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CHARACTERISTICS OF WATERPROOF LAMPS

A. A. Gorbunov [a*]

[a] *Federal State Budgetary Educational Institution of Higher Education, National Research Ogarev Mordovia State University, 430005, Republic of Mordovia, Saransk, ul. Bolshevistskaya, 68ok, RUSSIA.*

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ABSTRACT

This paper is devoted to the study of characteristics of experimental samples of waterproof lamps. The test is set up for LED luminaire (IP65) and filament lamp (IP54). The luminous flux and luminous efficiency are also observed. The LED lamp uses IPX5 test method, while filament lamp uses IPX4. The experiment traces the change in the parameters of the luminaires, taking measurements after every 1000 hours of their burning, with total 3000 hours. The test results on the moisture resistance of the investigated luminaires shows that the LED luminaire passes the test for the degree of protection. For the filament lamp, the result is negative (i.e., the moisture penetrates inside the lamp body).

1. INTRODUCTION

For lighting areas with high humidity, a special waterproof lighting is required, since combination of water and electricity is unsafe. Waterproof lighting fixtures vary in terms of design, luminous flux, color and other criteria [1].

Advantages of waterproof lamps include

- Reliability and durability due to impact-resistant sealed enclosure;

- Fire safety; most models operate at low voltage;

- Ease of installation of models on solar batteries or batteries, since they operate from their own power source;

- In models with LEDs, brightness adjustment is provided.

Their disadvantages

- For low-voltage devices, it is necessary to additionally purchase transformers converting the main voltage to 12 V;

- Labor-intensive installation; since some models of luminaires function from the main

*Corresponding author (A. A. Gorbunov). E-mail: alexdsmail@mail.ru

sources, then the sources are underground, a cable must be laid from the network to the installation site of the lighting device.

2. OBJECT OF RESEARCH

Two experimental sample fixtures were taken to study the characteristics:

- Lamp NBL-01-60-E27 / WH with a Uniel Sky 8W filament lamp;
- NBL-P01-7-4K-WH-IP65-LED.

Waterproof NBL series lamps are reliable and compact, already classic, round and oval, for outdoor and indoor use: everywhere where high protection against dust and moisture is required (Figure 1). The luminaires are designed to be used with incandescent lamps with a standard E27 base and are available in two sizes - for 60 W and 100 W lamps.

Figure 1. Light NBL-01-60-E27 / WH [2]

The degree of protection of this luminaire is IP54 (5- some dust can penetrate inside, but it does not disrupt the operation of the device. Full protection against contact; 4- protection against splashes falling in any direction).

Technical characteristics of the lamp are presented in Table 1.

Table 1. Technical characteristics of the lamp NBL-01-60-E27/WH [2]

Type of lamp	Luminaire with diffuser/diffuser
Lamp type	Incandescent lamp (general purpose)
Lamp base	E27
Lamp power	60W
Number of lamps (light sources)	1
Nominal voltage	230V
Type of control device (gear/transformer)	Not required
Body material	Aluminum
Color of a plafond/diffuser	White
Degree of protection (IP)	IP54
Suitable for emergency lighting	Yes
Light output	Straight
Suitable for wall mounting	Yes
Pulse ignition device (IZU)	Not required
Width	195mm
Protection class	I
Fire class "F"	Yes
Lamp color	No color

This lamp was taken from filament lamp manufacturer Uniel Sky with E27 base for the study. The appearance of the lamp is shown in Figure 2.

Figure 2. The appearance of the lamp Uniel Sky 8W

The Uniel Sky 4000K 8W LED bulb in the shape of a pear is an analogue of the Ilyich Lamp, not only in its characteristics but also in appearance. Thanks to sapphire LED strings, the light from the lamp extends to 360 degrees. Specifications of the lamp are presented in Table 2.

