

A COMPARISON OF CURRENT U.S. AND EUROPEAN STANDARDS  
FOR SIDE-MOUNTED TURN AND MARKER LAMPS

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| 16. Abstract<br><p>This study was designed to examine the possibility of recommending specifications for a dual-purpose device that would function as both a front side marker lamp and a side turn signal lamp. The research consisted of three activities. The first activity involved preparation of tabular comparisons of current U.S. and European standards for side marker lamps, side turn signal lamps, as well as front and rear turn signal lamps. The second activity consisted of analyzing the current standards. The third activity involved developing recommendations concerning a dual-purpose lamp based on the current U.S. and European standards.</p> <p>The results indicate that (both in the U.S and in Europe) the standards for the side turn signal lamps and the front side marker lamps are different in several respects, presumably because these two types of lamps are designed to serve different functions. The differences include mounting height, photometric and visibility angles, photometric minima, and constraints on flashing. However, there is no agreement about the relative importance of these two types of lamps. In the U.S., the front side marker lamps are required, but the side turn signal lamps are optional; the situation is reversed in Europe.</p> <p>Our conclusion is that the functional intent of the current U.S. and European standards concerning these two types of lamps for automobiles would be equally well served by a single lamp that is based on the overlapping properties of the equipment that is currently mandatory: the U.S. front side marker lamps and the European side turn signal lamps. Proposed values for such a lamp are provided.</p> <p>This study did not examine the rationale for the current standards. Future research should focus on this issue to address whether, in combination, the two separate functions of the rear turn signal and flashing front side marker lamps (or some slight modifications of either) would satisfy the functional intent of the front side turn signal lamps.</p> |  |  |   |   |           |
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## INTRODUCTION

This study was designed to examine the possibility of recommending specifications for a dual-purpose device for automobiles that would function as both a front side marker lamp and a side turn signal lamp. The research consisted of three broad activities. The first activity involved preparation of tabular comparisons of current U.S. and European standards for side marker lamps, side turn signal lamps, as well as front and rear turn signal lamps. (Front and rear turn signal lamps were included to summarize information provided by lamps about upcoming turns.) The second activity consisted of analyzing the current standards. The third activity involved developing recommendations concerning a dual-purpose device based on the current U.S. standard for side marker lamps and the European standard for side turn signal lamps. (This study did not examine the rationale for the current standards.)

## DEFINITIONS

### **Functional intent**

The U.S. vehicle standards are issued by the U.S. Department of Transportation, in Federal Motor Vehicle Safety Standard (FMVSS) No. 108. However, these standards rely, in part, on the Standards, Recommended Practices, and Information Reports of the Society of Automotive Engineers (SAE). (In tables to follow, we will make a distinction between language from FMVSS 108 and language originally from SAE documents.) The European standards are those of the Economic Commission for Europe (ECE) of the United Nations.

Table 1 presents the definitions of the functional intent for the four types of lamps of interest. These definitions were taken from the respective U.S. and European standards. The U.S. and European definitions for the turn signal lamps (front, rear, and side) are functionally equivalent. However, there is a major difference between the U.S. and European definitions of side marker lamps. The U.S. definition stresses the demarcation of the *length* of the vehicle, while the European definition deals only with the *presence* of the vehicle.

Table 1  
 Functional intent of turn signal (direction-indicator) lamps, side turn signal lamps,  
 and side marker lamps (J588 = SAE Standard J588, J592 = SAE Information  
 Report J592, J914 = SAE Standard J914, R48 = ECE Regulation No. 48).

| U.S.                             |   | Europe   |  |
|----------------------------------|---|--|--|
| Lamp                             | Functional intent   | Lamp   | Functional intent  |
| front and rear turn signal lamps | “the signaling elements of a turn signal system which indicate an intention to turn by giving a flashing light on the side toward which the turn will be made” (J588, 2.2.1)  | front, rear, and side direction-indicator lamp | “the lamp used to indicate to other road-users that the driver intends to change direction to the right or to the left” (R48, 2.7.11.) |
| side turn signal lamps           | “a lighting device normally mounted on the side of a vehicle at or near the front, and used as part of a flashing turn warning signal on the side toward which the vehicle operator intends to turn or maneuver” (J914, 2.) |  |  |
| side marker lamps                | “lamps mounted on the permanent structure of the vehicle as near as practicable to the front and rear edges, that provide light to the side to indicate the overall length of the vehicle” (J592, 2.2.2)                    | side-marker lamp                               | “a lamp used to indicate the presence of the vehicle when viewed from the side” (R48, 2.7.23)  |

## Visibility requirements versus photometric requirements

The standards for all four types of lamps of interest contain two separate, but related, aspects: geometric visibility (or, for short, visibility) requirements and photometric requirements. The visibility requirements specify that the lamp must be visible within a certain range of horizontal and vertical angles. The underlying goal is to assure that throughout the specified angles no structure of the vehicle obscures the effective light-emitting surface of the lamp. The formal definition of geometric visibility in the ECE Regulation 48 is as follows:

“Angles of geometric visibility” means the angles which determine the field of the minimum solid angle in which the apparent surface of the lamp must be visible. That field of the solid angle is determined by the segments of the sphere of which the centre coincides with the centre of reference of the lamp and the equator is parallel to the ground. These segments are determined in relation to the axis of reference. The horizontal angles  $\beta$  correspond to the longitude and the vertical angles  $\alpha$  to the latitude. There must be no obstacle on the inside of the angles of geometric visibility to the propagation of light from any part of the apparent surface of the lamp observed from infinity. (R48, 2.13)

