

**The Texas A&M Transportation Institute
Mobile Retroreflector Certification Program**

**Program Conducted by the
Texas A&M Transportation Institute**



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



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CHAPTER 1: INTRODUCTION

This document describes a program to evaluate the qualifications of providers that want to work on 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 A&M Transportation Institute (TTI) through an implementation project sponsored by TxDOT and the Federal Highway Administration. Oversight for the program is currently provided by TxDOT's Materials and Tests Division (MTD). The certification program assesses the capabilities of both provider personnel and equipment. The certification program does not endorse specific equipment or data collection techniques. It is the responsibility of the operator/provider to use the proper equipment and follow all applicable laws during the certification trial and while collecting mobile pavement marking retroreflectivity data. This document is divided into five sections: Introduction, Registration, Certification Trial, Certification Evaluation and Results, and Field Verification Evaluations and Results.

BACKGROUND

In the late 1990s, TxDOT began implementing pavement marking specifications that require retroreflectivity measurements prior to acceptance. Using portable (handheld) 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 provider to accurately measure the retroreflectivity of long-line pavement markings. A provider that wishes to be certified would send the personnel and equipment to TTI for the certification test. The test is conducted on a closed course test area and/or on open road test areas. The closed course test area consists of numerous pavement markings of various colors, patterns, and retroreflectivity levels. Figure 1 presents a photo of a portion of the closed course test area. The provider would measure a selection of pavement markings as directed by TTI officials and provide the measurement results to the TTI officials. TTI will evaluate the measurement values and determine whether the provider should be certified.

If a provider meets the certification requirements, the provider will be eligible to work on TxDOT contracts that use mobile retroreflectivity measurements. If the provider does not meet the certification requirements, the provider can attempt to become certified at a later date. Specific details on the certification registration and testing, certification results, and field verification testing are provided in later portions of this document.



Figure 1. Portion of TTI Certification Closed Course Test Area.

CERTIFICATION COURSE

The pavement marking retroreflectivity certification course is located on and around the Texas A&M University System RELIS Campus near Bryan and College Station, Texas. Some of the certification course is at a location that is closed to traffic and not accessible to the public. There are numerous pavement markings on the closed course. There are white and yellow lines in various marking patterns—single solid 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. Pavement marking types on the certification course include thermoplastic, waterborne paint, epoxy, and preformed tape. The pavement marking width of each line is between 4 and 6 inches. The certification course also includes pavement markings located on public roads in the Bryan, TX, area.

The provider will not be permitted to measure the retroreflectivity of any of the markings in the certification trial prior to the official measurement runs conducted with the equipment being submitted for certification. No measurements of the certification trial markings will be permitted with portable retroreflectometers (some measurements will be permitted for calibration purposes). The official retroreflectivity level for each pavement marking line is established by TTI personnel prior to or after the certification test using properly calibrated portable retroreflectometers. The official retroreflectivity values for a certification trial will be established no more than five days before or after the scheduled date of the certification trial. The official values are typically established the day prior, the day of, or the day after the certification trial.

In establishing the official values, TTI will measure marking retroreflectivity at minimum of every 40 feet on solid lines and at least once on each stripe of a broken line. For certification trials within a short time span, 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. TTI will also evaluate the marking with their mobile retroreflectometer to verify readings.

CERTIFICATES

Upon the successful completion of the certification program, notification will be provided indicating the certified operator and equipment have been added to the list of certified operators and equipment on the certification page website. <https://groups.tti.tamu.edu/visibility/mobile-retro-certification/certified-providers/> The driver of the vehicle is not being certified, only the operator. Certification will be valid for 12 months unless revoked due to field evaluations. The certification can be extended through successful field verification evaluations conducted by TTI (see Chapter 5). If the provider has shown the ability to provide accurate data on TxDOT contracts through TTI field verification evaluations, an extension on the certification will be given. These extensions may go on indefinitely. The certified providers list will identify the retroreflectometer type, retroreflectometer serial number, and the name of the certified operator. Chapter 4 and Chapter 5 identify the requirements for obtaining and maintaining certification.

Obtaining certification does not limit TxDOT's ability to require a provider 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 document. The steps are:

- Registration (Chapter 2).
- Certification Trial (Chapter 3).
- Certification Evaluation (Chapter 4).
- Field Verification Evaluations (Chapter 5).

DEFINITIONS

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

- 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.
- Certification Course – The closed course and open road areas where the certification trial takes place.

