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Optical Characteristics of Night Vision Goggles "PRILEP"

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Abstract: *The Institute of Information Technologies in cooperation with the private enterprise "ElkoE" has developed night vision goggles (NVGs) called "Prilep" [1]. The paper discusses some methods for measurement of the following optical characteristics of NVGs "Prilep" - magnification, field of view, eye relief, exit pupil diameter, diopter adjustment, and interpupillary adjustment.*

Keywords*: night vision goggles, optical characteristics, methods for measurement, magnification, field of view, eye relief, exit pupil diameter, diopter adjustment, interpupillary adjustment.*

Introduction

Night vision goggles are electro-optical devices that improve visibility in low light conditions. They amplify available ambient light, such as moonlight and starlight. NVGs, however, do not magnify an image. An object viewed through the goggles looks the same size as if it were seen in the day light without the goggles. Objects that are hard to see during the day are also hard to see at night through the goggles. NVGs performance is directly related to the amount of ambient light. During periods of high ambient light, the resolution is improved and objects can be identified at greater distances. However, visual acuity (the accuracy with which an object is seen) with NVGs will never be as good as it is with naked eye during daylight conditions.

The use of NVGs for military application has grown steadily over the past 30 years. Each successive NVG model represents some kind of improvement in terms of size, weight, ruggedness, gain, noise, resolution, field of view or spectral sensitivity. This concerns NVG "Prilep" also. Some new methods for testing their spe-

cific characteristics are needed to prove that. In the present paper we have concentrated on the following parameters: magnification, field of view, eye relief, diopter adjustment, interpupillary adjustment.

A binocular night vision device consists of two optical systems that are joined by a hinge and (typically) share a common focusing mechanism. The ability to create an image for both eyes simultaneously provides a realistic perception of depth. The night vision goggles "Prilep" has been developed as a classic binocular device, composed by two separate optical channels, each comprising of its own unique optical system and image intensifiers tubes (II+ generation , – "DEP"). The stereoscopic observing gives the NVGs user opportunity to determine the correct distance to object and to receive good orientation in extreme situations that are typical for military, police, and guarding operations.

Measurement procedures

Magnification

Magnification testing has been done by diopterscope and collimator with objective focus distance f'_{ob} = 300 mm, Fig. 1.

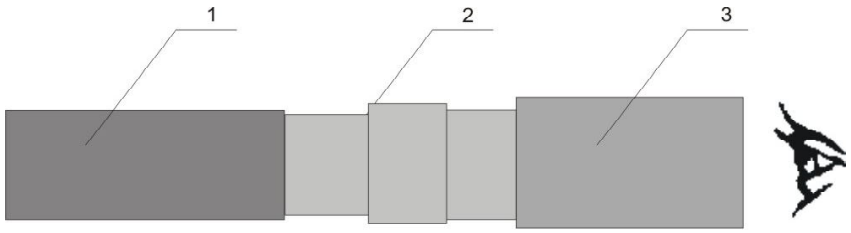

Fig. 1. Testing of magnification:
1 – collimator, 2 – NVG electro-optical channel, 3 – diopterscope

The proposed magnification testing methodology is based on the following procedure:

The diopterscope scale center is coincided with the collimator scale center. The number N_1 of the diopterscope scale marks, overlapped by the collimator image marks, are measured. Then the electro-optical channel of the NVG "Prilep" is mounted between the diopterscope and the collimator and the diopterscope marks N_2 coincided with the same collimator's scale marks are measured. The relation N_1/N_2 gives the magnification. For the NVGs "Prilep" it is exactly equal to 1.0, which is in the goggles range $(1 \pm 0.1)^x$.

Field of view

In order to conduct the test, the NVGs was fixed to an optical bench and placed on a known distance from a test screen. Two small vertical marks distanced 7.2 m from each other (W, Fig. 2) are placed on the test screen The screen is observed trough the NVGs from a distance of 10 m (L, Fig. 2). In [2] the same method is

used for the measurement field of view of the panoramic night vision goggle (PNVG) but the field of view is 100 degrees

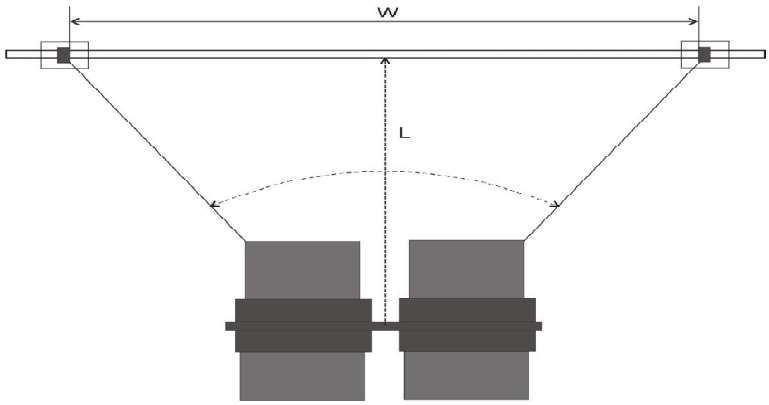

Fig. 2. Testing of the field of view

L(7.2 m) and *W*(10.0 m) selected determine the angle of the field of view by:

$$\operatorname{tg}\left(\frac{\alpha}{2}\right) = \frac{\sin(\alpha/2)}{\cos(\alpha/2)} = \frac{W/2}{L}.$$

exactly to 40°.