However, the requirement of “no obstacle on the inside of the angles of geometric visibility” is immediately relaxed (in the same paragraph) as follows:

If, when the lamp is installed, any part of the apparent surface of the lamp is hidden by any further parts of the vehicle, proof shall be furnished that the part of the lamp not hidden by obstacles still conforms to the photometric values prescribed for the approval of the device as an optical unit. (R48, 2.13)

The U.S. standard does not explicitly define visibility. Instead, it requires that

each lamp . . . shall be located so that it meets the visibility requirements specified in any applicable SAE Standard or Recommended Practice. (FMVSS 108, S5.3.1.1)

And, analogously with the European standard, it states that (for passenger cars)

no part of the vehicle shall prevent . . . any . . . lamp from meeting the photometric output at any test point specified in any applicable SAE Standard or Recommended Practice. (FMVSS 108, S5.3.1.1)

Importantly, visibility requirements do not specify luminous intensity minima that need to be directed in certain directions. Instead, that is dealt with in the second, related aspect—photometric requirements. Here the angles specify the directions towards which certain amount of luminous intensity must be directed.

## **CURRENT U.S. AND EUROPEAN STANDARDS**

Tables 2 through 5 list the current standards concerning color, height, location, photometric angles and minima, visibility angles, and restrictions concerning flashing for front, rear, and side turn signal lamps, and side marker lamps. However, vehicle marking and signaling is a relatively active area. For example, both SAE and GTB (Groupe de Travail "Bruxelles 1952") are currently working on proposing modifications to the existing U.S. and European standards. Therefore, the information in Tables 2 through 5, while valid as of December 31, 1993, might be modified in the near future.



Table 2  
Current U.S. and European standards for front turn signal lamps (108 = FMVSS 108, J588 = SAE Standard J588, R48 = ECE Regulation No. 48, R6 = ECE Regulation No. 6).

| Aspect   | U.S.   |               | Europe  |                               |
|--|--|---------------|---|-------------------------------|
|  | Specification  | Reference     | Specification   | Reference                     |
| Applicability  | Overall width < 2032 mm  | 108, J588     | All   | R48                           |
| Color  | Amber  | 108, Table IV | Amber   | R48, 5.15                     |
| Height †   | Same height, ≥ 38 cm, ≤ 211 cm   | 108, Table IV | ≥ 35 cm, ≤ 150 cm*  | R48, 6.5.4.2.2                |
| Location   | At or near the front, as far apart as practicable  | 108, Table IV | Outer edge to vehicle edge: ≤ 40 cm; ≥ 60 cm apart (edge to edge)       | R48, 6.5.4.1                  |
| Largest photometric angles <sup>Δ</sup>                  | ±20°H, ±10°V   | J588, 5.1.5.2 | ±20°H, ±10°V; also visibility angles below                              | R6, Annex 4                   |
| Photometric minima at selected large angles <sup>§</sup> | ≥ 25 cd at ±20°H, ±10°V  | J588, 5.1.5.2 | ≥ 17.5 cd @ ±20°H, ±5°V; 0.3 cd @ -45°, +80°H, +15°V                    | R6, 6.1, 6.2.3.1, and Annex 4 |
| Visibility angles <sup>Δ</sup>                           | Same as the photometric angles; also 0° to +45°H (no vertical angles), for area ≥ 12.5 cm <sup>2</sup> | J588, 5.4.1   | -45° to +80°H<br>-15°‡ to +15°V   | R48, 6.5.5                    |
| Flashing   | Required   | 108, S5.5.10  | Required; all turn signals (front, rear, and side) shall flash in phase | R48, 6.5.7                    |

†U.S.: to the center of the lamp.

Europe: maximum to the highest point, minimum to the lowest point.

\*If the structure of the vehicle makes it impossible, the maximum is 210 cm.

ΔThe horizontal angles are with respect to the longitudinal axis of the vehicle.

§U.S.: for lamps with one lighted section.

Europe: for single lamps not less than 4 cm from the headlamp.

‡If the height is less than 75 cm, this value is -5°.

Table 3

Current U.S. and European standards for rear turn signal lamps (108 = FMVSS 108, J588 = SAE Standard J588, R48 = ECE Regulation No. 48, R6 = ECE Regulation No. 6).