- Field Verification Evaluations – The field verification evaluations will be conducted by TTI and will serve as the in-field monitoring portion of the certification program. The field verification evaluations will be used to extend or revoke certification. Also referred to as a verification evaluation.
- Line – An individual line that is all or part of a pavement marking. A double yellow marking consists of two lines, while a white edge line 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. In some operations, the operator may also be the driver.
- 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 at the standard 30-meter geometry according to ASTM E1710 and that has been calibrated according to the manufacturer's guidelines. Official retroreflectivity values for the field verification evaluations will be established by TTI using a combination of portable and mobile retroreflectometers.
- 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. A portable retroreflectometer is often referred to as a handheld retroreflectometer.
- 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 provider that wishes to participate in the certification program must register in advance. To complete the registration process, the provider submits the necessary forms and develops a testing schedule through the Program Coordinator. The registration form is provided in the Appendix. The form should be completed and emailed to the Program Coordinator at least one week prior to the certification trial.

CERTIFICATION FEES

Table 1 outlines the certification fees. All fees are designed to cover the costs associated with preparing and maintaining the test course and certification equipment, establishing testing dates, coordinating testing personnel, conducting the certification trial, analyzing the data, and maintaining the certification website. The fee for a full certification trial covers one operator and one mobile retroreflectometer. Additional operators or mobile retroreflectometers can also be tested for an additional fee. If a full certification trial is failed, the fee for subsequent certification attempts is reduced. The certification trial and subsequent field comparison trials are described in the next two chapters.

Table 1. Certification Fees.

Fee Description	Fee
Full certification trial fee for one retroreflectometer and one operator	\$4000
Full certification trial fee for a currently certified operator on a new retroreflectometer, or a new operator on a currently certified retroreflectometer	\$2500
Additional operator or mobile retroreflectometer to be tested on the same day	\$1250
Fee for a 2 nd consecutive full certification trial (and any subsequent trials)	\$2500
Field Verification Evaluations	No Fee

REGISTRATION SCHEDULE

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. In preparing a schedule, the Program Coordinator works with the provider 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.

CONTACT INFORMATION

The contact information for the certification program is provided below:

Adam M. Pike, P.E.
Program Coordinator
Mobile Retroreflectometer Certification Program
Texas A&M Transportation Institute

Physical Address:
1111 RELIS Parkway
Bryan, TX 77807

Mailing Address:
3135 TAMU
College Station, TX 77843-3135

Phone: 979-317-2136
Email: a-pike@tti.tamu.edu
Verification Program Email: mobileretro@tamu.edu
Website: <http://tti.tamu.edu/group/visibility/mobile-retro-certification/>

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 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.
- 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 and operator:

- Previous experience (number of years and type of equipment) driving and/or operating mobile retroreflectometers.
- 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 2 provides examples of the information that will be identified as part of the certification program.

Table 2. Example of Retroreflectometer Identifying Information.

- | |
|--|
| <ul style="list-style-type: none">• 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.• Date the retroreflectometer was most recently serviced. |
|--|

Mobile Retroreflectometer Features

The mobile 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 for Pavement Markings” and any additional features beyond the minimum required. Table 3 provides examples of the features that must be identified.

Table 3. 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. • 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. • Ability to control the retroreflectometers temperature or to compensate for temperature changes. If software temperature compensation is used, testing results must be provided to validate proper compensation (Old Laserlux only). • Software that automatically compensates for changes in background retroreflectivity. • Software that automatically filters retroreflective raised pavement markers (RRPMs) from the data so they are not included in the average.

RETROREFLECTIVITY MEASUREMENT TRIAL

The provider shall measure the retroreflectivity of a sample of pavement markings on the TTI certification course as directed by the Program Coordinator. A single certification trial shall consist of no less than 12 certification runs as indicated in Table 4 and may include more as directed by the Program Coordinator. In addition to the closed-course certification runs, runs will also be conducted on public roads as indicated in Table 5. Pavement markings on the closed-course area shall be measured at a speed of approximately 35 mph unless directed to travel at a different speed and at or near the speed limit on public roads. To assess repeatability, some markings will be evaluated multiple times.

