Analysis of the headlights checking parameters

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Abstract. The article presents an analysis of the errors in checking the parameters of the headlights, a description of the process of checking the headlights during a periodic technical inspection using instruments for checking the headlights.

1. Introduction
Vehicle general inspection is a check of the wheeled vehicle (WV) in operation technical condition [1]. Cars, trucks with a permitted maximum weight up to 3.5 tons, motorcycles and other motor vehicles, semi-trailers and trailers not older than 3 years are not subject to general inspection. When a three-year term expires from the year of vehicle release, the inspection stickers become mandatory. The only exceptions are trailers, but only if they are owned by individuals, and they themselves have a mass of not more than 3.5 tons. For WV age from 3 to 7 years, technical inspection should be done every two years, after the expiry of the seven-year period – annually.

Regarding some types of cars, special rules have been established that relate the frequency of passing the inspection. In particular, it is necessary to conduct this procedure annually in relation to such WV as:
• trucks with permitted maximum weight up to 3.5 tons;
• cars, used to teach someone driving;
• WV with special signals.

More stringent deadlines are set for those cars that are used to carriage citizens, since the life and health of many people depend on their operability. It is necessary to conduct this procedure every six months for the owners of such WV as:
• passenger taxis;
• buses;
• trucks that are used for the systematic passengers carriages and have at least eight seats, apart from driver’s;
• and
• special vehicles and trailers for them that are intended for the dangerous goods transportation.

Types of external light sources:
• Halogen lamps first appeared in 1962. They, similar to lamp bulbs, have an internal spiral (or two spirals) that create temperatures up to 3000 °C, but their volume is filled with halogen steam: bromine or iodine. This prevents sedimentation of tungsten atoms on the flask walls, enhances the brightness of car headlights in 2-2.5 times and increases the service life in 2-4 times. The average power of halogen lamps is 35-60 W, and the maximum – 130 W. The luminous power for dimlight – 1000 lumens, for distance light – 1650-2100 lumens. Various types of halogen lamps differ from each other...
in the way they are installed in the car headlight and connected to the on-board power network. Halogen lamps with the following marking are most commonly used in automotive optics: H1, H3, H4 (most common), H7, H9, H11, as well as HB3, HB4 and R2:

- Xenon headlights have long gained popularity among manufacturers and motorists. Bright white natural light is produced by the eponymous ionized inert that placed inside the bulb of the gas-discharge xenon headlight. Two electrodes are used instead of a spiral. Between them, there is an arc, warming up xenon. The pressure inside the flask is approximately 30 atmospheres, and with operating headlamps up to 120 atmospheres. The brighter the light, the lower the electricity consumption. Therefore, these lights are more economical than the previous options, while they also provide good visibility on the road, since the powerful luminous flux created by them reaches 3200 lumens. Sometimes another inert gas – krypton or a mixture of gases – is used instead of xenon in the lamps. Xenon lamps operate at a constant voltage of 42 V or 85 V. But in order to “start the process,” an alternating current pulse with a frequency of 400 Hz and voltages up to 25,000 V is needed. An electronic ignition unit, individual for each lamp, is used to form such a pulse. The need to install it is a disadvantage of gas discharge lamps. Xenon headlights, in which there is an element that controls the power of the luminous flux, are called bi-xenon. But switching from a main beam to a passing one takes a certain time, since inert gases do not heat up quickly. Classification of xenon headlamps is based on the principle of the beam direction: the D1S, D2S, D3S and D4S lamps are designed for projector-type headlights, and D1R, D2R, D3R and D4R - for reflector-type headlights (with reflectors) [7];

- Modern LED car headlights are the modified version of conventional bulbs used in street light sources, adapted for use in vehicles. They based on a set of powerful, very bright LEDs emitting white light. For the first time, LED headlights appeared in 1992 as a replacement for lamps in turn signals and side lights. In the headlights of the front (head) light LEDs are mainly installed in prestigious car models. Their distinctive characteristics are efficiency, reliability, brightness, durability, compactness, insensitivity to shocks and vibrations, as well as effectivity and higher power compared to conventional light headlights. The main disadvantage that prevents the massive LED car headlights spread is their prohibitive cost [9].

