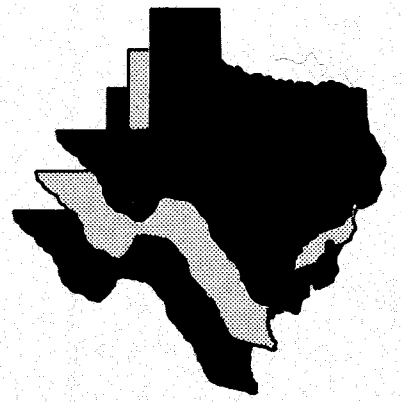
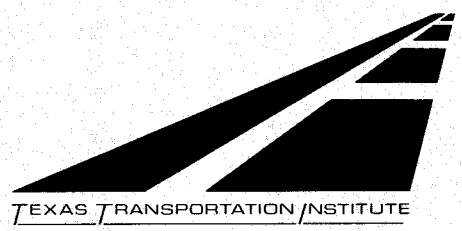


DEPARTMENTAL INFORMATION EXCHANGE



In cooperation with
Texas Department of Transportation
and the FHWA

Summary Report

Office of Research and
Technology Transfer

P.O. Box 5080 Austin, Texas 78763-5080

Phone 512-465-7644

FAX 512-465-7486

Summary Report 1298-S
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EVALUATION OF FREEWAY LANE CONTROL SIGNALS FOR TRAFFIC MANAGEMENT

PROBLEM STATEMENT

As the populations and the traffic problems in Texas Urban areas continue to grow, traffic managers search for effective ways to provide motorists with real-time information about driving conditions. One means of communication is the overhead lane control signal (LCS)—a device that, according to the *Manual of Uniform Traffic Control Devices* (MUTCD), can be used on freeways to notify drivers that it is necessary to stay out of a lane, that a lane is ending, or that a lane is temporarily blocked.

The Texas Department of Transportation (TxDOT) is planning to use the LCS as an integral part of the computerized freeway traffic management system projects underway in the six largest Texas urban areas (Austin, Dallas, El Paso, Ft. Worth, Houston, and San Antonio). While a variety of different LCS hardware technologies, symbol displays, light intensities, and color combinations are available, little objective data has been collected to determine which technologies are most appropriate for freeway conditions and which symbols are most readily recognized, understood, and responded to by drivers. Furthermore, there is really no current U.S. research that examines the interrelationships between roadway geometrics, traffic conditions, LCS installations, and driver responses.

OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 0-1298, Design, Installation, and Operation of Freeway Lane Control Signals, in cooperation with TxDOT and the Federal Highway Administration (FHWA), to study the following topics pertaining to freeway LCS:

- Motorist comprehension of standard MUTCD and various other freeway LCS symbols;
- How other symbols displayed over adjacent lanes in an LCS array affect motorists interpretations of an individual symbol;
- How alternative freeway LCS displays (using standard MUTCD symbols) actually affect motorist behavior in the field;
- Practical recommendations, based on laboratory and field results and on actual TxDOT experiences, regarding freeway LCS.

FINDINGS

Motorist Interpretation of LCS Signals

Four laboratory studies investigated motorist response to the following symbols: red X, yellow X, green downward arrow, yellow downward diagonal arrow, yellow downward arrow, circle-slash, and a red X superimposed on a green arrow. The *flashing* red X, green arrow, and yellow arrows were also evaluated.

Results indicate that the red X and the green arrow, symbols currently recommended in the MUTCD, are well understood and convey a clear and consistent meaning to the motorist. Nearly all the subjects participating in the studies correctly interpreted the green arrow to mean a lane is open and travel is permitted, and over 80 percent correctly interpreted the red X to mean a lane is closed and travel is prohibited. Interpretation was not affected by the presence of other symbols in an overall LCS array at a location.

The yellow X (the other MUTCD standard symbol to indicate that a lane is

LCS Design, Installation, and Operations Recommendations

- Establish operational policies and procedures for LCS prior to design and installation
- Consider flexibility in LCS system components such as symbol and illumination options
- Consider horizontal and vertical alignment of LCS arrays when selecting mounting locations
- Place LCS display units directly over through travel lanes
- Establish a regular LCS display unit maintenance schedule

Figure 1

about to close and that motorists should begin to vacate the lane) elicited a wide range of interpretations from respondents, depending on the context in which it was used. Many motorists felt that the symbol just indicated a need to slow down and be careful. Study results show that the yellow downward arrow suffered from the same lack of consistent and common interpretation as the yellow X. The interpretations also varied depending on whether or not there were red Xs in the LCS array.

The studies did show, however, that the yellow downward diagonal arrow conveyed a clear, consistent message to exit the lane in the direction of the arrow, regardless of what other symbols were present in the LCS array. Overall, 95% or more of the subjects provided this interpretation for the diagonal arrow.

Flashing displays did not affect interpretation of any symbols. Data on the circle with a slash and the red X over the green arrow were not significant enough to warrant a change in the use of a simple red X.

Ft.Worth Field Studies of Alternative LCS Configurations

Three field studies conducted on I-35W assessed actual driver response to alternative freeway LCS configurations upstream of single- and double-lane closures during daylight, off-peak traffic conditions. The following are key findings:

- None of the standard MUTCD configurations (red X and yellow X) significantly reduced travel speeds approaching and passing the lane closures.
- The red X and yellow X LCS configurations elicited a small (6.2%) but consistent movement from the closed to the open lanes.
- Subjective evaluations by TTI and TxDOT study personnel suggested that flashing the red X did appear to increase its target value to motorists; however, complete data on that effect could not be collected in the scope of this study.
- The effect of a single yellow X displayed over an inside travel lane appears to be consistent from location to location along the same freeway section.
- Displaying Changeable Message Sign messages in conjunction with LCS may result in additional shifts of traffic from the closed to the open lanes.

IMPLEMENTATION

Based on the findings from the lab and the field studies, as well as observations of TxDOT and TTI personnel, researchers have made several practical recommendations regarding the design, installation, and operation of freeway LCS. The main points are displayed in figure 1.

Because of the promising laboratory findings concerning motorist interpretation of the yellow downward diagonal arrow, and the limited results of the Ft. Worth field data, researchers recommended additional research and field testing of the yellow diagonal arrow and other LCS symbols. This work is currently being conducted under Study 0-1498, *Study of Visibility, Spacing, and Operational Issues of Freeway Lane Control Signals in Texas.* Specifically, this study will address what conditions make certain LCS more visible than others and allow more operational field studies to be conducted, possibly on San Antonio's system, which will have the yellow downward diagonal as an option. Final implementation may include a recommended revision to the MUTCD concerning the use of the yellow downward diagonal arrow; TxDOT standards for design, installation, and operation of freeway LCS; and suggestions to encourage public education about the meaning of LCS symbols.

Prepared by Kelly West, Science and Technology Writer, Texas Transportation Institute

The contents of this summary are reported in detail in the following TTI Research Reports: 1298-1, "Driver Interpretations of Existing and Potential Lane Control Signal Symbols for Freeway Traffic Management," by Gerald L. Ullman, Steven D. Wohlschlaeger, and Poonam B. Wiles. November 1993. 1298-2F, "Operation of Lane Control Signals for Freeway Traffic Management," by Gerald L. Ullman, Conrad L. Dudek and Poonam B. Wiles. November 1993. This summary does not necessarily reflect the official views of the FHWA or TxDOT.