

1. Report No. FHWA/TX-07/5-4150-03-1		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle GUIDE TO THE TEXAS TRANSPORTATION INSTITUTE MOBILE RETROREFLECTOMETER CERTIFICATION PROGRAM				5. Report Date October 2006; Publ. Feb 2007	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No. Report 5-4150-03-1	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. Project 5-4150-03	
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, Texas 78763-5080				13. Type of Report and Period Covered Technical Report: May 2004–August 2006	
				14. Sponsoring Agency Code	
15. Supplementary Notes Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration. Project Title: Qualification of Mobile Retroreflectometers					
16. Abstract This document describes a program whereby contractors can receive a certification to measure retroreflectivity of pavement markings on TxDOT highways using a mobile retroreflectometer. The document describes the procedures involved in obtaining the certificates for the driver/operator and the equipment. The certification program is conducted by the Texas Transportation Institute through partnership with the Texas Department of Transportation.					
17. Key Words Pavement Markings, Retroreflectivity, Measurement			18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service Springfield, Virginia 22161 http://www.ntis.gov		
19. Security Classif.(of this report) Unclassified		20. Security Classif.(of this page) Unclassified		21. No. of Pages 20	
				22. Price	

Guide to the Texas Transportation Institute Mobile Retroreflectometer Certification Program

**Program Conducted by
Texas Transportation Institute**



**In Cooperation with the
Texas Department of Transportation**



**and the
Federal Highway Administration**

**Report 5-4150-03-1
TxDOT Project 5-4150-03: Qualification of Mobile Retroreflectometers**

Version 2.0

**October 2006
Published: February 2007**

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CHAPTER 1: INTRODUCTION

This document describes a program to evaluate the qualifications of contractors that want to bid for Texas Department of Transportation (TxDOT) contracts to measure pavement marking retroreflectivity using mobile retroreflectometers. The certification program was developed by, and is administered at, the Texas Transportation Institute (TTI) through an implementation project sponsored by TxDOT and the Federal Highway Administration (FHWA). The certification program assesses the capabilities of both contractor personnel and equipment. This document is divided into three sections: Registration, Certification Trial, and Measurement Evaluation and Results.

BACKGROUND

In the late 1990s, TxDOT began implementing pavement marking specifications that require retroreflectivity measurements prior to acceptance. Using portable pavement marking retroreflectometers to take these measurements is time consuming and requires traffic control to protect the personnel located in the roadway while making the measurements. Mobile pavement marking retroreflectometers provide an attractive alternative for measuring retroreflectivity of significant lengths of pavement markings, as the measurements can be made from a vehicle while traveling at highway speeds. Such equipment also provides an added capability of measuring pavement marking retroreflectivity for purposes such as asset management and determination of end-of-service life.

The operation of a mobile retroreflectometer is significantly more complicated than the operation of a portable retroreflectometer. There are many different factors – such as mechanical equipment, operator, and software – that can affect the accuracy of mobile retroreflectivity measurements. Furthermore, it can be challenging to assess the accuracy of mobile measurements. To increase confidence in the accuracy of mobile measurements, TxDOT established this certification program.

OVERVIEW

The basic concept of the certification program is to provide a quantitative basis for evaluating the ability of a contractor to accurately measure the retroreflectivity of long-line pavement markings. A contractor that wishes to be certified would send the personnel and equipment to the TTI certification course. The course consists of numerous pavement markings of various colors, patterns, and retroreflectivity levels. Figure 1 presents a photo of a portion of the course. The contractor would measure a selection of lines as directed by TTI officials and provide the measurement results to TTI officials. TTI will evaluate the measurement values and determine whether the contractor should be certified.

If a contractor meets the certification requirements, the contractor will be eligible to bid on mobile retroreflectivity measurement contracts. If the contractor does not meet the certification requirements, the contractor can attempt to become certified at a later date. Specific details on the certification program, evaluation of measurements, and certification credentials are provided in later portions of this guide.



Figure 1. Portion of TTI Certification Course.

