

MEASUREMENT OF ILLUMINATION PARAMETERS OF THE HALLS AND EXHIBITED ITEMS OF THE STATE HERMITAGE AND THE STATE TRETYAKOV GALLERY

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ABSTRACT

The article focuses on the measurement of lighting characteristics of exhibited items in the exhibition halls of the two largest Russian museums – the State Hermitage and the State Tretyakov Gallery. The review of the current regulatory technical documentation for the design and implementation of museum lighting is given, the shortcomings are identified and the proposals for improving the legal framework for the lighting of the exhibited items are made. The measurements were carried out in accordance with existing recommendations, and according to which the lighting was designed in the museums. The principal measured parameters in this survey were UV radiation, illuminance of exhibited items, luminance distribution in the viewer's field of view, correlated colour temperature and the colour rendering index of the light sources. A brief overview of the measurement results of some halls of selected museums is given.

Keywords: lighting of museum exhibited items, exposition, measurements, UV radiation, illuminance, luminance, design recommendations

1. INTRODUCTION

Today, the design of museum lighting (precisely, the lighting of museum pieces) is carried out in Russia as well as throughout the world according to the long-established lighting standards developed in the (80–90) s of the last century in the format of recommendations [1–5].

The specified documents are outdated as they were focused mainly on incandescent lamps and, to some extent, on fluorescent lamps.

The recommended values of illumination on the exhibited items (mainly paintings and graphics) and the exposition accumulated during the exhibitions, were formed, on the one hand, based on the goal to ensure full perception of exhibited items, the general level of light adaptation and light comfort for people, and on the other hand, in terms of protection of exhibited items from harmful effects of optical radiation.

The comparison of the requirements contained in local documents [1–4] indicates a slight discrepancy. As for the publication of the CIE [5], the requirements for illuminance of paintings and the second group of exhibited items by light sensitivity and the requirements for their annual exposition are significantly tightened.

The most complete requirements for artificial lighting in museums were given in the recommendations of VNIPI “TYAZHPROMELEKTRO-PROEKT” [2], which used the results of research conducted by Leningrad Department of VNIPI together with VNIIR with the participation of the Hermitage Museum and the NIISPh. In addition to the illumination standards for exhibited items, they also contain:

– Limitation of the brightness of light sources and lighting devices within the view of observers up to 30° above the eye level by a value of (1000–1500) cd/m²;



Fig. 1. General lighting of the White Hall of the State Hermitage

- Limitations on the sharp difference of illumination in adjacent rooms (readaptation);
- Requirements for the brightness distribution on the room surfaces within the view of visitors – a difference of no more than 10 times;
- The requirement for the brightness of the ceiling, which should not be significantly higher than the brightness of the walls and exhibited items in a system with the light reflected from the ceiling... and others.

The qualitative characteristics of museum lighting should include correlated colour temperature T_{cc} and general colour rendering index R_a of light sources [6, 7]. It should be noted that when using LEDs, R_a becomes a rather imperfect parameter to evaluate colour rendering, and to assess the adverse affect of radiation on exhibited items it is better use the energy or photon values rather than light ones [8].

In this area, the research works on updating the above requirements for museum lighting are carried out.

The absence of a comprehensive regulatory document on the illumination level and quality of museum pieces and museum premises as a part of the state or sectoral (departmental) standard induced to conduct a study of the existing museum lighting through the example of two iconic museums in Russia – the State Hermitage and the State Tretyakov Gallery in Lavrushinsky Lane.

2. MEASUREMENTS

The museums, in which the survey was carried out, differ significantly in the interiors for exhibiting the works of art (mainly, paintings and graphics) and accordingly in their lighting systems. When



Fig. 2. General lighting of the hall No. 37 of the State Tretyakov Gallery (painting of the second half of the 19th century)

measuring, the authors followed the lighting requirements, which the experts of these museums were guided by in the design.