A single certification trial is required to qualify a mobile retroreflectometer and operator combination. A separate trial shall be required for each additional mobile retroreflectometer and operator combination submitted for certification. A representative of the Program Coordinator shall ride in the retroreflectometer vehicle during all certification runs. **No representatives of the provider or equipment manufacturer, other than those being certified at the time may assist in any way prior to, or during, the certification trial.**

Table 4. Closed-Course Runs Included in a Typical Certification Trial.

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

Table 5. Public Road Runs Included in a Typical Certification Trial

Road Surface	Marking Color	Minimum Number of Runs
Asphalt	White	2
	Yellow	2
Seal Coat	White	2
	Yellow	2

Calibration

Calibration of the mobile retroreflectometer may be conducted at any location that the operator sees as adequate. If requested, one line of each color on the closed-course that is not part of the certification trial will be made available to the group that is being certified. The group being certified may measure these lines as they wish. Calibration is the most important part of collecting accurate mobile pavement marking retroreflectivity data. The certification test does not evaluate the calibration because there are multiple ways to achieve a proper calibration and verify its accuracy. The certification test is most concerned with the data collected during the trial.

DATA SUBMISSION

During each certification run, the provider shall be required to make separate retroreflectivity measurements for each line being measured. The retroreflectivity values shall be aggregated in 0.05-mile intervals and provided in raw form to the Program Coordinator at the conclusion of the certification trial. Data should be submitted in electronic format. All retroreflectivity measurements shall be in units of millicandelas per meter squared per lux (mcd/m²/lux). The provider 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 must be submitted in DVD or electronic file format.
- GPS coordinates of the aggregated retroreflectivity measurements and what position (beginning, middle, end) of the aggregated data the GPS coordinates represent.
- Equipment operating temperature readings.
- Speed of the testing vehicle during aggregate data measurements.

Once the provider has submitted required data, the provider shall leave the certification course unless additional equipment or personnel are also being qualified. To comply with TxDOT Special Specification “Mobile Retroreflectivity Data Collection for Pavement Markings,” additional data are also required to be submitted. These data may be submitted at the conclusion of the certification trial or in the following weeks. Results will not be given until all required data are submitted. The additional data that are required to be submitted are data in the format that is required by Part 3 of the Special Specification. Since the certification trial is a special circumstance, all parts of the Special Specification may not be applicable; these areas are noted or specific instructions are noted below in italics:

Data file. Provide data files with the following information:

- Date.
- District number; (*TTI Certification*).
- County; (*Brazos*).
- Name of the mobile retroreflectometer operator.
- Route number with reference markers or other reference information provided by the Engineer to indicate the location of beginning and end data collection points on that roadway; (*N/A*).
- Cardinal direction; (*Required only for data collected on actual road*).
- Line type (single solid, single broken, double solid, etc.).
- Line color.
- File name corresponding to video.
- Data for each centerline listed separately.
- Average reading taken for each 0.1-mile interval or interval designated by the Engineer; (*0.05 for certification*).
- Accurate GPS coordinates (within 20 feet) for each interval.
- Color-coding for each interval indicating passing or failing, unless otherwise directed by the Engineer (Passing and failing thresholds will be provided by the Engineer); (*<175 = Red, 175–250 = Yellow, >250 = green*).
- Graphical representation of the data (y-axis showing retroreflectivity and x-axis showing intervals) corresponding with each data file.
- Distance in miles driven while measuring the pavement markings.
- Event codes (pre-approved by the Engineer) indicating problems with measurement.
- Portable retroreflectometer field check average reading and corresponding mobile average reading for that interval when applicable; (*N/A*).
- Upper validation threshold (may be included separately with the raw data but must be clearly identified with the data collected using that threshold).

Map in Electronic Format. Provide a map in an electronic format approved by the Engineer with each Mobile Retroreflectivity Data Collection (MRDC) submission that includes the following information (*Required only for data collected on actual roads*):

- Date.
- District number; (*TTI Certification*).
- County; (*Brazos*).

- Color-coded 1-mile intervals (or interval length designated by the Engineer) (*0.05-mile interval for certification*) for passing and failing retroreflectivity values or retroreflectivity threshold values provided by the Engineer; (*Code each run individually, same thresholds as above but values > 150 should be indicated with green*).
- Percentage of passing and failing intervals, if required by the Engineer. (*Failing is less than 100*).

Video. Provide a high-quality DVD or electronic video file with the following information:

- Labeled with date and corresponding data file name.
- District number.
- County.
- Route number with reference markers or other designated reference information to indicate the location of beginning and end collection points on that roadway.
- Retroreflectivity values presented on the same screen with the following information:
 - Date.
 - Location.
 - Starting and ending mileage.
 - Total miles.
 - Retroreflectivity readings.
 - Upper validation thresholds (may be included separately with the raw data).

