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High Contrast Filters and Their Use in the Aviation Environment (Reprint)

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HIGH CONTRAST FILTERS AND THEIR USE IN THE AVIATION ENVIRONMENT

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ABSTRACT

There is a persistent perception that visual performance can be improved through the wearing of yellow tinted (blue-blocking) glasses, visors, etc. A review of past studies was conducted to identify a trend in performance effects. An additional series of laboratory and field investigations was conducted to evaluate performance with color identification tasks. The general findings support the conclusion that while performance for a specific task under specific environmental conditions may be enhanced through the wearing of blue-blocking filters, blanket use of such filters would result in more tasks and conditions where performance is degraded than those where performance is enhanced.

BACKGROUND

The perception that viewing through "yellow" (also referred to as "minus-blue," "amber" or "blue blocking") filters (i.e., glasses, goggles, or visors) improves visual performance has been a persistent one. These filters are particularly popular in fog, haze and snow environments. While buried in folklore, this concept can be traced back in the literature to as early as 1912.[1] And even today, a reader giving only a cursory look through current general interest hunting and gun magazines will find more than one advertisement for "high contrast" shooter's glasses.

The military has been no exception to the concept of "yellow" goggles or visors. In combat, where even the smallest edge can make the difference between life and death, soldiers, sailors and aviators are all looking for that one improvement which will make the difference. In response, the tri-service community, over the years, has conducted numerous studies to investigate the possible benefits of using these "vision enhancers,"[2-16]

The U.S. Army has had a continuous interest in the potential use of "yellow" visors in haze and snow environments. Users among the tri-service community claim that "yellow" filters increase target acquisition performance and enhance contour differences in border detection tasks." However, virtually all studies have failed to find any significant improvement in performance.

By theory, any filter prevents light of a particular wavelength or band of wavelengths from passing through the filter and into the eye. This action reduces the amount of information which the user receives. Therefore, in principle, these filters can not allow a user to see "something" which was not there before. However, filters can improve signal to noise ratios, thereby improving probability of target detection.

This paper documents the most recent revisiting of the "yellow" visor issue. The Army is currently fielding the newer Head Gear Unit model 56/P (HGU-56/P) aviation helmet. It is replacing the Sound Protective Helmet model 4-B (SPH-4B). Although not authorized for Army-wide use, "yellow" visors have been in use by certain units. These visors were manufactured to fit the older SPH-4 series helmets. As the individual SPH-4B helmets have been replaced, aviators found they could not transfer their yellow visors. This resulted in a flood of requests for HGU-56/P compatible yellow visors. These requests were forwarded to the office of the Program Manager-Aircrew Integrated Systems (PM-ACIS), Huntsville, Alabama. PM-ACIS is responsible for the development of Army aviation life support equipment. In May 1999, the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama, was asked to take another look at the yellow visor performance issue to include performance for tasks in snow and glacier environments.

DEFINING THE "YELLOW" FILTER

Before progressing too much further, it is important to point out that this issue is complicated by the fact there is no single "yellow" filter or visor. The use of the qualifying terms "yellow," "amber," "high contrast" is not well defined.

As explained by Boff and Lincoln,[16] the visible filter colors of yellow and amber do not necessarily relate exactly to specific spectral transmissions. However, all of the various perceptual shades of yellow filters will attenuate the wavelengths in the blue region to some degree. In addition to the transmissions at specific wavelengths, the perception of yellow is also influenced by several factors, such as the type and amount of lighting, the reflectance or emittance of objects, and the adaptive state of the eye to both overall illumination and by wavelength.

Glass filter materials are classified as ionically colored from ions of transition elements or rare earths and/or colloidallv colored. Most plastic and gel filters are made by dissolving suitable organic dyes, The filters can be either uniform within the optical media or coated to the media.

The Kodak Photographic Filters Handbook" lists 10 Wratten filters (#2A (pale yellow), 2B, 2E, 3,8, 9, 11 (yellow-green), 12, 15, and 16 (yellow-orange) as yellow filters. The primary differences in the spectral curves are the slopes of the curves and the 10% transmission points, where the #2B filter transmitts approximately 10% at 400 nanometers (nm) and the #16 filter transmitts 10% at approximately 525 nm. The #12 yellow filter transmits approximately 10% at 505 nm.

Schott Optical glass filters label the long pass filters with a suffix according to the approximate 50% transmission point and the prefix color codes for yellow and orange filter series are GG and OG, respectively." The 50% transmission interval between the different long pass filters is approximately 20 nm. The slope of the spectral curves covers approximately 30 nm from the 10% to the 95% transmission points.

