Appendix: AAMVA License Plate Legibility Testing Guidelines for Reflective Sheeting

Policy

The American Association of Motor Vehicle Administrators (AAMVA) endorses the concept of a uniform motor vehicle registration license plate system. In addition, AAMVA recommends that member jurisdictions adopt the following standards:

1. Two license plates should be issued for all passenger type vehicles and single unit trucks. One plate can be issued for tractors, motorcycles, and all types of trailers.

2. License plates should prominently display the name of the jurisdiction and the registration number. The date of registration expiration shall be displayed on the vehicle by means of a reflecting validating sticker on the rear license plate, except on vehicles that are required or permitted to have only one license plate, or those plates manufactured with an expiration date and for which a sticker is not required. Secondary decals should be placed on the windshield for jurisdictions that have multiple uses for the stickers. New validating stickers may be issued upon renewal of registration in lieu of issuing new plates for the vehicle.

3. License plates should be manufactured in two sizes, depending on their use. Passenger type vehicles, tractors, trucks, trailers, etc., should be issued standard 6" x 12" plates. Smaller plates measuring 4" x 7" may be used on motorcycles or other small vehicles.

4. License plates can be issued for multi-year periods and should be reissued on a regular basis to insure that the information they display remains legible.

5. Fully reflective license plates should be adopted and used.

6. Motor vehicle agencies should consult with jurisdictional, and if applicable local law enforcement representatives, prior to adopting new license plate standards or designs.

7. Jurisdictions should use a standardized format for all license plates, including specialty plates.

8. License plates must be readable in daylight and night using low beam headlights, under optimal conditions at a distance of no less than 75 feet.

9. Duplication of alpha/numeric combinations is discouraged to allow accurate retrieval of vehicle registration information.

10. Reflective decals should be color-coded and with durable printing. Motor vehicle agencies should consult with jurisdictional, and if applicable local law enforcement representatives, prior to adopting new color schemes for registration stickers. [*Amended 2003*]

Design Guidelines

The design guidelines listed here are based on knowledge gained from both laboratory and field testing of legibility of reflective license plates and signs. These guidelines should be considered by motor vehicle administrators to ensure a readable license plate design. Consult with jurisdictional, and if applicable, local law enforcement representatives prior to adopting new license plate standards or design.

Note: For those jurisdictions employing the exposed lens reflectorized license plate process, a dark non-reflective background with contrasting light reflecting (white or yellow preferably) alpha numerics would be acceptable for both standard and graphic design license plates if they meet the 75 foot readability criteria.

Background Color

White (optimum)
Yellow
Pastels / Toned Colors / Other background colors are possible (See Graphics, below)

Alpha Numerics

Colors in recommended order for contrast with *white* background:

1. Black
2. Green (transparent or opaque)
3. Blue (transparent or opaque)
4. Brown (transparent or opaque)
5. Red (transparent or opaque)

Colors in recommended order for contrast with yellow background:

1. Black
2. Opaque Blue, Green, or Brown
3. Red (transparent or opaque)

Transparent colors must be coated dark enough to provide adequate color intensity and contrast ratio.
Minimum **contrast ratio** between the alpha numeric colors and the background is 4-to-1, that is, the background is 4 times brighter than the alpha numeric (Olson & Sivak, 1983).

Size of alpha numerics should be maximized to provide best legibility.
Spacing between characters should be at least equal to the stroke width.

Graphics

Jurisdiction name character color should provide a good color contrast with the background color.

Graphics provided behind the alpha numerics should be avoided. When desired in a design, these graphics should never exceed 30 percent of full color strength to maintain good contrast with the alphanumerics.

Use of a standardized format for specialty plates.

Legibility Testing

This test is designed to eliminate illegible license plates. It is not designed to provide the optimal legibility or identify the maximum legibility distance. The test procedure measures legibility accuracy in stationary vehicles. The rear plate legibility is assessed as if the observer were trying to read the plate of a lead car. The front car test places the observer in the position of identifying the plate of an approaching car. If jurisdictions wish to test legibility for plates of marked cars, the target car position can be changed appropriately and the lights turned off.

Test Preparation Recommendations

License Plates

The license plate(s) to be tested should be fabricated in the same manner as in-use plates if possible. For consistency across different jurisdictions, we recommend the use of mixed numbers and letters for the test plate(s). The number and grouping of alphanumerics should be in accordance with the jurisdiction's policy. If more than one plate design is being tested, different legends should be used on each plate to avoid memorization. Likewise, different plates with different legends should be used for the front and rear tests, and the day and night tests. So, four unique plates will be needed for a complete evaluation.

Substantial differences in the ease of legibility exist across letters and numbers. Legends containing medium difficulty alphanumerics should be used. Combinations that form words, or pronounceable non-words (e.g. CUZ), or familiar acronyms (e.g. FBI) should be avoided as these are recognized and remembered better than random arrangements. Likewise, series of numbers or letters (e.g. 123, DEF) should be avoided. Recommendations for average difficulty combinations are listed below (based on Zwahlen, 1991):

LLL NNN	*NNN LLL*	*LNL NLN*
UPJ279	729KET	B3W4Z3
PWF407	299MSA	C6Y4D5
XKU240	924PJN	C9S9Y7
KPJ290	475PCV	C3T3Y6
CFY392	070WRH	D9X3C9

LLL NNN	*NNN LLL*	*LNL NLN*
XOW427	803PKV	C7H4Z9
MWF039	469YZU	D4N7T9
KCY304	404UXN	D3G9P4
PYJ739	702PRD	C3X5J6
MKO024	772TGF	C4A8X7

Test Location

The same test location should be used for both the day and night sessions if possible. A location should be selected that has a low background complexity. There should be no moving traffic, commercial signs, or pedestrians in the background to interfere with the test. The location should be dark at night with no overhead lighting or light sources from buildings or commercial signs in the background. The road used should be level, smooth asphalt. The roadway should be dry, as wet roads can reflect a significant amount of light and bias the testing. A minimum distance of 150 feet is necessary with a minimum width of 24 feet or two standard lane widths.

