STANDARDISATION OF LIGHT SIGNALS FOR ROAD TRAFFIC CONTROL

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1. Introduction

Light signals for road traffic control are applied in an increasing number of cases in order to promote the flow of traffic at highly trafficked intersections. Although individual waiting times may increase, it is generally accepted that the capacity of intersections and road safety are increased.
International harmonisation of industry and traffic requires standardisation; lacking better grounds, these standards are usually based on the plausible assumption that road-traffic-control signals must be clearly visible for all road users. "Clearly visible" cannot be defined precisely, but it is usually understood as being well above the threshold of visibility found in a laboratory set-up.

In recent years, a number of countries have set up national recommendations, regulations or standards for traffic signals. Although they show a certain similarity, important discrepancies still exist that are unfavourable to trade and transportation. The International Commission on Illumination (CIE) took the initiative for further international harmonisation. A Technical Report has been prepared, which will be published in the near future (CIE, 1981). This paper briefly discusses that report.

The CIE-report is restricted to those aspects of road-traffic-control signals that are directly seen by the users and are directly related to the signaling function. It does not cover other important matters concerning traffic signals, such as traffic engineering matters, the regulatory status, the legal obligations of local authorities and the road user, and electrical and mechanical engineering.
The report deals with the colour, the luminous intensity, and the luminous intensity distribution of signal lights. The "phantom effect" is also discussed. Since recognition of "cut-out" figures, or symbols, used with lights has become important, the report examines some details of their shape and size. Only lanterns of 20- and 30-cm diameter are considered.

2. Colours

Road-traffic-control signal lights consist normally of three separate units that emit red, yellow (or amber), and green light.

The colours given in the CIE-Technical Report are in agreement with the CIE recommendation (CIE, 1975). In road traffic, people whose colour perception is defective can take part as pedestrians and drivers. Therefore, even the "restricted" green was considered too wide, and further restrictions are given. See Table I. The result is a rather blu-ish green, and amber yellow, and a light (nearly orange) red. See Verriest (1980).

Colour of signal	Boundary	Equations
Red	Purple+	$y = 0.990 - x$
	Yellow+	$y = 0.320$
	Red+	$y = 0.290$
Yellow	Red	$y = 0.382$
	White	$y = 0.790 - 0.667x$
	Green	$y = x - 0.120$
Green	Yellow+	$y = 0.726 - 0.726x$
	White	$x = 0.650y$
	Blue	$y = 0.390 - 0.171x$
White	Yellow+	$x = 0.440$
	Purple	$y = 0.047 + 0.762x$
	Blue	$x = 0.285$
	Green	$y = 0.150 + 0.640x$

+ Denotes a restricted boundary

Table 1. Recommended colour boundaries for light signals for road traffic control.

3. Peak intensity and light distribution

For normal roads and for built-up areas, the rule-of-thumb value of 100 m has been adopted as the minimum distance from which signals must be (clearly) visible. When perceived from 100 m, lenses of 30- and 20-cm diameter have discernable dimensions. However, experiments did show that for viewing conditions that pertain to practical conditions of road traffic - notably taking into account the peripheral vision - the "power" of the beam can be described adequately in terms of the luminous intensity alone. Considerable research has indicated that under full daylight conditions a peak value (maintained value) of 200 cd ensures adequate visibility (see, for example, Adrian (1963); Cole & Brown (1968); Jainski & Schmidt-Clausen (1967); Fisher (1971). It is desirable that at night the peak intensity should be between 50 and 100 cd; intensities of less than 25 cd or more than 200 cd should be avoided. At least 100 cd should be provided in directions making an angle of $\pm$ 11° lateraly or 8° down with the beam axis. Further research is required to find out whether a more detailed description of the beam and of the light distribution is necessary.

4. Shape of symbols

It is recommended to have the signal as a light-emitting cut-out figure on a dark (black) background, rather than a dark symbol on a bright background. Because the latter suffers from irradiation, the signal with a symbol can easily be confused with the roundel signal without a symbol. It is important to ensure that the luminance of the symbol is reasonable uniform.

5. Phantom effect

When light enters the signal latern from the outside, it may - after reflection and refraction - be emitted in a way similar to the way in which light is emitted from a signal in operation. These are called phantom effects. Their adverse consequences can be reduced in a number of ways:

1. By reducing the light that falls into the lens (e.g. by means of hoods or louvres);
2. By reducing the light emitted after refraction (e.g. by special optical construction of the lens, or the mirror; by special lamps; by additional, internal shields);
3. By ensuring that signals in operation are always considerably "brighter" than the phantom (e.g. the minimum value of 200 cd);
4. By limiting the confusion by means of redoubling the signals and locating them in less "vulnerable" position in the intersection.

Further research on this matter is desirable; particularly since it is not completely clear at this time at what level the phantom effect begins to be really disturbing.

6. Additional equipment and signal location

Background screens help to identify and to localise the signal in the road and, by reducing the glare from the sky, may reduce the requirement for the peak intensity. Background screens are considered an essential part of all road-traffic-control signal installations.
The location of the signals at the intersection is also important. However, because intersections may vary considerably in size, shape, and layout, general rules can hardly be given. Furthermore, there are legal differences in traffic regulations from one country to the other.

7. Conclusion

The CIE Technical Report is the first attempt at international harmonisation and standardisation for road-traffic-control signal lights. The obvious next step is to prepare official CIE Recommendations. As the results of the first tentative steps toward international co-operation already indicate, such recommendations can be of considerable benefit for road traffic.

8. References

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