Likewise, several versions of yellow visors have been identified. Gentex Corporation, Carbondale, Pennsylvania, a major supplier of protective visors used in the Army, provided USAARL with spectral data for two versions of the yellow visor. They were identified and labeled as “amber” and “high contrast.” The amber visor is believed to be of a design developed in the late 1970’s; the high contrast visor is of a design developed for the U.S. Air Force for Desert Shield (1994). Figure 1 shows the spectral transmittance curves for these two visors. The amber visor has a 3dB (50%) cutoff at approximately 470 nm; for the high contrast visor, the cutoff point is at a significantly higher wavelength of approximately 515 nm. A sample of another yellow (amber) visor was obtained from an Alaskan Army aviation unit. The spectral transmittance curve for this visor is shown in Figure 2. Also included in Figure 2, for comparison, is the spectral transmittance curve for the Army’s Class I clear visor. The yellow (amber) visor shows a 3dB down point at approximately 470 nm and is very likely a sample of the Gentex amber visor.

METHODS

Two approaches were used to assess filter/visor performance. First, a review of current and past literature was conducted. Second, using photographic and video techniques, laboratory and field experiments were conducted to assess the effects of filter use selected operational tasks

Literature Review: The literature search located over 200 papers in which some aspect of the form or function of blue blocking filters was studied. The following are synopses of the more important and relevant papers:

Perhaps the best explanation of why things look brighter with yellow filters was reported in a recent article on the “Effect of Yellow Filters on Pupil Size” by Chung and Pease (1999).” The yellow filter was a CPF 550 and pupil sizes were measured over approximately 4 log units (0.144 to 18,150 cd/m^2) to 18,150 cd/m^2)with the yellow filter and

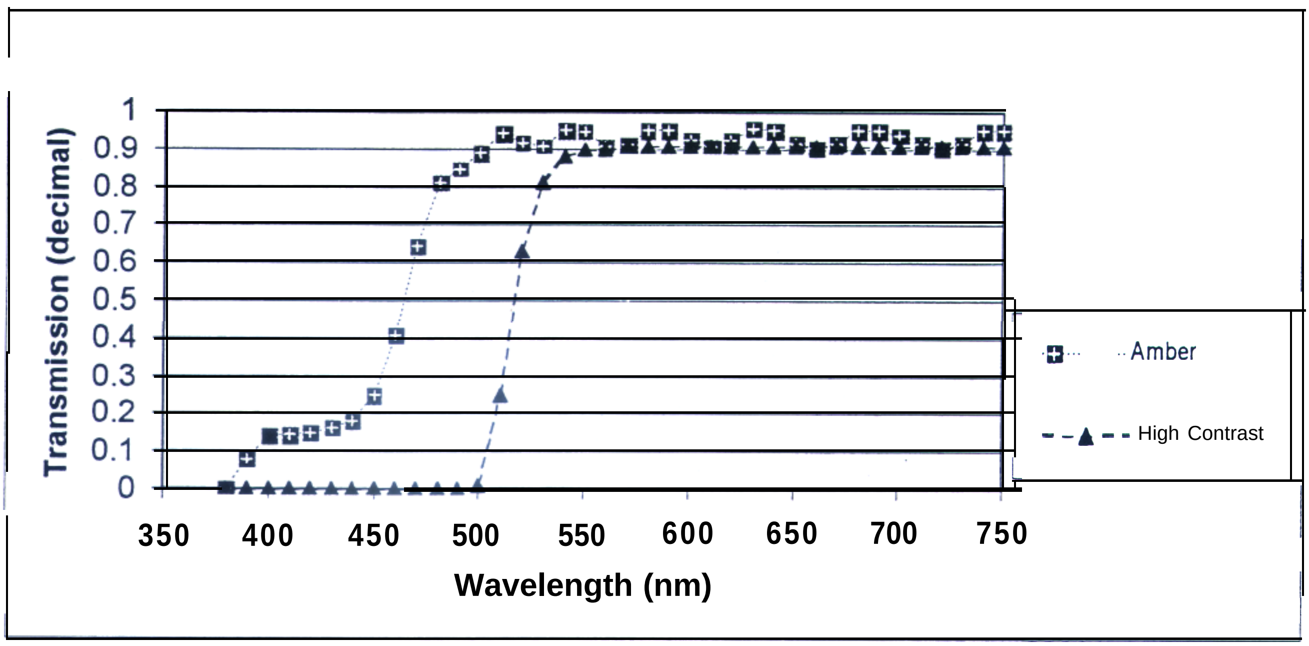

Figure 1. Spectral transmittance curves for Gentex amber and high contrast visors.

