

WORKPLACE HYGIENE IN CORRECTIONAL FACILITIES: PROBLEMS AND SOLUTIONS

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The state takes the responsibility of protecting the life, health and working ability of inmates of penitentiary institutions. This study aimed to explore working conditions at a correctional facility located in Tatarstan. Among the most significant workplace hazards were high noise and vibration levels, poor lighting, exposure to increased concentrations of harmful substances in the air, physical distress, constrained posture, sensory stress, and monotonous work. Health evaluation of 5,009 incarcerated individuals exposed to poor working conditions revealed that they were more likely to develop work-related diseases than their counterparts who worked in the office. Among the former skin and subcutaneous tissue diseases, hearing impairment, respiratory conditions and cardiovascular disorders were 2.1, 1.7, 1.5 and 1.3 times more frequent, respectively. Our study revealed the lack of medical examinations on admission, as well as regular medical checkups, and the reluctance of the inmates to use personal protection at work. Based on the study results, adequate measures were taken to improve working conditions, raise awareness of hygiene problems among the inmates and initiate routine medical checkups. The number of incarcerated individuals working under bad conditions plunged from 68 % to 19 %. Also, up to 82 % of inmates started to use personal protection.

Keywords: inmate, safety at work, working conditions, work environment, hard labor, work intensity, personal protection

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Received: 24.09.2017 **Accepted:** 04.10.2017

ГИГИЕНИЧЕСКАЯ ОЦЕНКА УСЛОВИЙ ТРУДА В УЧРЕЖДЕНИЯХ ИСПРАВИТЕЛЬНОЙ СИСТЕМЫ: ПРОБЛЕМЫ И ПУТИ РЕШЕНИЯ

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Государство берет на себя обязанность сохранить жизнь, здоровье и трудоспособность осужденных к отбыванию наказания в учреждениях пенитенциарной системы. Целью исследования являлось изучение условий труда заключенных одного из исправительных учреждений в Республике Татарстан. К наиболее значимым вредным производственным факторам на рабочих местах по результатам их обследования были отнесены повышенный уровень шума, недостаточный уровень искусственной освещенности производственных помещений, повышенный уровень общей и локальной вибрации, превышение предельно допустимых концентраций вредных веществ в воздухе рабочей зоны, а также физические перегрузки, вынужденная рабочая поза, сенсорные нагрузки и монотонность работы. Анализ заболеваемости 5 009 осужденных, работавших во вредных условиях труда, показал, что среди них чаще в сравнении с лицами, работавшими в офисных помещениях, регистрировали заболевания, обусловленные неблагоприятными условиями труда, в том числе болезни кожи и подкожной клетчатки — в 2,1 раза, нарушения слуха — в 1,7 раза, болезни органов дыхания — в 1,5 раза, заболевания системы кровообращения — в 1,3 раза. Исследование выявило отсутствие предварительных и периодических медицинских осмотров, а также нежелание осужденных использовать средства индивидуальной защиты. По результатам исследования были проведены мероприятия по улучшению условий труда, была налажена санитарно-просветительная работа, внедрена система медицинских осмотров. Число работающих во вредных условиях труда снизилось с 68 % до 19 %. Средства индивидуальной защиты стали применять до 82 % заключенных.

Ключевые слова: заключенные, безопасность рабочих мест, условия труда, факторы рабочей среды, тяжесть труда, напряженность труда, средства индивидуальной защиты

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Статья получена: 24.09.2017 **Статья принята к печати:** 04.10.2017

Occupational health and safety is still a concern faced by the members of some social groups, including inmates of correctional facilities (CF).

Labor is believed to be beneficial for physical and mental health in closed communities; it promotes strong bonding, encourages team spirit and respect for human dignity, and facilitates re-socialization. The penitentiary system gives inmates an opportunity not to lose their professional skills and learn a new profession that may aid further re-integration into the society. Through work inmates partially reimburse the expenses for their upkeep, pay fines imposed by court decisions, earn some pocket money and save up for the time when they will be released.

Working conditions for those serving sentences should be created taking into account the state of their health, work capacity, experience, availability of work skills and profession.

Working hours, health and safety requirements, sanitation and hygiene norms are established by the labor legislation of the Russian Federation. Labor protection is a system of preserving the life and health of workers in the process of work, including legal, socio-economic, organizational and technical, sanitary and hygienic, rehabilitation and other measures. Provision of acceptable working conditions will help to preserve the health of working convicts [1–3].

The aim of the study was to investigate the working conditions of those serving sentences in correctional institutions and to develop measures to optimize the labor process for preserving the health of convicts.

