

The Change of Bus Drivers' Functional State

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Abstract – This paper provides the results of drivers functional state research for those, who are working on city bus routes. These results are necessary for further investigations of driver's psychophysiology. Actuality of this issue consists in the necessity of taking into account of the driver's stress level which is one of the key factors of his behavior in complex traffic situations.

Key words – traffic, psychophysiological indicators, driver, functional state.

I. Introduction

The driver is one of the least investigated elements of the "driver-vehicle-road-environment" system. The safety of all traffic participants (road users) and the quality of services provision of passengers transportation depend on his actions. That's why, the problem of defining and investigation of driver's basic psychophysiological indicators, which may adequately reflect the impact of external motion factors on his functional state, has aroused. This is stipulated by the fact that under the impact of negative factors the driver may be in a state of excessive stress, make false decisions, disregard the rules of road traffic, lose control over the transport process, etc. Usually this is the prerequisite of road accidents with consequences of different seriousness.

II. Investigation of driver's functional state

The important problem of scientific research is development of new methods of movement safety ensuring. The life and health of all road users exactly depend on these methods. For efficient solving of this problem it is necessary to determine and eliminate the main causes of road accidents [1, 2]. Depending on the functional state of the driver his reliability is being changed. This indicator is considered as the possibility of performing certain tasks in the specified conditions [3].

Also the wide range of other scientists have been investigating the influence of driver's functional state on his reliability, considering it as one of the components of traffic safety. Thus, it has been established that the time of driver's reaction changes with the change of his functional state and it has been proven that in both simple and complex situations the time of reaction largely depends on human functional state [4].

In the publication [5] it was stated that during the continuous work the drivers' basic functional indicator, i.e., attention, the time of perception reaction, etc., are being worsened. It was established that during the motion the driver's functional state is being changed and the body

weariness is being increased. The scientists have proved that driver's functional state is being changed during certain stages that are responsible for human performance [5]. On the present stage of applied physiology development there exist different methods of investigation human state, which is being changed under the influence of certain factors. These changes are considered as a result of adaptation of a body to the influence of external conditions.

The most widespread usage during the investigating of driver's functional state have electrophysiological methods of analysis. The most used methods are [6; 7]: 1) electrocardiogram; 2) electroencephalogram; 3) elektrookulohram; 4) skin-galvanic reaction.

This is stipulated by the fact that all the methods may correctly record (register) the indicators of driver's functional state during the motion.

The easiest (handiest) methods of investigation of driver's psychophysiological indicators during his professional activity are electrophysiological ones. They are ones of the most instructive. As the indicator of human functional state mathematical and statistical analysis of heart rate variability is usually used. It is carried out with the use of data obtained by registering of electrocardiogram. With a help of detected changes of human cardiovascular system, one may determine even the smallest changes which occur in the body and, correspondingly, the character of influence of certain factors on driver's functional state.

There exists a large variety of methods of investigation and evaluation of heart rate variability. The most widespread ones are statistical, geometrical, spectral analysis, autocorrelation analysis, variation pulsometry etc. [8]. In transport investigations the method proposed by R.M. Baievskiy is used. It consists of several techniques which need the following initial data [5; 8; 9]: 1) expectation (the indicator which generally displays the final result of the influence on cardiovascular system); 2) standard deviation (one of the basic indicators of heart rate variability, which characterizes the state of regulatory mechanisms); 3) mode (the indicator which displays the number of R-R intervals that are most common); 4) variation scale (swing) (the indicator which displays the difference between the largest and smallest value of R-R interval); 5) mode amplitude (the indicator which displays the proportion of cirdiointervals which corresponds to the mode value); 6) coefficient of variation (the normalized evaluation of standard deviation); 7) spectral power in the range of very low frequencies; 8) spectral power in the range of low frequencies; 9) spectral power in the range of high frequencies

One of the basic techniques which provide complex evaluation of human body functional state on the basis of analysis of electrocardiogram indicators is index of activity of regulatory systems. The determination of this indicator is carried out according to the algorithm which consists of five criterions:

$$IIAPC = |A| + |B| + |B| + |\Gamma| + |D| \quad (1)$$

The index of activity of regulatory systems is a complex evaluation of heart rate variability and displays human functional state. This indicator is being evaluated by

standard units according to the ten-point scale: 1, 2, 3 – the state of regulatory systems in the range of optimal stress which is necessary for interaction between the human body and the environment; 4, 5 – moderate stress under which the body requires additional reserves for functional adaptation to the conditions of environment. This body state is observed during the adaptation to working activities at the beginning of working day, and under the emotional stresses; 6, 7 – pronounced stress of regulatory systems, in which the body's defence mechanism is being mobilized; 8,9,10 – the state of exhaustion of regulatory systems, failure of adaptation. This body state is characterized by reducing of regulatory mechanisms activity when the accumulated tiredness and nervous strain are observed. The protective and adaptation mechanisms of the body cannot cope with and cannot respond to the impact of external factors.

III. Results of full-scale research

For analysis of indicators of electrocardiogram of the driver the software environment «Cardio Lab» was used. On the basis of obtained data according to the technique of R. M. Baievskiy the changes of index of activity of driver's regulatory systems during the motion were determined. After analysing of all the data of full-scale research it was established that the area in which the road lies, the level of road loading and the type of vehicle influence the driver's functional state.

It was established that the functional state of route vehicle driver, i.e., his index of activity of regulatory systems, reaches maximum values when driving in mountainous conditions and within inhabited localities under high-level road loading. The minimal values of this indicator are observed when driving along the roads in flat terrain. This proves the fact that these conditions of motion have the least impact on the driver. As the results of investigation state, the permissible duration of the driver's working depends on the specific power of the vehicle, which is driven, and the area in which the road lies. According to the Order of the Ministry of Transport and Communication of Ukraine "About the approval of Regulation of working time and rest time of wheeled vehicles drivers", the maximum duration of vehicle driver working without having a rest should not exceed 4 hours [9]. But taking into account the fact that there are recommended certain durations of driver working on different route vehicles and in different conditions of motion route running when the value of index of activity of regulatory systems exceeds 7 points and the driver's body is in the state of exhaustion of regulatory systems and the probability of adaptation failure increases.

Conclusion

It was established that the drivers are in a state of pronounced stress during the extended working when driving the route vehicles on the roads in mountainous

areas, and their bodies are on the verge of adaptation failure. Depending on the type of vehicle and the level of road loading, this state occurs when the working duration exceeds 115-230 minutes. During the route vehicle driving on the roads which lies in flat terrain, the values of drivers' indexes of activity of regulatory systems are within the range of optimal and pronounced body stress. The exception applies to drivers of buses of group 1 under the level of road loading larger than 0.5 conventional units. In the case of route vehicle driving within the inhabited localities, the driver's functional state largely depends on working conditions, and the values of index of activity of regulatory systems exceeds 7 points on the average at 77% of the permitted motion duration.

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