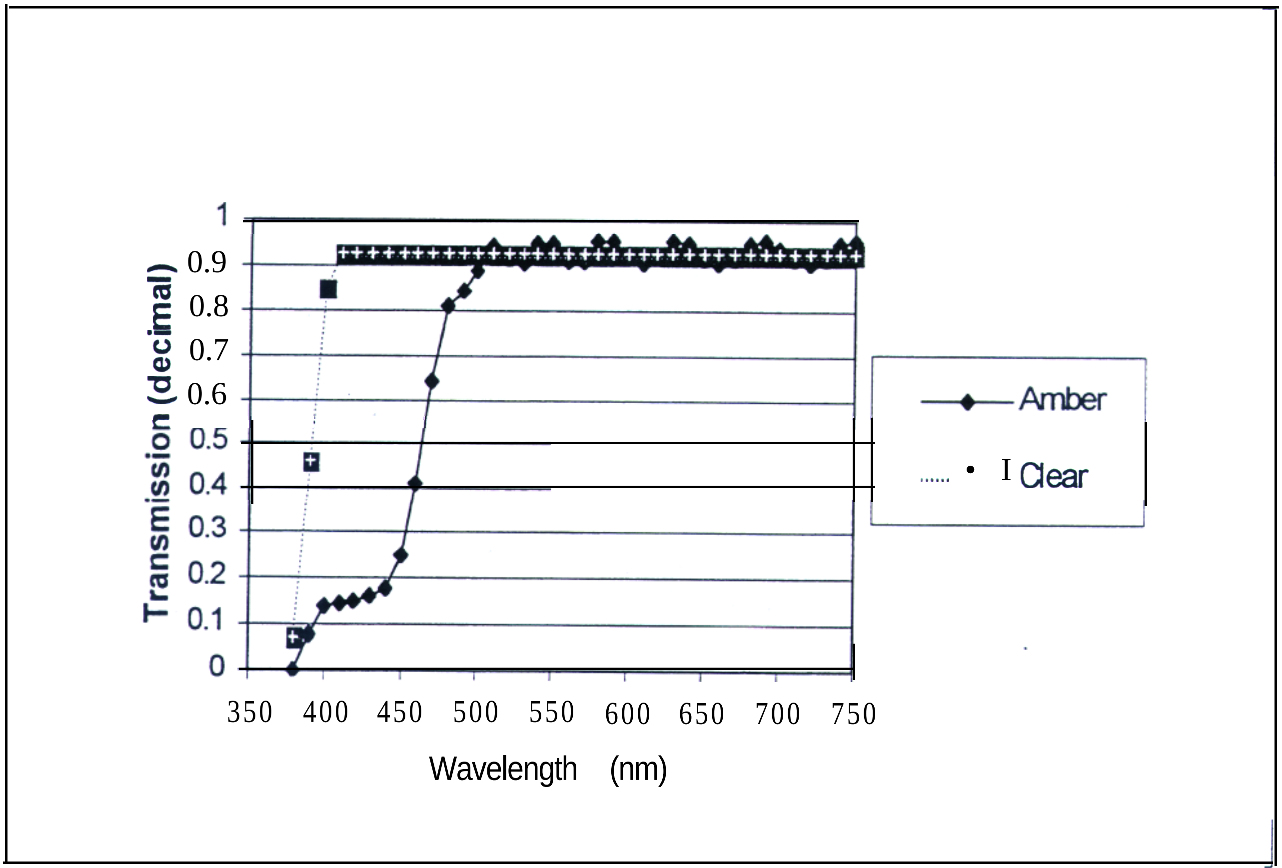

Figure 2. Spectral transmittance curves for Alaskan yellow and Army Class I clear visors.

with neutral density filters. The pupil size with the yellow filter was equivalent to a neutral density filter of approximately 40% transmission. The study concluded that the pupil diameter was larger with the yellow lens which may explain some of the reported apparent brightness enhancement. [This paper contains 9 references.]

Rabin and Wiley (1996)[15] had seven subjects match suprathreshold contrasts using a colored monitor and slitting the viewing area vertically. Yellow letters were varied in size and contrast on a brighter yellow background (109 cd/m^2) on one side of the field. Subjects adjusted the contrast of gray letters on a white background (113 cd/m^2) on the other side of the field to match the yellow letter contrast . Four letter sizes from 20/75 to 20/600 Snellen acuity equivalent and four contrasts from 7.4% to 62.5% were used. The authors found no significant differences with changing letter size, but an approximately 23% difference in contrast matched adjustments between the yellow and gray displays for the 7.4% and 15% targets was found, with the yellow letters requiring less contrast. Repeating the experiment using two subjects with and without a 3-mm artificial pupil, they found the contrast enhancement with the yellow filters dropped from 24% to 13%. Therefore, pupil size may explain part of the phenomenon, but not all. [This paper contains 9 references.]

