

EXPLANATORY NOTE

CONTRACTING AUTHORITY: BELOGRADCHIK MUNICIPALITY

CONTRACTOR: " N S PROJECT" Ltd.

OBJECT: "Current repair and artistic lighting of" Magurata "cave with rock paintings from the Bronze Age", Belogradchik municipality, Vidin district "



Location: village of Rabisha, Belogradchik municipality

I. Objective and tasks of the developer

The present work has been carried out by the Assignor - Municipality of Belogradchik, in connection with the realization of the repair of the existing artistic lighting in the "Magurata" cave, introducing modern energy efficient light sources and lighting fixtures, according to the specific difficult working conditions.

The proposed development proposes replacing existing halogen spotlights with new energy-efficient LED light sources with several times less power consumption about 5 times and a much longer service life of 50,000 hours.

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II. General information and requirements

The Magura is among the largest and most beautiful Bulgarian caves. It is located in the northwestern part of Bulgaria, southwest of Vidin. The cave is carved in white limestone on a pointed mound called Magura. The whole cave has ten different halls and about twenty branches with a total length of about 3 km.

Found fragments of clay pots collected on the surface were dated to the Neolithic and the end of the Bronze Age, and six residential levels were distinguished in the studied cultural layer of the Triumphal Hall. In the cave there are also the famous rock drawings - one of the masterpieces of the prehistoric art in Europe, the total number of which amounts to about 700. The archaeological excavations in the cave enabled for the first time in northwest Bulgaria to explore little known and almost unexplored prehistoric cultures .

The appearance of this underground beauty for tourists and lovers of nature is possible only with the appropriate artificial lighting in the cave.

The design and realization of a lighting system in a cave area implies the observation of a number of specific requirements: safe movement of the observers (tourists) along the route; performing local lighting of the formations; different orientation of the tourist's view; preserving the natural appearance (color, moisture, etc.) of the environment; possibility to control switching on and off by sector of the electric power supply network, etc. Taking into account the severely aggravated operating conditions: 98% humidity, rock paths and dripping water areas, a high degree of protection for lighting fixtures, spotlights, switchboards and starting devices is required.

In Bulgaria there is not enough experience in lighting design of cave spaces, which is why the realized lighting systems often do not comply with the multilateral requirements.

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III. Characteristics of the existing electric and lighting system.

The tourist route in the Magura cave along the main axis and the lateral deviations in the galleries has a total length of 1930 m. More than 150 specific formations with different spatial orientation and illumination capabilities are located along its length. The humidity reaches 98%, and in the Hall of the Stalactones, the Throne Hall and others. there is dripping water.

The cave was electrified in 1961 via the 20 kV power line of the Mezdra power supply and the low voltage air line to the main dashboard in the building. In 1987, a mast transformer station was built near the entrance of the cave. On a cableway, electricity is supplied to a main electrical panel in an outbuilding.

1. Light sources.

Currently, the following lighting fixtures and projectors have been installed in the cave according to the latest electrical lighting project (since 2001):

- Halo projector, type Tesla, Czech Republic. The reflecting surface of the reflector is electrochemically polished, and the lens is made of optic glass resistant to heat radiation. The projector can be rotated and guided in the horizontal and vertical plane by means of a light alloy holder. Compatible with a halogen filament lamp 100 W, 200 W, with a voltage of 220V.
- **waterproof light**. Betting on lighting in separate areas with "small" 60 W incandescent lighting and on the touring light path of the tourist path with a compact fluorescent lamp 8 W;
- **projector**, halogen, for general lighting of the large cave halls with incandescent halogen lamp 1000 W and 1500 W;
- "**luminous band**" (flexible transparent synthetic tube with built-in miniature lamps - 16 W / m) for contouring and illumination of the route trail. The experiments conducted in the cave confirmed its feasibility.

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2. Achieved objectives of the lighting system in the Magura cave.

The tasks of the lighting system are considered in the following directions: provision of general, local, route and emergency lighting.

The principle of model design in the cave was realized, using several types of lighting and light sources. Through site modeling, the location of all 303 projectors and lighting fixtures in the cave was determined.

The enclosed table Annex 1 - "Location and Direction of Lighting in the Magura Cave" provide full details of the number, type of lights and spotlight, type and power of the light source, location and way of mounting, direction and illuminated space and formations.

General lighting is only necessary for the bulk of the large rooms. It is realized with spotlights with a halogen filament lamp. There is a possibility of single turning them on and off to allow individual exposure of individual entities. Total lighting is designed in the "Triumph Hall", "Surrostehto", "Hall of the stalactites", "Hall of the Fallen Pine", "Hall of the Poplar".

The local (individual) lighting of the individual rock formations is covered with the Tesla spotlight, taking into account the proposed exposure and the design of the cave.