2. Materials and methods
As part of the general inspection, the verification of external light sources is carried out. External lighting devices are the instruments for illuminating the road, a license-plate number, and light signaling devices [1]. As the general inspection part, the inclination angle of the light beam to the road surface is controlled, i.e. the headlights adjustment, as well as the strength of their light.

Light intensity – part of the optical path emitted in a certain direction [1].

Requirements for testing external lighting devices:
• headlights are checked at the WV, located at the post, equipped with a horizontal flat working platform with slopes of not more than ± 0.1% and a device for checking the headlights installed on the orienting device, ensuring the relative position of the WV and the device with maximum error ± 0, 2%;
• the location of the WV on the working platform must ensure parallelism of the reference axis of the headlight and the plane of the working platform with an accuracy of ± 0.1%;
• the device placement on the working platform must ensure the optical axis parallelism of the objective lens to the working platform with an accuracy of ± 0.1% and the longitudinal or perpendicular WV center plane to the rear wheels axis with an error of ± 0.2% and passing the optical axis through optical center headlamp diffuser. The distance from the center of the headlight lens to the plane of the device lens should be (350 ± 50) mm, unless the manufacturer of the device does not specify a different value in the instruction manual;
• headlights are checked visually on the unloaded WV and on the corresponding headlight range control position;
• headlight lenses when checking should be clean and dry outside, the air pressure in the tires should correspond to that WV manufacturer established the in the operating instructions;
• in the device lens focusing plane a movable screen with markings is installed that provide the ability to check the headlights and adjust the marking position in height;
• the position of the cut-off line left part in the “dipped beam” mode is determined visually relative to the marking of the movable screen built into the device [8];
• the headlights light intensity the is measured with an accuracy of no more than 7% using a sensor built into the movable screen of the device and corrected for the average curve of the human eye spectral sensitivity. The sensor sensitivity should correspond to the intervals of luminous intensity permissible values [2].
• the load of the car, the headlights cleanliness and the pressure in the tires [2] also affect the accuracy of checking the headlights.

Requirements for the mutual placement of the device, vehicle and working platform are specified in the standard [2] and regulations [1]. However, the installation and orientation of the device is done manually and almost “by eye”.

According to the order of the Ministry of Industry and Trade of the Russian Federation of December 6, 2011 No. 1677 a device for controlling the adjustment and headlight intensity [3] is, among other things, mandatory device for technical inspection.

Let us systemize the measurement ranges and errors of the measured parameters, according to [2] and [3] in Table 1.

| Measured parameters, units | Range measuring | Maximum error according to [2] | Maximum error according to [3] |
|---------------------------|-----------------|-------------------------------|-------------------------------|
| Tilt angle of the light beam cut-off line in the vertical plane | 0°00’ ÷ 2°20’ | ± 0.2 % / ± 0.1% | ± 0.1% |
| Headlights intensity, cd | 200 ÷ 125000 | 7% | 15% |
| Measurement height, mm | 250 ÷ 1400 | - | - |
| The error of the device’s optical axis orientation relatively the longitudinal plane of the vehicle | - | ± 0.2% | ± 30’ |

Let us present the most common models of instruments for checking the luminous intensity and controlling the adjustment of headlights used in Russia.

The headlamp IPF-01 (manufactured by NPF Meta, Zhigulevsk) light meter for the parameters is shown in Figure 1.

The motor vehicles headlights parameters meter IPF-01 is designed to control the technical condition and adjust the external vehicles’ light devices in accordance with the requirements of the Technical Regulations [1] and GOST R 33997-2016 [2].

