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Experimental Research facility with LED Lights.

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ABSTRACT

The article is devoted to the development and implementation of an experimental research facility for physiological and hygienic studies of LED lighting efficiency. A computer simulation of lighting conditions with fluorescent (basic option) and LED lights in DIALux program, which allowed to ensure the standard quantitative and qualitative indicators of a light premise environment where the visual works of A-2 class were performed. An experimental research facility that implements the levels of illumination at the range of 100 - 1000 lu using the studied lights with different correlated color temperatures of 3000, 4000 and 5000 K.

Keywords: LED Lighting, lighting, illumination, computer simulation of lighting, standard parameters of lighting conditions, experimental research facility.

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INTRODUCTION

The present level of LED technology development, the growing demands for energy efficiency of lighting systems, as well as the environmental and the economic aspects of advanced LED light sources (LED LS) provide a series of relevant issues for experts relating to the validity of their use, especially according to the physiological and hygienic aspects [1-3].

The possibility of using LED LS for favorable lighting conditions development require solid evidence that may be obtained through comprehensive studies of lighting effect from these LS on the eyesight and the body as a whole. The works of Russian and foreign scientists have some separate results about the effect of LED LS on some visual functions and visual performance. The results of these studies are small, inconsistent and ambiguous [4-7]. This suggests that the work of an experimental research facility (ERF) development and creation is an actual one for the LED lighting efficiency research.

METHODS

In order to study the LED lighting conditions a general lighting ERF was designed [8], and mounted at the lab number 316 of the building № 16 of FSBEI HPE "Moscow State University named after N.P. Ogarev".

The laboratory consisted of 4 rooms (Figure 1):

- One room - for the observer survey (Figure 2);
- Three rooms - for experimental studies, two of which had installed LED lights and one of which had fluorescent lights.

The reflection coefficients ρ of the ERF ceiling, walls and floor enclosing surfaces respectively made 0.7; 0.5; 0.3; the operational surface reflectance made 0.3. The enclosing and operation surfaces of the room were diffusely reflective.

The premise for survey had the shutters with a reflection coefficient ρ, equal to 0.1 and closing the light areas; the natural light was absent in experimental areas. The height of ceilings made 3 m.

The lamps were mounted at the experimental areas in order to create the necessary level of vertical illumination on the screen with the test object to measure the time of achromatic asthenopia and by campimeter on the wall of each room behind the observer, above his head (Figures 3,4).

Fluorescent lamps (FL) were chosen as a basic LS for comparison with LED LS were selected, because it is one of the most widely and deeply studied (iin terms of psychophysiological and hygienic influence of their radiation on the body) of LS mass use.

Figure 1: View of experimental research facility (photo)

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Figure 2: Premise for observer survey (model)

