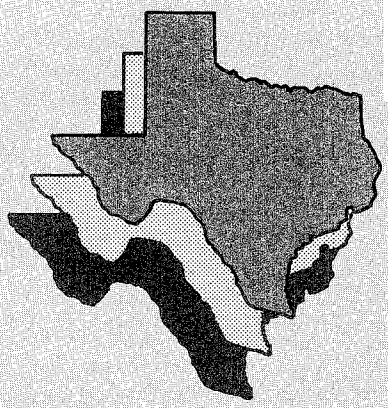


DEPARTMENTAL INFORMATION EXCHANGE

Summary Report 1144-1S
July 1993

IMPROVED PHOTOMETRIC DATA FOR HIGHWAY LIGHTING DESIGN APPLICATION

PROBLEM STATEMENT

When planning roadway lighting systems for highway facilities, many factors must be considered. Particularly important is roadway illumination intensity and uniformity (measured in footcandles) that, according to recent proposed methods, should take visibility level (VL) and small target visibility (STV) into account. Isofootcandle curves are graphical representations of the amount of light falling on the roadway from lighting fixtures or luminaires. The isofootcandle curves presently being used in Texas were developed in the late 1960s and early 1970s. New curves utilizing the latest industry developments are needed because current industry published data does not accurately represent actual field conditions. Measured under controlled laboratory conditions, these older data curves reflect the performance of hand selected optimized equipment rather than the randomly selected production equipment used in actual construction situations, and are, therefore, unsuitable for use as a standard.

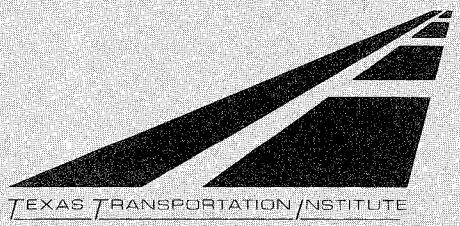
OBJECTIVE

The Texas Transportation Institute (TTI) conducted study 1144, *Development of Isofootcandle Curves For Highway Lighting Systems*, in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA) to develop isofootcandle design curves from modern roadway lighting fixtures, independent of manufacturer's data. The resulting report includes an extensive array of evaluations and data.

During the project, 75 separate production and experimental curves were produced from high and low pressure sodium luminaires. Roadway and underpass fixtures made up 40 of the curves, and high mast, 100 feet or over, made up the remainder.

Researchers evaluated fixtures from five major manufacturers. The production fixture plots (see report appendix) which resulted are intended to serve three purposes: 1) to aid in determining fixture type, illumination levels and locations from transparency template copies of these curves used with highway plans; 2) to evaluate the published photometrics of lighting manufacturers and cooperatively resolve any discrepancies between their laboratory data and that of production units in the real-world installations; 3) to develop and measure experimental lighting systems for which no manufacturer curves are available.

Investigators then evaluated roadway lighting design software from three luminaire manufacturers and compared results to those obtained at TTI. Lastly, researchers described investigations aimed at improving multi-fixture, high-mast installations in the areas of economic efficiency,



Texas
Department of Transportation

In cooperation with the
Federal Highway Administration
U.S. Department of Transportation

Research Summary Report

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greater separation, increased light levels, better uniformity, and less critical aiming.

FINDINGS

Isofootcandle Curves for Design Applications

Following a description of the facilities and instrumentation used in the development of the isofootcandle curves, TTI Research Report 1144-1 presents illustrations, explanations, and curves of the following eight field test setups using five different fixtures in eight scenarios:

- Single Arm 400W HPS Roadway Fixture Mounted at 50 Feet;
- Twin Arm 400W HPS Roadway Fixture Mounted at 50 Feet;
- Single Arm 250W HPS Roadway Fixture Mounted at 40 Feet;
- Twin Arm 250W HPS Roadway Fixture Mounted at 40 Feet;
- Twelve 400W, HPS Symmetrical, High Mast Fixtures mounted at 150 Feet;
- Twelve 400W, HPS Asymmetrical, High Mast Fixtures: 6 Aimed 0 deg. and 6 Aimed 180 deg. mounted at 150 Feet;
- Twelve 400W, HPS Asymmetrical, High Mast Fixtures: All Oriented One Way Mounted at 150 Feet;
- Twelve 400W, HPS, Asymmetrical, High Mast Fixtures (Modified): All Oriented One Way Mounted at 150 Feet.

Industry Data, Curves and Design Software

In the mid-1980's roadway lighting manufacturers started developing design application programs that would run on personal computers. These programs were based on the photometric data standards for the manufacturers' lighting fixtures, which were developed under laboratory conditions. The user selected the type and number of fixtures for an installation along with the mounting height and lamp output. The software retrieved the photometrics for that fixture and calculated according to the input conditions. Basically, the programs predicted the illumination on the roadway vs. location. However, it was observed in retrospect by some highway lighting engineers that the highway lighting project did not always produce the results expected during the design phase. With this in mind, researchers evaluated three commercial software packages (ALADEN, ICONTOUR, and AELIGHT) during their review of new industry equipment, data, and curves. Significant variations did exist between software simulations and real-world production fixtures. These production variations should be considered in critical applications or large jobs which may require independent photometric testing of sample units.

Evaluation of a High Mast, Low Sodium, Lighting System

The use of low-pressure sodium (LPS) fixtures in a high-mast configuration was evaluated. The objective of using LPS in this application was to reduce glare, lower operation cost and increase uniformity of illumination. While the glare was reduced and a uniform pattern with no abrupt changes was produced, the illumination level was less than optimum, and the level began decreasing at the pole rather than staying constant and then dropping off. Thus, for the majority of roadway illumination projects, the LPS fixtures produced at this time do not have the needed lumen output for use in a high mast configuration. Possibly some special applications could use this configuration if high footcandle levels are a lower priority than glare and efficiency.

CONCLUSIONS

Report 1144-1 contains information needed to produce an effective highway lighting system. While designers should not rely solely on the use of curves in designing conventional or high-mast systems, the fixture descriptions, footcandle curves, and successful or unsuccessful configurations will assist in the initial conception and preplanning of a lighting job. Since a lighting system consists of many different components, the contents of this report represent a part of the array of information an engineer needs in producing a proper highway lighting system at the lowest cost. Other methodologies using computer-assisted illuminance and/or luminance computer programs should be used based on the experience of the engineer and the nature of the facility to be illuminated. The curves developed may be of use in developing transparency template copies for overlaying on highway plans. They also may be used for comparison to curves produced by lighting manufacturers or to curves developed in specific field tests on a case by case basis.

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

The information described in this summary is reported in detail in TTI Research Report 1144-1, "Development of Iso-Footcandle Curves For Highway Lighting," Richard A. Zimmer, August 1991. The contents of this summary do not necessarily reflect the official views or policies of the FHWA or TxDOT.