Lighting fixtures and spotlights are designed to show and highlight only the most characteristic formations and spaces in the cave. Luminous flux is reflected in different directions, illuminating the surrounding space. In smaller volumes, the reflected flow is also sufficient to illuminate the route path, for example, in the "Gallery of Drawings", the illumination reaches several luxuries. The remaining spaces are relatively large in volume and additional route lighting is required.

The route lighting in the whole cave is realized taking into account the specific requirements of the terrain. It also acts as an emergency evacuation light (AOE) by continuously operating and "marking" the path. It is filled with two types of luminaires: in the flat part of the path with waterproof IP54 lamps with compact fluorescent lamps 8 W (energy saving lamps - ESL) on a metal bracket with PCM box; stairway and narrow passage is provided installation of "luminous strip" of

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flexible transparent synthetic tube with built-in miniature lamps, fed through PCMC box. The electrical lighting system for the street lighting consists of 9 electrical AOE panels. The power cord is set to a permissible voltage drop - SABT 3x50 + 25 mm².

There is an emergency power supply to the 10 kW diesel lighting, mounted on a silent foundation in the building outside the cave, and its emergency power is determined on the basis of full power. The switching of the emergency power supply after the diesel engine is started from the facade of the GRT by the duty staff.

The following light scenes are performed in the cave:

The "Triumphal Hall" - with the local lighting, the excavations of the ancient village, the grave to the first hearths, the Great Sword, Podmola and the stalagmites "Blue Buck", Stalactone (under № 25) 32), "The Grave of the Roman Girl", "Pauna" and others. The first transition encompasses the "Hall of the Drought". In addition to the general lighting, "Human Image" (under №65), "The Bear", "The Cave Dog", "The Medusa", "The Expanded Bat", "Strelbishte" and others.

The Stallactone Hall is exhibited individually: "Mamula", "The Gramada Stalactone", "Draperies", "Dolphin", "The Woman with the Headgear", "The Two Twin Brothers", "The Turtle", stalactones and singular formations: Kosherins ", " Sintro Lakes ", " Sandwich ", " Apple ", " Balkoncheto "and others.

The hall of the fallen pine - the locals lit up: the stalagmites "The Plowed Pine", "The Madonna", "The Dragon", "The Snowy Pines", "Oriental Knight", "Grandfather Mraz", "Waterfall", "Chess Figures" Romeo and Juliet ", " Climbers "and others.

The route along the route is filled with interesting lightening formations: "Arfite", "The small spider's tops", "Cactus", "The petrified waterfall", "Oriental town", "Kamila", " ", "Two Storks", "Stallgit Waterfall", "Orelcheto and Towers", "Snail", "Khan Asparuh", "Chasovoa", "Cemetery", "Cyril and Methodius"

"The Throne Hall" - the Kremlin, the Mushroom, the "The Petrified River", the "Tran", the "The Two Brethren", etc. are illuminated.

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1. Electrotechnical part of the lighting system in the Magura cave

The Main Switchboard (GRT) is a steel-tin cabinet that is mounted in the building of the cashier and the service staff. The total installed capacity according to the last project is about 72 kW. Distribution boards are located at the following locations:

T1 - immediately after the entrance;

T2 - to the right of the existing dashboard, in the Triumphal Hall in the niche;

T3 - to the old dashboard, next to the tomb of the "Roman maiden";

T4 - in the hall of the Surrosteevo;

T5 - at the entrance of the gallery with rock paintings;

T6 - in the hall of stalactites;

T7 - in the hall of the fallen pine;

T8 - on the site before the Oriental City;

T9 - in the Throne Room, under the "elephant's ear".

The main switchboard is mounted in the building at the entrance to the cave. It is powered by the power meter board at the mast transformer station, where a separate electricity meter is installed only for the cave with the necessary switching and protection equipment.

The sizing of power lines is met at a permissible voltage drop.

Including the spotlights on the switchboards takes place consecutively, with projectors in up to 3 boards. The backgammon is switched in the direction of the visitor's traffic: a T-1 board is inserted from the entrance, followed by a T-2 when it is moved along the path. Upon further movement of visitors, T-3 is switched on, but T-1 is turned off.

Dashboard T-5 is used to power the lighting in the Gallery of Drawings.

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To guarantee the allowable voltage drop on the T-6 switchboard, the T-1 board has a direct power cable of 3x185 + 95mm². Trays T-6, T-7 and T-8 (second stage of the project) are connected to 2 power cables connected in parallel. The control of the contactors in one panel is made by a pulse relay with the possibility of control with buttons from three places: from the board itself; from the previous dashboard; from the next board.