CHAPTER 4: CERTIFICATION EVALUATION

At the conclusion of the certification trial, the provider shall provide 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 provider have met the requirements to be certified for mobile retroreflectivity measurements.

CERTIFICATION REQUIREMENTS

To receive certification, the operator and the mobile retroreflectometer shall meet the requirements indicated below:

- The raw data submitted by the provider shall include all required information (0.05-mile aggregate retroreflectivity values, GPS coordinates, video with superimposed information, temperature measurements, and vehicle speed data).
- The average retroreflectivity values shall be within ± 15 percent from the official 30-meter retroreflectivity value for the markings as determined by the Program Coordinator. No more than 20 percent of the runs can be outside of the ± 15 percent window, and the average difference for all of the runs must remain within the ± 15 percent window.
- Demonstrate the ability to control the retroreflectometers temperature or to compensate for temperature changes. If software temperature compensation is used, testing results must be provided to validate proper compensation (Old Laserlux only).
- Software that automatically compensates for changes in background retroreflectivity.
- Software that automatically filters RRPMs from the data so they are not included in the average.
- 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.
- All data requirements of TxDOT Special Specification “Mobile Retroreflectivity Data Collection for Pavement Markings” must be met with the additional data that are submitted for certification.

To maintain certification, the operator and equipment will need to meet the requirements of the field verification testing as described in Chapter 5. If certification is not maintained through field verification testing, recertification will need to be conducted.

RESULT NOTIFICATION

Within 21 days of the certification trial, the Program Coordinator shall inform the provider via email of the results of the certification trial. The notification shall indicate whether the provider’s equipment and personnel passed or did not pass the certification requirements. If the equipment and personnel were certified, they will be added to the certification webpage <https://groups.tti.tamu.edu/visibility/mobile-retro-certification/certified-providers/>.

General information about the performance of the operator and retroreflectometer will be provided to improve future data collection. The Program Coordinator shall not provide a numerical result that indicates the extent to which the provider passed or failed the requirements (at the discretion of the Program Coordinator).

Once a retroreflectometer is certified, the certification shall remain in effect unless revoked due to field evaluations, or if no field evaluations were conducted in a 12-month period. A mobile retroreflectometer that possesses a valid certificate may be used to certify additional operators. 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 retroreflectometers certification. Likewise, an operator's certification shall not be prematurely canceled if the operator attempts to qualify a new mobile retroreflectometer and equipment failure prevents certification. In this case, the failure to qualify applies only to the equipment.

SUBSEQUENT CERTIFICATION ATTEMPTS

If a provider fails to qualify for certification, the provider may register for another certification trial. A subsequent certification trial is identical to the initial certification trial, except that the fee will be reduced, a different sample of markings will be measured, and there is 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)	No sooner than 30 days after first certification trial.
Third certification trial (failure during second certification trial)	No sooner than 60 days after second certification trial.
Fourth and subsequent certification trials (failure during third certification trial)	No sooner than 90 days after previous certification trial.

CHAPTER 5: FIELD VERIFICATION EVALUATIONS

Certified providers will be subject to field verification evaluations while collecting mobile retroreflectivity data on TxDOT jobs. These field verification evaluations will be conducted on a continual basis throughout the year. If the field verification evaluation does not result in data that is within TxDOT's requirements, the trial may result in the loss of certification. TxDOT may also require that data on the project be recollected so that the resulting data are within the accuracy that TxDOT has specified. These field verification evaluations, however, may also extend the certification (possibly indefinitely) if the data are continuously within TxDOT's requirements. TxDOT's current accuracy requirements are within ± 20 percent when comparing the provider supplied data to the TTI collected verification data.

To maintain certification, the operator and equipment will need to meet the requirements of the field verification evaluations. The field verification evaluations will be conducted at no charge to the provider. The field verification evaluations are described in greater detail below.

NOTIFICATION REQUIREMENTS

There will not be specific dates scheduled for the verification evaluations. Projects to be included in the verification evaluations will be randomly selected with a goal of evaluating at least 10 percent of all TxDOT pavement marking projects that have mobile retroreflectivity requirements. Providers are required to notify the TxDOT engineer and the certification Program Coordinator of **all** mobile pavement marking retroreflectivity activities. These notifications are covered in Item 666 and the Special Specification "Mobile Retroreflectivity Data Collection for Pavement Markings." Specific details about notification requirements are provided below.