CERTIFICATION COURSE

The pavement marking retroreflectivity certification course is located in and around Texas A&M University property near College Station, Texas. Most of the certification course is at a location that is closed to traffic and it is not accessible to the public. There are over 35 pavement markings on the closed course and the markings vary in length from 0.4 to 0.5 mile. There are white and yellow lines in various marking patterns – single broken line, double solid line, double solid/broken line, and single broken line. For each color and pattern combination, there are several lines at different retroreflectivity levels. The certification course may also include pavement markings located on public roads in the College Station area.

The contractor will not be permitted to measure the retroreflectivity of any of the markings in the certification course prior to the official measurement runs conducted with the equipment being submitted for certification. No measurements of the course markings will be permitted with portable retroreflectometers. The official retroreflectivity level for each pavement marking line is established by TTI personnel in advance of the certification effort using properly calibrated portable retroreflectometers. The official retroreflectivity values for a certification trial will be established no more than 30 days before the scheduled date of the certification trial.

In establishing the initial official values, TTI will measure marking retroreflectivity at distances not greater than 25 feet on solid lines and twice on each stripe on a broken line. For subsequent certification trials, TTI will confirm the accuracy of the official retroreflectivity values by taking spot measurements of the markings on the course to ensure that the official retroreflectivity values have not changed.

CERTIFICATES

Upon the successful completion of the certification program, certificates will be provided to the driver, operator (if separate personnel function as driver and operator), and retroreflectometer unit (which identifies the unit, the specific version of software that can be used with the retroreflectometer unit, and the vehicle that the equipment is mounted to). Each of these

certificates is specific to the person or equipment identified and is not transferable. Certificates will be valid for a period of one to two years, as indicated on the certificate. The retroreflectometer certificate will identify the components of the retroreflectometer (instrument, vehicle, and software version) by serial number. The operator and driver certificates will identify the individuals by name and driver license (state and number). The operator and driver certificates will indicate the type of mobile retroreflectometer that the individuals obtained certification for, but will not indicate the specific unit (serial number) associated with the certification. Chapter 4 identifies the requirements for obtaining certification.

Obtaining certification does not limit TxDOT's ability to require a contractor to measure or otherwise provide data as part of a retroreflectivity measurement contract, even though those data were not included as part of the TTI certification program.

PROCEDURAL STEPS

The certification procedure consists of several steps, which are described in separate chapters of this guide. The steps are:

- Registration (Chapter 2)
- Certification Trial (Chapter 3)
- Measurement Evaluation and Results (Chapter 4)

DEFINITIONS

The following definitions are used within this guide and/or as part of the certification program:

- Calibration Sample – A pavement marking or other material sample that is used to calibrate a portable or mobile retroreflectometer. The calibration sample may be provided by the retroreflectometer manufacturer or through another source.
- Certification Run – The process of measuring the retroreflectivity values for a specific single or double line marking on the certification course.
- Certification Trial – The activities executed at the certification course that are associated with an attempt to become certified. A certification trial consists of numerous certification runs plus additional activities.
- Line – An individual line that is all or part of a pavement marking. A double yellow marking consists of two lines, while a yellow centerline consists of one line.
- Marking – A pavement marking that consists of one or two individual lines.
- Mobile Retroreflectometer – A system that measures the retroreflectivity of long-line (parallel to travel direction) pavement markings while traveling at normal roadway speeds. A mobile retroreflectometer typically consists of a vehicle, an instrument that can be attached to either side of the vehicle, a computer that controls and processes the retroreflectivity data, software that processes the raw data, and any supporting equipment required to measure marking retroreflectivity. While measuring retroreflectivity with a mobile retroreflectometer, operating personnel remain in a vehicle.

- Mobile Retroreflectometer Driver – The person that is responsible for driving the mobile retroreflectometer vehicle during measurement operations.
- Mobile Retroreflectometer Operator – The person that is responsible for operating the supporting equipment (such as computers) while making retroreflectivity measurements. The operator may also drive the vehicle while operating the retroreflectometer.
- Official Retroreflectivity Values – The official retroreflectivity values for the markings on the certification course will be established by TTI using a portable retroreflectometer that measures retroreflectivity 30-meter geometry according to ASTM E1710 and that has been calibrated according to the manufacturer’s guidelines.
- Portable Retroreflectometer – A portable instrument that measures pavement marking retroreflectivity by placing the instrument on the marking. The instrument must be moved by the operator to measure retroreflectivity at a different location.
- Portable Retroreflectometer Operator – The person or persons that are responsible for placing and operating the portable retroreflectometer and recording the retroreflectivity measurements.
- Program Coordinator – The TTI person that is responsible for managing the certification program. This person will serve as the official contact person for the program.