The switchboards, located in inaccessible locations, are remotely controlled by the mounted TT-4 and TTU-6 launch panels, which are a 3-button metal box housing with IP44 protection.

The supply lines to the spotlight are equipped with a CBT cable: for Tesla projectors - CBT 3x1,5 mm², for spotlights with halogen lamp - CBT 3x2,5 mm², for waterproof luminaires - CBT 2x1,5 mm².

Example: Modular implementation of a T-1 switchboard

The following power distribution of the spotlights and lighting units to the electrical switchboards

Electric panel Number of spotlights Total number

Table -1 №1-22, №28 23

Table -2 №23-45, №50 (except №28) 23

Table -3 №46-65, (except №50) 19

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Table -4 №66-77 12

Board -5 №138-157 20

Table -5.1 No. 91-137 47

Table -6 №78-90; № 158-168, №172; 173; 174 26

Board -7 №169-213 40

Table -8 №214-255 40

Table - 9 №256-307 48

Total number of projectors 307

Annex 2 shows the exact installed electrical power according to the latest electrical design.

In Appendix 3 are presented scanned copies of the single-line diagrams of the electric switchboard in the cave.

If possible, it is recommended to install additional pipe earthed or galvanized bars inside the cave. Measurement of R is performed both on commissioning and periodically, in accordance with the requirements of BDS and EMS.

The spotlights and lighting fixtures are connected to a CBT cable laid in a trench and in PVC pipes. Where it is technically impossible to pass pipes, it is allowed to place the cable in cracks in the rocks so that it does not fall into the field of view of the visitors.

The electromagnetic lock, operated by a button, is mounted on the exit door of the cave. It is powered by the 3rd circuit of the AOE / T-9 emergency board. In this starting area visitors can even be without a guide. It is necessary to press the button of the lock and then the door itself. The door is self-closing to prevent external faces from entering the exit.

Each section is included in the tour guide immediately before entering it and shuts down immediately after the crossing so that the spotlight and lighting fixtures can illuminate for a minimum of time and do not interfere with the light-thermal regime of the cave.

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IV. Technical solution

1. Lights and sources

The present work has been carried out under a assignment by the Assignor - Municipality of Belogradchik, in connection with the realization of artistic lighting and ongoing renovation in the cave "Magurata".

After the last repair in 2001, the lighting system in the cave is highly compromised and energy-intensive. Lighting is poor and in poor condition, a large number of lighting fixtures are not working and are not in the proper state, leading to a difficult passage on the tourist route. The surveys revealed that the projectors were obsolete, much of their lamps were burned, the hulls were in poor condition. The light sources in them are of the old generation - halogen filament lamps with capacities of 100, 200, 1000 even 1500W. these sources are extremely inefficient and with a very short lifetime of exploitation - 2000 hours. When working at the cave at 8 hours per day in about 300 working days a year it turns out that these lamps have a life of less than 1 year.

From the above it becomes clear that the lighting system needs urgent repairs and replacement of the lighting fixtures.

When selecting the type of light source, the requirements of speleology, the recommendations for the protection of the cave environment and the foreign experience of lighting cave spaces are taken into account.

The project introduces priority use of LED light sources with different unit power, which for these conditions have the following advantages: correct color transmission of the illuminated objects in the surrounding space; the light output of the LED lamps becomes nominal immediately after the power supply and after a short-time shutdown, it immediately recovers; small heat emissions, small size and weight; easy installation and operation in cave conditions. Regardless of the lower efficiency, the use of this lamp is fully justified and rational.

The present work proposes replacing existing halogen spotlights and fluorescent lighting with new LED light sources that are characterized by very long life and low

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power consumption. Projectors with LED sources have different light-emitting radiation angles and different light spectra - from the warmest 2700K to the coldest over 6000K (daylight).

Lighting fixtures and spotlights are the main technical elements of the lighting systems that fall within the field of view of the visitors and therefore their choice and installation affects the overall impression.

The requirements are imposed by the cave conditions: high degree of protection - IP65, light distribution with narrow radiation angle, convenient operation and installation, etc.

The table is presented

Accentual artistic lighting

Type LED Source Number

Halogen Projector 60W / 220V LED Projector 10W / 220V 48

Halogen projector 100W / 220V, LED projector 20W / 220V 170

Halogen Projector 200W / 220V LED Projector 50W / 220V 137

Halogen projector 500W / 220V

LED spotlight 100W / 220V 2

Halogen Projector 1000W / 220V LED Projector 200W / 220V 12

Halogen Projector 1500W / 220V LED Projector 2 * 150W / 220V 7

Projector with NWR250W LED Spotlight 200W / 220V 7

Route lighting

Lume. direct mounting luminaire 8W / 220V Direct light-emitting diode wall lamp
Modular module with LED module 3-5W / 220V with anti-dazzle grid 100