To maintain certification, the provider will need to notify the Program Coordinator of **all** mobile retroreflectivity activities. This will allow for better coordination of field verification activities to provide verification data that are collected in as close of a time frame to the provider's data as possible.

Failure to provide the required notifications may result in the loss of certification for the provider.

Information pertaining to notifications and data submission are below:

- **Required Notification:** Notification to TTI at Mobileretro@tamu.edu with the required information at least 24 hours in advance of any mobile retroreflectivity measurements.
- **Notification of Any Schedule Changes:** Notification to TTI at Mobileretro@tamu.edu immediately if the schedule changes due to weather, equipment problems, or other factors and provide the re-scheduled date as soon as available.
- **Required Notification Information:** Submit the following information with each notification:
 - Mobile Retroreflectometer Provider contact name and phone number.
 - TxDOT Project Number (CSJ # when applicable).
 - Roadways and project limits to be measured.
 - Scheduled data collection date(s).

Scans or photos of project plan pages with the required information are acceptable.

- **Required Data Submission:** Submit mobile retroreflectivity summary data file in Excel format and map file for all measurements taken to TTI at Mobileretro@tamu.edu within three days of data collection.

FIELD MOBILE RETROREFLECTIVITY VERIFICATION EVALUATION

The provider will not be required to perform any field activities that are outside of those required for the contract they are working on. The provider will not need to schedule time to meet with TTI, nor will the provider be required to perform mobile retroreflectivity readings at any specific dates or times. The field verification evaluations should be of no impact to the field operations of the provider.

The Program Coordinator will randomly select projects to be included in the field verification evaluations. The goal will be to evaluate each provider multiple times a year. Providers doing more work are likely to be evaluated more frequently. Provider who have not had work and thus no field evaluations within a year may need to return to TTI for recertification, or a field certification trial may be performed to maintain certification (at the discretion of the Program Coordinator).

A field verification evaluation may consist of evaluating markings on a single roadway on a single project, evaluating markings on multiple roadways on a single project, or evaluating markings on multiple roadways on multiple projects. There is no set requirement for the quantity of markings on a project or the number of projects to be evaluated during a single field verification evaluation.

Determination of Locations

The Program Coordinator will use the provider submitted notification information to determine which projects will be evaluated. Projects will be randomly selected, but the selection will be stratified to ensure each provider and area of the state is represented in the verification program. Specific locations of evaluations will not be known to the providers until after the analysis of the data has been complete. If there is an issue with receiving the data from the provider or some other delay, the Program Coordinator may contact the provider for further information.

Data Collection

The provider will not be required to perform any field activities that are outside of those required for the contract they are working on. All data collected by the provider will be collected and submitted just as they are being collected and submitted as part of the TxDOT contract.

The TTI data collection team will use their mobile retroreflectometers to evaluate some of the same roadway sections as the provider. The TTI data collection team will also evaluate the sections (to the extent possible) with a portable retroreflectometer. A minimum of 20 portable retroreflectometer readings spread out over the length of an individual mobile interval will be collected at select evaluation sections (i.e., if mobile data are being collected in 0.1-mile intervals, the handheld comparison would be over a length of 0.1 miles). This would represent the minimum length and minimum number of readings for a portable retroreflectometer comparison

section. Spot readings using the portable retroreflectometer to ensure accuracy of mobile readings may be taken at various locations. These locations do not have a defined length or minimum number of required readings. The portable retroreflectivity measurements will be used to supplement the mobile data collected by TTI. TTI will conduct multiple trials with their mobile retroreflectometer at some locations and continually monitor the accuracy of their mobile system with comparisons to their portable retroreflectometer.

Data Submission

Providers are required to submit all summary data files and map files to TTI. TTI does not require the video data to be submitted to the verification program, but it is a requirement of the Special Specification and needs to be collected. The Special Specification for “Mobile Retroreflectivity Data Collection for Pavement Markings” requires data to be submitted to TxDOT within three days of the evaluation. This same three-day window applies to the submission of the data to TTI. Ideally when data are submitted to TxDOT, TTI would be copied on the email. It is acceptable to separately email TTI the data. TTI will analyze the data submitted for roadways where the field verification evaluations took place.

