traffic controllers during their shift, assessed according to the workplace conditions map under hygienic criteria, amounted to 76%. This indicates the possibility of working under hygienic, intellectual, sensory, and emotional stress, which, in turn, negatively affects the quality of their work and decision-making.

4. Conclusion

The conducted studies revealed that the working conditions of dispatchers in the air traffic control service within the "Uzaeronavigation" State Unitary Enterprise system fall into class 3.4 according to hygienic assessment criteria, categorizing them as harmful working conditions. This confirms the presence of factors in their workplaces that negatively affect their health. Concurrently, these working condition characteristics align with the inclusion of air traffic controllers in List 2 positions, which entitle them to additional guarantees and preferences, particularly up to 13-18 days of additional leave, as well as the right to retire 10 years earlier. The results of the integral point assessment showed that air traffic controllers experienced fatigue at a level of 24 percent and maintained work capacity at 76 percent during their work shift. This indicates the presence of high levels of psychophysiological stress in their labor process throughout their activity.

It is known that, despite recognizing the life and health of employees as a priority in state labor protection policy, attempting to address the problem through compensation payments and benefits, rather than genuinely improving existing unfavorable working conditions, may lead to an increased risk of occupational diseases among air traffic controllers in the long term. In this regard, it is crucial to develop scientifically-based technical and organizational solutions aimed at ergonomic and biomechanical optimization of workplaces, as well as reduction or elimination of harmful factors in the work environment, in order to fully align air traffic controllers' working conditions with sanitary and hygienic requirements.

The proposed method described above allows for the numerical determination and prediction of the probability of developing occupational diseases caused by exposure to fibrogenic aerosols among employees working in non-stationary workplaces in railway transport.

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