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The modern status analise of working conditions of current industry in the field of transport engineering

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S u m m a r y . In this article the analysis methodology for assessing the severity of conditions in the workplace as an example of current industry in the field of transport engineering, as well as the estimation of conditions for psychophysiological factors in compliance with regulatory requirements.
K e y w o r d s : working conditions, injuries, category of severity of labor productivity, physiological factors.

INTRODUCTION

In recent years, amid increasing technical equipment and constantly improving the working environment more clearly is the need to consider the impact stress of physiological functions in the workplace as an important factor that determines the able to work and health. As overstrain individual organs and systems, and its failure adversely reflects on the body condition and reduce the efficiency of labor, physical component which is still significant specific weight in engineering [13, 15, 20, 21, 23].

A state policy in the sphere of a labour protection and new safety concepts and nonaccident rate productions on industrial activity objects provide first of all an objective estimation of dangers and allow to plan ways of effort to combat them. In this connection increasing value gets exploring and designing interrelations in system "person-machine-environment" that has created necessary preconditions for perfection of existing norms and requirements to the workplace organization, and has caused occurrence of new research problems.

Nowadays widespread opinion that the accidental majority (80%) is caused by human mistakes or the behaviour contradicting safety precautions. According to the benor of co-ordinated opinion often expressed by supervising employees that the reason of accidents is "imprudence" or "levity". The victim in accident, on the contrary, gires as the reason "time trouble", "race", "cares" or "nervousness". These opinions are needed to oppose the fact that even at high degree of rationalization in actions for a labour protection it is impossible to do without requirements to safe workers behaviour which often are not carried out. The "unwillingness" and "inability" are difficult to distinguish among themselves; but both unwillingness inability can have the ergonomic reasons. Labour protection experts should include similar aspects in the menacing dangers

analysis and working out actions for accident prevention.

Every year in the world, according to information of IOW, approximately 270 million accidents, related to implementation professional duties, and 160 million professional diseases are registered. Almost 354 thousands of workers perish on a production, from them in countries with the developed market economy – 16,2 thousands, in former social countries – 21,4 thousands, in China – 73,6 thousands, in Indium – 48,2 thousands, in other countries of Asia and Pacific ocean – 83 thousands, in countries Near east – 28 thousands, in the countries of Africa in the south of Sahara – 54,7 thousands, in the countries of Latin America and Caribbean pool – 28,6 thousands. Unfortunately, about 12 thousand of died – children. It is also necessary to take into account the amount of workers which got professional disease and were excluded from a production process, for example, in 2004 2,2 million persons are incorporated, thus 32% the oncologic made, 23% – warmly vascular, 19% – traumatology, 17% are infectious diseases. As a result of illness every day in the world is absence on the workplace about 5% labour force. Through charges, related to the industrial accidents, lost to 1250 milliards dollars, or about 4% of world gross domestic product.

Professional activity of workers of many branches of industry remains dangerous, without regard to technical progress, as related to mobilization of functional backlogs, and in many cases passes in extreme and emergency situations, that requires enhanceable physical and emotional firmness. Exactly such workers which are added an enhanceable risk for a health require the special attention from the side of the state. Ukraine for the amounts of mortal accidents on 1000 workers substantially (negatively), as an analysis of the state of industrial safety testifies, exudes between the economic developed countries and former socialistic countries of Europe (Ukraine – 0,104, countries with a market economy – 0,038, former socialistic countries of Europe – 0,053). According to [2] Ukraine occupies the second after Portugal on a traumatism and 20 place after China for deaths of people on a production.

Most failures happen through fault of human factor. Results of analysis of production traumatism and death rate from industrial accidents in Ukraine confirm, that reason of plenty of accidents are mistakes of workers, through what every year injured to 75% and all of about 80% victims perished, group accidents also took a place through fault of «human factor» – 75-85% (after statistical materials of Ukrainian State mountain industrial supervision bulletins).

Ability to obtain "human operator" occupational injury depends on the workplace conditions that characterize the intensity and severity of labor, pszchophysiological characteristics and employee communication a number of specific factors. Analysis of the impact of both harmful and dangerous production factors (HDPF), and the qualities and capabilities of the human operator in real dynamics of production is a complex engineering task.

