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ASSESSMENT OF FACTORS INFLUENCING THE WORK ACTIVITIES OF ENERGY DISPATCHERS

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ABSTRACT.

This article presents a comprehensive analysis of harmful and hazardous factors in the production environment and work process by assessing compliance with hygiene standards at energy dispatcher workplaces within the Uzbekhydroenergo JSC system using standardized methods. Additionally, considering the impact of factors affecting energy dispatchers' work activities, including hazard levels, noise, vibration, work conditions, and intellectual workload, the level of fatigue and decreased performance during a shift are described using examples.

Keywords: energy dispatcher, harmful factor, comprehensive analysis, performance, evaluation, effectiveness.

INTRODUCTION

It is well known that human interests are a priority in our country, and large-scale measures are being taken to systematically implement labor relations, improve the occupational safety system, and reduce the incidence of industrial injuries and occupational diseases. In particular, reforms are being implemented to analyze the state of occupational safety and ensure the employment of workers in decent jobs. Objective 22 of the Decree of the President of the Republic of Uzbekistan dated January 28, 2022, No. UP-60 "On the Development Strategy of the New Uzbekistan for 2022-2026" provides for the continuation of industrial policy aimed at ensuring the stability of the national economy and increasing the share of industry in the gross domestic product, as well as further liberalization and completion of the transformation of leading industrial sectors, the energy system, and the economy. Presidential Resolution No. PP-3913 of August 20, 2018, "On measures to improve the structure of labor agencies and strengthen the system for protecting citizens' labor rights and occupational safety," noted the need to respect citizens' labor rights, ensure occupational safety, and ensure safe working conditions [1, 2]. These examples already serve as a practical embodiment of the reforms being implemented in the energy sector.

In the process of writing the article, the problem considered was the analysis of working conditions at the workplace of energy dispatchers working in the operational dispatch service of the JSC "Uzbekgidroenergo" system, the complex and cumulative impact of harmful and hazardous production factors using standardized methods and means, and an incomplete study of the compliance of working conditions with hygienic standards. [3].

The purpose of the study is to assess compliance with hygienic standards for the working conditions of energy dispatchers in the operational dispatch service of JSC Uzbekhydroenergo, determine actual concentrations of harmful substances in the workplace, levels of noise, infrasound, ultrasound, vibration, electromagnetic radiation, microclimate and light environment, atmospheric pressure, and compliance with hygienic standards.

The scientific studies of a number of foreign scientists were analyzed, in particular: Bondarenko, N.A. "Ensuring the safety of transport production in the "driver-train-dispatcher" system taking into account computer stabilography," Zhuravleva, O.P. "Stress resistance and the ability to process information in the structure of professionally important qualities of train dispatchers ensuring traffic safety," Urmanova, V.A., Sidiknazarova, K.M. "Life safety," Rashidova, V.A. "Study of the severity and intensity of the work process of train dispatchers of the railway," Khudoykulova, Zh.B. "Development of health measures to improve the working conditions of dispatchers," Goibnazarova, Kh.T. "Ways to improve management efficiency by modernizing the activities of the "Unified Dispatch Center. In the process of studying the literature, attention was paid to the compliance of working conditions with hygienic standards, the results of the assessment of harmful factors of the production environment and the work process, recording the complex and cumulative impact of harmful and hazardous production factors [3, 4].

Research Methodology.

To obtain practical research results, the processes of collecting, analyzing, and visualizing data on the topic were conducted using automated information technology tools (MS Excel, MATLAB, Statistica, etc.). Methods of comparison, statistical analysis, video timing, theoretical modeling, and experimental research were employed. This approach not only improves the quality of experimental analysis but also serves as a reliable and effective theoretical and practical basis for an in-depth study of energy dispatchers' working conditions, identifying existing problems, and developing technical solutions.

Analysis and Results.

An assessment was conducted of the compliance of the working conditions of energy dispatchers of the operational dispatch service of JSC Uzbekhydroenergo with hygienic standards, as included in the working conditions maps at workplaces, which record the complex and combined impact of harmful and hazardous production factors using standardized methods and tools. According to the analysis, the following results were obtained: for the highest level and level of hazard, in conditions where the overall assessment of working conditions corresponds to class 3.2; in conditions of combined exposure to three or more factors included in class 3.1; and in conditions where two or more harmful factors are included in classes 3.2, 3.3, and 3.4, working conditions were rated one level higher, respectively.