METHODS

The study was conducted in one of the penitentiaries of the Republic of Tatarstan. At the correctional facility, production enterprises have been set up, including foundry, woodworking, metalworking, slag-blocking, sewing industries and auto services, employing up to a third of all convicts. The assessment of sanitary and hygienic conditions of labor of the affected persons was carried out by carrying out laboratory-instrumental studies of physical factors in the workplace, determining the concentration of harmful substances in the air of the work area, studying the severity and intensity of the work process, and the safety of workplaces and the provision of prisoners with personal protective equipment in accordance with the guidance R 2.2.2006-05 *Guidance on hygienic assessment of working environment factors and labor process. Criteria and classification of working conditions* (Table 1).

Particular attention was paid to the study of the role of harmful production factors, the impact of which on the worker under certain conditions leads to illness or disability.

Assessment of the state of health was carried out on the basis of an analysis of data on the incidence of 5,009 working

convicts obtained from the analysis of registration form No. 025-10/y-11. The comparison group included office workers (information and computing center, marketing department, logistics department, technical control department, technical department, a group of economists and accountants).

Individual protective equipment (IPE) plays an important role in the system of preventive measures aimed to ensure safe working conditions and to reduce occupational poisoning and diseases. To learn why IPE are ignored in the prison, we surveyed 5,009 inmates.

RESULTS

Noise sources in the conditions of foundry, blacksmith, metalworking and woodworking industries are working machines, manual power tools, electric machines, compressors, forging and pressing, handling and auxiliary equipment. The effect of high noise levels leads to a decrease in efficiency, development of fatigue, increase in morbidity and disability among workers [4]. Table 2 shows noise levels measured in the workshops of the correctional facility.

The table shows that the actual levels of production noise at the workstations of the spindle and forge areas exceeded the maximum permissible meanings. Unstable production noise in the workstations surveyed had a fluctuating character, with a continuous change in the sound level over time. The impulse noise was characteristic for the spindle and forging sections. The value of the equivalent noise level (in terms of the duration of the work shift) was calculated to estimate the possible harmful effect of noise of different levels and duration. The obtained data made it possible to classify the working conditions according to the level of effect of industrial noise on the spindle and forge areas to the harmful conditions of the 2nd degree (class 3.2).

Metalworking, woodworking machines, casting machines, press-forging equipment, transport are sources of general vibration. That is why the majority of working places, with the exception of places on forging and transport sites, were classified as places with harmful working conditions (class 3.1) of "general vibration" factor. Transport department workers are also exposed to local vibrations. The corrected acceleration of local vibration here was 118.3 ± 7.2 dB, which is acceptable (Class 2).

Inmates working in sewing workshops were exposed to the harmful effects of local vibrations produced by sewing machines. The acceleration of vibration was 134 ± 0.1 dB, exceeding the occupational standard of 126 dB; therefore, working conditions here were assigned to Class 3.2. High frequency vibrations of 30–125 Hz cause vascular, neural, muscular, bone and joint pathologies. The source of the general vibration in the sewing section is the engines, which most machines fasten directly to

Table 1. Assessment of labor conditions in the state penitentiary. Measurements taken

Measurement	Number of measurements/workplaces
Class of working conditions	296 workplaces
Noise levels	296 measurements
Vibration levels	204 measurements
Microclimate (in cold and warm seasons)	1, 776 measurements
Lighting	623 measurements
Air contamination	223 samples
Physical effort	2, 368 measurements
Stress	2, 368 measurements

the table top and do not have damping pads. Vibration is then transferred to the table top and machine body. The value of vibration increases with wear and malfunction of machines [5].

Hygienic assessment of production facilities showed that the total artificial illumination is significantly lower than the established norms at workplaces of turners, milling machines, in the area of processing colored castings; turners and thread-rollers of the assembly area of hulls and covers (Table 3). Insufficient lighting causes the development of eye fatigue, decreases work capacity and labor productivity, increases the number of defects and the danger of occupational traumatism [6].

As can be seen from the table 3, the total artificial illumination at the workplace of the machine operators is not sufficient, that's why working conditions for the "lighting" factor can't be recognized as acceptable. The lighting conditions on the mechanical section, the area of processing colored castings, the assembly of housings and covers, the spindle and forging areas belong to class 3.2, that means that they can cause persistent functional changes in the organs of vision. It was revealed the need to install additional lighting in general system of artificial lighting, replacement of lamps with more powerful ones, and installation of local lighting for machine operators.

