

THE INFLUENCE OF ENERGY-INFORMATION IMPACT ON AN ELECTRIC VEHICLE.

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Abstract. The main results of studying the energy-informational impact on the driver of an electric vehicle. The parameters of electrical and magnetic fields recorded in the vehicle exhibit fairly complex patterns. A significant influence on the level of electromagnetic radiation comes from the electronic devices for onboard diagnostics and control, passive and active noise and vibration protection means, navigation systems, immediate access to information, climate control devices, air purification, and security systems. Moreover, during the movement of the electric vehicle, there is a change in electromagnetic radiation due to the presence of external fields from power lines, telecommunication towers, radio transmitting stations, and others. The loads arising from the operation of an electric vehicle inevitably affect the elements of its structure, resulting in their alteration. Apart from regular operational faults, which are unavoidable, sudden malfunctions can always occur due to changes in the technical condition of the vehicle and road conditions, which are of an incidental nature.

Key words: electric vehicle, electromagnetic fields, comfort and safety system, resonance phenomena, driver reaction, emergency situation, national standard, STB, components of consciousness, biological effect of microwaves, fatigue mode.

Introduction. Comfort and safety systems can create conditions for emergency situations: all typical errors occurring during vehicle control are linked to the driver's reaction, which may depend on the comfort system installed in the vehicle; strong electromagnetic field effects are evident in electric vehicles where the battery pack is placed under the rear seat or in the trunk, and the current flows practically throughout the entire electric vehicle, turning the car into a charged circuit; the maximum electromagnetic field occurs in the area where the driver sits, the low-frequency field in an electric car changes thousands of times, and these changes have a harmful effect on the human body, potentially affecting the driver's reaction speed; during the operation of electrically powered vehicles, electromagnetic fields are generated that may disrupt electromagnetic safety - according to GOST R 54811-2011[1] "National Standard of the Russian Federation - ELECTRIC VEHICLES," trolleybuses, including trolleybuses, are not considered electric vehicles in this standard, although these vehicles' operation involves electrical equipment that needs assessment for the electromagnetic safety of drivers and

passengers. In the Republic of Belarus, guidance is based on global technical regulations No. 20[2] and STB 2594-2021 [3].

Main part. In recent times, parameters characterizing the frequency spectrum of generated, amplified, or converted oscillations have gained increasing importance in high-frequency radio electronics. The output frequency spectrum contains not only the main oscillation but also side oscillations located outside the frequency band (undesirable oscillations). Currently, the frequency band is used by at least four services - broadcasting, radio navigation, etc. Satellite communication systems are combined with terrestrial radio relay lines, and the power of radio transmitting devices tends to increase, while the sensitivity of radio receiving devices steadily rises. Interference leads to errors in the operation of navigation equipment, disruption of telephone and telegraph communication, and harmful effects on the human body, which is also enclosed within a circuit represented by an electric vehicle [4].

It is noted that different electromagnetic fields can alter the body's motor activity, change sensitivity to stimuli, disrupt the formation of conditioned reflexes, and suppress memory. Changes in motor activity have been observed under the influence of extremely high-frequency fields. An electromagnetic field initiates a braking process; this principle is employed in the technique of radio-harassment. Beam-like effects of the electromagnetic field have been proven. The impact of extremely low-frequency fields does not immediately lead to pathological changes in biological systems but concludes at the second stage of adaptation. Extreme stimuli cause distress effects - depletion of the body's protective resources, damage to biological structures, and various forms of pathology. Extreme stress on regulatory-adaptive mechanisms may fail to maintain and support a stable, consistent state - homeostasis, leading to a lethal outcome. Studies [5] have highlighted work on auditory effects resulting from exposure to pulsed electromagnetic radiation. Exposure of the head to rectangular pulses with a peak energy flux density of about 300 mW/cm², averaging about 0.1 mW/cm², caused auditory sensations in humans.

With the emergence of electric transport, the driver may be subjected to informational-psychological influence on all components of consciousness - mental processes (perception, memory, imagination, thinking, attention). As metrological values and sensations indicating an unfavorable information environment, reactions of the driver's organism to the influence of electromagnetic fields of radio frequency and microwave range can be highlighted.

Among the entire spectrum of physical fields of electromagnetic nature, electromagnetic fields of the microwave range stand out due to their highest biological significance and

pronounced symptomatology. Sources of these fields in electric transport or an electric vehicle and in the scanned ether can be various radio-emitting means, broadcasting devices, household electrical appliances, sources of electromagnetic radiation for radio communications, such as Wi-Fi, wireless Wi-Max, LTE (long-term evolution), Bluetooth, which employ microwaves, some properties of the magnetic field used in electric motors, direct current generators, magnetrons [6].

