A Color Comparator for Lights in the Vicinity Of Traffic Signals

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In city driving conditions there exists the problem of advertising signs of the same or nearly the same color and in close proximity with traffic signals causing the driver to confuse the two.

An instrument designed to be used in the comparison of the colors of distracting lights with established color limits is to be discussed. The color limits, suggested by the National Bureau of Standards, delineate those which are considered unlikely to be confused with traffic signal colors, red and green. The device utilizes an optical system that contains neutral density wedges, a field splitting prism and a standard reference source consisting of a tungsten source operated at a specific color temperature and selected glass filters.

In use, a light source such as a neon advertising sign, in close proximity with a traffic light, is selected. It is then to be determined whether the source is within the range of allowable colors. The instrument is aimed at the source and the nearest matching color from the reference source is selected by means of a rotating filter holder. Then the field brightness or the reference source brightness is adjusted by means of the density wedge associated with it until a brightness match is obtained in the split image field. The reference source impinges upon two semicircles separated by a small distance and the remainder of the circular field contains the source to be measured. It is then determined whether the external source is within the range of allowable colors. In the case of the green limit, for example, whether the external source is bluer or greener than the reference source.

Relating this to the standard ICI color triangle, the green limit is a line given by $y = x + 0.040$ and the red limit is a line given by $6 = x - 0.240$. These lines are established by three filters for each line. If the color to be measured falls in between any two reference colors, the observer must use his experienced judgement to make a determination.

Some field observations are to be presented and discussed.

Confusion of sign colors with traffic signal colors is a real problem in city driving and the subject requires further study so that practical limits can be established that are not unduly restrictive yet will avoid the distractions that now exist.

● COLORED LIGHT from advertising and display sources has reached such extensive use and variety of color that there is a definite possibility of interference of these light sources with the traffic signals. In some instances the color of the background advertising and display sources is so close to the color of a traffic signal that they render the signal practically invisible. In Contra Costa County, California, a proposal has been made to limit the color of advertising and display signs to colors outside the range of traffic signals, thereby reducing the loss of visibility of traffic signals due to color interference.[1]

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[1] Ordinance 1009, Sec. XIII, Illuminated Signs.

Subsection 1. All outdoor advertising structures wherever situated in the unincorpor-

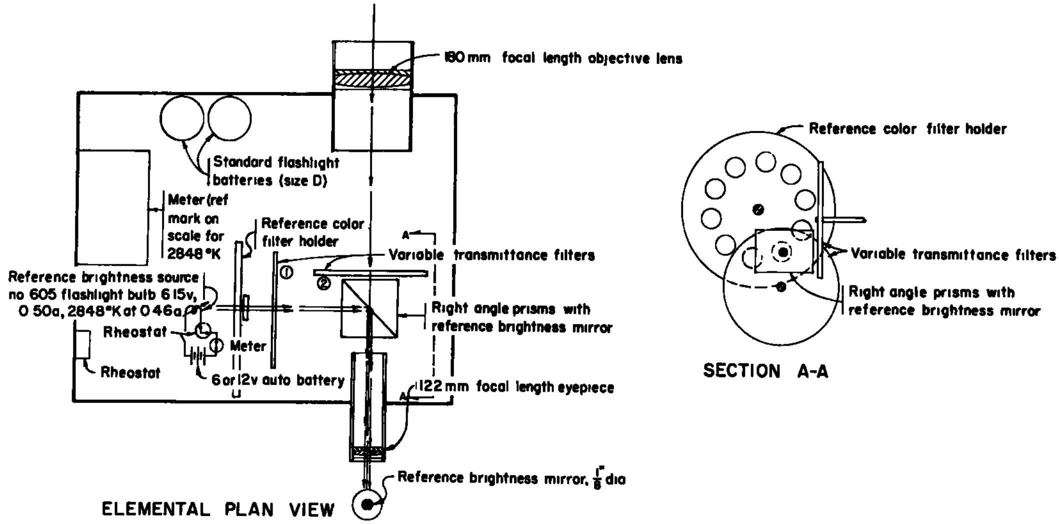

Figure 1. Color comparator for lights in the vicinity of traffic signals.