MATERIALS AND METHODS

In connection with an economical situation which was folded in Ukraine, the brightly expressed forms of chronic diseases and disability which comes as a result of the ill-timed measures use are all more frequent registered, thus among the persons of young capable working age. Transformation, which is observed in character, flowing and terms of professional diseases development related to diminishing of technological actions intensity, increase of psychoemotional tension level and decline the physical loadings. In same queue, modern pattern of production change, unwillingness of employers instrumental in the exposure of professional diseases on the their development early stages, for avoidance of additional charges on treatment and rehabilitation of a victim, incuriosity of workers in the exposure of professional diseases through possibilities to lost a job is reasons of low exposure and registration of professional diseases.

As a rule, an accident rate and traumatism through fault of «human factor» is conditioned: by insufficient motivation of observance of safety; by the low level of professional preparation on questions of workers safety; admitting to implementation risky jobs of people with the enhanceable traumatism risk, psychophysiological qualities of which do not answer the requirements of certain labour activity; by the presence of factors which reduce reliability and safety of worker activity (fatigue, exhaustion, excitation et ctr.).

As practice shows, in Ukraine of expense on measures in relation to a labour and prophylaxis of accident rate and production traumatism protection in once or twice below than financial losses from failures. In spite of that during realization of any measures it is necessary to take into account financial charges, much major to spare the special attention the social consequences of failures and catastrophes – loss of health, life of citizens and country labour potential, increase of incomplete families amount and children-orphans. Combination of ecological and professional factors with psychological overloads, from data of WOH, is reason of most diseases. Approximately 30-50% workers of the developed countries grumble about stress overloads to the parahypnosiss, depression, cardiovascular pathology.

Analysis and research of practical results which are conducted in the different countries of the world, show a dependences of the state of health and capacity of workers on their psychophysiological qualities high degree, that testifies about expedience on enterprises with the enhanceable level of production danger psychophysiological selection and psychophysiological examination. Such approach, as developed countries experience testifies, results to diminishing of the technical systems depending on appearance and terms of activity accident rate level on 40-70%, diminishing of technogenic catastrophes amount – on 20-25%, decline of traumatism level as a result of «human factor» – on 40-45%.

Presently in the conventional classification of causes of industrial accidents highlighted three basic types of these reasons [1, 5, 11, 12, 19]. First, a technical reason, which can be described as being dependent on imperfect production processes and the use of physically and obsolete equipment. Secondly, this organizational reasons entirely determined by the level of the workplace and the company as a whole organization. Thirdly, it's personal (psychophysiological) causes, which can be roughly classified physical and neuro-psychiatric worker overload, leading to its erroneous actions through mental strain, strain analyzers (visual, auditory, tactile), monotony of work, stress, disease state of fatigue caused more physical (static and dynamic) loads. Injury may lead to discrepancy anatomical and physiological and psychological peculiarities human body of work performed by it. Also in many technical systems, design of machines, devices and control systems have not taken into account physiological characteristics and possibilities of man yet.

Almost all accidents are caused by multiple factors and "accidental" coincidence of events, but first of all violations of safety requirements admitted workers and employers. Considered, that in modern manufacturing all less skilled worker can get into unexpected situations with the "unknown" security requirements, but increasingly openly violated safety rules or unreasonable behavior creates a dangerous situation. In today's difficult for workers of manufacturing joint action to secure individually for its parameters, factors may in certain circumstances lead to dangerous, critical or emergency situations, and link this combination is usually workers, which affect the behavior and working conditions.

The analysis shows that in recent years have increasingly come to the fore issues of psychological and physiological voltage employee moving the background need to improve the traditional conditions of work related to exposure to physical environmental factors (temperature, humidity, light, noise, vibration and polluted atmosphere) [3, 6, 7, 16, 18]. This is caused by a relative decrease in physical activity on a person at the same time

the growth of psychological and physiological stress. The result is known – chronic fatigue, mental and psychological overload, worsening relations with other workers and management. At the same physiological and psychological fatigue is accompanied by deterioration performance, disease , loss of concentration and coordination, loss of care and diligence. All this substantially increases the risk of injury in the same physical conditions of the workplace.

The aim is to analyze the methodology for assessing the severity of conditions in the workplace for example working production in the field of transport engineering and rating conditions for psychophysiological factors in accordance with regulatory requirements.