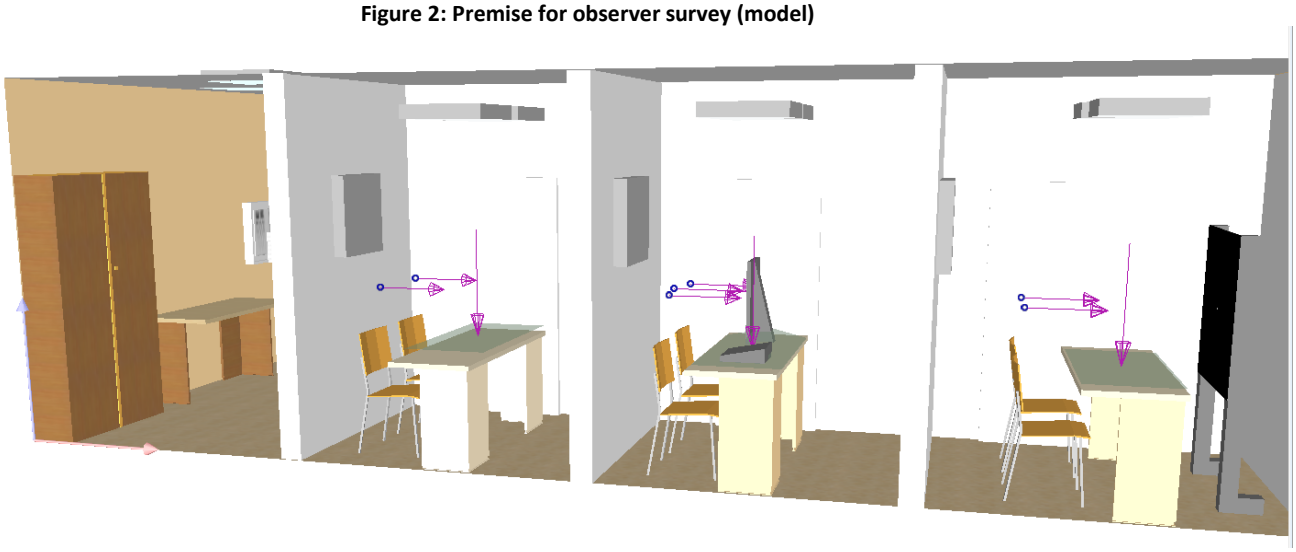

Figure 3: Experimental premises. UGR checkpoint placement for observers and horizontal operation surfaces in experimental areas

Figure 4: Visual performannce in room 2 and 3

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The mental and proofreading operations at the duration of 90 minutes were selected as a visual performannce model. The functional load was demonstrated by the calculation of curvilinear shape areas on graph paper, by the processing of proof-tests, compilation of scientific article annotations taken from magazines (font size makes no more than number 8, the contrast between an object and a background is positive and negative one, >0.5). The operation for 1.5 hours according to a selected model of an equivalent and an eye fatigue within the real operating conditions during a full working day.

MAIN PART

The lights from the following manufacturers were selected for experimental studies:

- Jjoint Russian-Korean company "Nepes Rus" LLC (LED lights - Cap Flat 66-16);
- "Ardatovsky Lighting Plant" (LED lights - DVO12-38-001 Prizma and LL - LVO04-4h14-041 PRS, LVO04-4 × 18-041 PRS).

The list lights chosen for experimental studies is presented in Table 1, the layout of lights in ERF - Figure 5.

Table 1: The list of lights used in experimental studies

Light type	Specification summary, manufacturer	LS type, manufacturer
LVO 04-4×14-041 PRS	IP20, prismatic diffuser made of PMMA, under T5, SCD with the management under DALI protocol, cos [fi] = 0,99, "ASTZ" OJSC	Osram FH 14W/830 HE; Master TL5 HE 14W/840, Philips
LVO 04-4×18-041 PRS	IP20, prismatic diffuser made of PMMA, SCD with the management under DALI protocol, cos [fi] = 0,98, "ASTZ" OJSC	Osram L 18W/950
DVO 12-38-001 Prizma	IP 40, prismatic diffuser made of PMMA, driver with the management under DALI protocol, cos [fi] = 0,96, "ASTZ" OJSC	SD STW8Q14B, Seoul Semiconductor
Cap Flat 66-16	IP 20, "remote phosphor" technology", driver with the management under DALI protocol, cos [fi] = 0,94, "Nepes Rus" LLC	SD, $T_{цв}$ = 4094 K, "Nepes Rus" LLC
Cap Flat 66-16	IP 20, "remote phosphor" technology", driver with the management under DALI protocol, cos [fi] = 0,94, "Nepes Rus" LLC	SD, $T_{цв}$ = 3045 K, "Nepes Rus" LLC

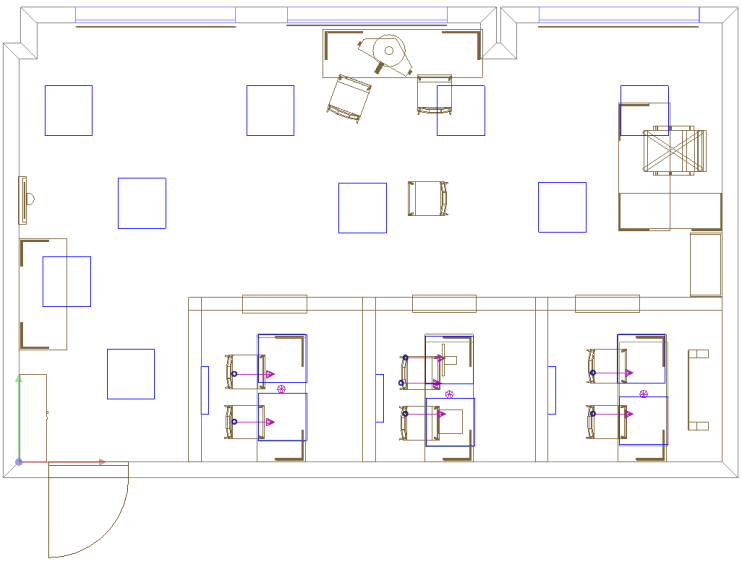

Figure 5: Layout of lights in ERF

Prior to the equipment of the experimental premises with lights, the options of lighting were modeled in DIALux program in order to meet the requirements of SP 52. 13330.2011 52 "Natural and artificial illumination" and SanPiN 2.2.1/2.1.1.1278-03 "Hygienic requirements for natural, artificial and combined illumination of the residential and public buildings" and SanPiN 2.2.1/2.1.1.2585-10 "Changes and additions №1 to SanPiN sanitary rules and standards 2.2.1/2.1.11278-03 "Hygienic requirements for natural, artificial and combined illumination of residential and public buildings" for the total illumination of public and administrative buildings.