If the Hermitage is a complex of palace buildings outstanding in architecture and decor and, therefore, it is a work of art – a valuable showpiece requiring high-quality interior lighting, then the Tretyakov Gallery is specially created for the exhibition of artistic works.

The general lighting of the Hermitage halls (Fig. 1) and, in part, of the paintings is provided by multi lamp chandeliers and floor lamps in addition to natural light through the large windows, while in the Tretyakov Gallery, with its mainly windowless rooms (Fig. 2), it is realized by luminous ceilings with artificial light sources with the addition (on the second floor) of natural light coming through the glazed widow lantern.

Both approaches to museum lighting have their advantages and disadvantages. It is believed that the best impression of paintings is created in natural light, but this light varies both during the day and seasonally. On cloudy days, the Hermitage does require additional illumination, and to exclude glare on the surfaces of paintings, the windows should be curtained. As for the luminous ceiling in the Tretyakov Gallery, which simulates the sky through artificial and natural light or artificial light only, it provides comfortable lighting of the rooms as a whole and uniform and sufficient lighting of paintings, but at the same time has the high power consumption. Thus, the total power consumption of lighting fixtures with fluorescent lamps of hall No. 38 of 190 m² with full lighting is 12.1 kW. Switching to LED tubes will mitigate this drawback. At the same time, the Hermitage is a leader and innovator

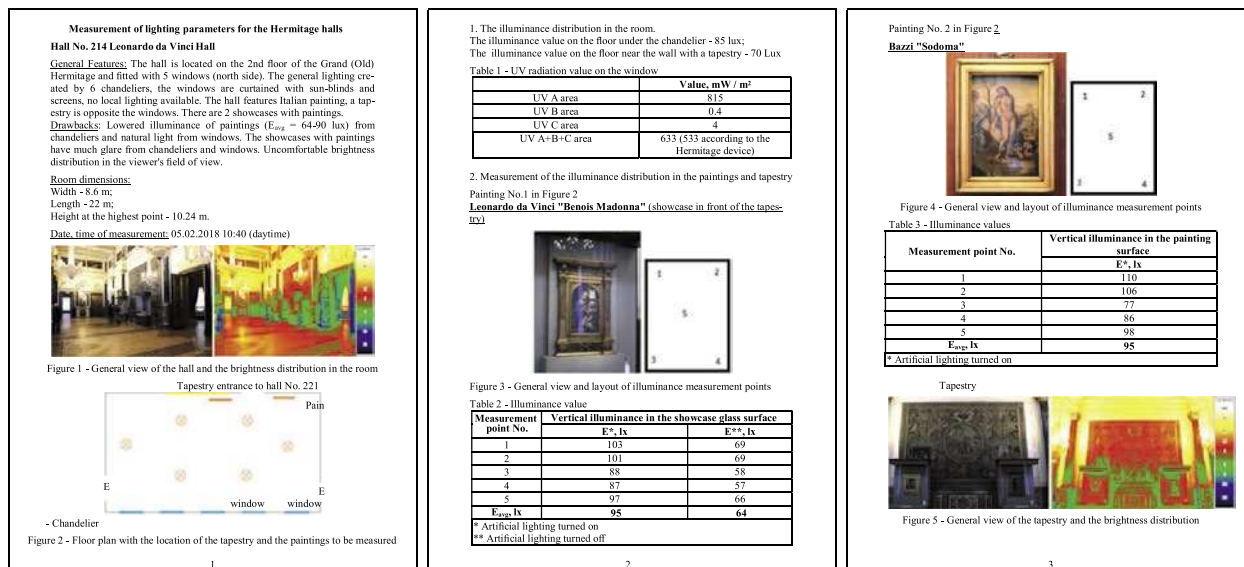


Fig. 3. Example of measurement report

in the field of aesthetics and museum lighting equipment, having passed the way from candles and incandescent lamps through fluorescent and halogen lamps to the LEDs.