In order to evaluate the range of colors permitted for advertising and display signs the Public Works Department, Contra Costa County, Martinez, California arranged to have a color comparison meter and a field procedure developed by the staff of the ITTE in the Illumination Laboratory of the University of California. The results of the investigation are presented herein and the instrument that was developed is described. This instrument allows the operator to determine the relative color of a sign or light with respect to the adjacent traffic signal, and it enables the operator to determine whether or not the color of the sign is within the allowable limits.

Design of a Color Comparison Meter

The characteristics desired in the instrument were as follows:

1. The specified limit colors shall be accurately reproduced.
2. The brightness of the limit colors shall be variable and capable of being made comparable to those found in advertising signs and displays.
3. The instrument must be portable.
4. The reference colors shall be defined in terms of the ICI trichromatic color coordinate system.

The instrument design is shown in Figure 1. The variable transmittance neutral

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ated territory of Contra Costa County which are within the descriptions of Subsection 2 hereof, shall not have a light source or surface which fails to meet the color specifications of Subsection 4 hereof.

. . . .

Subsection 3. Color specifications. Colors are defined herein in terms of the chromaticity coordinates defined on April 11, 1951, by the American Standards Association, Incorporated, 70 East 47th Street, New York 17, New York in their standard designated "American Standard Method for Determination of Color Specifications Z58. 7. 2-1951."

Subsection 4. Color specifications for illuminated signs.
The chromaticity coordinates for colors which are not confusible with traffic signal colors must be as follows:
Y must be greater than X minus 0. 240 (to avoid confusion with red traffic signal).
Y must be less than X plus 0. 040 (to avoid confusion with green traffic signal).

filter (1) satisfies the condition that the brightness of the limit colors can be made comparable to the brightness of adjacent advertising signs. The variable neutral filter (2) in the path of the object serves to reduce the object brightness to a desired level, thus permitting a brightness match between the object field and the reference brightness source. The color filters are inserted between the reference brightness source and the variable filter (1) to permit a color match. The variable transmittance filters are of the evaporated aluminum type and are very nearly neutral. The reference light source is a No. 605 flashlight bulb operated at 0.46 amps to give the spectral distribution of Std. Illuminant A (2848 K).

The optics consist of a coated achromat objective lens of 180 mm focal length with a coated achromat eyepiece lens of 122 mm focal length. A mirror is placed at the focal plane of the objective lens at 45 deg to the main optical path and forms a ⅛-in. diameter split field image of the reference brightness source. The mirror is an ellipse at 45 deg to the principal focal plane so that it projects as a circle in the focal plane. The circle of the mirror is split with a clear central strip so that a color comparison may be made between two areas of the reference color and the color of the advertising or display source to be evaluated.

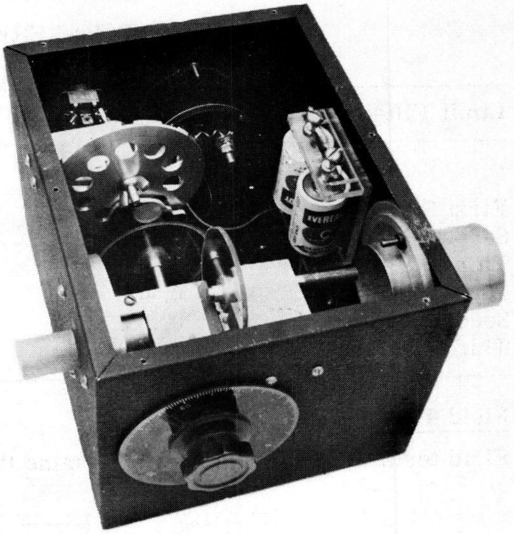

Figure 2. Color comparator instrument.

A photograph of the instrument is shown in Figure 2.

Procedure for Use of the Instrument

1. Adjust both variable filters for maximum transmittance and then focus the optics on the scene.
2. Match the brightness of the questionable light source in the scene to the brightness reference source in the instrument by selecting the correct color filter and then rotating either or both variable mirrors until a visual brightness match is made. Select the color filter that is the nearest in hue to the source being evaluated.
3. Look at the questionable light source in the field to view and determine its chromaticity in terms of the reference color.