Functions of the device IPF-01:
• measurement of the cars headlights angularity;
• measurement of external light devices light intensity;
• measurement of the time period between the moment of turning and the direction indicators to the first flash appearance;
• measurement of the direction blinker indicator passing frequency.

The headlights checking device OPK (produced by the GARO plant, Veliky Novgorod) is shown in Figure 2.

The headlights checking device OPK is intended for checking, adjusting and measuring the luminous intensity of all types of external light devices of motor vehicles according to [1] and [2]. The optical camera and orientation device are located on the mobile stand. A focusing lens, a marking screen and a luminous intensity indicator are installed in the optical camera body. The screen moves vertically by rotating the dial of the cut-off value. The camera’s installation height is measured by guide on the rack.
The optical axis of the camera is installed in a horizontal plane by the level, and the car axis parallelism is achieved using a slot-type or mirror-type orienting device.

**Figure 1.** Headlamps light checking device IPF-01.

**Figure 2.** Headlights checking device OPK.

Configuration:
- Checking the luminous intensity of the dipped beam and distance light headlights, fog lamps, tail lights, stop lamps, direction indicators, headlights with a xenon light source;
- Adjust the angle of the headlights;
- Measurement results are displayed on a backlit LCD display;
- The measuring chamber moves easily in a vertical plane and is securely fixed in the installed position;
- Four photoelectric receivers are reliably protected from extraneous external light sources;
- Automatic data transfer to a personal computer via RS-232.

Analyzing the above material, it is possible to conclude that to improve the WV safety it is necessary to reduce the errors in measuring the parameters of external light devices, it is necessary to improve the accuracy of measurements using the exact equipment.

External light source faults:
1. Laps burnout. During operation, wolframite evaporates, sediments on the inside of the tube, thereby reducing its transparency. It is confirmed that the luminous flux at the end of the life of the tube is only 75% of the initial flux. The main lamp burnout cause is that the current density and temperature evenly increase in the weakest section of the thread. Lamps in most cases burn out at the moment of switching on, the current increases sharply. Incorrect operation of the relay-regulator significantly reduces the life of the light bulb. At rough operation the tungsten wire can break.
2. Head lamp lens malfunction. Light devices have more frequent malfunctioning lenses – these are external dirt, scratches. When you clean the diffuser with a dry cloth, you only aggravate the effects of abrasion by covering it with scratches net.
3. Overheating of the car’s external light sources. Heating often serves as the primary cause of a huge number of defects in light-signaling devices. The internal volume of the lamp is heated by the lamp. If this happens specifically while driving, the oncoming air cools the device perfectly. But if it burns for a long time during parking, the lens may even melts a little. The quality of the
devices is also affected by alternate heating and cooling. After the lamp is turned off, the inside air is cooled, drawing in the water and solid dust that settles there. Then the moisture condenses out through the drainage holes, but if they are clogged, it can speed up corrosion. If you constantly misted the lens, then you should clean the drain hole.

4. Corrosion of the reflector. The optical characteristics of the mirror surface sometimes disturb. This happens because of the corrosion at the bottom of the reflector from bad ventilation and water accumulating here. Due to corrosion, at first, the intensity of the light beam decreases. The result is a reduction in the illuminated part of the road and uneven illumination of the roadside [6].

3. Results and discussion

However, it should be noted that at present, in the general inspection framework, when checking external light devices, such factors as:

• change of the car load;
• changing the slope of the platform on which the measurement is made;
• changing the angles of the device and the car mutual bracing;
• tire pressure change.

Therefore, a study aimed at examining the errors of control of car’s external light devices during its general inspection is relevant, and will be carried out taking into account the influence of all the above factors.

4. Conclusion

Thus, the external light sources of the car are an important part of the automobile design. One of the most important components of the wheeled vehicles safety under their operating conditions is the control of the external lighting devices technical condition. Timely testing of car’s external light sources increases both vehicle and pedestrian safety in the dark [10].

References

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