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**INDUSTRIAL LIGHTING AND ITS IMPACT ON OCCUPATIONAL
HEALTH AND SAFETY AND ENVIRONMENT**
**ПРОИЗВОДСТВЕННОЕ ОСВЕЩЕНИЕ И ЕГО ВЛИЯНИЕ НА БЕЗОПАСНОСТЬ
ТРУДА И ОКРУЖАЮЩЮЮ СРЕДУ**

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Abstract. *The paper discusses the requirements of Russian and European regulatory documents for lighting work areas. A comparative analysis of the characteristics of modern light sources is given. The results of instrumental measurements of indicators of industrial lighting at the enterprise of railway transport are shown. The proposed measures to improve the quality and environmental friendliness of the light environment in the industrial enterprise.*

Key words: *industrial lighting, quality parameters of the light environment, light sources, energy efficiency.*

Introduction.

The light environment at the workplace is created by industrial lighting – a set of methods for obtaining, distributing and using light energy to provide favorable conditions for vision. Optimal lighting conditions play an important role in ensuring occupational safety, have a positive psychophysiological impact on workers, and contribute to improving productivity and quality of work. The specificity of the light environment of railway enterprises is the need to provide comfortable lighting in work areas that have different conditions of visual work and the peculiarities in the perception by workers of objects of observation: in open areas of hauls, stations and maintenance points; in the cabins of locomotives; in industrial workshops of large volume, in the premises of engineering and control services, in the buildings of railway stations, etc. The modernization of the lighting system should solve a complex of interrelated technological, socio-economic and environmental tasks: to provide the required quantitative and qualitative indicators of the working area lighting; minimize the risk of injury to workers; reduce luminaire energy consumption and greenhouse gas emissions from power plants; reduce the generation of hazardous waste (mercury-containing fluorescent lamps) and the amount of environmental charges; to reduce the level of light pollution and technogenic load on the biosphere.

**Main text.**

The main regulatory requirements for lighting and order of instrumental control are established in the standards and sanitary rules [1-5]. In addition, factors of the light environment are taken into account when establishing classes of harmful and hazardous working conditions with a special assessment of working conditions [6]. Analysis of the documents shows that the normalized and, respectively, controlled set of Quantitative and qualitative parameters of the light environment is different, but when establishing classes of working conditions for workers and the compensation and benefits provided by law, employers are guided only by quantitative indicators of lighting [6]. At the same time, quality indicators, such as the pulsation coefficient, the presence of direct and reflected brilliance in the field of view of an employee, the discomfort indicator, the glare index, etc., greatly affect the risk of injury and labor efficiency. In addition to standardized indicators, the quality characteristics of industrial lighting include: the favorableness of the spectral composition of light, its degree of dispersion and direction; consistency of illumination and other lighting indicators in time and space, the absence of a stroboscopic effect; reliability of lighting installations in specific production conditions; fire, electrical and environmental safety of lamps; the possibility of regulation, efficiency and energy efficiency of the lighting system.

The European norms EN 12464-1: 2011 (“Light and lighting. - Lighting of workplaces. Part 1: Indoor work places”) have been operating in EU countries since 2011. EN 12464-1 regulates such requirements for lighting workplaces in rooms that provide visual comfort and sufficient visual performance for people with normal visual functions. The standards set requirements for quantitative and qualitative indicators of illumination in relation to planes in which visual tasks are solved constantly or occasionally. As a new criterion for assessing the quality of lighting, the average cylindrical illuminance was introduced. For workplaces with personal computers and video terminals, the maximum permissible brightness of general lighting fixtures are brought in line with the modern characteristics of monitor displays. Additionally, recommendations are given on the implementation of correct and energy-saving lighting solutions.

The light sources used, incandescent, gas-discharge (high and low pressure) and LED, have a significant impact on the quality indicators of the light environment with artificial and combined lighting. A comparison of the characteristics of light sources is given in Table 1.

The data table 1 show that today LED lamps are optimal for creating a high-quality light environment at workplaces.

The instrumental control of the lighting conditions was carried out by the authors on 06/29/2018 in the administrative and production buildings of the wagon depot – a structural division of JSC «Russian Railways». The control method, the choice of measurement points, the processing of results complied with the requirements of regulatory documents [1-5]. At the enterprise there is a wide variety of types and types of used light sources, in the production workshop, low-pressure fluorescent lamps, DRL arc lamps and LED lamps of various modifications are operated simultaneously. This creates uncomfortable conditions for visual work,

**Table 1****Comparative characteristics of light sources**

Characteristics	Lamp incandescent	Fluorescent Lamp	LED light lamp
Luminous efficiency (energy efficiency)	low	medium	high
Pulsation light	low	high	absent
Emitted spectrum of light	continuous	line	continuous/ line
UV component	absent	present	present
Special environmentally friendly disposal	is not required	required	is not required
Fire hazard	high	low	medium
Service life	small	medium	long

Authoring

especially in the dark. The planned replacement of light sources for energy-efficient and environmentally friendly LED lamps is not fully implemented. In accordance with the current federal and industry laws and regulations, a system for handling hazardous waste, including used mercury-containing fluorescent lamps, has been established in the wagon depot [7].

Conclusions.

It is established that the quantitative indicators of natural and combined lighting meet the standards. The quality indicators of the combined lighting at workplaces with LED lamps comply with the standards. The value of the pulsation coefficient of the luminous flux of fluorescent lamps above the maximum permissible level, which requires corrective measures. There was a discrepancy between the UV radiation levels at all surveyed workplaces and the requirements of regulatory documents [3, 5]: the UVU remote control exceeded the UV-A spectral range in workshops (with fluorescent lamps, LED lamps); unacceptable presence of UV radiation in the spectral ranges of UV-B and UV-C; the most significant deviations for the worse were recorded on computer workstations with liquid crystal and LED monitors in the administrative building.

The main purpose of measuring and monitoring the state of the light environment, lighting conditions at workplaces is the development of corrective measures to improve working conditions. The authors have developed and provided basic preventive measures to improve the quality and environmental safety of industrial lighting at the wagon depot.

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Аннотация. В работе рассматриваются требования российских и европейских нормативных документов к освещению рабочих мест. Отмечена специфика зрительной работы на территории железнодорожных объектов и влияние освещения на безопасность и производительность труда персонала. Дан сравнительный анализ характеристик современных источников света. Показаны результаты инструментальных замеров показателей производственного освещения на предприятии железнодорожного транспорта. Предложены мероприятия по повышению качества и экологичности световой среды на производстве.

Ключевые слова: производственное освещение, параметры качества световой среды, источники света, энергоэффективность.

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