Table 2. Industrial noise levels at production areas

Work areas	M ± SD. dB(a)	EL. dB(a)
Comparison group (office workers)	56.8 ± 8.4	60
Painting plot	66.0 ± 0.0	80
Mechanical processing area	78.6 ± 0.0	80
Nonferrous casting area	76.0 ± 0.0	80
Section for the assembly of housings and covers	64.7 ± 7.2	80
Spindle section	82.6 ± 12.0	80
Lock section	69.9 ± 14.9	80
Tool area	61.4 ± 13.6	80
Forging site	88.4 ± 0.0	80
Mechanical repair area	67.9 ± 13.7	80
Power-repair-mechanical section	58.2 ± 3.24	80
Transport area	67.1 ± 7.87	80
Railway section	60.6 ± 9.99	80
Oxygen substation	48.0 ± 0.0	80
Woodworking area	72.8 ± 11.0	80
Mounting area	65.0 ± 8.6	80
Sewing area	66.1 ± 4.77	80
Production-duty department (elimination of accidents)	64.2 ± 6.85	80

Note. EL — exposure limit

Table 3. Lighting in work areas

Work areas	M ± SD, lx	Minimum acceptable level, lx
Comparison group (office workers)	300.2 ± 128.5	300
Painting plot	204.7 ± 5.0	300
Mechanical processing area	186.2 ± 32.7	200
Nonferrous casting area	236.3 ± 20.5	200
Section for the assembly of housings and covers	148.2 ± 76.4	200
Spindle section	230.3 ± 43.6	200
Lock section	195.6 ± 75.4	200
Tool area	207.9 ± 99.1	200
Forging site	250.0 ± 0.0	200
Mechanical repair area	178.8 ± 111.5	200
Power-repair-mechanical section	248.6 ± 35.5	200
Transport area	145.0 ± 119.2	200
Railway section	101.5 ± 14.7	200
Oxygen substation	75.5 ± 0.71	200
Woodworking area	160.8 ± 15.5	200
Mounting area	244.7 ± 38.2	200
Sewing area	279.5 ± 130.0	400
Production-duty department (elimination of accidents)	123.0 ± 33.5	200

Assessment of air pollution in the working area showed that there was the dust in the air of the working area with an admixture of silicon dioxide in a volume of 2–10 %. Among the aerosols of predominantly fibrogenic action, the largest danger is dust containing free silicon dioxide [7]. The maximum permissible concentration (MPC) of such dust, depending on the content of silicon dioxide is 1 and 2 mg/m³. For other types of dust, MPC is 2–10 mg/m³. In our study, the proportion of samples with excess of hygienic standards was 84.4 %. Dust pathology can be manifested in the form of catarrh of the upper respiratory tract, dust bronchitis and pneumonia [8].

The share of samples with excess of MPC of mineral oils is 25.4 %. Lubricating oils, when inhaled, can irritate the mucous membranes of the upper respiratory tract. On the skin of workers may develop oily folliculitis and oily acne [2].

Gasoline fumes were detected in the air of the transport area. On average, their concentrations did not exceed occupational standards per shift. However, the share of non-standard samples was 33.3 %. The content of products of incomplete combustion of fuel did not exceed the maximum permissible values in samples of air in the breathing zone of workers in the transport section of shop No. 5. The studies were carried out taking into account the effect of summation.

The concentration of benzene, manganese in welding aerosols, lead-cadmium solder, acetone, white spirit, carbon monoxide, chlorine did not exceed the established standard values (according to the analysis of industrial air samples). In most cases working conditions could be assigned to Class 1 (third degree). Hygienic assessment of working conditions of convicts by chemical factor in office premises showed their compliance with class 2, that is, working conditions were acceptable.

Hygienic assessment of the microclimate of industrial premises showed that the air temperature in the workplace was within the acceptable range (Table 4). Relative humidity of air fluctuated in a range of 60–75 % with the speed of air movement from 0,1 to 0,3 m/s. Thus, according to the main parameters of the microclimate, working conditions were characterized as admissible (class 2).

The hygienic assessment of the working conditions of the convicts showed that the class of working conditions in all production facilities was harmful (Class 3.1-3.2, 1st to 2nd degree). In terms of stress, working conditions were either acceptable or harmful (Table 5).