| Aspect   | U.S.  |               | Europe  |                                  |
|--|---|---------------|---|----------------------------------|
|  | Specification   | Reference     | Specification   | Reference                        |
| Applicability  | Overall width<br>< 2032 mm  | 108, J588     | All   | R48                              |
| Color  | Amber or red  | 108, Table IV | Amber   | R48, 5.15                        |
| Height †   | Same height,<br>≥ 38 cm,<br>≤ 211 cm  | 108, Table IV | ≥ 35 cm,<br>≤ 150* cm   | R48, 6.5.4.2.2                   |
| Location   | On the rear, as<br>far apart as<br>practicable  | 108, Table IV | Outer edge to<br>vehicle edge:<br>≤ 40 cm;<br>≥ 60 cm apart<br>(edge to edge)       | R48, 6.5.4.1                     |
| Largest<br>photometric angles <sup>Δ</sup>                     | ±20°H, ±10°V  | J588, 5.1.5.2 | ±20°H, ±10°V;<br>also visibility<br>angles below                                    | R6, Annex 4                      |
| Photometric<br>minima at selected<br>large angles <sup>§</sup> | ≥ 15 cd<br>(amber)<br>≥ 10 cd (red) @<br>±20°H, ±10°V   | J588, 5.1.5.2 | ≥ 5 cd @<br>±20°H, ±5°V;<br>0.3 cd @ -45°,<br>+80°H, +15°V                          | R6, 6.1, 6.2.3.1,<br>and Annex 4 |
| Visibility angles <sup>Δ</sup>                                 | Same as the<br>photometric<br>angles; also<br>0° to +45°H<br>(no vertical<br>angles),<br>for area<br>≥ 12.5 cm <sup>2</sup> | J588, 5.4.1   | -45° to +80°H<br>-15°‡ to +15°V   | R48, 6.5.5                       |
| Flashing   | Required  | 108, S5.5.10  | Required; all<br>turn signals<br>(front, rear, and<br>side) shall flash<br>in phase | R48, 6.5.7                       |

†U.S.: to the center of the lamp.

Europe: maximum to the highest point, minimum to the lowest point.

\*If the structure of the vehicle makes it impossible, the maximum is 210 cm.

<sup>Δ</sup>The horizontal angles are with respect to the longitudinal axis of the vehicle.

<sup>§</sup>U.S.: for lamps with one lighted section.

Europe: for single lamps not less than 4 cm from the headlamp.

<sup>‡</sup>If the height is less than 75 cm, this value is -5°.

Table 4

Current U.S. and European standards for side turn signal lamps (108 = FMVSS 108, J914 = SAE Standard J914, R48 = ECE Regulation No. 48, R6 = ECE Regulation No. 6).

| Aspect   | U.S.   |               | Europe   |                      |
|--|--|---------------|--|----------------------|
|  | Specification  | Reference     | Specification  | Reference            |
| Applicability  | Optional; information below applies to vehicle < 9.1 m in length           | 108           | All cars for no more than 9 persons, and all cars and light trucks ≤ 6 m in length | R48, 6.5.3           |
| Color  | Amber  | J914, 5.1.7   | Amber  | R48, 5.15            |
| Height <sup>†</sup>                                      | ≥ 68.5 cm, ≤ 122 cm  | J914, 5.3.3.2 | ≥ 50 cm, ≤ 150* cm   | R48, 6.5.4.2.1       |
| Location   | As close to the front as practicable                                       | J914, 6.2.1   | Center of the lamp to the front edge of the vehicle: ≤ 180 cm                      | R48, 6.5.4.3         |
| Largest photometric angles <sup>Δ</sup>                  | -30°, -70°H<br>-5°, +15°V  | J914, 5.1.5   | -30°, -85°H<br>-15° <sup>‡</sup> , +15°V   | R6, 6.2.1.1, Annex 1 |
| Photometric minima at selected large angles <sup>§</sup> | ≥ 5 cd @ -70°H, +15°V;<br>≥ 15 cd @ -70°H, 0°V                             | J914, 6.1     | ≥ 0.6 cd @ -85°H, +15°V  | R6, 6.2.1.1          |
| Visibility angles <sup>Δ</sup>                           | same as the photometric angles (i.e., -30° to -70°H<br>-5° to +15°V)       | J914, 5.3.1   | -30° to -85°H<br>-15° <sup>‡</sup> to +15°V  | R48, 6.5.5           |
| Flashing   | Required; either simultaneously or alternately with the front turn signals | J914, 5.3.2   | Required; all turn signals (front, rear, and side) shall flash in phase            | R48, 6.5.7           |

<sup>†</sup>U.S.: to the center of the lamp.

Europe: maximum to the highest point, minimum to the lowest point.

\*If the structure of the vehicle makes it impossible, the maximum is 230 cm.

<sup>Δ</sup>The horizontal angles are with respect to an axis perpendicular to the longitudinal axis of the vehicle. Positive angles are in the forward direction, negative in the rearward direction.

<sup>§</sup>U.S.: for lamps with one lighted section.

Europe: for single lamps not less than 4 cm from the headlamp.

<sup>‡</sup>If the height is less than 75 cm, this value is -5°.

Table 5  
Current U.S. and European standards for side marker lamps (108 = FMVSS 108, J592 = SAE Information Report J592, R48 = ECE Regulation No. 48, R91 = ECE Regulation No. 91).

| Aspect                                      | U.S.  |               | Europe <sup>§</sup>  |               |
|---|---|---------------|--|---------------|
|   | Specification   | Reference     | Specification  | Reference     |
| Applicability                               | Overall width < 2032 mm   | 108           | Optional *, if length ≤ 6 m  | R48, 6.18.1   |
| Color                                       | Front: amber<br>rear: red   | 108, Table IV | Amber (the rearmost can be red if it is grouped with the rear position lamp)           | R48, 5.15     |
| Height **                                   | ≥ 38 cm   | 108, Table IV | ≥ 25 cm,<br>≤ 150 *** cm   | R48, 6.18.4.2 |
| Location                                    | Front: as far to the front as practicable;<br>rear: as far to the rear as practicable | 108, Table IV | One lamp within the first third and/or one within the last third of the vehicle length | R48, 6.18.4.3 |
| Largest photometric angles <sup>Δ</sup>     | ±45°H, ±10°V  | J592, Table 2 | ±30°H, ±10°V   | R91, Annex 4  |
| Photometric minima at selected large angles | ≥ 0.25 cd (red),<br>≥ 0.62 cd (amber), @<br>±45°H <sup>†</sup> , ±10°V                | J592, Table 2 | ≥ 0.6 cd @<br>±30°H, ±10°V   | R91, Annex 4  |
| Visibility angles <sup>Δ</sup>              |   |               | -30° to +30°H<br>-10° <sup>‡</sup> to +10°V  | R48, 6.18.5   |
| Flashing                                    | May flash for signaling   | 108, S5.5.10  | Not allowed  | R48, 5.9      |

<sup>§</sup>Passenger cars for 9 or fewer people.