Table 2. Uniel Sky Lamp Specifications

Options	Values
Power Consumption (W)	8
Power supply (V)	220
Luminous flux F_L (LM)	800
Service life (hr)	30000
Diameter (mm)	60
Length (mm)	102
Base	E27
Light angle	360°
Color rendering index	Ra>80

NBL-P-LED luminaires are an energy-efficient analogue of standard airbag luminaires in shape, size and lighting characteristics. The appearance of the lamp NBL-P01-7-4K-WH-IP65-LED is shown in Figure 3.

Figure 3. Lamp NBL-P01-7-4K-WH-IP65-LED [3].

Degree of protection of this luminaire is IP65 (6- Dust cannot get into the device; full protection against contact. 5- Protection against water jets from any direction).

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Technical characteristics of the lamp are presented in Table 3.

Table 3. Technical characteristics of the lamp NBL-P01-7-4K-WH-IP65-LED [3]

Type of lamp	Luminaire with diffuser/diffuser
Lamp type	Light-emitting diode (LED)
Lamp power (P)	7 W
Nominal voltage	220 ... 240 (V)
Ceiling/diffuser material	Opal plastic
Body material	Plastic
Body-color	White
Color of a plafond/diffuser	White
Degree of protection (IP)	IP65
Light distribution	Symmetrical
Suitable for emergency lighting	Yes
Light output	Straight
Suitable for wall mounting	Yes
Surface type	Matte
Length	208 mm
Width	120 mm
Height/depth	74 mm
Protection class	II
Temperature limit	-40 ... 40 (° C)
Light color category	Neutral cold white (3300-5300 K)
Average nominal lifetime	30,000 (h)
Color temperature	4000 (k)

3. STUDY OF ELECTRICAL AND LIGHT CHARACTERISTICS

The GO-2000 goniophotometer from Everfine was used to measure the electrical and light characteristics of the studied samples.

Before starting work, the lamps should be stabilized. Stabilization charts for NBL-01-60-E27/WH luminaires with Uniel Sky 8W filament lamp and NBL-P01-7-4K-WH-IP65-LED are shown in Figures 4 and 5.

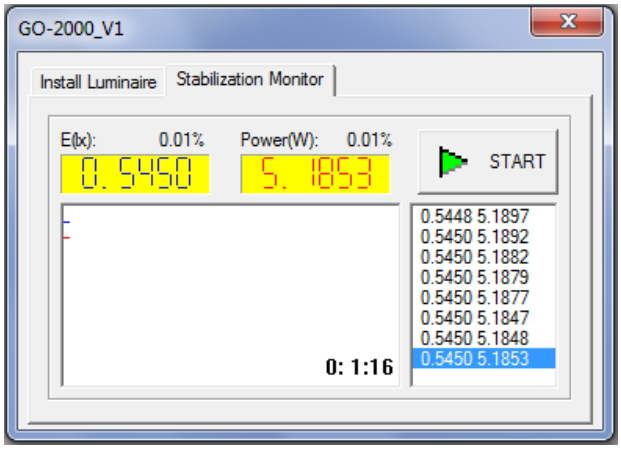

Figure 4: Stabilization schedule of the lamp NBL-01-60-E27 / WH with Uniel Sky 8W filament lamp.

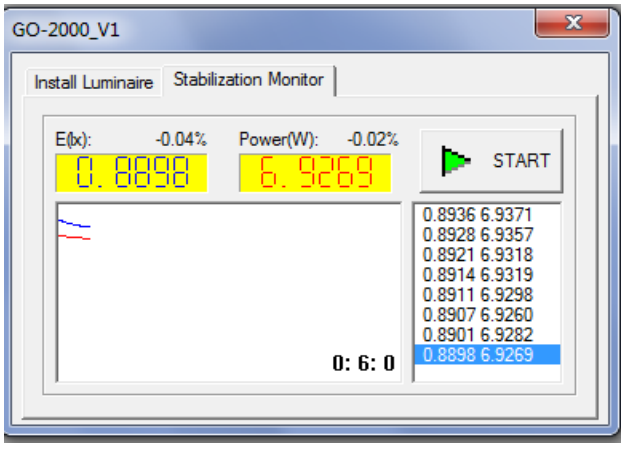

Figure 5: Stabilization schedule of the lamp NBL-P01-7-4K-WH-IP65-LED.