The study showed that the majority (73.1 %) of the inmates exposed to harmful or dangerous factors did not use personal

Table 4. Air temperature in work areas

Work areas	Category of task depending on energy expenditure	Air temperature, C° (M ± SD)	
		Cold seasons	Warm seasons
Comparison group (office workers)	1b	23.4 ± 2.9	23.3 ± 2.8
Painting plot	2b	23.5 ± 0.5	23.5 ± 1.2
Mechanical processing area	2a	20.9 ± 0.2	20.3 ± 1.6
Nonferrous casting area	2b	24.9 ± 1.1	20.4 ± 0.8
Section for the assembly of housings and covers	2a	21.1 ± 0.5	21.0 ± 0.5
Spindle section	2a	23.0 ± 0.6	21.5 ± 1.1
Lock section	2a	20.2 ± 1.3	19.9 ± 1.4
Tool area	2a	20.3 ± 1.5	20.0 ± 1.1
Forging site	2b	24.8 ± 0.0	22.6 ± 0.0
Mechanical repair area	2b	20.0 ± 1.5	19.6 ± 1.5
Power-repair-mechanical section	2b	20.6 ± 0.7	20.3 ± 0.8
Transport area	2a	22.4 ± 0.9	21.0 ± 2.7
Railway section	2a	21.9 ± 0.7	16.7 ± 5.3
Oxygen substation	2a	22.5 ± 0.6	21.8 ± 0.2
Woodworking area	2b	22.1 ± 0.6	21.7 ± 2.2
Mounting area	2a	22.6 ± 0.1	22.1 ± 0.3
Sewing area	2a	24.3 ± 1.2	22.8 ± 1.9
Production-duty department (elimination of accidents)	2a	19.7 ± 1.6	17.2 ± 5.7

Table 5. Work classes depending on the physical effort required by and stress induced

Work type	Class of working conditions	Stress class
Sewing manufacture, seamstresses	3.2	3.2
Sewing manufacture, cutters	3.1	2
Foundry	3.2	3.1
Production of woodworking	3.1	3.1
Manufacture of metal machining	3.2	3.1
Construction industry	3.2	3.1
Painting production	3.2	2
Transport area	3.2	3.2
Production duty department (elimination of accidents)	3.1	3.1

protection equipment (PPE). The survey of persons who did not use PPE showed that 54.9 % of them do not know the means of individual protection; 47.6 % of those surveyed believed that their use made work difficult; 44.9 % noted the inconvenience of their use; 39.7 % did not know how to apply them; 25.9 % did not associate their health with work in harmful conditions; 17.1 % said they did not consider it necessary to use PPE. On average, every inmate provided 2 or 3 arguments against the use of personal protection.

Working conditions seriously affect workers' health [2, 9–14]. Our analysis revealed that in the inmates exposed to occupational hazards, morbidity rates were significantly higher than in those unexposed (1,267.2 ‰ vs 810.6 ‰, $p < 0.05$). Among the most common conditions were skin or subcutaneous tissue diseases (2.1. times more common), hearing impairment (1.7 times more common), respiratory diseases (1.5 times more common), cardiovascular diseases (1.3 times more common). It should be noted that the absence of medical examinations on admission and before working shifts, as well as regular medical checkups, prevented us from identifying those individuals who should not have been allowed to work in the harmful working conditions.

DISCUSSION

The study of working conditions in production facilities where convicts work allowed to identify violations of sanitary and hygienic requirements at individual workplaces in terms of noise level, vibration, illumination level, microclimatic parameters and chemical air pollution in the work area. The fact of evasion by working convicts from the use of PPE is established, which subsequently leads to an increase in the incidence among them. The use of personal protective equipment becomes

necessary in cases where there are difficulties in ensuring the safety of technological processes and also in conditions of contact with factors harmful to health. Upon conducting a study, we proposed a number of measures for optimizing working conditions in the correctional facility aimed at reducing noise levels and total/local vibration and improving lighting conditions. These measures have been implemented. We also attempted to educate the inmates on the benefits of personal protection equipment and taught them how to use it. Based on the results of our study, preliminary and periodic medical examinations of convicts have been resumed before admission to work.

The study has also shown that the sanitary and hygienic conditions at the workplace have improved for the majority of convicts. The number of working in hazardous working conditions decreased from 68 % to 19 % (classes 3.1–3.2). During preliminary medical examinations 3.9 % persons who had a contraindication to work. During periodic medical examinations, 12.6 % of convicts were dismissed from work for health reasons, while performing medical examinations directly before the change — 10.2 % of convicts. The proportion of individuals using personal protection equipment is now 82 %.

CONCLUSIONS

The work of convicts takes place in certain production conditions, which can affect their health and work capacity, if hygiene requirements are not observed. Based on the results of our study, we have proposed and implemented measures aimed to eliminate occupational hazards, including optimization of manufacturing processes, automation, installation of modern equipment, reduction of the amount of manual labor, all of which have proved to be incredibly effective in a very short time.

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