Aircrew visors and visual performance under varying levels of illumination

Sqn Ldr N Taneja

No. 1 Sqn, AF c/o 56 APO, India

MK Vyawahare, B. Aravindakshan

Institute of Aerospace Medicine, IAF, Bangalore 560 017, India

Visors form an integral component of the aircrew flying clothing assembly. They serve various protective functions, and their requirements are laid down by MILSPECS 43511. This study investigated the effects of varying levels of illumination on the visual performance, with and without the use of visors. A total of 60 subjects participated in this study, in which the four visors currently in use were evaluated. The time to recover visual function on exposure to bright illumination varied with the levels of illumination and the type of contrast used. The time to read also showed a similar trend. Visors produced a significant reduction in the above parameters. A glare of 2000 lux did not affect the visual acuity or target detectability but produced a significant reduction in the glare. For the parameters tested the visors conformed to MILSPECS, except for luminous transmittance. It appears that luminous transmittance at different levels of illumination does influence the visual performance. The visor with the least luminous transmittance was rated the best by the subjects. The operational significance of the findings are discussed in this paper.

Keywords: Visors; Visual performance; Illumination levels.

Vision is of special importance in aviation, as almost 80% of the information needed to fly is provided by the visual senses [1]. In the search for something better than man's eyes, various electronic and electrooptical aids have been developed, but despite all these innovative advances, man's eyes will continue to play a vital part in aviation.

Coexistent with the technological advances are the increasing stresses imposed on the human physiology. Vision is one of the special senses that can be affected by various flying stresses. Inherent to the various physiological problems associated with vision are the characteristics of the pilot's environment and its variability. Of the various environmental factors which could influence a pilot's visual performance in flight are characteristics like glare, brightness of the surroundings, camouflage, contrast, illumination of targets, colour contrast and flashes of high-intensity light.

To counteract the visual problems associated with the physical environment in flying, various types of visors are recommended for use by the aircrew. MILSPECS V 43511 of 1976 lays down the requirements/standards of these visors [2]. However, a different situation exists in our Air Force. For example, different aircraft, like the Jaguars, MiGs, and Mirages, originate from different countries and have their own aircrew flying clothing assemblies.

The question is whether similar/uniform standards are being followed by different countries. Another problem is that aircraft fly under extremely different geographical terrains, with the same/more or less the same clothing assembly. The question is whether the flying clothing assembly is suitable for all types of terrains. In the context of the present study, are the different visors adequate for the terrain over which they are being used?

With the above in mind and with no data available on the performance characteristics and limitations of these visors under varying flying conditions, this study was undertaken to evalu-

ate the visual performance using different kinds of visors.

The main objectives of this study were:

1. To study the effects of varying levels of illumination on visual performance.
2. To study the effects of aircrew visors on visual performance under varying levels of illumination.
3. To compare the various aircrew visors presently being used by the aircrew for the above parameters.

Material and methods

We used four visors for the study. These were procured locally and are currently in use in IAF. They are: Jaguar tinted visor (grey), ABEU tinted visor (grey), Russian visor green and Russian visor brown.

These visors were first tested for the following: luminous transmittance, optical distortion, refractive power and colour transmittance (subjective). The second part of the study was aimed at evaluating (i) the time to recover visual function on exposure to illumination levels of 5000 lux to 20,000 lux, and (ii) the time to read the last two lines of Snellen's distant vision chart using three different sets of contrast levels: black letters on white background (B/W), brown letters on yellow background (B/Y) and grey letters on white background (G/W). The various parameters were recorded with and without the use of visors. Next we studied the effect of glare on the visual performance and the role a visor plays. A glare of 2000 lux was produced at the subject's eyes such that the glare did not fall directly on his eyes. The effect of visors, if any, on colour perception of targets and their percentage of detection was then studied.

Results and discussion

Table 1 shows the average levels of luminous transmittance of the various visors tested. It is obvious that none of the visors tested conformed to the standards laid down by MILSPEC'S, i.e. a luminous transmittance of 12–18%. Moreover, the luminous transmittance is seen to increase with increasing levels of illumination. However, the standard of 12–18% laid down by MILSPECS does not specify the range of illumination. If, however, our aircrew are satisfied with the visors in use, then we need to carry out more studies to lay down our own requirements and standards.

Table 1. Average levels of luminous transmittors of the various visors

Visor	5000 lux	10,000 lux	15,000 lux	20,000 lux
Jaguar	23	23	30	37.5
ABEU	22	22.5	30	36
Russian green	37	38.5	45	51
Russian brown	37	38	40	49.5

All values are percentages

Table 2 shows the time to recover and read on exposure to varying levels of illumination. It is seen that the time to recover visual function after being exposed to bright levels of illumination is a function of the level of illumination as well as the contrast of the target. The time to recover continued to increase from 15,000 to 20,000 lux. At higher levels of illumination the time to recover may still be much higher. This time is significant because during this time the pilot would be flying blind or with reduced visual function. The time to recover and read was maximum for grey on white target.

Visors produced a remarkable decrease in the time taken for the eyes to recover and read under various levels of illumination tested; however, there was no statistically significant difference between these visors despite the wide luminous transmittance range of the visors. None of the subjects preferred the brown visor when reading the brown target on yellow background. When one of the authors discussed this point with pilots who have flown over the desert are flying currently over that region, they are quite unanimous in expressing that they prefer to fly with the visor up than down.

A glare of 2000 lux at the subject's eyes produced only a subjective discomfort, with no effect on the visual acuity. Visors, as they are meant to, gave ample protection against this glare and it was seen that the visor with the

Table 2. Trend to recover and read an exposure to varying levels of illumination

	Time to recover (s)			Time to read (s)		
Lux	Black on white	Black on yellow	Grey on white	Black on white	Black on yellow	Grey on white
5000	2.9	3.3	3.2	9.9	11.5	11.4
15,000	23	31	39	11.2	12.7	13.4
20,000	32.8	39.2	51	12.5	14	14.7

lowest range of transmittance was the one which was subjectively rated the best (ABEU visor). Visors did not influence the target detectability or the colour perception of targets at the levels of illumination tested.

Conclusions

1. The luminous transmittance of none of the visors at any of the illumination levels tested was in the range specified by MILSPECS.

2. Subjects showed a preference for the visors with lesser transmission values as the levels of illumination increased.

Recommendations

1. We need to carry out further studies to lay down the standards for visors for our requirements. At present we have blue, green, brown and grey-coloured visors in our inventory. We need to find out which is suited for which terrain or whether a single visor can be used effectively over all terrains.

2. For this we will have to carry out further studies:

   at more levels of illuminations;
   with more graded contrasts; and
   field studies over different geographical terrains.

References

1. Stringer FS. Optimization of pilot capability and avionic system design. In: AGARD Report No. 118, Neuilly-sur Seine, AGARD, 1978.
2. MILSPECS V 43511. Aircrew Visors Polycarbonate, 1976.