CHAPTER 2: REGISTRATION

Any contractor that wishes to participate in the certification program must register in advance. To complete the registration process, the contractor submits the necessary forms and fees, and develops a testing schedule through the Program Coordinator. The forms for registration are provided in the Appendix. The forms should be completed and mailed or emailed with the reservation fee to the Program Coordinator. This fee is non-refundable unless canceled more than 21 days in advance of the scheduled certification date, and is partially refundable if canceled more than 21 days in advance. The fee covers the cost associated with submitting one retroreflectometer and one driver/operator combination for certification. Additional retroreflectometers and personnel may also be submitted for certification for an additional fee.

REGISTRATION FEE

Upon receipt of the registration fee, the Program Coordinator will contact the contractor to schedule a date for the certification trial and determine the number of retroreflectometers and personnel that will be submitted for certification. All fees are designed to cover the costs associated with preparing and maintaining the test course, establishing testing dates, coordinating testing personnel, and conducting the certification trial. The certification program fees are listed in Table 1 and the refund schedule is listed in Table 2. The test course is generally available year-round, but the ability to schedule a certification trial on a specific date is dependent upon course and testing personnel availability.

Table 1. Registration Fees.

Fee Description	Fee
Reservation fee for one retroreflectometer, one operator/driver combination	\$6000
Additional retroreflectometer, operator, and driver (on the same day)	\$2500
Additional operator/driver combination on the same retroreflectometer on the same day	\$1000

Table 2. Refund Schedule.

Days before scheduled certification evaluation	Refund
Great than 21 days	90%
21 days or less	None

REGISTRATION SCHEDULE

In preparing a schedule, the Program Coordinator works with the contractor to identify a primary date and an alternate date. The alternate date serves as a backup in case inclement weather or other conditions prevent the certification trial on the primary date.

To the extent practical, the Program Coordinator will try to coordinate certification trials of individual contractors that request certification near the same time period. If the schedules can be coordinated so trials occur close to one another, there may be a reduction in the certification fees.

CONTACT INFORMATION

The contact information for the certification program is provided below:

Program Coordinator
Mobile Retroreflector Certification Program
Texas Transportation Institute
The Texas A&M University System
TAMU 3135
College Station, TX 77843-3135
Phone: 979-845-6004
Fax: 979-845-6006

CHAPTER 3: CERTIFICATION TRIAL

The data collection aspect of the certification trial is intended to be a one-day effort to generate data that serve as the basis for determining whether the retroreflectometer and driver/operator combination submitted for certification are qualified to measure pavement marking retroreflectivity using a mobile retroreflectometer. The certification trial consists of the following activities:

- equipment and personnel identification,
- retroreflectivity measurement trial, and
- data submission.

EQUIPMENT AND PERSONNEL IDENTIFICATION

The identification step records identifying information about the driver/operator personnel, retroreflectometer instrument, vehicle, computer, software and other equipment; ensures that the retroreflectometer provides the minimum features required to obtain certification; and documents any additional features provided by the retroreflectometer. The retroreflectometer is expected to produce 30-meter retroreflectivity readings.

Driver and Operator Identifying Information

The Program Coordinator will collect the following information about the driver/operator or driver and operator:

- photocopy of driver license information that identifies the state of issue, license number, type of license, name, address, and birth date;
- photo of the person from the shoulder up (similar to a driver license photo);
- previous experience (number of years and type of equipment) driving and/or operating mobile retroreflectometers; and
- pavement marking application and/or retroreflectivity measurement training.

Retroreflectometer Identifying Information

The retroreflectometer operator and driver will identify to the Program Coordinator (or designated representative) the various components of the mobile retroreflectometer and provide access to identifying information for each of the components. Table 3 provides examples of the information that will be identified as part of the certification program.

Table 3. Example of Retroreflectometer Identifying Information.