The steps will give a qualitative evaluation of the color of the advertising sign with respect to the adjacent traffic signal if both are approximately the same brightness. The color of the sign can be approximately located on the trichromatic color chart of Figure 3.

Limit Filters

The instrument incorporates the color filters suggested by D. B. Judd of the National Bureau of Standards in a letter to Francis J. Collins, District Attorney, Contra Costa Co., Martinez, California, dated October 19, 1955, as being those which will not be confused with traffic signal colors.

In the ICI system the recommended color limits are:

1. y must be greater than $x - 0.240$ to avoid confusion with the red traffic color.
2. y must be less than $x + 0.040$ to avoid confusion with the green traffic signal.

The National Bureau of Standards suggested the use of Lovibond glass filters with the specifications shown in Table 1 as color limits. The actual filters that were obtained were quite close to these limits and are shown plotted in the ICI color triangle in Figure 3.

TABLE 1

LOVIBOND REFERENCE COLOR FILTERS
(Used with Standard Illuminant A)

Limit Filter	Chromaticity	Coordinates	Lovibond Notation		
	x	y	R	Y	B
First Red	0. 615	0. 375	13. 5	20. 0	0
Second Red	0. 580	0. 340	14. 0	0	0
Third Red	0. 540	0. 300	23. 0	0	5. 5
First Green	0. 400	0. 440	0	5. 0	5. 0
Second Green	0. 320	0. 360	0	1. 5	8. 0
Third Green	0. 240	0. 280	0	2. 5	14. 5

Field Tests

Field tests were conducted to determine the effectiveness of the meter. Two areas