\*The information in this column applies to vehicle for which side marker lamps are optional.

\*\*U.S.: measured to the center of the lamp.

Europe: maximum measured to the highest point, minimum to the lowest point.

\*\*\*If the structure of the vehicle makes it impossible, the maximum is 210 cm.

<sup>Δ</sup>Horizontal angles are with respect to an axis perpendicular to the longitudinal axis.

<sup>†</sup>For vehicles less than 9.1 m long, the inboard requirements may be met at a distance of 4.6 m on a vertical plane that is perpendicular to the longitudinal axis of the vehicle and located midway between the front and the rear side marker lamps (108, S5.1.1.8).

<sup>‡</sup>If the height is less than 75 cm, this value is -5°.

## ANALYSIS OF THE STANDARDS

### U.S. standards versus European standards

**Color.** The only practical difference between the two sets of standards is that for the rear turn signal lamps the U.S. standard allows either amber or red, while the European standard mandates amber.

**Height.** The major differences are as follows: (1) The minimum height for both the side turn signal lamps and side marker lamps is higher in the U.S. than in Europe. (2) The maximum height for the side turn signal lamps is higher in Europe than in the U.S. (3) The U.S. standard has no maximum height limitation for the side marker lamps.

**Location.** The U.S. standards are more permissive; they use language such as “at or near the front” and “as far apart as practicable.” The European standards contain more specific restrictions.

**Photometric angles.** Figure 1 summarizes the U.S. and European requirements for the horizontal photometric and visibility angles. The horizontal photometric coverage is wider in Europe than in the U.S. for all turn signal lamps, but is wider in the U.S. than in Europe for the side marker lamps. The vertical photometric coverage for all turn signal lamps is wider in Europe than in the U.S., and is the same for the side marker lamps.

**Photometric minima.** The photometric minima at comparable angles are higher in the U.S. than in Europe for all turn signal lamps, and are the same for the front side marker lamps.

**Visibility angles.** The required horizontal visibility angles (see Figure 1) are greater in Europe than in the U.S. for all lamps except the side marker lamps (which are optional in Europe). The major differences are as follows: (1) Both the inboard and the outboard visibility requirements for the front and rear turn signal lamps are substantially smaller in the U.S. than in Europe. (2) The European standard requires the side turn signal lamps to be visible from a smaller lateral offset (in relation to the vehicle in question) than is the case for the optional U.S. side turn signal lamps. This difference is, presumably, a consequence of the greater frequency of bicyclists in Europe, and their need to detect side turn signals. (3) In the U.S., there are no visibility requirements for the side marker lamps.

The vertical visibility angles for all turn signal lamps are wider in Europe than in the U.S.

**Flashing.** The European standards require all turn signals on the same side (front, side, and rear) to flash in phase, and they prohibit the side marker lamps from flashing. In the U.S., (1) all turn signal lamps are required to flash, (2) the side turn signal lamps can flash either in-phase or out-of-phase with the front turn signal lamps, and (3) the side marker lamps, while generally steady burning, may flash for signaling purposes.