Next, we measure electrical parameters of luminaires to verify the declared parameters. The measurement results are presented in Table 4.

Table 4: Measurement results

Lamp / Harkey	NBL-01-60-E27 /WH	NBL-P01-7-4K-WH-IP65-LED
Voltage U, (B)	220.0	220.0
I, A	0.046	0.058
P, W	5.0	6.76
F_L, LM	452.5	610.0
luminous efficacy (η, LM/W)	87.12	90.18

Table 5: Measurement results

Lamp / Harkey	NBL-01-60-E27 /WH	NBL-P01-7-4K-WH-IP 65-LED
1000 hours		
Voltage U, (B)	220.0	220.0
I, A	0.045	0.057
P,W	5.0	6.76
F_L, LM	437.3	568.8
η, LM/W	87.46	84.14
T_c, K	4169	4367
Ra	80.41	84.64
2000 hours		
U, B	220.0	220.0
I, A	0.045	0.056
P,W	5.0	6.76
F_L, LM	427.9	540.8
η, LM/W	85.58	80.0
T_c, K	4148	4454
Ra	80.39	84.96
3000 hours		
U, B	220.0	220.0
I, A	0.044	0.056
P,W	5.0	6.76
F_L, LM	406.9	519.8
η, LM/W	81.38	76.89
T_c, K	4210	4425
Ra	80.84	84.35

K: Thermodynamic temperature (Kelvin).

To study the luminous magnitudes of the luminaires, a light measuring ball (2 m) - OL IS 7600 (Figure 6.2) and a spectroradiometer OL 770 VIS / NIR were used. The experiment was to trace the change in the parameters of the luminaires, taking measurements after every 1000 hours of their burning. Table 5 represents the measurements after every 1000 hours of burning lamps.

Figures 6-7 show graphs for the dependence of the luminous flux and luminous efficiency on the burning time.

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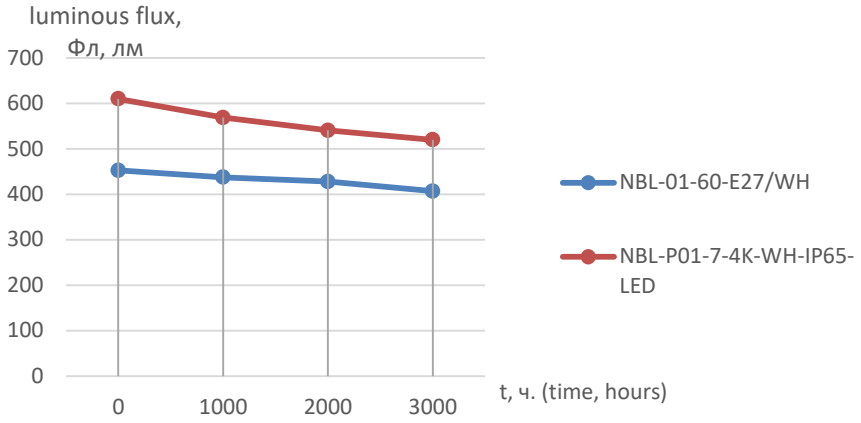

Figure 6. Graph of the luminous flux of lamps from burning time (hours)