The analysis of the results of the assessment of the compliance of the working conditions of energy dispatchers of the operational dispatch service of the JSC "Uzbekgidroenergo" system with hygienic standards in the workplace showed that their working conditions belong to class 2.0 in terms of actual concentrations of harmful substances in the workplace, to class 3.1 in terms of noise, infrasound, ultrasound, vibration levels, to class 2.0 in terms of non-ionizing electromagnetic radiation levels, to class 2.0 in terms of microclimate indicators in the cold period of the year, the light environment of industrial premises, atmospheric pressure, to class 3.2 in terms of the severity of the work process, to class 3.2 in terms of the impact of the workload of the work process, and the overall assessment of the compliance of the working conditions of energy dispatchers with hygienic standards in the workplace corresponds to class 3.3.

In accordance with the Regulation on the Procedure for Certifying Workplaces for Working Conditions and Equipment Hazards, guarantees and preferences are established for the workplace of energy dispatchers in the operational dispatch service for work in hazardous conditions (class 3.3). Energy dispatchers' annual additional leave must range from 7 to 12 days per day, which entitles them to retire five years earlier than the generally established age, provided they have the required position and the required general and specialized work experience.

The results of the analysis of the assessment of compliance with hygienic standards of working conditions at the workplace of energy dispatchers: points were determined for factors of the production environment and the work process related to classes 3.1 and 3.2, taking into account the time of exposure to each factor (see Table 2.1). For exceeding the permissible noise level at the workplace - 4 points, for the vibration level - 4 points, for an uncomfortable body position during a shift - 3 points, for intellectual workload, that is, for the content of the work - 3 points, for the reception (perception) of signals (information) and their evaluation - 4 points, for the level of task complexity - 4 points, for the dimensions when observing the object - 4 points, for the duration of continuous work during a shift - 4 points, for shift work - 3 points [5].

The duration coefficient of exposure of energy dispatchers to factors of the production environment and work process related to classes 3.1 and 3.2 during the working (days) of a shift was determined using the following formula:

$$K_9 = \frac{t_i}{t_s(t_k)} = \frac{576}{720} = 0{,}8$$

at the same time t_i – duration of exposure to factors of the production environment and the work process (taken from the certification report of the map of working conditions of the workplace), minutes; t_s (t_k) - duration of the working (days) shift, minutes.

The comparative value of the scoring of factors of the production environment and the work process at the workplace of energy dispatchers was determined by the following formula:

$$\sum_{i=1}^{9} x_i = x_9 \cdot K_9 = 33 \cdot 0{,}8 = 26{,}4$$

Here x_9 – the sum of points assigned to factors related to classes 3.1 and 3.2 of the production environment and work process, points; K_9 is the coefficient of the duration of time of actual exposure to factors of the production environment and work process in a work shift (days).

The total amount of points awarded for taking into account factors of the work process and production environment that exceed permissible standards $\sum_{i=1}^{9} x_i = 26{,}4$ It was possible to determine the numerical value of fatigue experienced by energy dispatchers during a shift, as a percentage. The empirical formula (2.35), developed by the researchers, was used:

$$Ch_k = \left(\frac{\sum x_i - 15{,}6}{0{,}64}\right) \cdot \frac{K_{hyuk}}{K_{chyuk}} = \left(\frac{26{,}4 - 15{,}6}{0{,}64}\right) \cdot \frac{0{,}88}{0{,}55} = 27\% \qquad (2.35)$$

Where $\sum_{i=1}^{9} x_i$ - the total score for factors of the work process and production environment that exceed acceptable standards; K_load = 0.88 - the actual workload; K_{chyuk} = 0,55 - maximum workload, 15.6 and 0.64 - regression coefficients.

According to the calculation results, the fatigue of dispatchers during the shift was 27%. Based on the numerical value of the state of fatigue, the numerical value of the performance of train dispatchers during the shift as a percentage was determined using the formula (2.36):

$$I_q = 100 - Ch_k = 100 - 27 = 73,\% \qquad (5)$$

Where $Ch_k -$ Fatigue index in conventional (relative) units (Ch=27), %;
100 - indicator (level) of performance, %.

Research has shown that the fatigue rate of energy dispatchers while performing their duties under current working conditions is 27%, while their performance capacity is 73%. These figures indicate that energy dispatchers may be functioning under stress. This, in turn, can negatively impact the efficiency and quality of their tasks and decisions.

Determination of the propagation of airborne and structural noise generated at the energy dispatcher's workplace

Depending on the hydroelectric power plant design, the noise level generated by hydraulic turbines can vary. Noise level measurements at the nearest control station in the engine room where the PL 40/587A-V-500 hydraulic turbine is located can be obtained from the calculations provided in the table below (Table 1).

Table 1.