Depending on the duration and intensity of electromagnetic field exposure, changes induced in the organism by radio frequency and microwaves are divided into alterations from acute thermogenic effects. Upon exposure, warmth is felt at the site of action, similar to the effect of sunlight; mild discomfort, headache, dizziness, nausea, vomiting, a sense of fear, thirst, slight weakness, limb pains, increased sweating are noted. Body temperature elevation, bouts of tachycardia, disruption of cardiac activity, hypertension are observed. Exposure of the head to rectangular pulses with peak energy flux densities of about 300 mW/cm² and averages of 0.1-0.4 mW/cm² causes auditory sensations [7].

The drowsy state of the driver, arising with a moderate degree of intoxication, may occur under the influence of pulsed magnetic fields, exhibiting symptoms similar to alcohol intake, affecting the central nervous system and the brain, sharply inhibiting its normal function. The influence of the magnetic field, when the car represents a closed circuit, especially with active comfort systems, can be likened to alcohol intoxication and classified into three degrees: mild, moderate, and severe. A comparison of states under the influence of alcohol and electromagnetic fields is presented in table [8].

Table - Comparison of states when exposed to alcohol and electromagnetic field.

Ethanol concentration in blood plasma and action phase, driver reaction. Degree of intoxication.	Clinical symptoms	Observed changes	Electromagnetic field intensity, mW/cm ²
0.5% (50 mg%) subclinical phase.	Without visible deviations in behavior and well-	Feeling of warmth. Vasodilation. With 0.5-1	100

Slight absentmindedness or appearance of aggression.	being, registered only with the help of special tests	h irradiation, the pressure increases by 20-300 mm Hg.	
1.5% (150% mg) euphoria. The driver's reaction time increases by one and a half times. There is a risk of hitting a pedestrian. Mild intoxication.	Increased sociability, talkativeness, increased self-esteem, decreased attention and judgment, impaired performance of test assessment tasks. Emotional instability, decreased criticism, memory impairment, decreased sensitivity, incoordination of movements.	Auditory effect when exposed to pulsed magnetic fields	0,4
		The biological effect of microwaves begins.	10
2.5% (250 mg%) excitation. The reaction worsens 6-9 times, and there is a high risk of falling asleep while driving. Moderate intoxication.	Emotional lability, decreased inhibitory behavior, loss of criticism, impaired memory and ability to concentrate, impaired perception and decreased reaction time, muscle incoordination. Disorientation, dizziness, confused speech, changes in emotional status (fear, sadness, anger), diplopia,	Decreased blood pressure, a tendency to increase heart rate, slight fluctuations in the blood volume of the heart.	1

	decreased pain sensitivity.		
4% (400 mg%) sopor. The driver has no control over himself. Severe intoxication.	Impairment of consciousness to the depth of stupor: marked decrease in response to stimuli, complete muscle incoordination, inability to stand, urination, defecation, convulsive syndrome. Apathy, inability to walk or stand, involuntary urination, defecation, sleep or superficial coma (stupor).	An increase in blood pressure followed by a decrease. The hypnotic effect begins, it is these higher cells that are inhibited and switched off	100
5% (500 mg%) coma. Severe intoxication.	Anesthesia, analgesia, decreased reflexes, hypothermia, respiratory and hemodynamic impairment, possible death.	Voice changes, motor agitation, pronounced vocal changes, convulsions, body temperature, pulse, respiratory movements (shortness of breath).	300
7% (700 mg%) and above	Death due to cerebral edema.	Pain during irradiation.	600

The table shows a correlation between clinical symptoms from the concentration of ethanol in the blood and observed changes in physical condition depending on the intensity of the electromagnetic field, mW/cm^2 . A possible result is delayed inhibition.

Biochemical changes in the brain during a 10-minute exposure to a constant magnetic field of 50 mT lead to an increase in the tissue content of ammonia by 56%, glutamic acid by 62%, aspartic acid by 41.2%, with a simultaneous decrease in glutamine content by 71.3%. The content of gamma-aminobutyric acid, associated with inhibitory processes of the nervous system, increases by 60%. This results in the appearance of spindle-shaped structures, and predominance of delta waves in the electroencephalogram (EEG), characteristic of a sleep state and influencing

the drowsiness of the driver affected by the comfort system of the car when assessing road conditions.

A method for diagnosing the driver's state during movement can involve registering shifts in the EEG rhythm distribution in the fatigued brain, displaying the driver's condition on the screen of the car's information system through sensors installed in the driver's seat. An example is presented in the figure.