- Vehicle manufacturer, model, year, serial number, and license plate number.
- Instrument type, manufacturer, and serial number.
- Software being used and version number.
- Computer manufacturer and serial number.

Retroreflectometer Features

The retroreflectometer operator and driver will identify and demonstrate to the Program Coordinator (or designated representative) the features available on the mobile retroreflectometer being submitted for evaluation. This portion of the evaluation includes features required by TxDOT in the statewide special specification for mobile retroreflectivity data collection and additional features beyond the minimum required. Table 4 provides examples of the features that may be identified.

Table 4. Example of Required Retroreflectometer Features.

<ul style="list-style-type: none">• Measures pavement marking retroreflectivity using the International Commission on Illumination (CIE) 30-meter geometry.• Ability to mount the instrument on both the left and right side of the vehicle (but not at the same time).• Ability to create video of markings being measured with measurement values on video.• Ability to provide global positioning system (GPS) coordinates for aggregated marking retroreflectivity data.

RETROREFLECTIVITY MEASUREMENT TRIAL

The contractor shall measure the retroreflectivity of a sample of pavement markings on the TTI certification course as directed by the Program Coordinator. Pavement markings shall be measured at a speed of no less than 45 mph. A single certification trial shall consist of no less than 11 certification runs as indicated in Table 5 and may include more as directed by the Program Coordinator. Some certification runs may be conducted on a public road. A single certification trial is required to qualify a mobile retroreflectometer and driver/operator combination. A separate trial shall be required for each mobile retroreflectometer or driver/operator combination submitted for certification. A representative of the Program Coordinator shall ride in the retroreflectometer vehicle during all certification runs.

Table 5. Closed-Course Runs Included in a Typical Certification Trial.

Color	Pattern	Minimum Number of Runs
Yellow	Single Broken	2
	Single Solid	2
	Double Solid	2
	Double Broken/Solid	1
White	Single Broken	2
	Single Solid	2
Repeatability	Variable	3-6

As part of the certification program, the contractor will be required to measure some of the markings multiple times. These measurements will be used to assess repeatability.

For a two-person team, each person may be qualified as both operator and driver by exchanging positions halfway through a certification trial. If this option is selected, the certification evaluation will be based on all data collected for the trial. Accordingly, if the operator and driver choose to exchange positions halfway through the trial, they will both be qualified for both positions or both fail to be qualified for either position. It will not be possible for individuals who exchange positions during a trial to be qualified in one position and not qualified in the other position.

DATA SUBMISSION

During each measurement run, the contractor shall be required to make separate retroreflectivity measurements of each line in the marking. The retroreflectivity values shall be aggregated in 0.05 mile intervals and provided to the Program Coordinator at the conclusion of the certification trial. Data should be submitted in both electronic format and hard copy. All retroreflectivity measurements shall be in units of millicandelas per meter squared per lux (mcd/m²/lux). The contractor shall also provide the following data in support of the retroreflectivity measurements:

- video of markings being measured with measured retroreflectivity values superimposed over the video or otherwise presented on the same screen or in combination with the video – video may be submitted in VHS or DVD format;
- global positioning system coordinates of the aggregated retroreflectivity measurements and what position (beginning, middle, end) of the aggregated data the GPS coordinates represent;
- equipment operating temperature readings; and
- speed of the testing vehicle during aggregate data measurements.

Once the contractor has submitted all required data, the certification trial is complete and the contractor shall leave the certification course unless additional equipment or personnel are also being qualified.

MULTIPLE OR REPEAT CERTIFICATION TRIALS

If a contractor wishes to conduct multiple certification trials (to qualify additional equipment or personnel or to repeat a certification trial due to a failure to qualify on a previous attempt), the certification runs shall consist of a different sample of pavement markings than were included in a previous certification trial.

CHAPTER 4: MEASUREMENT EVALUATION AND RESULTS

At the conclusion of each certification trial, the contractor shall provide to the Program Coordinator the retroreflectivity measurements and other data as identified in the previous chapter. The Program Coordinator and/or selected TTI staff will then analyze the data to determine if the equipment and personnel submitted by the contractor have met the requirements to be certified for mobile retroreflectivity measurements.