If both the vertical marks are simultaneously visible, the NVGs field of view is at least 40°. The results of NVGs "Prilep" testing show a calculated field of view of 43.30°.

Eye relief and exit pupil diameter

Eye relief depends on the distance *H*, the NVGs are held away from the eye and still have the full field of view. In case *H* is longer, the eye relief is better and reduces eyestrain which is important for eyeglasses wearers. The distance *H* must be as longer as possible but without cutting of the image area in order to achieve the optimal seeing. Testing is done by a sample tube with an iris diaphragm. The sample tube touches the element of the eyepiece surface and the iris diaphragm is adjusted to the required size *D* (Fig. 3).

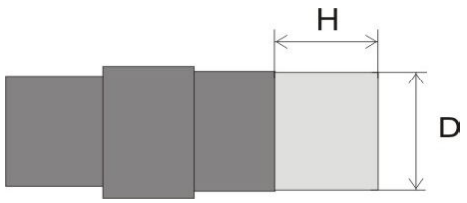

Fig. 3. Eye relief and eye diameter testing sample

The observer closes his eye to the sample tube and looks the screen of the image intensifier tube (IIT). The size of *H* and *D* are not less then 15 mm accordingly to the requirements of the user. The both NVGs channels are tested independently. The test is successful if the whole screen is seen. The results of NVGs "Prilep" testing show eye relief distance *H* of 15 mm and exit pupil diameter *D* of 22 mm.

Diopter adjustment

Diopter adjustment allows the user to adjust the binoculars channels to his or her vision requirements. Diopter adjustment is independent of focusing, and needs to be set only once. The placement and design of the diopter adjustment dial makes it easy to use and also prevents unintentional movement. A "fine-focus" adjustment ring helps accommodating for vision differences between the right and left eyes. Most military systems demand a +2 to –6 diopter range adjustment for differences in individuals' eyesight. In the case of NVG "Prilep" the testing has done by collimator with objective focus distance f'_{ob} = 300 mm, diopterscope and set of resolution charts. The eye-piece is adjusted at the end position. The diopterscope is adjusted to most clear image of the used resolution chart. Second measurement is done when the eyepiece is adjusted to the other end position. The test result for NVGs "Prilep" has shown diopter adjustment from –4.5 dpt to +4.5 dpt, which is in the needed range from –4 dpt to +4 dpt.

Interpupillary adjustment

The distance between the eyes differs from person to person. The adjustment for this difference is accomplished by opening or closing the hinged portion of the NVGs.

The testing has been done by the standard caliper gauge. The end interpupillary distances L_1 and L_2 are measured and the eye-piece diameter is subtracted (Fig. 4). The test is successful if the measured distances are between 54 mm up to 72 mm and the NVGs "Prilep" testing gets exactly the same range.

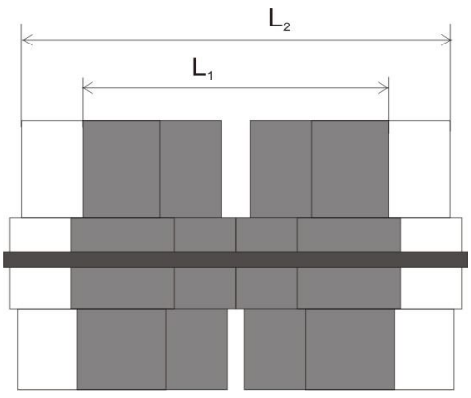

Fig. 4. Interpupillary adjustment testing

Results from NVGs “PRILEP” test

The testing procedure has been done in low luminance radiation. The optical magnification of NVGs “Prilep” is 1,0^{x}. The test results from measurement of the field of view are 43.30°. Most devices of the same class have a field of view of 40.0°.

NVGs	Magnification	Field of view,	Diopter adiustment. (dpt)	Eye lelief distance, mm	Exit pupil diameter, mm	Interpupillary adjustment, mm
NVGs “Prilep”	1.0^{x}	43.30°	–4.5 up to +4,5	22.0	15.0	54 up to 72
Other NVGs averages	1.0^{x}	40.0°	–6 up to +2	15	NA	55 up to 71

The NVGs “Prilep” have passed full military testing for Bulgarian army and implementation armament. The NVGs “Prilep” are produced by the Bulgarian company “ElkoE”.

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Някои оптични характеристики на очила за нощно виждане “Прилеп”

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(Резюме)

В настоящата работа са представени някои методики за измерване на оптичните характеристики на очила за нощно виждане “Прилеп” – увеличение, зрително поле, отдалеченост и диаметър на изходната зеница, диоптрична настройка и попилно разстояние. По описаните методики са измерени параметрите на разработения български уред – очила за нощно виждане „Прилеп“. Получените параметри са сравнени с параметрите на

други уреди от същия клас. Измерените показатели показват различия при параметъра зрително поле, който е 43.30°, а при другите фирми е 40.0°. При по-голяма част от очилата за нощно виждане с военно предназначение, диоптричната настройка на окуляра е от +2 до –6, а при очилата „Прилеп“ е от +4,5 до –4,5.