Noise pressure level at the workplace when hydroturbines are operating at full power

Measurement location	Geometric mid-frequency bands, Hz									dBA
	31,5	63	125	250	500	1000	2000	4000	8000	
Maximum permissible level	107	95	87	82	78	75	73	71	69	80
Workplace	80	85	87	84	85	87	80	76	72	90
Study room	86	91	93	89	91	92	86	81	73	94

When the hydraulic turbines located in the engine room of the hydroelectric power plant under study are not operating at full capacity, noise levels at the power dispatcher's workstation reach 90 dBA. Experience shows that noise discomfort levels during operational conditions significantly exceed permissible limits. Sound pressure levels generated during operation of the hydraulic turbines at the hydroelectric power plant were measured in free air conditions while operating at less than full capacity. The measurements were conducted in dry weather, when air velocity did not exceed 4 m/s [6]. Atmospheric pressure, air temperature, and magnetic fields were within the specified measurement conditions. The acoustic environment in the measurement area ensured free propagation of sound energy within one decibel. However, doubling the distance from the noise source reduces the sound pressure level by 4-5 dBA. There were no objects around the microphone that interfered with the free sound field. The results of experimental studies under noisy conditions, i.e., with the hydroturbines operating at full power and without full power, are presented below (Figs. 1 and 2).

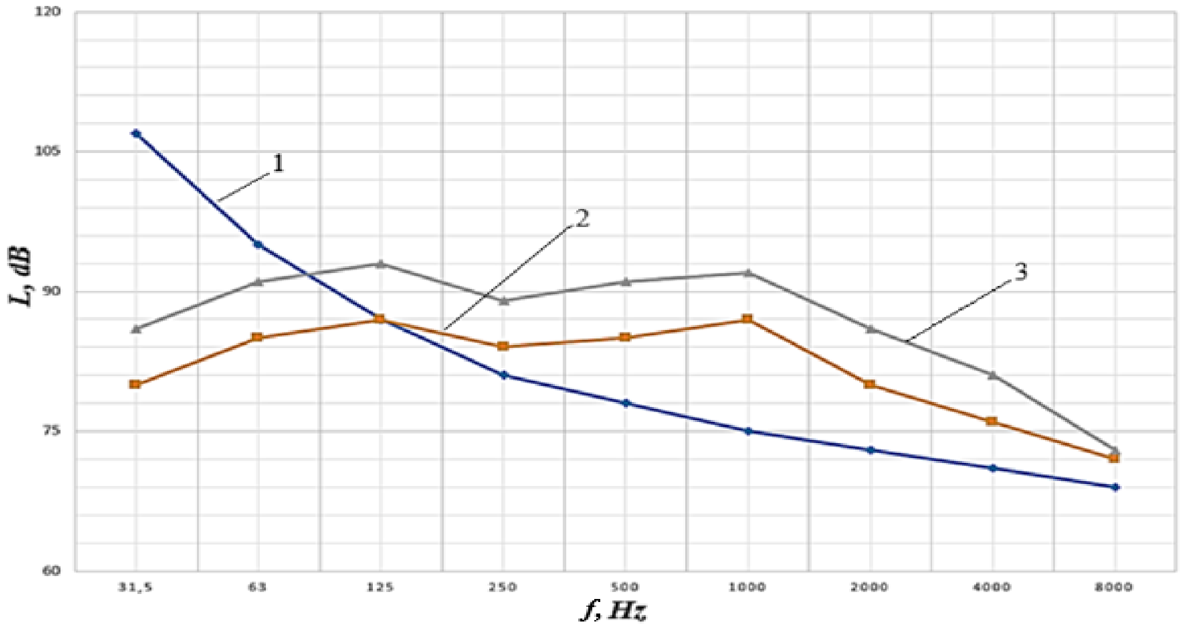

Figure 1. Noise level in the workplace when hydroturbines are operating at full power

1- **Maximum permissible level**; 2 – Workplace; 3 – general noise in the work area

When hydraulic turbines operate at full power, the pressure level at the power dispatcher's workstation in the frequency range of 31.5-125 Hz is at the maximum permissible level, and in the frequency range of 250-8000 Hz, the sound pressure level exceeds the permissible limit by 3 dB to 12 dB. The sound pressure level in the power dispatcher's workspace is at the maximum permissible level in the frequency range of 31.5-63 Hz, and in the frequency range of 125-8000 Hz, the sound pressure level exceeds the maximum permissible level by 4 dB to 17 dB.

Table 2.