The requirements for qualitative and quantitative indicators concerning general illumination of public and administrative buildings, where visual works of A-2 class are performed, chosen by us as the basic one are presented in Table 2.

In order to establish the reasonable applications of LED lights in lighting devices, the experimental studies were conducted at three illumination levels: 200, 400 and 1,000 lux, which are most common to perform visual works in the premises of various applications. Table 3 presents the studied lighting options.

Table 2: Standardized quantitative and qualitative indicators of the light environment for main premises of public and administrative buildings

Premises	Illumination normalization area (H – horizon., V – vertical.), m	Visual performance level and sublevel	Operation surface illumination at general illumination, lux	Joint UGR discomfort value, no more than	Illumination pulsation ratio, no more than
Main premises of public and administrative buildings	Г-0,8	А-2	400	21	10

Table 3: Illumination options under study

Basic illumination option	Illumination option under study	Illumination level, lux
LVO 04-4×14-041 PRS, $T_{цв}$ = 2953 К	Cap Flat 16-66, correlated $T_{цв}$ = 3045 К	200
LVO 04-4×14-041 PRS, $T_{цв}$ =2953 К	Cap Flat 16-66, correlated $T_{цв}$ = 3045 К	400
LVO 04-4×14-041 PRS, $T_{цв}$ =2953 К	Cap Flat 16-66, correlated $T_{цв}$ = 3045 К	1000
LVO 04-4×14-041 PRS, $T_{цв}$ = 3917 К	Cap Flat 16-66, correlated $T_{цв}$ = 4094 К	200
LVO 04-4×14-041 PRS, $T_{цв}$ = 3917 К	Cap Flat 16-66, correlated $T_{цв}$ = 4094 К	400
LVO 04-4×14-041 PRS, $T_{цв}$ = 3917 К	Cap Flat 16-66, correlated $T_{цв}$ = 4094 К	1000
LVO 04-4×18-041 PRS, $T_{цв}$ = 4914 К	DVO 12-38-001 Prizma, correlated $T_{цв}$ = 5033 К	200
LVO 04-4×18-041 PRS, $T_{цв}$ = 4914 К	DVO 12-38-001 Prizma, correlated $T_{цв}$ = 5033 К	400
LVO 04-4×18-041 PRS, $T_{цв}$ = 4914 К	DVO 12-38-001 Prizma, correlated $T_{цв}$ = 5033 К	1000

The change of work surface illumination level was achieved by the use of regulated SCD and drivers. In case of all used fluorescent and LED lights the dimming of luminous flux was performed according to DALI protocol. The brightness of light outlets in all illumination options at equal illumination was always the same.

The simulation of lighting options using DIALux allowed to determine the height of light suspension which provided the working surface illumination E = 1000 lux. The other, lower light levels, up to E = 100 lx were created by the light flux dimming.

The simulation in DIALux program also allowed to ensure the normalized quantitative and qualitative ERF indicators (the horizontal illuminance on the working surface, the uneven distribution of light and UGR indicator) (Table 4, Figure 6).

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Table 4: UGR at the control points at LED light illumination

Number of a control point	Value UGR
UGR 1	<10
UGR 2	10
UGR 3	<10
UGR 4	<10
UGR 5	14
UGR 6	14

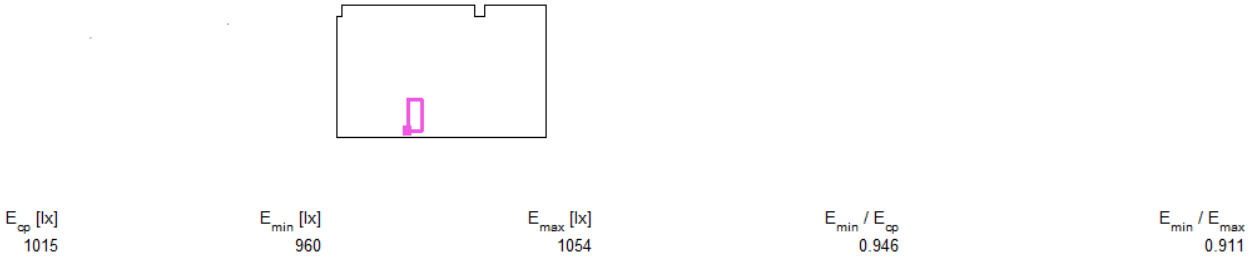

Figure 6: Distribution of light and its unevenness at the lighting with two CapFlat 66-16 ($T_{цв}$ = 3045 K) lights.