Suggestions for appropriate locations include parking lots (provided there is no overhead lighting), driving test exam roads, private driveways (provided there is enough distance).

Vehicle Selection & Preparation

Two vehicles will be needed for the test. It is recommended that similar passenger cars be used for both the observer's car and the target car on which the test plates will be placed. The target car should have its headlights and taillights off for the rear plate night test. This is recommended to reduce differences across vehicles due to taillight design. For the front plate test, the target car should have its low-beam headlights on.

The headlights on both cars should be cleaned and aimed properly prior to the testing (headlight aiming guidelines can be found in the Society of Automotive Engineers Ground Vehicle Lighting Manual, 1991). The observer's car should use both low-beam headlights and high-beams only for the nighttime test. The windshield of the observer car should be clean and free of cracks or pits that may interfere with viewing.

Patrol cars should not be used for the test vehicles, as they are often marked with reflective materials and the extra lights and words present on most official vehicles could be distracting.

The test license plates should be mounted in the standard center front and rear position. If direct mirror reflection occurs from the observer's car headlights, the plate should be tilted back 5 degrees.

Vehicles should be positioned in the same lane for the rear plate test and in the oncoming lane for the front plate test.

Test Subject Selection & Instruction

Test subjects should be selected according to each jurisdiction's needs. Law enforcement officers are likely candidates and should be included. Be aware that law enforcement officers in general have excellent eyesight and are well-practiced in reading license plates. For this reason, their accuracy on the legibility test may be much higher than average citizens. It also would be appropriate to include average citizens in the testing as their license plate reading abilities should be included in design decisions for plates to be legible in accident and crime witness reports. Only licensed drivers should be used.

Subjects should not be allowed to see the test plates prior to testing. They should be unaware of the letters and numbers being used in the study. For this reason, those people arranging the testing should not participate as subjects in the legibility test.

Subjects should be tested alone, seated in the driver position of the car. It is important to have the subject in the driver position because of the geometry of the headlights illuminating the license plates. Subjects should be tested alone so that the responses are unbiased by others' opinions. They can report their responses either to an experimenter in the car or via radio to an experimenter positioned near the target car. Subjects should be instructed to be as accurate as possible and to guess when not certain. A guess is better than responding "blank" or "I didn't see it." Often in tasks such as these, a guess is found to be accurate even when confidence in the answer is low.

A minimum number of five subjects is recommended. Ideally, a range of ages should be represented in the subject group.

Testing Procedure

The measure of performance in the test will be number (or percent) of letters correctly identified. In addition, it is recommended that a subjective rating of difficulty be obtained from each subject. This rating will be particularly helpful if more than one candidate plate is being evaluated. It is possible that two plates would produce similar legibility accuracy, but all subjects could agree that one was much more difficult to read than another.

The test conditions proposed here are rather ideal. When other factors are introduced (e.g. motion, poor weather, dirt on license plate), the legibility in the field could significantly worsen. Any plate judged to be difficult to read in these ideal test conditions may prove impossible to read when any worsening factors are introduced. Because of these ideal testing conditions, a strict pass/fail criterion for legibility is recommended (see section below).

The distance between the subject and the car should be held constant. The exposure duration, or amount of time the license plate is visible to the subject, should also be held constant.

Testing must be conducted both day and night. It is possible for a candidate plate to appear fine at night and be illegible during the day, and vice versa.

Distance Between Cars

We recommend a distance of seventy-five (75) feet between vehicles. Legibility distances this great should be attainable with law enforcement officers as subjects. This distance will be challenging for many subjects, but the test is meant to be challenging to weed out poor license plate designs.

Subjective Difficulty Rating

In addition to the legibility test, a rating of legibility difficulty is also useful information to obtain in testing. A five-point difficulty as shown below is recommended:

1	2	3	4	5
Very Easy	Easy	Challenging	Difficult	Very Difficult

Subjects should be instructed to circle the appropriate number. Ratings of "$2^1/_2$" should be avoided, as they make tallying the results difficult. In analyzing this data, the average rating could be calculated (sum of the numbers divided by the number of subjects) or a frequency tabulation of each response could be presented (e.g., three people rated it #2, five people rated it #3).

Pass/Fail Criteria

This test is constructed to provide information for a "go/no go" decision. It is recommended that in order for a license plate to be judged as legible, 80 percent (4 out of 5) of the subjects should be able to *accurately identify each character* in the test as described.

If the test is being used to compare two competitive designs, the rating scale should provide useful information in the case of a tie on the legibility test.

References

Olson, Paul & Sivak, Michael (1993). *Nighttime legibility of license plates.* University of Michigan Transportation Research Institute, Report # 83-35.

Fricker, Jon (1986). *Human information processing and license plate design.* Transportation Research Record # 1093.

Zwahlen, Helmut (1991). Reflective license plate material: Evaluation of conspicuity and legibility performance for a standard license plate configuration using beads on paint versus reflective sheeting. Arizona Department of Transportation, Research Project HRP– PL-1 (39)358, Study Log Number 93-2-0005.