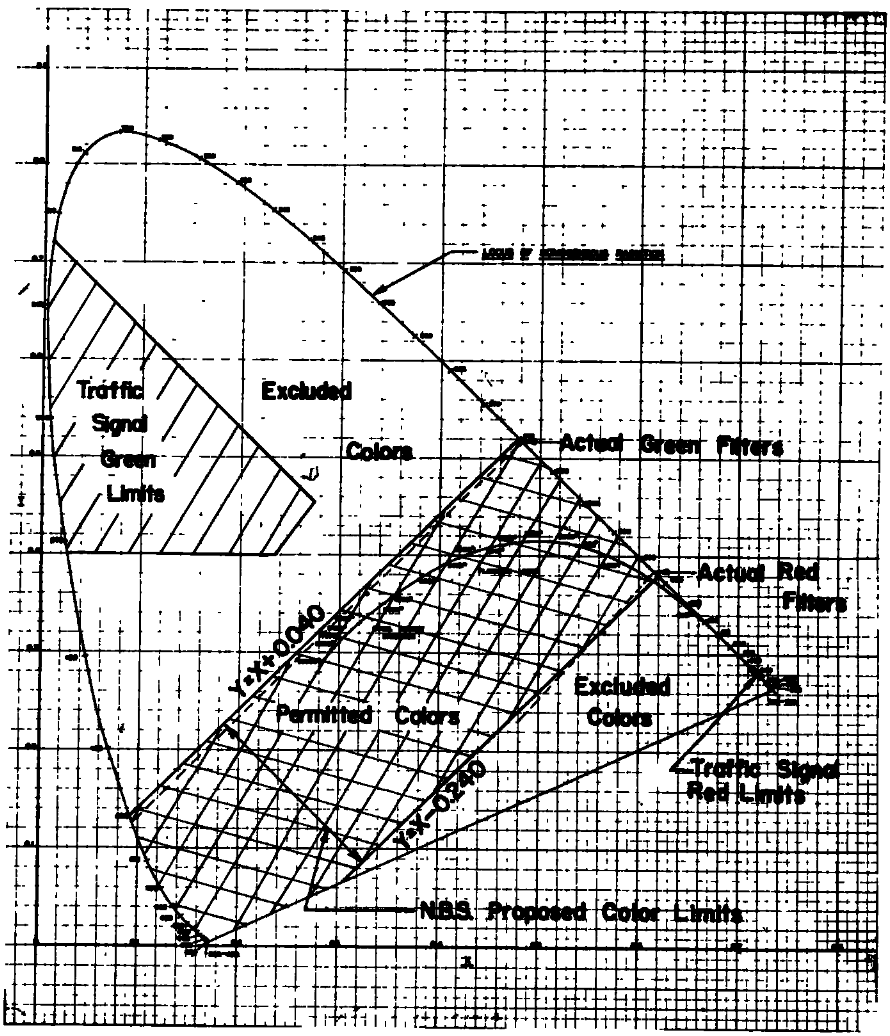

Figure 3. Trichromatic color chart.

were selected, one being a congested downtown intersection having a high concentration of advertising and display signs and traffic signals on every corner. The second area was a retail business district with less sign density than the above intersection area and had random placement of traffic signals.

RESULTS

It was determined that the meter gave a good indication of the chromaticity of the colors observed but that several additional limiting color filters would be desirable.

Approximately 90 percent of the reddish, greenish or blueish signs fall within the excluded area on the chromaticity diagram of Figure 3.

DISCUSSION

Strict enforcement of the Contra Costa County Ordinance would mean the elimination of a very large number of advertising and display signs in the vicinity of traffic signals.

The problem resolves itself into two conditions, namely (a) signs being mistaken for signals and (b) signal lights being invisible in a confusion of background signs. In the former case (a) it is felt that the color limits used in the experimental meter give a fair indication of colors that might be mistaken for signal lights. There is the question though of whether this condition has much importance. The error of seeing too many signals, while somewhat discomfiting to the driver, should cause no serious harm. It is the second condition; namely, signals becoming invisible in a background confusion of similarly colored signs, that is the important problem.

The instrument as it is now designed will give an answer to problem (b) but we are not satisfied that the answer is correct. The meter indicates that almost all of the red, green or blue hues used in advertising and display signs would cause the signal to be mistaken or missed by a driver. The color limits for permitted colors seem to be too narrow but there is not sufficient data to recommend where the limits should be located. The permitted colors could be somewhat closer to the traffic signal color limits (see Fig. 3).

There are several variables that could not be isolated in the preliminary investigations with the instrument. They are as follows: 1. Time factor—Since the investigators were consciously searching out both signals and signs that might be confused with traffic signals, the actual condition of the average driver with the many distractions of driving was not reproduced. For an average driver the time available for detecting signals is much more restricted. 2. Familiarity—There are cues that suggest the existence of traffic signals over and above their actual visibility. For example, in a downtown area one would expect signals on every corner; one may note other stopped cars presumed to be at a traffic signal. Other cues, although somewhat unreliable, are pedestrians. 3. Color blindness—What the normal observer would not confuse, the color-blind person might, and conversely. Since about 5 percent of the population is color-blind, their number is significant.

There is still another element in the discrimination of signal lights, in a maze of other lights—brightness differences. A bright light of a given hue (say a blue-green signal light) may be visible although somewhat desaturated in color when it is surrounded by less bright lights of a similar hue even though the surrounding lights may be quite close to the color of the signal and within the area of excluded colors. In this instance the brightness of the signal rather than its hue is the primary factor in its detection. The signal may or may not be seen depending upon the brightness differences. In the opposite situation where the surrounding lights are much brighter than the signal lights, the color of the signal again tends to lose its importance since the glare of the surrounding lights masks the signal and makes it very difficult to detect even when the colors of the two are grossly different. It is mainly the condition where the signal and the background signs are of approximately equal brightness that color differences or similarities are important.

CONCLUSIONS

The work that has been done so far indicates that a field technique to compare actual advertising and display colors with reference limit colors is practical.

It appears that the color limits suggested by the NBS are unduly restrictive. It would seem that the blue-green and red limit for advertising and display signs could be set closer to the signal green and signal red colors (see Fig. 3).

Before the actual limits can be unequivocally set, further research must be conducted and the aforementioned variables held constant insofar as possible in controlled laboratory experiments.