Noise level in the workplace when hydroturbines are operating at partial power

Measurement location	Geometric mid-frequency bands, Hz									dBA
	31,5	63	125	250	500	1000	2000	4000	8000	
Maximum permissible level	107	95	87	82	78	75	73	71	69	80
Workplace	75	80	82	79	80	82	75	71	70	85
Study room	81	86	88	84	86	87	81	76	72	89

When hydraulic turbines operate at full power, the sound pressure level at the power dispatcher's workstation in the frequency range of 31.5-250 Hz is at the maximum permissible level, while in the frequency range of 500-2000 Hz, the sound pressure level is 2 dB to 7 dB above the maximum permissible level. At a frequency of 4000 Hz, the sound pressure level is at the maximum permissible level, and at a frequency of 8000 Hz, the sound pressure level is 1 dB above the maximum permissible level. It was found that the sound pressure level in the power dispatcher's workspace is at the maximum permissible level in the frequency range of 31.5-63 Hz, while in the frequency range of 125-8000 Hz, the sound pressure level is 1 dB to 12 dB above the maximum permissible level [7].

As can be seen from the conducted studies, the power dispatcher's workspace has zones with varying noise levels. The highest sound levels were recorded near the front wall of the room where the dispatcher's workstation is located. It was established that the level of noise discomfort in this zone exceeds sanitary standards by 14 dBA when hydraulic turbines are operating at full power and by 9 dBA when operating without full power.

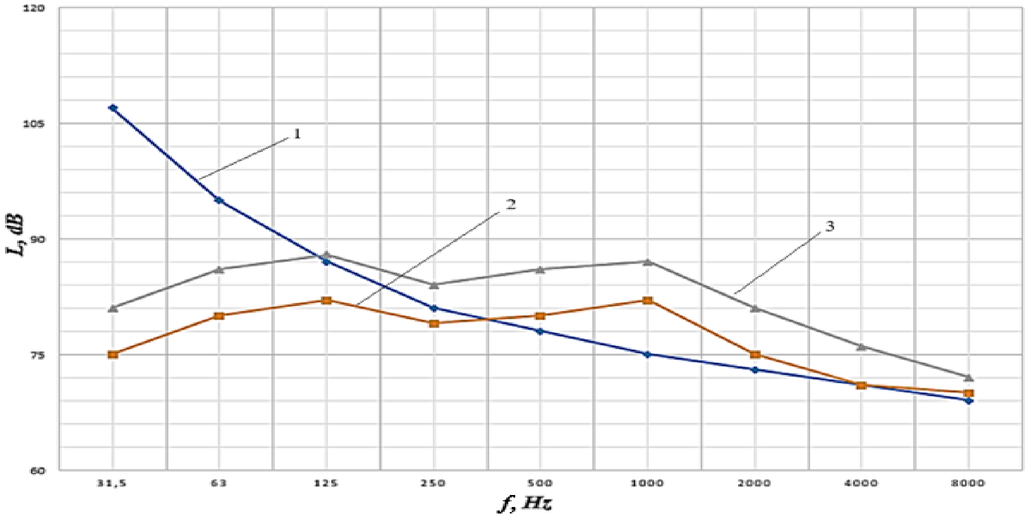

Fig. 2. Noise level in the workplace when hydroturbines are operating at partial power

1- Maximum permissible level; 2 – place of work; 3 – general noise in the work area

The sound emissions from hydraulic turbines during operation influence the formation of the sound field both on the front wall of the room housing the power dispatcher's workstation and within the workstation.

Analysis of the spectral composition of acoustic characteristics reveals that the formation of the sound field occurs as a result of the simultaneous influence of airborne and structural noise components. It should be noted that for the airborne component of noise, not only external but also internal sources must be considered [8]. Such internal sources for the power dispatcher's workstation should include air conditioners and relays.

Sound pressure levels in the engine room, where the hydraulic turbines are located, exceed the maximum permissible values over a wide frequency range. This circumstance has a decisive influence on the formation of the sound field in the engine room. Therefore, measurements were conducted in front of the hydraulic turbines and near the wall between the dispatcher's workstation and the engine room (Fig. 3).