Heikens (1995)[20] provides a good literature review of the use of yellow filters or "blue blockers" for aviation going back to 19 12. The author concludes that although subjective reports from fighter pilots have been mainly favorable, all operational evaluations of yellow filters have failed to show any improvement in the visual acquisition of small targets under any atmospheric conditions. The author recommended blue-blockers not be used for most flying environments because of “their adverse effects on distance perception, interpretation on certain terrain features, potential for hazards to disappear, and the difficulties encountered in instrument readings and the loss of certain map features.” [This paper contains 52 references.]

Provines et al. (1983; 1992),[11,13] using 20 subjects and 400 visual acquisitions of T-38 aircraft on predictable approaches to landing, found no significant differences in acquisition performance due to the use of yellow filters (~470 nm cutoff). The environmental conditions varied from clear skies to overcast. They concluded that “yellow lens wear neither enhanced nor degraded visual acquisition performance for detection of approaching aircraft under high-ambient illumination and good visibility conditions.” [These papers contains 10 references each.]

Rieger (1992)[21] measured contrast sensitivity with the Visual Contrast Test System (VCTS 6500) for 15 subjects with and without yellow filters and found a statistically significant improvement with the yellow filters. Note: The yellow filters used in this study were tinted CR-39 lens. Spectral transmittance data were not provided. [This paper contains 7 references.]

Kuyk and Thomas (1990),[22] using the Corning CPF 550 and other blue-blockers filters, found significantly lowered performance on the Farnsworth-Munsell 100-Hue test and three hue identification tasks below levels obtained in either neutral-density filter or no-filter conditions. [This paper contains 29 references.]

Aarnisalo (1988),[23] using 7 different Schott Glass yellow filter glasses (cutoff values of 404, 420, 426, 438, 480, 497, and 5 10 nm), found reductions in photopic and scotopic luminosities in all but the 404-nm filter. Filtered photopic luminosities were reduced by as much as 22%, scotopic by 64%. The author also investigated the effects of these filters on color discrimination (1987).[24] Using the Farnsworth-Munsell 100-hue test, 10 subjects were tested for the 7 filters above. Reduced color discrimination was found for those filters having cutoff values of greater than 480 nm. [These papers contain 12 and 21 references, respectively.]

Kelly et al. (1984)[25] measured contrast thresholds for achromatic stationary and drifting sinusoidal gratings using 52 and 44 subjects, respectively, and found no statistically difference in performance with a yellow filter or a transmission matched neutral density filter. However, subjectively, the subjects preferred the yellow filter 2 to 1 over the neutral density filter. [This paper contains 7 references].

Corth (1985),[26] in responding to Kinney and Luria (1983),[9] criticized their findings of improved depth perception. Corth states his experience had shown the opposite conclusion where the effectiveness of the yellow filters over snow diminishes with increasing overcast skies. He offers the argument that the yellow filter enhances the contrast under clear skies due to the high blue spectral content of scattered skylight. He states this enhancement decreases with decreased illumination. [This paper contains 3 references.]

Yap (1984)[27] found monocular contrast sensitivity was improved with yellow filters (80% transmission) under photopic conditions, but this improvement was not significant at most spatial frequencies under mesopic (twilight) conditions. [This paper contains 12 references.]

Kinney and Luria (1983)[9] reported improved estimation of depth depressions in snow with yellow goggles (58% correct) than with neutral gray goggles (50% correct) with 60% transmission for overcast skies, but not for clear skies. Forty skiers were asked which of two 0.7-meter diameter depressions was deeper at viewing distances of 5 to 30 meters in 5 meter increments. Unfortunately, the investigators did not use forced choice, but allowed the subjects to respond or not, counting the nonresponses as misses. Therefore, beyond 15 meters, the correct responses fell below the chance value of 50%. [This paper contains 42 references.]

Schlichting et al. (1980)[8] used 34 subjects to determine the distance to detect a series of either 4 or 5 holes in the snow and determine which was the shallowest and the deepest. The study was conducted just after sunset in flat snowy terrain. The subjects wore either a yellow lens goggle or a 60% neutral density goggle. The mean detection and depth of hole distances for the yellow filter lens was greater, but the differences were not statistically significant. Approximately 70% of the subjects preferred the yellow filter and thought it enhanced their vision. [This paper contains 32 references.]

Kinney et al. (1980)[7] reported the results of several laboratory and field studies on the effects of yellow filters. Two tests of stereopsis (Howard-Dolman and random-dot stereograms), depth estimation, contrast sensitivity, and reaction times were conducted. The results showed no difference in stereoacuity, but improvements in the perception of low contrast contours were found with the yellow filters. [This paper contains 45 references.]