Thus, in far 1949, the lighting of the Hermitage halls with fluorescent lamps was marked by the experts (A.I. Brodsky, B.A. Vvedensky, etc.) as very successful, as the paintings in such light are perceived much better than in natural light. Later, such companies as *Philips*, *Tochka Opory*, etc. have been working on the modernization of lighting in the Hermitage, and recently the BOOS LIGHTING GROUP International Lighting Corporation has joined them [11]. Out of 60,000 of the total number of light sources used in the Hermitage, 15,000 are LED sources, while the remaining 45,000 are HL, FL, CFL and MHL.

In the Hermitage, the measurements were carried out in 16 halls (the halls of French art of the 17th century, Leonardo da Vinci, Italian art of the Renaissance of the 16th century, decorative and applied art of Venice of the 15th – 16th centuries, French applied art of 17th-18th centuries, ministerial corridor, portrait gallery of Romanov's house, White Hall, etc.), located on the 2nd and 3rd floors, where lighting is arranged in different ways, including the use of floor lamps, directional spotlights, hanging chandeliers, luminous ceilings, etc. In the State Tretyakov Gallery the measurements were carried out in only 9 rooms on the 1st and 2nd floors of the building (painting and sculpture of the second half of the 19th century, painting of the turn of the 19th-20th centuries, the graphics of the 18th – early

20th centuries, the hall of Old Russian art, etc.), which allowed us to cover all lighting techniques used in the State Tretyakov Gallery – luminous ceilings, spotlights, clear-stories. The list of measured parameters and instruments used is presented in the Table.

The results of measurements are included in the reports the example of which is shown in Fig. 3.

The measurements in the Hermitage covered a negligible number of halls and exhibited items, mainly the oil painting. Therefore, it is possible to make only the general estimates of lighting, which is characterized by a large-scale transition to and use of modern lighting devices including devices with adjustment of angular size of light beam, light flux, etc., as well as the involvement in lighting design of specialized enterprises (*Philips*, *Tochka Opory*, etc.)



Fig. 4. Lighting of Hall No. 169 of the State Hermitage by the Tochka Opory Company

Table. Measured Parameters and Instruments Used

Parameter measured	Instrument name	Instrument appearance
Illuminance on paintings and in halls including semi-cylindrical (cylindrical) illuminance	Luxmeter-flicker meter Ecosphere EcoLight 02 type	
	LMT Pocket Lux 2 Luxmeter with attachment for measuring semi-cylindrical illuminance	
Radiation spectrum of lighting devices, R_a and T_{cc}	UPRtek MK350S Spectrophotometer	
Luminance (distribution in the observer's field of view)	LMK mobile advanced Photometer	
UV radiation	TKA-AVS UV-radiometer	
Temperature (distribution on the painting)	Testo 882 imaging radiometer	

From the latest works of the Tochka Opory company, it is worth noting the good lighting, made in accordance with the recommendations on illuminance ($E_{avg} \sim (145-160)$ lx) and colour rendering ($T_{cc} = 3100$ K at $R_a = 96$). It should be noted the successful implementation of the upward lighting techniques, free from the blinding of lighting devices and glare in the paintings (Fig. 4).

In general, the lighting in the Hermitage is performed professionally both in terms of perception of the exhibited items and their preservation – all windows, in addition to the double curtains, have UV radiation protection films.

