Arrow panels are often used in work zones to inform drivers of the need for a lane change or, under certain conditions, caution on the part of the driver. Portable changeable message signs are used to advise motorists of unexpected traffic and routing situations. Although these devices have been used in traffic control applications for many years, there are no established photometric standards that can be used as the basis for a procurement specification.

This report summarizes the Texas Transportation Institute’s (TTI) recommendations for test methods for measuring the photometric properties of Type C arrow panels (Figure 1) and portable changeable message signs (Figure 2). The intent of the test method is to provide TxDOT with measurable criteria for qualifying arrow panels and changeable message signs for purchase by TxDOT.
What We Did . . .
Researchers investigated a number of issues related to arrow panels and changeable message signs, focusing on the photometric characteristics of the devices.

What We Found . . .

Arrow Panels
As shown in Figure 3, increased viewing angle can sharply reduce the effective output of an arrow panel as seen by the driver. Researchers reviewed potential angularity effects due to lane positioning and roadway curvature by examining lateral clearance between vehicles and arrow panels in various positions. By combining vehicular operating speeds, typical roadway alignments, and viewing times for sign displays, researchers established minimum angularity requirements for viewing arrow panels.

The daytime conspicuity of varying luminous intensity levels was tested in a study that manipulated arrow panel luminous intensity to test its influence on motorist behavior. Observations of the number of vehicles in the closed lane indicated that luminous intensity levels were related to the lane-changing behavior of the motorists. Comparisons between driver responses showed that even in low-complexity visual environments there is a minimum level that is necessary to facilitate timely lane changing.

Portable Changeable Message Signs
Examining portable changeable message signs, researchers used a luminance meter to make a series of background luminance measurements (sign “off”) under sun overhead, backlit, and washout conditions. Additional luminance measurements of the sign’s immediate surroundings were taken and used to evaluate external contrast. By combining well-established recommendations from the literature with the background measurements made in the field, recommendations for character luminance were developed so that the desired contrast levels could be achieved under backlight, sun overhead, and some washout conditions.

The Researchers Recommend . . .
Researchers developed recommendations for the photometric properties of both Type C arrow panels (diesel and solar) and portable changeable message signs, recommending changes to their respective specifications by TxDOT.

Arrow Panels
Based on the field studies conducted and findings reported in the literature, researchers developed a table of recommended luminous intensities for arrow panels, shown in Table 1. The values provide a level of performance that will help ensure that most drivers in most situations can see the information they need in a timely manner.

Recommendations regarding minimum angularity performance were also developed to help ensure acceptable performance in commonly encountered situations.

Portable Changeable Message Signs
Researchers recommend a minimum daytime character luminance of 4000 cd/m² and a contrast ratio of 5. However, both backlight and washout conditions present tremendous problems for portable changeable message sign visibility, particularly with older motorists. Because of this, no minimum luminance level can ensure that the sign be read by all observers under all conditions. Protective screens should be well maintained to maximize the contrast that this luminance will provide, particularly in washout conditions.

Based on previous research, researchers recommend a minimum nighttime character luminance of 30 cd/m². Little research has been conducted with respect to a nighttime maximum character luminance needed to prevent unacceptable levels of glare; thus, a maximum value was not recommended.

Testing Procedures
Recommended testing procedures were developed to ensure that specified performance levels are met. The procedures center on the use of a tripod-mounted luminance meter. By measuring the performance of the arrow panels or portable changeable message signs with a luminance meter, TxDOT can reliably compare the performance of purchased equipment in the field with the panel specification values. Additionally, a laboratory test on a sample of the individual lamps used in arrow panels is recommended to ensure that arrow panels purchased can meet all specifications, including hot spot and angularity requirements.

Table 1. Recommended luminous intensity requirements

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Speed (mph)</th>
<th>Minimum On-Axis cd/lamp</th>
<th>Minimum Off-Axis cd/lamp</th>
<th>cd³</th>
<th>cd³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>≥ 45</td>
<td>500</td>
<td>1000</td>
<td>300</td>
<td>800</td>
</tr>
<tr>
<td>Night</td>
<td>≥ 45</td>
<td>150</td>
<td>1200</td>
<td>240</td>
<td>550</td>
</tr>
</tbody>
</table>

* Intensity requirements for the entire panel when displaying a left or right flanking arrow (30 lamps if seasoned).