Richards, W.A. (1973)[28] also measured contrast sensitivity to sine-wave gratings and found an adaptive process to the yellow filters after a few seconds where any measured improvements within the first three seconds of viewing through the yellow filters were nullified within 8 seconds. He also noted that contrast for certain colored targets against a particular background either becomes more or less visible with spectral filtering viewing. He suggested the possibility of using two complementary color filters in each eye, such as yellow in one eye and a blue in the other, to ensure maximum contrast in one of the eyes. [This paper contains 63 references.]

Dobbins and Kindick (1965)[3] evaluated three types of lenses as aids to personnel detection in a semideciduous tropical forest. The lenses were yellow (50% transmission at 460 nm), red (50% transmission at 580 nm) and dichroic (0% transmission between 575 to 590 nm) The results showed no significant improvements and were not recommended. [This paper contains 4 references.]

Bierman, (1952)[29] and Ross (1950)[30] showed no improvements with yellow filters, although commonly used, in shooting accuracy. Bierman studied 136 soldiers at Fort Leonard Wood, Missouri, on rifle ranges of 100, 200 and 300 yards under optimum conditions. Ross studied 21 U.S. Marine Corps riflemen using 6 different filters. [Neither paper contains any references.]

Photographic and video images: Attempting to describe the effects of yellow filters on various scenes and color shades via theory and spectral plots is not as effective as comparing the images with and without the various yellow filters. A number of laboratory and field experiments were conducted:

Color spectrum: A standard visible color spectrum chart was viewed with and without a #12 yellow Wratten filter (10% at 505 nm and 50% at 5 15 nm). The primary difference noted was the absence of the blue component below 490 nm which appears black and the color shift towards green for the spectral band between 490 and 560 nm when viewed through the filter. This loss of the blue portion of the visible spectrum is where the term "blue blocker" originates.

Color checker chart: The Munsell color checker chart commonly is used in adjusting color balance in sensors and displays. Both photographs and video images of the color checker chart show the same effect when yellow filters are used in front of the sensor such as a video camera or when the unfiltered image is viewed through a #12 (515 nm) or the Alaskan visor (470 nm) yellow filters. In actual viewing of the chart, very little changes are seen in the yellows, reds and greens; and the blues appear as blacks or greens. The gray scale is now a yellow scale where white can not be distinguished from the yellow color. For individuals with normal color vision, the color perception changes with the yellow filter would be approximately the same.

Aviation sectional charts: Aviation maps color code information such as areas with dense populations and urban structures (yellow), water (blue), altitude of terrain (light green for low to dark browns for high terrain), restricted areas (blue), controlled airspace (blues and magenta). When these maps are viewed with the yellow filters, resulting color shifts cause a loss of information. For example, population and urban structures blend away and water and restricted areas appear greenish.

Resolution charts: High and low contrast Bailey-Lovie charts were viewed and photographed with and without the #12 yellow Wratten filter. As in agreement with previous, more controlled studies, no effect on resolution was noted. However, if a difference in resolution is seen with the yellow filter image, the probable cause is the viewer's refractive error and chromatic aberrations of the eye. The few individuals who report resolution improvements typically also see resolution improvements when viewing through small minus power ophthalmic lenses (-0.25 to -0.50 diopter). To determine the spherical power for a distant lens prescription, eye examiners frequently use the red-green bichrome test which exploits the color aberrations of the eye. This will be discussed in the effects section of this paper.

Signaling smoke grenades: Signaling colored smoke canisters were obtained with the colors red, green, yellow, and violet. The canisters were activated at a firefighters' training site and video recorded from both the ground and an orbiting helicopter. For the ground video recordings, one of the two cameras used a yellow #12 Wratten filter. The video camera in the aircraft did not use any filters. The distance fi-om the aircraft to the cannister activation point was approximately 1/4 mile at an altitude above ground level (AGL) of approximately 600 feet. Review of the unfiltered ground and air video recordings while viewing through the yellow filter showed that the red and green colors were not affected, but the yellow smoke looked white and the violet smoke looked orange, which is the same noted when viewing the color checker chart. The ground yellow filtered video tape showed the same color changes.