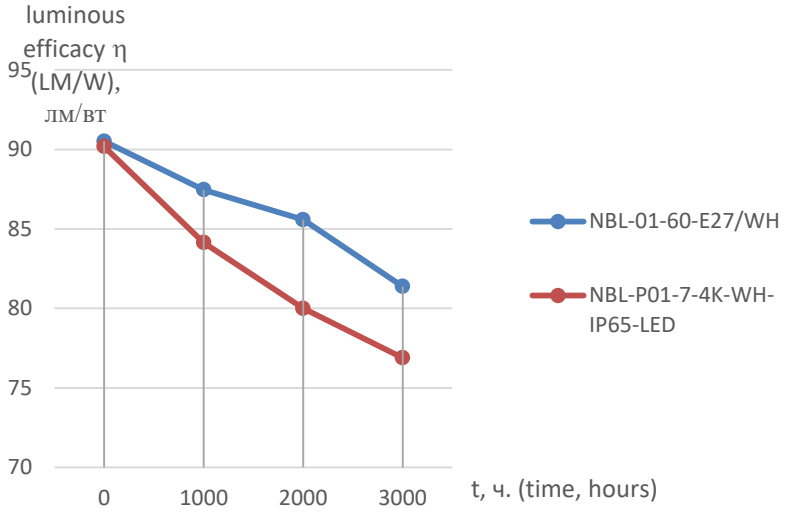

Figure 7: Graph of light output luminaires from burning time.

After 3000 hours, the luminous flux and luminous efficiency in both lamps gradually decreased. For the NBL-P01-7-4K-WH-IP65-LED, the luminous efficacy decreased more intensely than the NBL-01-60-E27 / WH.

Figures 8 and 9 respectively represent the graphs for color temperature and color rendering index versus burning time.

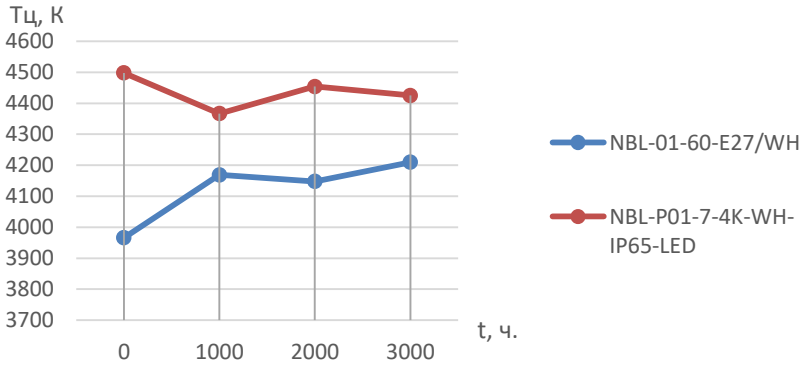

Figure 8: Graph of color temperature fixtures from burning time.

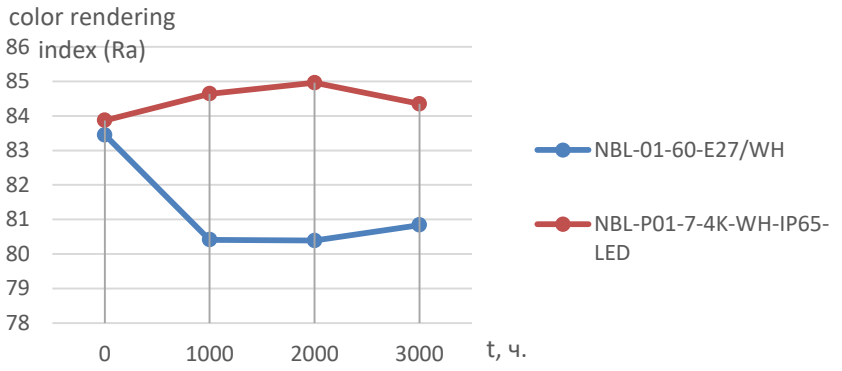

Figure 9: Graph of the color rendering index of lamps from burning time.

4. MOISTURE RESISTANCE TEST

To check the lamp for moisture resistance, it is installed, as for normal operation, but in the most unfavorable position, in a moisture chamber, where the relative humidity is maintained from 91% to 95%. The air temperature at any point of the chamber where the sample is located must be maintained with an accuracy of about 1 ° C for any suitable temperature t from 20 °C to 30 °C.