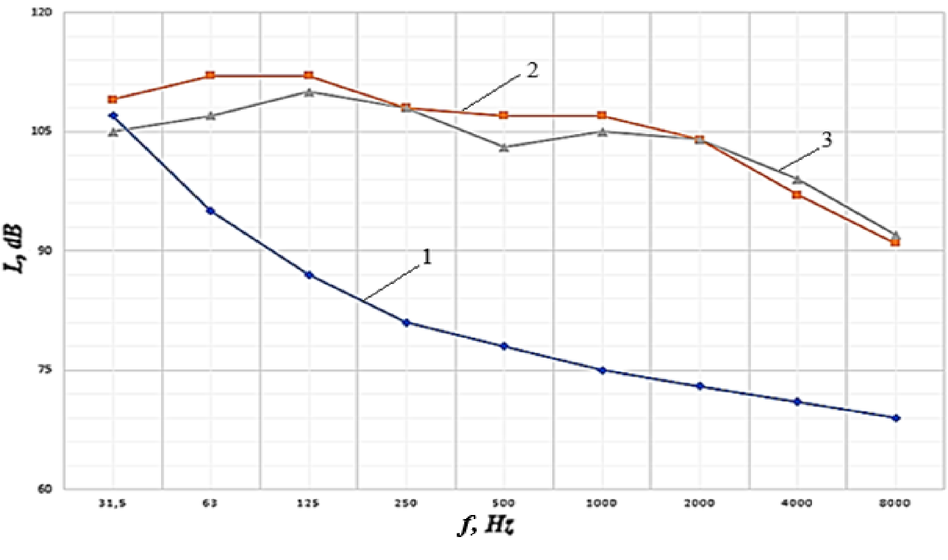

Fig. 3. Noise spectra of a hydraulic turbine in the engine room

1- Maximum permissible level; 2 – next to the hydro turbine; 3 – The control room workstation is located near the wall between the control room and the engine room..

Thus, based on the results of measurements in the frequency range of 250-2000 Hz at octaves 4-7, it was established that the sound pressure level was 26-32 dB higher than the standard values. In the sixth octave (in the mid-high frequency range of 1000 Hz), the maximum sound pressure level was recorded at 107 dB, which is 32 dB higher than the standard values [9, 10].

The characteristics of airborne noise sources present in the power dispatcher's workstation, including air conditioners and relays, and their overall impact were studied. The above experimental data suggest that the airborne component of noise from external and, to some extent, internal sources in the control room significantly influences the acoustic properties [10, 11-14].

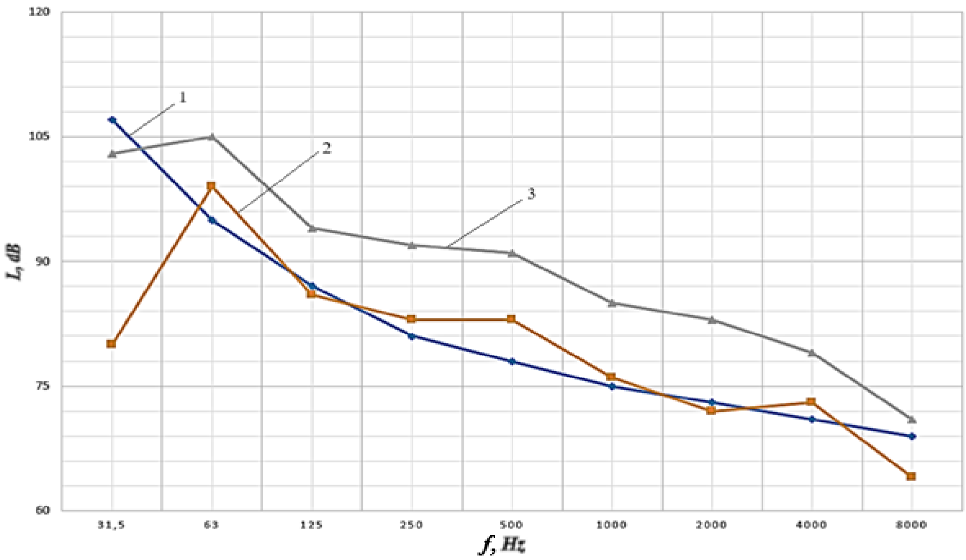

Figure 4. Spectra of internal noise in the energy dispatcher's workroom:

1- Maximum permissible level; 2 – noise generated by the air conditioner; 3 – шум, создаваемый реле

This indicates insufficient sound insulation capacity of the fencing elements between the room where the power dispatcher works and the engine room [12].

CONCLUSION

In conclusion, it can be concluded that the level of airborne and structure-borne noise generated in the control room exceeds sanitary and hygienic standards by 4 to 17 dB in most frequency ranges. Research has established that the noise level at the control room's dispatcher's workstation is high when hydraulic turbines are operating at full power, especially in the frequency range of 250-8000 Hz. This condition is assessed as a risk factor for the physical and psychological stress of energy dispatchers, their work efficiency, and their health. In any case, it is important for us to create a stable (normal) environment in the room and at the workstation where the energy dispatcher works.

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