RESULTS, DISCUSSION

For different types of work are different assessment of their condition. Severity of physical activity can be estimated by the load, which are human muscle have. But the rate of weight work should consider "various qualities" influence of all elements of working conditions in various forms of activity. However, with the same severity on changes in the body of workers can be caused by various reasons. In some cases, these can be HDPF, others – excessive exercise, in the third – lack of movement, etc., it is also possible different combinations of these reasons. Weight of work should to characterize the severity of the cumulative effect of all the elements that make up the human conditions, its performance, health, livelihoods and recovery workers. In this interpretation of the concept of gravity works equally applicable for both mental and the physical labor.

An objective assessment of the severity of work can be done by assessing reactions and changes in the human body, that is based on its functional state. There are three functional states of man: normal, marginal (between normality and pathology) and pathological. They can recognize by medical-physiological and technical-economic indicators. According to the above established six categories of work conditions.

Category severity of labor based on an integrated assessment of biologically significant factors operating conditions. Under biologically meaningful understanding factors such work, which most likely influence the formation of certain reactions (normal, marginal, pathological) body worker. Each biologically significant factor estimate in points from 1 to 6. Category severity of labor is determined by the following data [8, 9, 10, 22, 17]:

I category – 18 points,
II category – 19,7-33,0 points,
III category – 34,4-45,0 points,
IV category – 45,7-53,0 points,
V category – 53,9-58,5 points,
VI category – 58,9-60,0 points.

Based on the basic theoretical concepts and using job evaluation data on the effect of plant below shows the general characteristics of jobs manufacturing facilities by major environmental factors.

In areas of the enterprise departments exist or may arise in the implementation process of the processes following physical factors:

- moving machines and mechanisms,
- moving parts production equipment and products,
- high or low temperature,
- excessive dust and air pollution,
- high or low humidity,
- insufficient illumination of the workplace,
- noise and vibration in excess that allowable standards,
- high levels of electromagnetic fields,
- high level of static electricity,
- risk of electric shock.

Harmful psychological factors that influence employees during the work shift can carry on physical and neuro-emotional (static and dynamic) congestion, work monotony, mental stress, strain analyzers.

In Table. 1 the determination of harmful and dangerous physiological factors for severity of labor for the results of job evaluation, in terms of which there is a surplus of norms.

Table 1. **Comparative evaluation of the actual conditions in the workplace in mechanical engineering from the regulatory requirements for psychophysiological factors**

№ п/п	Shop, position, profession	№ working place	№ similarly. place	Severity of labor				Working out	
				Dynamic. work		Static. work			
				stand.	fact	stand.	fact	stand.	fact
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	**CLT**								
1.2	duber	4	5;5a					>50%	59,40%
1.4	molder hand forming	20		>30,5	48,8				
2	**HS**								
2.5	gas welder	8-20				18001-43000	42750	25%	43,70%
2.6	plumber	6-22;6-26; 6-28;6-41; 7-11;7-12	6-38;6-39;6-42; 6-50;6-51;6-52			18001-43000	61560	25%	47,90%
2.8	metalizater	101				18001-43000	48300	25%	41,60%
2.9	metal cleaner	99				43001-97000	174600		
2.16	painter	6-10	100			18001-43000	51300		
3	**MST**								
3.1	batterier	1	4	37-63	67			25%	47,90%
3.2	copper	68	3;67;69;…;71			18001-43000	43500	25%	33%
3.3	electroplating	10	3;9;15	18-30,5	39,48				
3.5	electric gas welder	39	38			18001-43000	40800	25%	48%
3.9	hydro sand pourer	20	17;…;19	23-45	72,8	43001-97000	70632		
3.10	heat-treaters	15;25;,26	29;…;31;33	41-90	112,5				
3.11	painter	1				18001-43000	91134	25%	67,70%
3.13	polisher	4-18	4-17;4-19					25%	45%
3.16	electric welder	48-1	48-2			18001-43000	44544	25%	48%
3.18	exile	2-11	2-2;2-3; 2-17;2-21					25%	48%
3.19	bath adjuster	15	12;…;14	37-63	65,25				
4	**IST**								
4.3	batterier	1	2;5	23-45	47,1			25%	35,43%
4.5	mechanic mechanical assembly work	1	7;…;10					26-50%	47,83%
4.6	driver vtutrishnoho combustion engines	1	7;…;10					26-50%	41,35
5	**ZST**								
5.7	electric welder	90-1	90-7			18001-43000	49680	>50%	37,50%
5.10	painter	100-1	100-3;100-4			18001-43000	58760	>50%	51,50%
5.11	cutter	8-1;3				18001-43000	72000		
5.12	hand forged blacksmith	301-3	301-4			18001-43000	69600		
5.13	smith - stamper	301-1	301-2	23-45	72,2				
6	**TRT**								
6.1	electric gas welder					18001-43000	24000	25%	41,60%
6.2	electric welder	1-34	1-32;1-33			18001-43000	25500	25%	39,50%
6.7	painter	1-5.1	1-5.2;…;5.4; 2-62;2-59;2-60; 3-5.1;…;5.8			18001-43000	49800	30-50%	41,60%