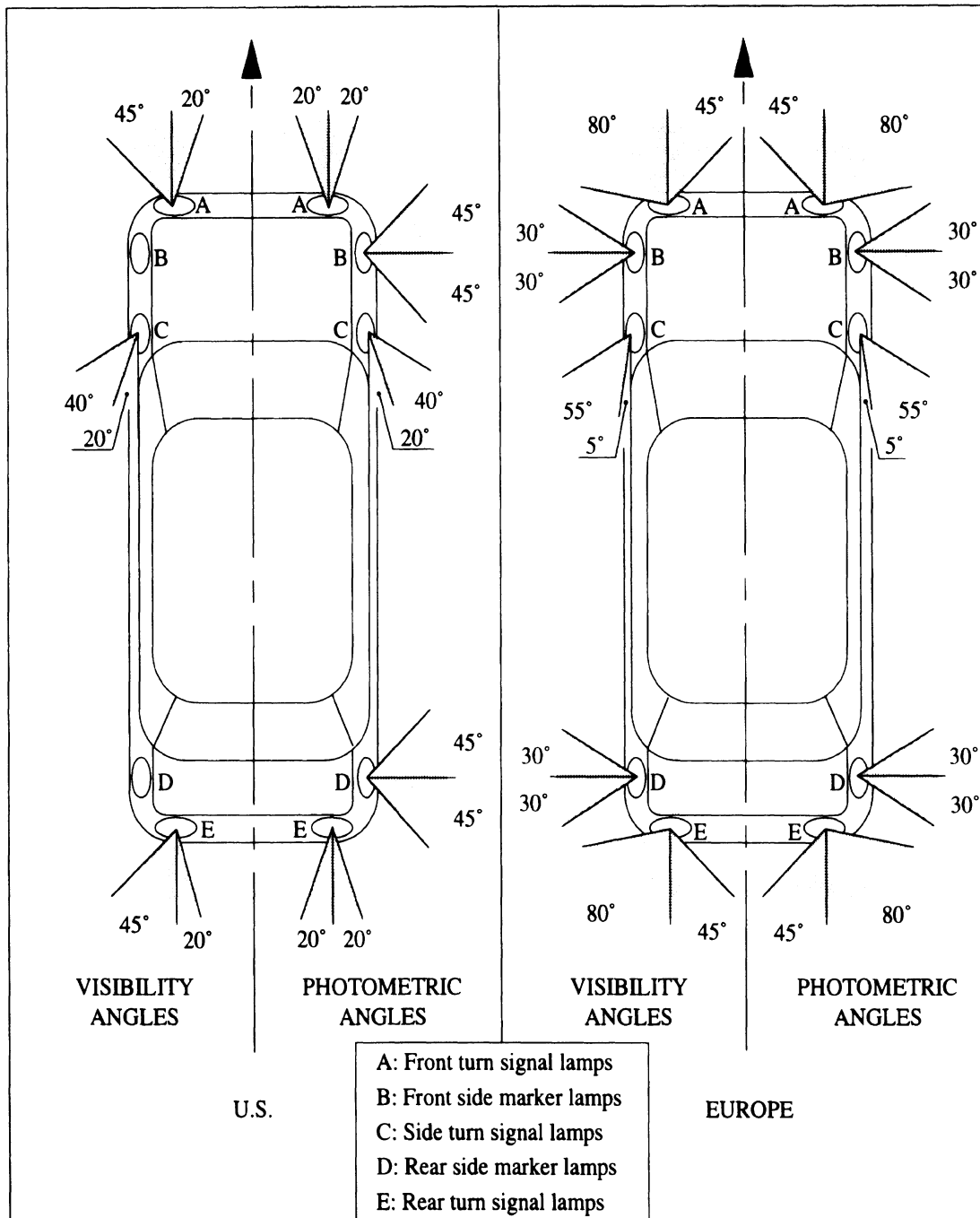


Figure 1. A comparison of the horizontal photometric and visibility angles in the current U.S. and European standards.

## **Standards for side turn signal lamps versus standards for front side marker lamps**

The nature and extent of the differences in the standards for the side turn signal lamps and the front side marker lamps are critical in considering a combined lamp. Consequently, this section will examine these differences in detail.

**Color.** The color requirements are compatible.

**Height.** In both the U.S. and in Europe, the minimum height for the side turn signal lamps is greater than for the side marker lamps. In the U.S., there is no maximum height for the side marker lamps.

**Location.** The location requirements in the U.S. are rather nonrestrictive for both types of lamps (e.g., “as close to the front as practicable”), while the European standards are somewhat more restrictive for both lamps.

**Photometric angles.** As is evident in Figure 1, the horizontal angles are substantially different for the two types of lamps. The requirements for the side turn signal lamps are designed to assure that the light is directed towards traffic that (1) is moving in the same direction, (2) is offset laterally, and (3) is at the side or at the rear of the vehicle in question. On the other hand, the photometric angles for the side marker lamps are centered around an axis that is perpendicular to the longitudinal axis of the vehicle. Thus, the requirements for the side marker lamps are designed to assure that the light is directed towards traffic that is moving at an angle towards the vehicle in question.

In the U.S., the range of the horizontal photometric angles for the side turn signal lamps is  $40^\circ$ , and the range for the side marker lamps is  $90^\circ$ . The overlap between these two ranges is  $25^\circ$ . Thus, to maintain the coverage of both current lamps, the photometric angles for a combined lamp would need to cover  $105^\circ$ . The situation in Europe is somewhat different. There, the range of the horizontal photometric angles for the side turn signal lamps is  $55^\circ$ , and the range for the side marker lamps is  $60^\circ$ . The two ranges share a boundary, but do not overlap. To maintain the coverage of both lamps, the visibility angles for the combined lamp would need to cover  $115^\circ$ .

In the U.S., the vertical angles upward are somewhat greater for the side turn signal lamps than for the side marker lamps ( $+15^\circ$  vs.  $+10^\circ$ ), but the situation is reversed for the vertical angles downward ( $-5^\circ$  vs.  $-10^\circ$ ). In Europe, the vertical angles are greater for the side turn signal lamps than for the side marker lamps ( $\pm 15^\circ$  vs.  $\pm 10^\circ$ ).

**Photometric minima.** The photometric minima in the U.S. (but not in Europe) are greater for the side turn signal lamps than for the front side marker lamps. For example, at the horizontal, the required luminous intensity for the largest controlled horizontal angle for the side turn signal lamps is 24 times that for the largest controlled horizontal angle for the front side marker lamps. This difference implies that the two types of signals are considered to be fundamentally different. Presumably, the underlying logic is that the side turn signals

need to be detected under more challenging conditions, including large peripheral viewing angles and daytime ambient illumination. Thus, a combined lamp should meet the somewhat more demanding photometric minima of the side turn signal lamps (at least for the angles that cover the needs of the side turn signal lamps). On the other hand, contrary to the above argument about the fundamentally different nature of the side turn signal lamps and front side marker lamps, the minima in Europe for the two types of lamps are the identical (and are the same as the U.S. minimum for the front side marker lamps).