CERTIFICATION REQUIREMENTS

To receive certificates, the driver and operator or driver/operator, plus the mobile retroreflectometer, shall meet the requirements indicated below:

- The data submitted by the contractor shall include all required information (0.05 mile aggregate retroreflectivity values, GPS coordinates, video with superimposed information, temperature measurements, and vehicle speed data).
- For each marking on the course, no more than one of the 0.05 mile aggregate retroreflectivity values shall be more than ± 15 percent different from the official 30-meter retroreflectivity value for the marking as determined by the Program Coordinator. Where multiple retroreflectivity measurements were made on a line, all retroreflectivity values shall meet the ± 15 percent criteria.
- The driver and operator or driver/operator shall possess a valid driver license from a state in the United States and make it available to the Program Coordinator for inspection.

RESULT NOTIFICATION

Within 21 days of the certification trial, the Program Coordinator shall inform the contractor of the results of the certification trial. Notification shall occur by email, U.S. mail, or fax as selected by the contractor. The notification shall indicate whether the contractor's equipment and personnel passed or did not pass the certification requirements. If the equipment and personnel were certified, the following permanent certificates will be mailed to the contractor within two weeks of the notification date:

- An equipment certificate that indicates the serial number of the retroreflectometer unit, the serial number and license plate of the vehicle, the serial number and model of computer, and the version number of the software.
- Personnel certificates for the driver and operator (or driver/operator) that indicate the name, driver license number, and date of birth of the certified person. The certificate will indicate whether it is for a driver, operator, or driver/operator, and will include a photo of the person.

Each permanent certificate shall be valid for one year from the date of notification. The Program Coordinator will provide temporary certificates if requested by the contractor.

To maintain the integrity and confidentiality of the certification course, the notice of passing or failing the certification trial shall not include any information about the actual performance of the contractor during the certification trial beyond that of a pass or fail result. The Program Coordinator shall not provide a numerical result that indicates the extent to which the contractor passed or failed the requirements.

Once a retroreflectometer is certified, the certification shall remain in effect until the expiration date of the certificate as long as the equipment is not modified. A mobile retroreflectometer that possesses a valid certificate may be used to qualify additional operators and/or drivers. If such a trial results in a failure to qualify, the failure applies only to the personnel and shall not result in the premature cancellation of the retroreflectometer's certification. Likewise, an operator's or driver's certification shall not be prematurely canceled if the operator and/or driver attempt to qualify a new mobile retroreflectometer and fail to do so. In this case, the failure to qualify applies only to the equipment.

SUBSEQUENT CERTIFICATION ATTEMPTS

If a contractor fails to qualify for certification, the contractor may register for another certification trial. A subsequent certification trial is identical to the initial certification trial, including the required fees, except that a different sample of markings will be measured and there may be a minimum time period between subsequent certification trials. Table 6 indicates the time between successive recertification trials.

Table 6. Waiting Periods between Recertification Trials.

Type of Trial	Scheduling Limitations
First certification trial	None
Second certification trial (failure during initial certification trial)	None
Third certification trial (failure during second certification trial)	No sooner than 30 days after first certification trial
Fourth certification trial (failure during third certification trial)	No sooner than 60 days after second certification trial
Fifth and subsequent certification trials (failure during previous certification trial)	No sooner than 90 days after previous certification trial

APPENDIX: REGISTRATION FORM

To register, the contractor should complete the registration form and send it to TTI using the contact information on page 6. TTI will acknowledge receipt of the registration form within two days of receipt and contact the contractor to begin scheduling the certification. An electronic version of the registration form is available from the Program Coordinator.

Company information	Name	
	Representative	
	Address	
	City, State Zip	
	Phone	
	Fax	
	Email	
	Web site (if applicable)	
Vehicle information	Manufacturer, year and model	
	Vehicle identification number	
	License plate number and expiration date	
Retroreflectometer information	Manufacturer	
	Model number	
	Serial number	

Registration form (continued)

Computer and software information	Computer manufacturer and model number	
	Computer serial number	
	Computer software name and version number	
Personnel information	Operator's (or driver/operator) name	
	Operator's driver license number and state	
	Driver's name (if using two-person crew)	
	Driver's driver license number and state	
Scheduling information	Person responsible for scheduling	
	Preferred contact information	
	Preferred certification dates	
Additional comments or information		