1	2	3	4	5	6	7	8	9	10
6.8	metal cleaner	Пр3-15				43001-97000	125400		
6.9	hand forged blacksmith	2-91.1;2-90	2-91.2	23-45	54,85				
6.11	electric welder on automatic and semiautomatic machines	4-15к-19к				18001-43000	24000	25%	38,50%
6.12	roller in	4-19к-20-к				43001-97000	105300		
7	**RMT**								
7.1	heat-treater	108		23-45	49				
7.2	roller in	135				43001-97000	45840	25%	37%
8	**PKT "**Tool Manufacture**"**								
8.1	electric welder	12	13;13-1;…;3			18001-43000	40800	25%	46,00%
8.5	smither	2-5				43001-97000	151200		
8.7	electric gas welder	14				18001-43000	40800	25%	45%
9	**TOE**								
9.1	locksmith	21	22;…;27					25%	55,20%
9.2	electric gas welder	28				18001-43000	45750		
10	**TZP**								
10.1	bakeliter	1		18-30,5	33,53				
10.2	polisher	71				43001-97000	100320		
10.3	electroplater	3	4-10	18-30,5	37,77				
11	**ATT**								
11.1	batterier	301		23-45	70,78			25%	38,50%
12	**TST**								
12.1	painter	8-27	8-28;…;30			18001-43000	85905	25%	23,96%
12.2	etcher	8-22	8-17;8-18	18-30,5	38,28				
13	**RT**								
13.2	electric welder	291	292			18001-43000	40800	25%	46%
13.6	electric gas welder	212	211			18001-43000	40800	25%	48,00%
13.7	polisher	133						25%	44,80%
13.8	painter	490				18001-43000	79680		
13.9	roller in	344	345					25%	45,80%
14	**TOM**								
14.1	roller in	6-3	6-4;…;6-6;6-8; 6-11			18001-43000	45750		
14.2	gascutter	4-1	4-2			18001-43000	40200	25%	47,90%
14.3	painter	1	2;3			18001-43000	58515		
14.9	electric welder	по цеху				18001-43000	39000	25%	45,80%
15	**IPT "**Pamir**"**								
15.1	pressed-vulcanizer	1	2-6	37-63	69,12			25%	39,50%
15.2	glass-plastic products former	12	13-16					25%	41,60%
16	Typography								
16.1	sealer manually	10	11;13	20001-40000	50000			25%	47,90%
16.2	sealer	16	17;18	20001-40000	42500				

The analysis of working conditions in the workplace in current production (Table 1) showed that physical activity (dynamic and static) and time that spent in an uncomfortable working position significantly exceed regulatory requirements, such as electric welder jobs, gas welder jobs, painters, batteriers and others, so it is necessary to assess the severity of labor for the calculation of compensation and benefits to employees and further develop measures to eliminate deviations.

Methods of assessing the severity of work establishes the relationship between working conditions and the integrated response of the human body. It takes into account sanitaryhygienic and psychophysiological requirements for working conditions. The former include the presence in the work area exceeding standard indicators of microclimate (temperature, humidity and air velocity, toxic substances, dust, vibration, noise, ultrasonics, the heat radiation, electromagnetic fields, biological factors, etc.) [2, 24, 25, 26].

In the latter include:

- physical, dynamic and static load,
- worker working pose and his movement in the work area during the period of the working time,
- variability and duration of continuous operation per day,
- the accuracy of visual works,
- number of observation given objects,
- pace of work, its monotony,
- the amount of information received and processed,
- the mode of work and rest,
- neuro-emotional and intellectual activity.

In assessing the severity of labor into account the elements of working conditions that actually affect the employee's particular job. In this case, each element receives a quantitative assessment criteria on a scale from 1 to 6 (Table 2).