Analysis of color and saturation changes with yellow filters: The color shifts and saturations caused by viewing through two different yellow helmet visors were analyzed by a spreadsheet program previously developed for analyzing filter effects in Army cockpits. The lighter yellow visor transmitted a small percent of blue light and the 50 percent transmission point occurred at 470 nanometers. The "high contrast" darker yellow vision did not transmit blue wavelengths and the 50% transmission point was 5 15 nanometers (Figure 3). Selected phosphors used in cockpit multifunction color displays (Figure 4) and Munsell colored dyes on the Commission Internationale de l'Eclairage (CIE)Uniform Chromaticity Scale (UCS) were modeled with both visors. The analysis showed significant color shifts in the display phosphors (Figures 5a and 5b) and Munsell colored dyes (Figures 6a and

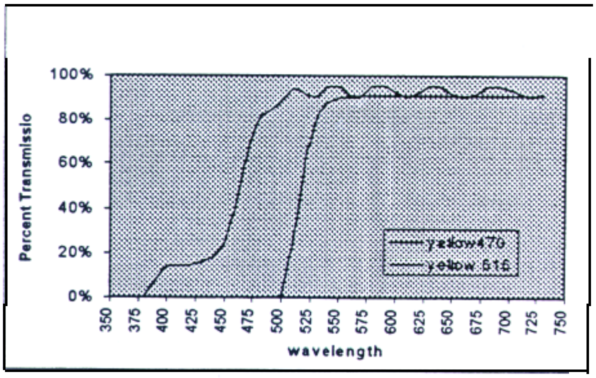

Figure 3. Yellow 470 and 515 visors.

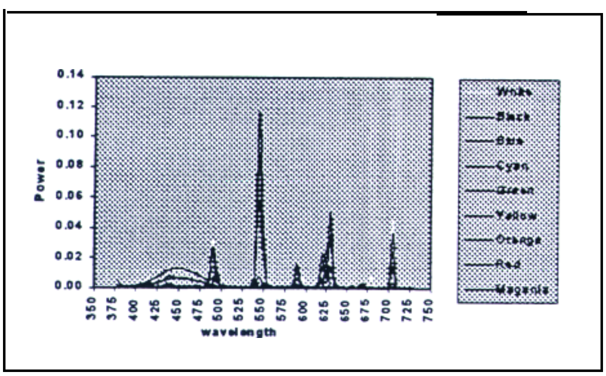

Figure 4 Display Phosphors

6b) with the yellow visors with more shift from the 5 15 nanometer "high contrast" filter than the 470 nanometer filter. All colors shifted toward the red-green saturation line of the CIE UCS.