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Lighting flexible line 16W / m, 220V ROPE LIGHT illuminated LED line with length 20m, possibility of loading up to 60m, safe supply voltage 36V, length of one segment 33cm, 10pcs LED in segment, 1.5W / m 300m

The following power can be deduced from the attached table

- existing position - 78,2 kW
- a new energy-efficient solution - 18.0 kW

From the replacement table presented, it is clear that when replacing the luminaires we will have the following advantages:

- a significant reduction of the installed electric power - about 4 times. This will lead to significant savings and reduced electricity costs;
- Implementation of sources with about 25 times longer lifetime - direct reduction of operational costs are practically equated to 0 in view of the lifetime of the lighting system, about 15-20 years.

2. Power supply and electrical panels

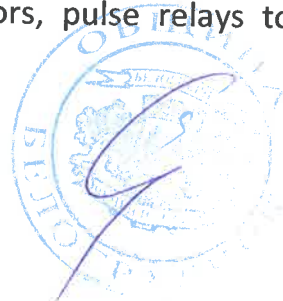
In view of the drastic reduction of the installed capacity (about 4 times) and the presented review of the electrical engineering project of 2001 (bcIII.3), it is clear that the site is secured with electrical power and no activities related to the power supply of GRT all under the tray in the cave.

Due to the harsh climatic conditions in the cave, some electrical boards have corroded. In the present study, it is planned to replace the boxes of electrical switchboards with the new ones with a higher degree of protection - IP54.

Due to the installation of LED sources, which are characterized by a large short-time starting current, it is necessary to replace automatic safety guards by installing new ones with "D" off curves.

It is intended to replace all switchboards, contactors, pulse relays to ensure trouble-free operation.

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Replacing these elements will not affect the interior of the cave in any way. These are items that will only be repaired by looking for minimizing the size of the boxes on the electrical boards.

For the preparation of the new switchboards, the existing schemes in Annex 3 will be used.

At the request of the Employer, three interactive screens will be installed in the cave. For their power supply, a new power cable CTV3x2,5mm² from Dashboard T-2 to Screen-1, from T-5.1 for Screen-2 and from Dashboard-6 for Screen-3 will be installed. The screens are located near the existing electrical panels, and the supply cable will be minimal in the hollows, without the access of tourists. For screens supply, two waterproof contacts 220V / IP54 are provided, mounted and fastened to the structure of the screens. Annex 4 shows the mounting locations of the screens and nearby power supply panels.

V. Safety and security equipment for electrical installations

The provision of healthy and safe working conditions is carried out in accordance with the specifics of the activity carried out and the requirements of the technical, technological and social development in order to protect the life, health and working capacity of the employees.

Installation and operation of the system shall be carried out according to the national regulations, documents and requirements of the manufacturer.

The BTCTB events have been developed in accordance with the following normative documents:

- Ordinance No 2 of 22 March 2004 on the minimum requirements for health and safety at work for construction and erection works
- Ordinance No 7 on the minimum requirements for health and safety at work and working equipment (SG No 43 of 13.05.2003)
- Health and Safety at Work Act
- Ordinance No. I - 1971 / 29.10.2009. - for building and technical rules and fire safety standards
- No. 3 for electrical devices

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- Regulation №4 on lightning protection of buildings, outdoor equipment and open spaces
- and all existing regulations concerning this type of objects.

The installation and dismantling and the work on the electrical installation must be carried out by electricians entitled to operate electrical apparatus powered by a voltage up to 1000V. The setting, commissioning and testing of the electrical installation must be carried out by qualified electric meters. All installation and installation work must be carried out with the voltage switched off. All activities performed on the site related to electro-construction, with to be performed with the correct tools of personnel with the relevant TBT and TE qualification group. When carrying out the construction and assembly works, the requirements of all applicable normative documents for this type of construction and installation work must be observed. Notwithstanding the above-mentioned measures, the site must comply with all existing instructions, regulations and laws dealing with safety, fire and sanitary protection issues.

VI. Preservation and reproduction of the environment

This Explanatory Memorandum is elaborated on the basis of the "Environmental Protection Act" of 2002 and all its amendments to date.

In order to improve the economic, social and environmental efficiency of the site, its design, construction and operation have complied with the requirements for rational land use, better organization of construction works, limiting the harmful effects of electromagnetic fields and minimizing the underground landscape.

In the operation of communications networks there are no waste products. In the event of an accident, the replacement of wires, cables and equipment shall be carried out in a timely manner, and the dismantled materials shall be transported in an appropriate location.

All data on the technological part are given in the previous chapters, all the gauging distances, according to Ordinance № 3 and the applicable norms are observed.

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Designer:

/ eng. Anton Petrov /

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