SUMMARY

A ERF is designed and built which allows

- To develop the light levels in the range of 100 - 1000 lux on the working surface using fluorescent and LED lights with various correlated color temperatures, excluding the LS luminous flux pulsation, the direct and reflected glare;
- To ensure the reliability and the ease of use;
- To carry out physiological and hygienic research of LED lighting conditions [9, 10].

CONCLUSIONS

The designed ERF allowed to test the complex methods developed by the authors to assess the impact of LED lighting conditions on the state of a sight organ and a human body as a whole [11], to carry out the research concerning a sight organ in terms of LED lighting at the regulation of the illumination quantity and quality [9,10,12].

The designed ERF will be used to study the efficiency of LED lighting in different industries.

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REFERENCES

[1] Behar-Cohen, F., Martinsons, C., Vienot, F., Zissis, G., Barlier-Sals, A., Cesarini, J.P., Enouf, O., Garcia, M., Icaud, S., Attia, D., 2011. Light-emitting diodes (LED) for domestic lighting: Any risks for the eye? Journal of Progress in Retinal and Eye Research, 30: 239 – 257.

[2] Wahnschaffe, A., Haedel, S., Rodenbeck, A, Stoll, C, Rudolph, H, Kozakov, R, Schoepp, H, Kunz, D., 2013. Evening Short-Term Exposure to Conventional Light Suppresses Melatonin and Increases Alertness Perception. International Journal of Molecular Sciences. 14: 2573 – 2589.

[3] Klanjsek-Gunde, M., Friskovec, M., Sever-Skapin, A., Bernard, J., 2010. Fotobioloska varnost nekaterih virov nekoherentnih umetnih opticnih sevanj. Vakuumist. 30(4): 9 – 15.

[4] Gooley, J.J., Chamberlain, K, Smith, K.A, Khalsa, S.B., Rajaratnam, S.M., van Reen, E., Zeitzer, J.M., Czeisler, C.A, Lockley, S.W., Clin, J, 2011. Exposure to room light before bed time suppresses melatonin onset and shortens melatonin duration in humans. Journal of Endocrinol. Metab, 96: 463-472

[5] Wright M., 2010. Debate continues over the impact of light on human health. LEDs magazine, 46: 25.

[6] Stevens, R.G., Blask, D.E., Brainard, G.C., Hansen, J., Lockley, S.W., Provencio, I., Rea, M.S., Reinlib, L., 2007. Meeting report: The role of environmental lighting and circadian disruption in cancer and other diseases. Environ. Health Perspect, pp:1357–1362.

[7] Zheleznikova O.E., Amelkina S.A., Sinitsyna L.V., Aksenova S.V., Kulikova M.P., 2014. Design and assembly of experimental research facility with LED lighting. Journal of Natural and Technical Sciences. 1: 169-176.

[8] Mikaeva S.A., Amelkina S.A., Zheleznikova O.E., Amelkin E.A., 2014. The development and assembly of experimental research facility with LED lighting. "Assembly in mechanical and tool engineering" journal. 7: 46-48.

[9] Amelkina S.A., Zheleznikova O.E., Sinitsyna L.V., Kokinov A.M. Experimental research of psycho-physiological and hygienic efficiency of LED lighting. "Natural and technical sciences" journal. 1: 159-168.

[10] Amelkina, S. A., Zheleznikova, O. Y., Sinitsyna, L.V., 2014 (September – October). Hygienical evaluation of LED lighting systems. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 5(5): 1613-1618.

[11] Amelkina S.A., Zheleznikova O.E., Kiryukhina S.V., Sinitsyna L.V., 2013. Comprehensive methodology development to assess the impact of LED lighting conditions on the eyesight the human body state as a whole. "Natural and Technical Sciences" journal. 5: 249 - 258.

[12] Amelkina, S. A., Zheleznikova, O. Y., Mikaeva, S. A., 2014. Development of experimental research installations with led light sources. Life Science Journal, 11(12s): 131-133.