With the simultaneous influence of several factors integral assessment of severity of labor in points determined by [2]:

$$U_T = \left[X_{max} + \frac{\sum_{i=1}^{n} X_i}{n-1} \cdot \frac{6 - X_{max}}{6} \right] \cdot 10, \qquad (1)$$

where: U_T – integral factor in the difficulty category scores,

X_{max} – element of working conditions in the workplace that has the highest score,

$\sum_{i=1}^{n} X_i$ – quantify the amount of points important elements of working conditions without X_{max},

n – number of elements working conditions,

10 –number that entered for ease of calculation.

According to the value of the integral indicator of working conditions, work performed, is assigned to one or another category of severity (Table 2).

Table 2. Dependence severity categories of labor from integrated assessment of working conditions [14]

Category of labor	1	2	3	4	5	6
Integrated assessment of working conditions, U_T, points	till 18	18,1-33	33,1-45	45,1-53	53,1-59	59,1-60

Category severity of labor indicates the degree of adverse effects of this work on the human body, and therefore to reduce its efficiency. Proceeding of gravity, provided economic recommendations of differentiation payment for working conditions, size of the compensation provided under adverse conditions. Description of existing with harmful and dangerous production factors allows developing action for their elimination and recovery conditions.

When differentiation payment in accordance with the conditions specified items assessing their over-corrected depending on the duration of their impact on the employee during the work shift:

$$X_i = X_i \cdot \frac{t}{t_{sm}}, \qquad (2)$$

where: X_i – evaluation of the i-th element of working conditions in points,

t – the actual duration of the initial element of working conditions, min.,

t_{sm} – time changes, min.

The integral indicator of severity of work determine the impact of working conditions on human performance. For this first calculated the degree of fatigue in arbitrary units. The relationship between the integral indicator of severity of labor and fatigue is expressed b [4] equation:

$$Y = \frac{U_T - 15,6}{0,64}, \quad (3)$$

where: Y – an indicator of fatigue in arbitrary (relative) units,

15,6 and 0,64 – regression coefficients,

U_T – integral indicator of the severity categories of labor in points.

Knowing the degree of fatigue, it is possible to determine the level of efficiency, the value of opposite fatigue, according to the equation:

$$R = 100 - Y, \quad (4)$$

where: R – the level of efficiency in relative units.

Accordingly, we can estimate how performance changed with a decrease or increase in hard of work and how it affected her performance:

$$P_{PT} = \left(\frac{R_2}{R_1} - 1\right) \cdot 100 \cdot 0,2, \quad (5)$$

where: P_{PT} – increase productivity,

R_1 and R_2 – performance in conventional units before and after the introduction of measures to reduce hard of labor,

0,2 – correction factor that reflects the average correlation between the increase of performance and increase productivity.

In addition, integrated assessment of working conditions can predict injuries in the enterprise. Growth of industrial accidents on automated lines defined by the expression:

$$K = \frac{1}{1,3 - 0,0185 \cdot U_T}, \quad (6)$$

where: K – the growth of industrial accidents, the number of times,

U_T – integral indicator of the severity categories of labor in points.

The design and manufacturing process equipment provides an optimal working environment and to achieve conditions that correspond to the first category of weight work.

If the equipment is perfection structural developments involving not only performance, but also with anticipation rigging equipment safety devices, etc., the value of production traumatism taken as a 1 unit, and in this case, the integral indicator of the severity of labor equals: U_T = (1,3-1,0) / 0,0185 = 16,2, describing the project trauma danger production process. When improving conditions (decrease the integrated assessment elements conditions under 16,2 points) going on reducing injuries growth and the deterioration - increasing or increased injuries on the project trauma danger project.

CONCLUSIONS

1. The investigation revealed deficiencies of existing methodologies to assess the severity categories of labor, including those related to working posture of the human operator.

2. During assess the severity categories of labor does not count amplitude and direction of limb movements, and load them in the workplace.

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АНАЛИЗ СОВРЕМЕННОГО СОСТОЯНИЯ УСЛОВИЙ ТРУДА НА ДЕЙСТВУЮЩЕМ ПРОИЗВОДСТВЕ В ОТРАСЛИ МАШИНОСТРОЕНИЯ

Андрианова Александра, Анисимова Тамара

Аннотация. В статье проведен анализ методологии оценки категории тяжести труда рабочих мест на примере действующего производства в машиностроительной отрасли, в частности, по тем факторам, которые касаются психофизиологической нагрузки, в соответствии с действующим законодательством.

Ключевые слова: рабочие места, травматизм, категория тяжести и производительности труда, психофизиологические факторы.