The general brightness distribution in the view of observers is quite well implemented. As for the temperature distribution, it was distributed evenly

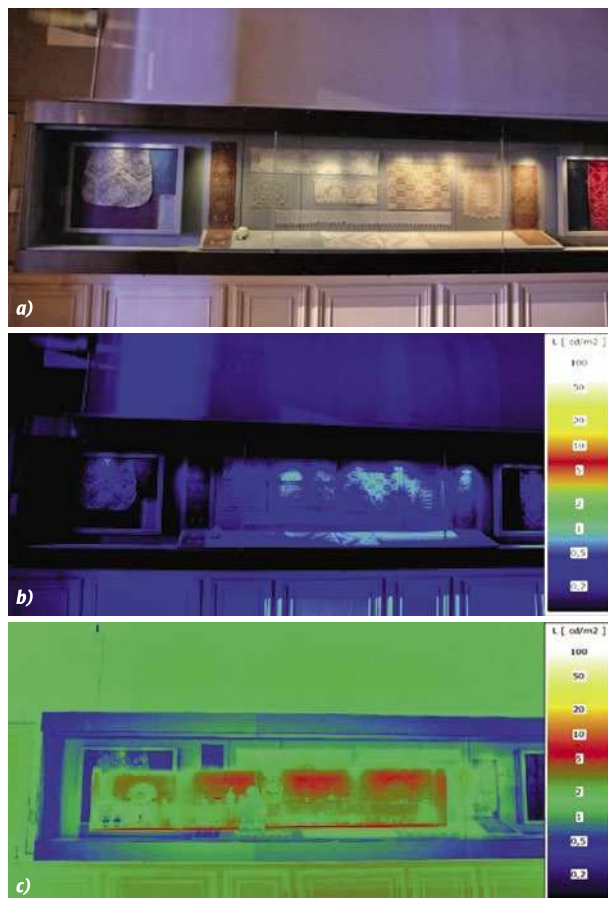


Fig. 6. Lighting of a showcase with a cloth in hall No. 223 of the State Hermitage Museum (decorative and applied art of Venice of the 15th – 16th centuries): a) the showcase photo; b) colour and luminance image of the showcase with the turned off illumination of the opposite showcase; c) colour and luminance image of the showcase with the turned on illumination of the opposite showcase

in all the paintings viewed and did not differ from the ambient temperature in the room, which complies with the requirements for the museum pieces storage.

However, in many cases the museum premises are dark (Fig. 5), the paintings are not sufficiently illuminated, especially in the absence of natural light, the condition of minimizing the brightness of adjacent rooms is not always met. In many halls, the measurement of cylindrical illuminance indicated that the saturation of rooms with light does not comply even with the low requirements for this indicator (not less than 50 lx according to GOST R55710–2013 [9]).

There is also an unsuccessful combination of exhibitions: for example, the showcases of hall No. 223, contrasting in the illumination level (one of them presents glass and bronze (exhibited items insensitive to light), and the other – open-work fabric

(extra sensitive exhibited items, the standard illumination is less than 50 lx)), installed opposite each other (Fig. 6).

In the State Tretyakov Gallery the lighting is comfortable, uniform from luminous ceilings, created mainly by luminous ceilings (these halls are the majority), no glare on the paintings. T_{cc} of the ceiling lighting is (4000–4200) K, and there are “over lights” of paintings (Fig. 7): E_{avg} from 180 to 280 and even up to 350 lx, which is quite possible to eliminate by adjusting the light coming from the ceiling and from the exhibition luminaries.

It should be noted that according to the specialists of the State Hermitage and the State Tretyakov Gallery they are guided by the Instruction on the Accounting and Storage of Museum Values in the State Museums of the USSR, which was enacted by the order No. 290 of the Ministry of Culture of the USSR dated 17.07.1985 [10]. According to paragraph 224 of this instruction: “For all kinds of graphics, books, manuscripts, photographs, fabrics, botanical and zoological collections, the level of illuminance should be within (50–70) lx. For all other exhibited items it should be 75 lx.” That is, in technical sense the lighting complies with the requirements, and this once again demonstrates the imperfection of the regulation for museum lighting, as such a low-variation lighting gradation for different light sensitivity groups of the exhibited items (50–70 and 75 lx) hardly makes sense, given, moreover, the error of measurements of average illuminance, which is about 10 %. In fact, judging by the results of measurement of illumination in the surface of oil painting works, both museums were guided by recommendations, including international ones [1, 2, 5, etc.], allowing illuminance up to (150–200) lx.