**NA** (Not Applicable)
Researchers investigated a number of issues related to arrow panels and changeable message signs, focusing on the photometric characteristics of the devices.

What We Found . . .

Arrow Panels
As shown in Figure 3, increased viewing angle can sharply reduce the effective output of an arrow panel as seen by the driver. Researchers reviewed potential angularity effects due to lane positioning and roadway curvature by examining lateral clearance between vehicles and arrow panels in various positions. By combining vehicular operating speeds, typical roadway alignments, and viewing times for sign displays, researchers established minimum angularity requirements for viewing arrow panels.

The daytime conspicuity of varying luminous intensity levels was tested in a study that manipulated arrow panel luminous intensity to test its influence on motorist behavior. Observations of the number of vehicles in the closed lane indicated that luminous intensity levels were related to the lane-changing behavior of the motorists. Comparisons between driver responses showed that even in low-complexity visual environments there is a minimum level that is necessary to facilitate timely lane changing.

Portable Changeable Message Signs
Examining portable changeable message signs, researchers used a luminance meter to make a series of background luminance measurements (sign “off”) under sun overhead, backlight, and washout conditions. Additional luminance measurements of the sign’s immediate surroundings were taken and used to evaluate external contrast. By combining well-established recommendations from the literature with the background measurements made in the field, recommendations for character luminance were developed so that the desired contrast levels could be achieved under backlit, sun overhead, and some washout conditions.

The Researchers Recommend . . .

Researchers developed recommendations for the photometric properties of both Type C arrow panels (diesel and solar) and portable changeable message signs, recommending changes to their respective specifications by TxDOT.

Arrow Panels
Based on the field studies conducted and findings reported in the literature, researchers developed a table of recommended luminous intensities for arrow panels, shown in Table 1. The values provide a level of performance that will help ensure that most drivers in most situations can see the information they need in a timely manner. Recommendations regarding minimum angularity performance were also developed to help ensure acceptable performance in commonly encountered situations.

Portable Changeable Message Signs
Researchers recommend a minimum daytime character luminance of 4000 cd/m² and a contrast ratio of 5. However, both backlight and washout conditions present tremendous problems for portable changeable message sign visibility, particularly with older motorists. Because of this, no minimum luminance level can ensure that the sign be read by all observers under all conditions. Protective screens should be well maintained to maximize the contrast that this luminance will provide, particularly in washout conditions.

Testing Procedures
Recommended testing procedures were developed to ensure that specified performance levels are met. The procedures center on the use of a tripod-mounted luminance meter. By measuring the performance of the arrow panels or portable changeable message signs with a luminance meter, TxDOT can reliably compare the performance of purchased equipment in the field with the panel specification values. Additionally, a laboratory test on a sample of the individual lamps used in arrow panels is recommended to ensure that arrow panels purchased can meet all specifications, including hot spot and angularity requirements.

Table 1. Recommended luminous intensity requirements

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Speed (mph)</th>
<th>Minimum On-Axis</th>
<th>Minimum Off-Axis</th>
<th>Maximum On-Axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>≥ 45</td>
<td>500</td>
<td>1000</td>
<td>5500</td>
</tr>
<tr>
<td>Night</td>
<td>≥ 45</td>
<td>150</td>
<td>300</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Intensity requirements for the entire panel when displaying a solid white or yellow flashing arrow (10 lamps if mounted).

© 2010 TxDOT

Figure 3. The effect of angularity on arrow panel visibility (the arrow sign on the right is at a slight angle)
Arrow panel and Portable Changeable Message Sign Requirements

Arrow panels are often used in work zones to inform drivers of the need for a lane change or, under certain conditions, caution on the part of the driver. Portable changeable message signs are used to advise motorists of unexpected traffic and routing situations. Although these devices have been used in traffic control applications for many years, there are no established photometric standards that can be used as the basis for a procurement specification.

This report summarizes the Texas Transportation Institute’s (TTI) recommendations for test methods for measuring the photometric properties of Type C arrow panels (Figure 1) and portable changeable message signs (Figure 2). The intent of the test method is to provide TxDOT with measurable criteria for qualifying arrow panels and changeable message signs for purchase by TxDOT.