**Visibility angles.** In the U.S., there are no requirements concerning the visibility angles for the side marker lamps. In Europe, the situation is the same as for the photometric angles. Specifically, in Europe the range of the horizontal angles for the side turn signal lamps is  $55^\circ$ , the range for the front side marker lamps is  $60^\circ$ ; the two ranges share a boundary, but do not overlap. To maintain the coverage of both lamps, the visibility angles for the combined lamp would need to cover  $115^\circ$ .

**Flashing.** In the U.S., there is no restriction on flashing for the side marker lamps. On the other hand, in Europe the side marker lamps are prohibited from flashing. However, side marker lamps are optional in Europe (if the vehicle length is no more than 6 m).

The European standard requires that the side turn signal lamps flash in phase with the front and rear turn signal lamps. The U.S. standard allows either in-phase or out-of-phase flashing. The underlying rationale for the European requirements is, presumably, that all turn signals from the same vehicle be perceived as belonging to the same object. In-phase flashing of two lamps (a side turn signal and either a front or a rear turn signal) would assist in formation of a perceptual unit, while out-of-phase flashing would deter such formation. However, out-of-phase flashing may also be *beneficial*, by guaranteeing that in the overlap region one turn lamp will always be in the on state when the turn signal is engaged. Empirical research is needed to resolve this issue.

**Summary.** The important (but surmountable) differences in the standards for the side turn signal lamps and the front side marker lamps are in height, visibility and photometric angles, photometric minima in the U.S., and flashing restrictions in Europe. Furthermore, side turn signal lamps are optional in the U.S., while side marker lamps are optional in Europe. This international difference in the types of lamps that are mandatory leads to our recommendation for a combined lamp.



## **DEVELOPING RECOMMENDATIONS FOR A COMBINED LAMP**

### **Overview**

The aim of this research was to explore the viability of a dual-purpose lamp that would combine the functions of a side turn signal lamp and a front side marker lamp. The analysis of the current standards indicates that, despite the fact that the standards for the two lamps are different, the functional intent of standards in both the U.S. and Europe can be satisfied by a combined lamp. The most important aspects of current standards that leads to this interpretation is the distinction that they make between mandatory and optional equipment. In the U.S. side turn signal lamps are optional; in Europe side marker lamps are optional. This section will first summarize the most important considerations related to the feasibility of a combined lamp, and then provide an approach for developing recommended values for such a lamp.

### **Feasibility of a combined lamp**

In both the U.S. and Europe, the standards for the side turn signal lamps and the front side marker lamps are different in several respects, presumably because these two types of lamps are designed to serve different functions. The differences include mounting height, photometric and visibility angles, photometric minima in the U.S., and constraints on flashing in Europe. However, the significance of these differences for the prospects of a combined lamp is greatly affected by major differences between the U.S. and Europe with respect to what equipment is mandatory. In the U.S., the side marker lamps are required, but the side turn signal lamps are optional. In Europe, the situation is reversed: the side turn signal lamps are required, but the side marker lamps are optional. Thus, for a combined lamp to meet the safety level provided by the lamps that are currently mandatory in the U.S. and Europe, it would need to fulfill only the functions currently served by the U.S. side marker lamps and the European side turn signal lamps (and not necessarily the functions currently served by the U.S. side turn signal lamps and the European side marker lamps).

In addition to the international differences in what equipment is mandatory, there are also international differences concerning flashing restrictions. In the U.S., the side marker lamps are allowed to flash, while in Europe they are prohibited from flashing. Because in the U.S. the side turn signal lamps are not required, but the side marker lamps can flash, flashing side marker lamps that would also meet the photometric and visibility requirements of the side turn signal lamps would fulfill the current functions of both types of lamps. In the U.S., the combined lamp could be nominally considered a side marker lamp, because only side marker lamps are currently required. In Europe, only the side turn signal lamps are allowed to flash (and the side marker lamps are optional); thus in Europe the combined lamp

could be nominally considered a side turn signal lamp. Therefore, it would be possible for both the U.S. and Europe to retain the lamps that are currently required, but the lamps would be upgraded to incorporate also the aspects of the lamps that are required only in the other jurisdiction.

### **General approach for developing values for a combined lamp**

Before we present our recommendations for the characteristics of a combined lamp, we will outline a simple approach to combining the current standards. This approach only permits lamps that are already currently acceptable in both jurisdictions (see Figure 2). We will refer to this approach as the restrictive approach, but it has also been called the “window of opportunity” approach. Its major advantage is that it leads to alternatives that provide, in both jurisdictions, the same level of safety as do currently allowable alternatives. Furthermore, it does not require any regulatory changes; manufacturers can de facto adopt this approach on their own simply by restricting themselves to the options that fall in the window permitted in both jurisdictions. The major disadvantage of this approach is that it may create unnecessary constraints on manufacturers.

The values for a combined lamp based on a strict application of the restrictive approach are presented in Table 6. The differences between these values and the current U.S. standards for the front side marker lamps and the European standards for the side turn signal lamps are summarized in Table 7.