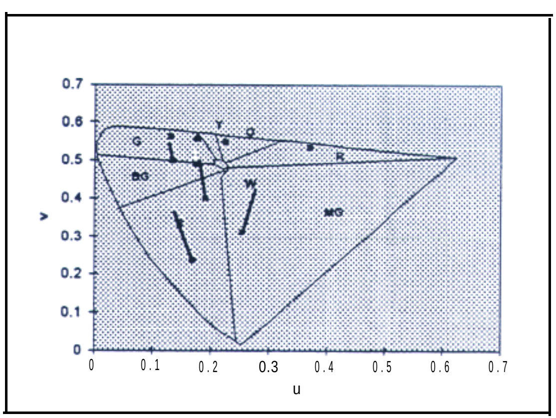

Figure 5a. Color shift in selected phosphors for yellow 470 visor

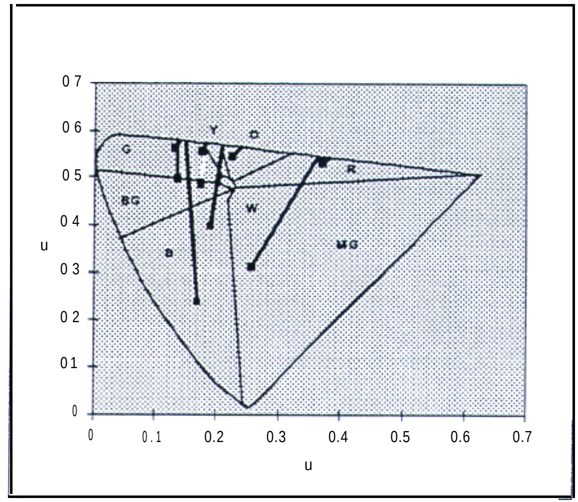

Figure 5b. Color shifts in selected phosphors for yellow 515 visor

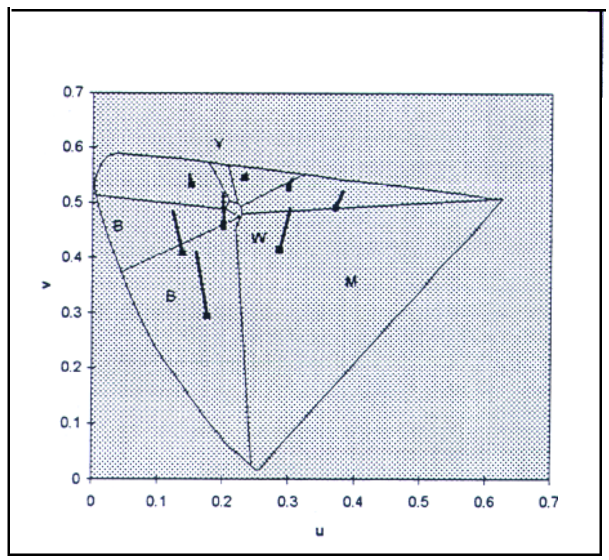

Figure 6a. Color shifts in selected Munsell color squares for yellow 470 visor

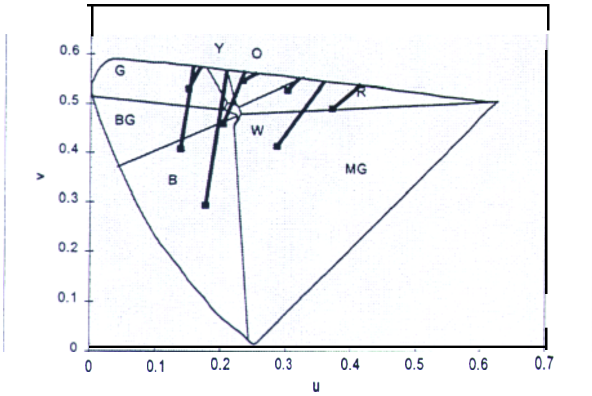

Figure 6b. Color shifts in selected Munsell color squares for yellow 515 visor

<u>Personal observations:</u> On 16 March 1999, during cross country flight from Fort Rucker, AL to Redstone Arsenal, AL, the following personal observations were made while wearing yellow and standard gray sun visors installed in an HGU-56/P helmet. Flight times were 0545 to 0900 hours and 1400 to 1600 hours. Conditions were: Skies clear and visibility 20 miles; humidity approximately 45%; and barometric pressure 30.16 to 30.20 inches Hg. Altitudes varied from ground level to approximately 4500 feet AGL the following observations comparing the vision with and without the yellow visor:

1. Prior to sunrise, there was a noticeable dimming of vision when using the yellow visor compared to no visor or a clear visor. This had been noted on several night flights before. Around sunrise, the yellow visor seemed to neither dim nor brighten the image. Gradually, approximately 30 minutes after sunrise, the image appeared brighter with the yellow visor than without. However, neither resolution nor detection appeared to be improved.

2. After approximately 30 minutes after sunrise, the tinted sun visor was used in conjunction with the yellow visor on this very bright and clear day

a. Smoke from small brush tires was difficult to detect with the yellow visor. When closer to the tires, the smoke at the source could be seen with the yellow visor, but the size and length of the smoke along the direction of the wind were smaller.

b. Water in ponds, creeks, and puddles in fields was more difficult to differentiate from other growth with the yellow visor.

c. Resolution of wires did not seem to make any difference with or without the yellow visor.

d. Dirt roads and trails, brown, clay, and sandy in color, seemed to have more color contrast with the yellow visor, but there were no parts of the dirt roads that were only visible with the yellow visor and not visible without the yellow visor.

e. Hard surface roads had less contrast with the yellow visor than without. However, there was no road that could not be seen with the yellow visor, but could be seen without the visor.

f. The color contrast between green and brown foliage appeared more pronounced with the yellow visor than without. Red and green colors appeared more saturated.

g. Immediately after sunrise, fog layers formed over streams and ponds. The top of the fog varied slightly like snow over terrain. No difference was noted between the shape and valleys in the fog with or without the yellow visor.

h. Just above the horizon, a thin brownish-yellow layer, probably from industrial discharge, was not visible with the yellow visor.

i. The appearance of haze and aerial perspective were reduced with the yellow visor. At very low altitudes without the yellow visor, tree lines at increasing distances were desaturated with increasing amounts of light gray to white.

DISCUSSION

Contrast and color chances:

When the blue end of the spectrum is removed from a scene, there are certain predictable effects on color shifts and contrast of objects within that scene. As shown with the color shift analysis, the reds and greens become more saturated with the yellow filters, and the colors of blue and white are absent (blue is attenuated and white is perceived as yellow).

The appearance of haze is basically white, which means the spectral content is a balance of the red, green, and blue components. When the blue component is filtered out, the haze is not as apparent to the observer, but visibility through the haze is essentially the same. In other words, the visible radiance energy that is transmitted through the atmosphere to the observer would be the same except the blue components would be attenuated with the yellow filter.

At night, colored lights are used at airports to provide information to the pilots. Blue lights outline taxiways. At larger air terminals, green taxiway turnoff lights may be used to lead the pilot on a curved path from the runway centerline to the center of the intersecting taxiway Taxiway centerline lights, if installed, also are green. With the high contrast yellow visors, pure blue light is not transmitted. All broad band blue lights would appear green. All white or yellow lights would appear yellow.