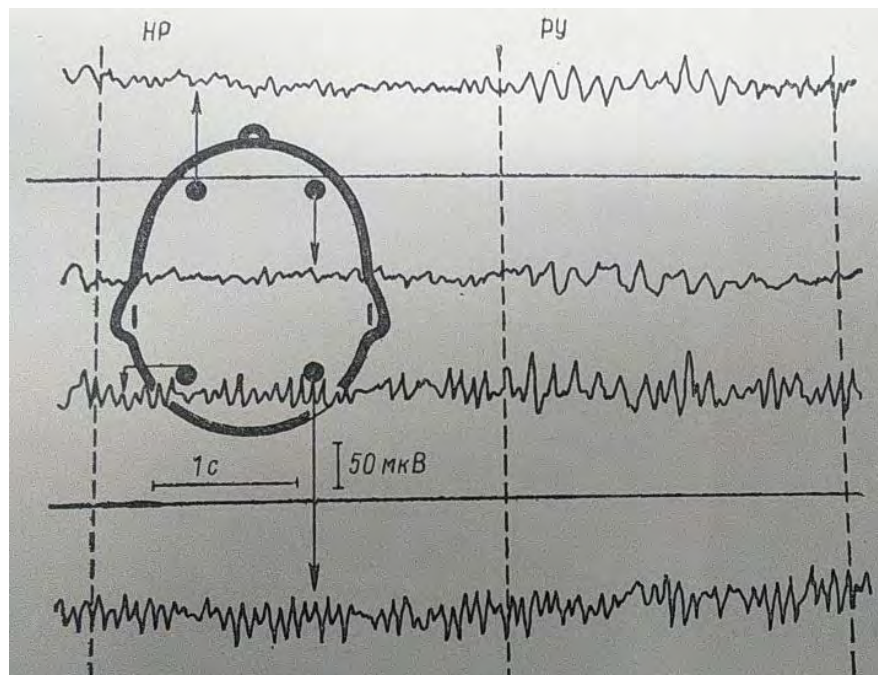


Figure - Shifts in the distribution of EEG rhythms in a tired brain: NR - normal mode; RU – fatigue mode.

From the figure, it is evident that the appearance of slow waves in the EEG indicates the driver's brain transitioning to a state of reduced functional mobility - slowing down, i.e., drowsiness. This reaction can be implemented as a warning indicator for the driver, signaling the brain's transition to a state characterized by decreased attention during movement [9].

A mobile phone held to the ear, as an emitter of waves in the decimetre range with significant penetration, can impact human brain structures. It is noted that different electromagnetic fields can alter the body's motor activity, change sensitivity to stimuli, disrupt the formation of conditioned reflexes, and suppress memory.

Therefore, it is advisable to have a device that signals the emergence of hazardous radiation modes within the vehicle, correlated with the effects of pulsed magnetic fields. Under the influence of these fields, symptoms akin to alcohol intake, affecting the central nervous system and the brain, sharply inhibiting normal function, are observed.

The comfort system, depending on its power level within the vehicle, exerts a negative impact on subtle mental functions: attention worsens, calculation accuracy diminishes, carelessness manifests, and reaction speed slows down. The most dangerous phenomenon for the driver is the slowing of reaction time depending on the level of excitement of the cerebral cortex during vehicle movement, especially in the case of an electric vehicle. This can lead to impaired coordination of movements.

Conclusion. The United Nations Economic Commission for Europe has developed norms for the permissible efficiency of braking characteristics in mechanical vehicles. The primary assessment parameter adopted is the value of the minimum braking distance required to stop a given vehicle moving at a specified speed close to the maximum. Therefore, the energy-informational impact on the driver of an electric vehicle will influence their reaction during braking, leading to an increase in reaction time.

The influence of a magnetic field, especially when the car constitutes a closed circuit, particularly with active comfort systems, can be compared to alcohol intoxication and categorized into three levels: mild, moderate, and severe. Accordingly, the reaction time to the appearance of an obstacle necessitating braking increases from 1.5 to 9 times.

At an electromagnetic field intensity of 10 mW/cm², biological effects of microwaves begin. The reaction time of a driver under the influence of alcohol or pulsed magnetic fields increases by 1.5-9 times; thus the reaction time of the driver can range from 2.1 to 18 seconds, and correspondingly, the braking distance will be 70 meters or more.

There is no direct correlation between changes in a biological entity and the frequency, intensity, and duration of exposure to extremely low frequencies concerning the manifested biological effect. The only existing explanation is that under certain narrow frequency spectra and amplitudes, energy fields occur, which affect biological entities, especially in specific cases, affecting the driver and passengers of an electric vehicle.

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