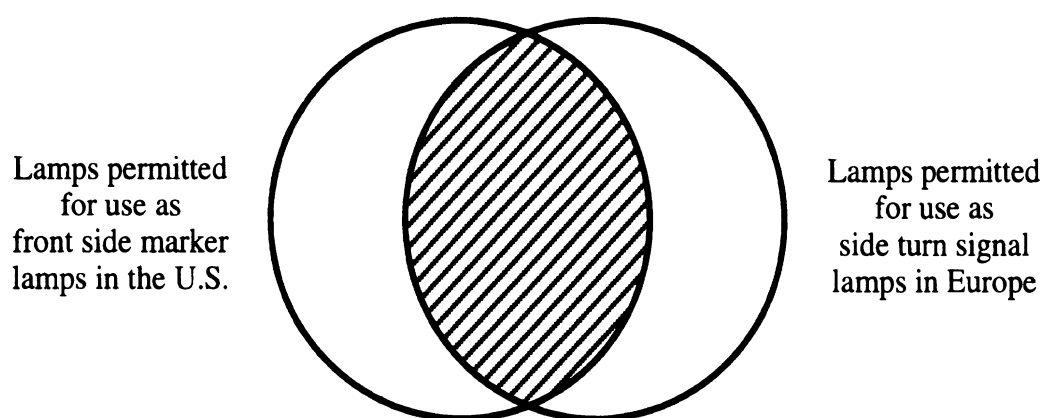


Figure 2. Schematic illustration of the restrictive approach for arriving at the values for a combined lamp. The shaded region indicates lamps that would be permitted when using this approach.

Table 6  
Values for the combined side turn signal and front side marker lamp exclusively on the restrictive approach.

| Aspect                          | Value   |
|---------------------------------|---|
| Color                           | Amber (current U.S. and European specification for both side turn signal lamps and front side marker lamps)   |
| Minimum height *                | ≥ 50 cm (current European minimum for side turn signal lamps)   |
| Maximum height **               | ≤ 150 <sup>†</sup> cm (current European maximum for side turn signal lamps)   |
| Location                        | Center of the lamp to the front edge of the vehicle: ≤ 180 cm (current European limitation)   |
| Photometric angles <sup>‡</sup> | -30° to -85°H, -15° <sup>§</sup> to +15°V (encompassing the European angles for side turn signal lamps), and<br>-30° to +45°H, -10° to +10°V (encompassing the U.S. angles for front side marker lamps that do not overlap with the European angles for side turn signal lamps) |
| Photometric minima              | Throughout all of the above photometric angles: ≥ 0.6 cd (current European minimum for side turn signal lamps, and current U.S. minimum for front side marker lamps <sup>Δ</sup> )  |
| Visibility angles <sup>‡</sup>  | Identical to the photometric angles above   |
| Flashing                        | In phase only (current European standard for side turn signal lamps)  |

\* Measured to the lowest point.

\*\* Measured to the highest point.

<sup>†</sup> If the structure of the vehicle makes it impossible, this value is 230 cm.

<sup>‡</sup> The horizontal angles are with respect to an axis perpendicular to the longitudinal axis of the vehicle. Positive angles are in the forward direction, negative angles in the rearward direction.

<sup>§</sup> If the height is less than 75 cm, this value is -5° for the horizontal angles from -85° to -45°, and -10° for the horizontal angles from -45° to -30°.

<sup>Δ</sup> The actual U.S. minimum of 0.62 cd was rounded to 0.6 cd.

**Table 7**  
 Comparison of the values for the combined lamp based exclusively on the restrictive approach with the current standards for the mandatory lamps in the U.S. and Europe.

| Aspect             | Relation of the value for the combined lamp to the current U.S. standard for the front side marker lamps | Relation of the value for the combined lamp to the current European standard for the side turn signal lamps |
|--------------------|--|---|
| Color              | Identical  | Identical   |
| Minimum height     | More restrictive (50 vs. 38 cm <sup>*</sup> )  | Identical   |
| Maximum height     | More restrictive (150 cm <sup>†</sup> vs. no current maximum)  | Identical   |
| Location           | More restrictive (center of the lamp to vehicle edge $\leq 180$ cm vs. as close as practicable)          | Identical   |
| Photometric angles | More restrictive (covering also angles for side turn signal lamps)                                       | More restrictive (covering also angles for side marker lamps)   |
| Photometric minima | Throughout the angles of side marker lamps: identical <sup>‡</sup>                                       | Throughout the angles of side turn signal lamps: identical  |
| Visibility angles  | More restrictive (covering also angles for side turn signal lamps)                                       | More restrictive (covering also angles for side marker lamps)   |
| Flashing           | More restrictive (in phase only vs. in phase or out of phase)  | Identical   |

<sup>\*</sup>The current U.S. minimum, measured to the center of the lamp, is 38 cm. The minimum for the combined lamp in Table 6, to be measured to the lowest point, is 50 cm.

<sup>†</sup>If the structure of the vehicle makes it impossible, this value is 230 cm.

<sup>‡</sup>The actual U.S. minimum of 0.62 cd was rounded to 0.6 cd.

The combined lamps outlined in Table 6 would function the same way as the side marker lamps that are already used on some U.S. automobiles: They would be on continuously when the headlamps are on, and they would flash when the turn indicator is engaged. Furthermore, the luminous intensity in the on state when flashing would be the same as the luminous intensity when continuously on.