The test results of the NBL-01-60-E27 / WH luminaire for the degree of protection provided by the IP X4 enclosure according to GOST IEC 60598-1-2013 are presented in Table 6.

Table 6: Results of the lamp NBL-01-60-E27 / WH.

Test requirements	Test method	Test result
The luminaire shell must provide protection against the ingress of dust, solid particles and moisture according to the luminaire classification based on the degree of protection indicated on it. All lamps must be moisture resistant during operation.	IPX4 - the test is conducted through spraying with a rocking pipe at a vertical angle of ± 180 for 10 minutes under load and 10 minutes without any load in the rain chamber.	After the tests, accumulations of water on electrical insulating parts, water ingress on parts under voltage, and accumulations of water near cable entries were detected. Requirements were not met.

Table 7 presents the test results of the NBL-P01-7-4K-WH-IP65-LED luminaire for the degree of protection provided by the IP X5 enclosure according to GOST IEC 60598-1-2013.

Table 7: Test results of the lamp NBL-P01-7-4K-WH-IP65-LED.

Test requirements	Test method	Test result
The luminaire shell must provide protection against the ingress of dust, solid particles and moisture according to the luminaire classification, based on the degree of protection indicated on it. All lamps during operation must be moisture resistant.	IPX5 - the test is carried out by douche of the lamp from all sides with a stream of water formed by a nozzle. The water flow should be 12.5 l / min ± 5%, the inner diameter of the nozzle is 6.3 mm, the distance between the nozzle and the surface of the shell is 2.5-3 m., and ultimately, the test duration is 15 minutes.	After testing, the work of the lamp is not interrupted, the accumulation of water insulating parts, the ingress of water on the parts under voltage, the accumulation of water near the cable glands are not observed. All requirements are met.

5. FINDING

After 3000 hours, the luminous flux and luminous efficiency in both lamps gradually decreased.

In the NBL-P01-7-4K-WH-IP65-LED luminaire, the luminous efficacy decreased more intensively (by 15%) than the NBL-01-60-E27 / WH (by 11%). The color temperature of the NBL-01-60-E27 / WH increased by 6%; while, that of the NBL-P01-7-4K-WH-IP65-LED slightly decreased (1%). Moreover, the color rendering index in NBL-01-60-E27 / WH in the first 1000 hours decreased sharply with time by 4%, while in NBL-P01-7-4K-WH-IP65-LED, it did not change significantly (increases ≈0, 5%).

6. CONCLUSIONS

The results of the study revealed that the NBL-P01-7-4K-WH-IP65-LED LED luminaire features are more stable than the NBL-01-60-E27 / WH luminaire with a Uniel Sky 8W filament lamp.

The test results on the moisture resistance of the investigated luminaires showed that the NBL-P01-7-4K-WH-IP65-LED LED luminaire passed the test for the degree of protection, and the test for the degree of protection of the NBL-01-60-E27 / WH luminaire with Uniel filament lamp Sky 8W was negative (moisture penetrated inside the lamp body).

7. AVAILABILITY OF DATA AND MATERIAL

Used or generated data already present in this study.

8. CONFLICT OF INTEREST

The authors confirm that the presented data do not contain a conflict of interest.

9. ACKNOWLEDGMENTS

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Dr.Gorbunov A.A. (ORCID: 0000-0002-0290-3217) is an Associate professor at Department of lightning technology, Deputy Director for research of the Institute of electronics and lighting of Federal State Budgetary Educational Institution of Higher Education "National Research Ogarev Mordovia State University. He graduated with honors from the Faculty of Lighting at the Moscow State University named after N.P. Ogaryova. He has a PhD in Technical Sciences. He is a specialist in the research and development of Power Efficient Light Sources and Lighting Devices based on them.