3. CONCLUSION

Unfortunately, the survey was carried out only for two museums and in a limited volume. It is quite expected that lighting in many other Russian museums may be different, and, therefore, it is advisable to continue these measurements extending them to museums of different categories and exhibitions.

The authors express their gratitude to the management and staff of the energy services of the State Hermitage and the State Tretyakov Gallery for their warm welcome and assistance in carrying out measurements in the exhibition halls of the museums.



Fig. 5. Examples of insufficient lighting in the halls of the State Hermitage: a) Portrait Gallery of the Romanov House; b) Ministerial Corridor

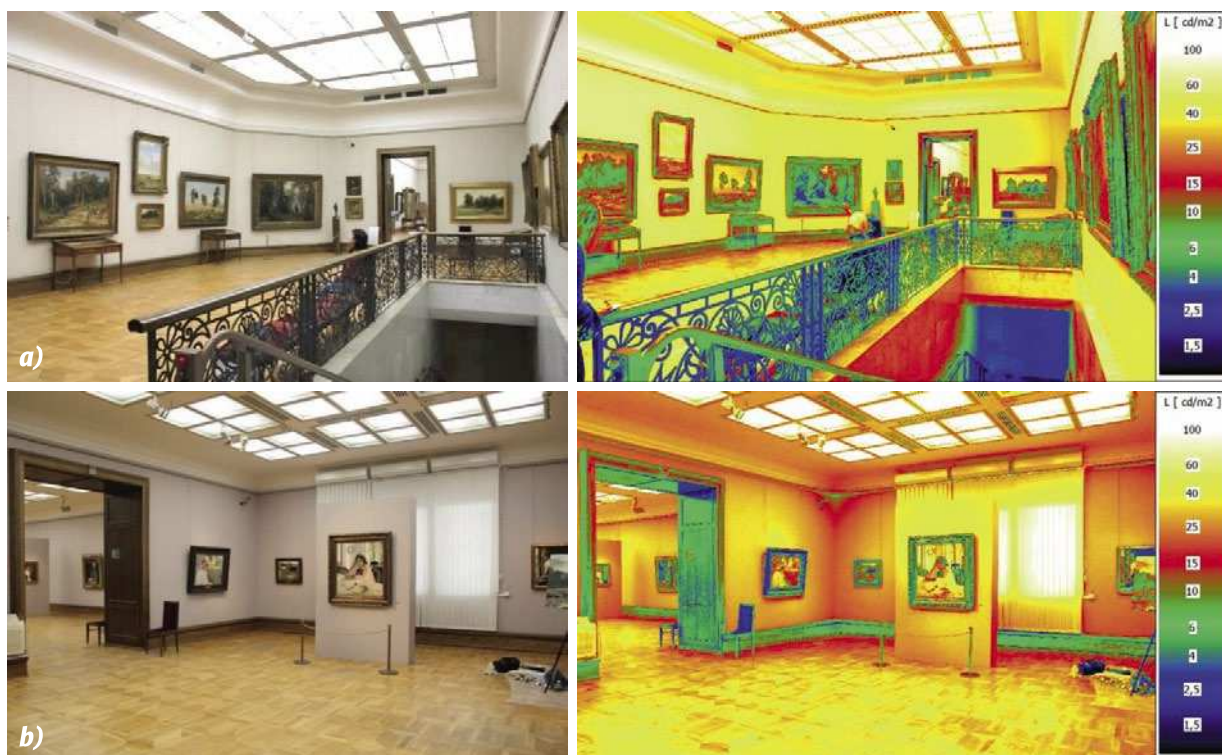


Fig. 7. Examples of lighting of the Tretyakov Gallery halls in photographs and colour luminance images: a) hall No. 25 (painting and sculpture of the second half of 19th century); b) hall No. 41 (painting of the turn of 19th-20th century)

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