An entry in Table 7 labeled "more restrictive" indicates that for this aspect the proposed specification is more demanding than the current standard (for the relevant lamp), and therefore any lamp meeting the proposed specification will also meet the current standard. There would, of course, be no regulatory barrier to industry adopting the "more restrictive" recommendations even with no regulatory changes. Nevertheless, if it was considered desirable for insuring uniform practice by industry, the "more restrictive" recommendations could be incorporated in existing regulations. Such changes can be thought of as additions to, rather than changes in, existing regulations because they would not permit any equipment that is not already permitted.

As illustrated by the entries in Table 7, using the restrictive approach results in lamps that are fully consistent with the current U.S. standard for the front side marker lamps and the current European standard for the side turn signal lamps. This follows because there are no entries in Table 7 labeled "less restrictive," only entries "identical" and "more restrictive." (Only the "less restrictive" entries would call for less strict requirements, and would thus require regulatory changes.)

However, there is one possible regulatory objection that is not evident from the information in Table 7. Because the combined lamp would be on continuously when headlamps are on and no turn is being signaled, some might argue that it goes against the spirit of the European standard to claim in Europe that the lamps is a "turn signal" rather than a "side marker." Thus the combined lamp might be objected to in Europe on the basis of the prohibition against flashing for *optional* side marker lamps. However, the fact that a combined dual-purpose lamp can technically meet the current requirements in both the U.S. and Europe is a concrete demonstration that the functional intentions behind regulations in the two jurisdictions are compatible. As we have stated previously, the circumstance that is critical for arriving at this interpretation is that, although both jurisdictions have specifications for both side turn and side marker lamps, and although those specifications are not fully compatible, neither jurisdiction *requires* both types of lamps. Thus, if side turn signal lamps are used in the U.S., they must be substantially more intense than in Europe, but it is also acceptable to have no side turn signals at all. Likewise, in Europe side marker lamps are not permitted to flash, but it is also acceptable to dispense with them entirely.

## CONCLUSIONS

Our conclusion is that the functional intent of the current U.S. and European standards concerning front side marker lamps and side turn signal lamps for automobiles would be equally well served by a combined lamp that is based on the properties of the equipment that is currently mandatory: the U.S. front side marker lamps and the European side turn signal lamps. Such a lamp would be on continuously when the headlamps are on, and it would flash when the turn indicator is engaged. Furthermore, the luminous intensity in the on state when flashing would be the same as the luminous intensity when continuously on. The recommended values for the such a combined lamp are outlined in Table 8. These values are based, in general, on values in Table 6, which in turn were derived from the overlapping requirements of the current U.S. standard for the front side marker lamps and the current European standard for the side turn signal lamps. This approach was used because it ensures that the level of safety provided by the combined lamp will be at least as good as that provided by currently allowable lamps in each jurisdiction. Furthermore, this approach requires no regulatory changes. However, it does result in more constraints on manufacturers.

The only exception to adopting overlapping requirements is that we do not recommend restricting the flashing of the combined lamp to be in phase with the other turn signal lamps on the same side. As discussed above, there is no persuasive empirical evidence in support of such a restriction. Furthermore, out-of-phase flashing may be beneficial, by assuring that one turn lamp will always be in the on state when the turn signal is engaged. Field studies evaluating driver behavior in response to in-phase and out-of-phase flashing of side turn signal lamps (or side marker lamps) are needed to provide information that would either fully justify no restriction on flashing, or call for either in-phase or out-of-phase flashing.

Because the aim was to maintain (and not necessarily to improve) the current safety level provided by the mandatory equipment in the two jurisdictions, the recommended values are closely tied to current U.S. and European standards. If the aim had been an overall improvement in signaling, scientific information about factors affecting detection and identification of signals would also have been included in the derivation of the values for the proposed combined lamp.

This study did not examine the rationale for the current standards. Future research should focus on this issue to address whether, in combination, the two separate functions of the rear turn signal and flashing front side marker lamps (or some slight modifications of either) would satisfy the functional intent of the front side turn signal lamps.

Table 8  
Recommended values for the combined side turn signal and front side marker lamp.

| Aspect                        | Value  |
|-------------------------------|--|
| Color                         | Amber  |
| Minimum height *              | $\geq 50$ cm   |
| Maximum height **             | $\leq 150^{\dagger}$ cm  |
| Location                      | Center of the lamp to the front edge of the vehicle: $\leq 180$ cm   |
| Photometric angles $\ddagger$ | -30° to -85°H, -15° $^{\S}$ to +15°V<br>-30° to +45°H, -10° to +10°V |
| Photometric minima            | Throughout all of the above photometric angles: $\geq 0.6$ cd        |
| Visibility angles $\ddagger$  | Identical to the photometric angles above                            |
| Flashing                      | In phase or out of phase   |

\* Measured to the lowest point.

\*\* Measured to the highest point.

$\dagger$  If the structure of the vehicle makes it impossible, this value is 230 cm.

$\ddagger$  The horizontal angles are with respect to an axis perpendicular to the longitudinal axis of the vehicle. Positive angles are in the forward direction, negative angles in the rearward direction.

$\S$  If the height is less than 75 cm, this value is -5° for the horizontal angles from -85° to -45°, and -10° for the horizontal angles from -45° to -30°.

## CITED STANDARDS

- ECE (Economic Commission for Europe) Regulation 6. (Last revised August 9, 1993). *Uniform provisions concerning the approval of direction indicators for motor vehicles and their trailers*. Geneva: United Nations.
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