Placebo and adaptive effects:

Subjective reports of improved visibility, acuity, contrast, and brightness occur by approximately 60% to 70% of individuals participating in previous yellow filter studies.[8, 11, 25] Reducing the blue components in a scene will give the appearance of reduced haze and potentially dilate the pupils more than the equivalent neutral density transmission. When the blue components of an image are filtered out, the visual system begins to increase the eye sensitivity to blue light. This is easily demonstrated by placing a yellow filter in front of one eye and viewing scenes and backgrounds with broad band spectrums. After only about 1 minute, the initial differences between the color shades seem to diminish between the two eyes except for blue and yellow objects. When the yellow filter is removed, the image previously viewed through the yellow filter will have a distinct bluish or hazy appearance compared to the unaided eye.

Gains and losses:

Several researchers on the yellow filter issue have mentioned that for any improved contrast between a specific colored target and background with yellow or any other spectral filters, there will also be as many or more color combinations that will yield less contrast and visibility between the object and background. However, removing one (blue) of the three primary colors from the visual image has the potential to mask objects with blue and white components that are used for color coded information to the aviator.

Refractive errors:

For individuals who are slightly nearsighted, there is a possible improvement with the use of yellow filters. As previously noted, the eye has chromatic aberrations, which means the red wavelengths focus further from the cornea than green wavelengths; blue wavelengths focus even closer. The red-green bichrome test is used by eye examiners to adjust the spherical component when determining the refractive status of a person. Slightly nearsighted persons see letters clearer in the red end of the spectrum than in the blue end; whereas, slightly hyperopic individuals see letters clearer in the blue end of the spectrum. This is very evident by the beginning presbyopic aviator, who have noted that aircraft with blue and white cockpit lighting are easier to see than cockpits with red lighting. For those individuals who can demonstrate improved resolution with yellow filters, a similar small minus power spherical lens such as -0.50 diopter will show a similar resolution improvement.

Effects on night vision:
As the ambient light level decreases, the visual system shifts from photopic (day) vision to scotopic (night) vision. The cones, which transmit color vision, are less sensitive to light than the rods, which are predominately used for night vision. With the shift from photopic to scotopic vision, the eye also becomes more sensitive to the blue end of the spectrum and less sensitive to the red end. This shift in color sensitivity with changes in light level is called the Purkje shift. Therefore, the same "high contrast" yellow filter (OG 515) that has the equivalent of 78% day (photopic) transmission will only have 36% equivalent night (scotopic) transmission.[23] As the 50%-point of the yellow filters occurs more towards the blue end of the spectrum, the differences between the equivalent photopic and scotopic transmissions also narrow.

The cockpit lighting for Army aircraft has been converted from red to blue-green to provide compatibility with night vision image intensifiers. Since the yellow visors are blue blockers, the blue lighting and caution/warning segment lights are much dimmer through yellow filters. A caution to this effect was disseminated to the Army aviation community in June 1995.[31]

Many commercial advertisements for yellow night driving glasses provide testimonies of improved visibility, less glare, better dark adaptation, etc. However, research on these yellow glasses fail to support these claims.[32-34]

Compliance with MIL-V-43511C neutralitv and chromaticity:The two yellow visors evaluated do not meet the clear visor requirements stated in MIL-V-43511C, Visors, flyer's helmet, polycarbonate.[35] We received a light colored yellow visor (approximately 470 nm) from an Alaskan Army aviation unit in 1995 and conducted tests to determine if the yellow visor met the percent transmission, neutrality and chromaticity specifications for Army helmet visors. The results showed that the 470 nm met the percent transmission requirements, but failed to meet the neutrality specification.

CONCLUSIONS

From the literature review, laboratory assessments, and personal observations, we can not recommend using yellow visors for Army aviation, even though the majority of the aviators who have looked through yellow glasses or visors subjectively prefer the yellow filtered image over the nonspectrally tinted image. However, if there is a condition or situation where the yellow filter could improve detection or recognition, we believe that any full color image capture system such as colored photographic film or video tapes can be used to show this effect. The full-colored image, whether a hard copy photograph or a colored monitor, can be viewed with the appropriate yellow or other spectral filter and the visual perceptions will be very similar to the actual scene for any changes in contrast, resolution, or color. The Alaskan Army aviation unit that requested approval to procure yellow or high contrast amber visors has been challenged to photograph or video tape the conditions under which the yellow filter improves visual perception. We hope to have some image samples to compare this winter and possibly personally observe with and without yellow filters during flight operations over snow.

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