FIELD VERIFICATION EVALUATION ACCURACY REQUIREMENTS

An individual field verification evaluation will be conducted on multiple pavement markings that may be part of multiple projects that the provider is evaluating. No more than 20 percent of the markings evaluated can fall outside the ± 20 percent accuracy range, and the average of all the verification evaluations must be within ± 20 percent. If these accuracy criteria are not met, the provider will fail the field verification evaluation. The providers’ data and equipment must meet all requirements of the full certification evaluation and the requirements of Special Specification for “Mobile Retroreflectivity Data Collection for Pavement Markings.”

RESULTS NOTIFICATION

Within three working days of receiving the providers’ data, the Program Coordinator shall inform the provider via email of the results of the field verification evaluation (if the project was selected for a field verification evaluation). The notification shall indicate whether the provider’s equipment and personnel passed or did not pass the verification requirements. If the equipment and personnel passed, the provider will maintain their certification. Certification can be maintained indefinitely by continually passing the field verification evaluations. General information about the field verification evaluation results will be provided to improve future data collection. If the provider fails the verification evaluation, additional actions will need to be taken by the provider to maintain certification. The next section describes the required actions for providers if they fail a field verification evaluation.

REQUIRED PROVIDER ACTIONS AND STEPS TOWARD LOSS OF CERTIFICATION

A committee comprised of one representative each from the Materials and Tests Division (MTD), the Traffic Safety Division (TSD) and the TTI Mobile Retroreflectometer Certification Program will review the actions which may result in a loss of certification. Maintaining certification is based on accuracy of field checks and proper notification by the provider of upcoming work.

Requirements for notifications and accuracy of data are provided within this document. The following section outlines actions that will result in the loss of provider certification.

The first time it is determined by the certification review committee that proper notification was not provided as required the provider will receive a warning. The second time it is determined by the certification review committee that proper notification was not provided as required the provider's certification will be suspended until notification compliance is met. The third time it is determined by the certification review committee that proper notification was not provided as required, the provider's certification will be suspended, and recertification will be required. The notification requirements are on a rolling one year basis.

A single failure of a field verification evaluation will not result in the loss of certification. If two or three consecutive field verification evaluations are failed, certification will be revoked. A multistep process that is based on the quality of the data collected will be used to determine the status of the mobile retroreflectivity provider.

A field verification evaluation with data exceeding the ± 20 percent accuracy requirements, but below 35 percent different will result in one strike toward certification loss. A field verification evaluation with data exceeding ± 35 percent difference will result in two strikes toward certification loss. A successful field verification evaluation will result in losing one strike.

Keep in mind that data that exceed 35 percent difference will result in two strikes. This means that if the provider previously had one strike, that they would then lose certification. The goal of the three-strike system is to increase the quality of the data collected by providers by reducing the quantity of poor data collection, while providing incentive to conduct high quality data collection. A basic outline of the requirements for each strike is listed below:

- **Strike 1:** After the first failed field verification evaluation, the provider must review the mobile retroreflectivity measurement data, measurement procedures, and equipment to identify any possible causes for the difference in measurements and provide the information to TTI prior to taking further measurements. Take corrective actions if needed and provide documentation of corrective actions taken to TTI. A list of possible causes of error and possible corrective actions is provided later in this chapter.
- **Strike 2:** After a second consecutive failed field verification evaluation, the provider's certification will be put on probationary status. Probationary status indicates that certification will be revoked if the next field verification evaluation is failed. The requirements of Strike 1 shall be repeated for Strike 2.
- **Strike 3:** After a third consecutive failure with data between 20 and 35 percent different, or after two consecutive failures where one or both failures exceed 35 percent difference, the provider's certification will be revoked. A full re-certification at the TTI facilities will be required to regain certification after corrective actions are identified and documentation provided to TTI.

The strike status is not based on a specific operator, it is provider based. Each operator must maintain certification, but if one fails due to exceeding the allowable measurement values, in essence they all fail for verification purposes. Once Step 3 is achieved, all operators for a provider will lose their certification.

Non-Validation Actions and Corrective Actions

If the data do not validate or meet the required performance levels, several actions may need to be taken. This section will describe possible causes for non-validation and corrective actions that may need to take place.

Possible Causes

Based on experience using mobile pavement marking retroreflectivity equipment, experience managing the mobile pavement marking retroreflectivity certification program, and experience evaluating provider field data collection, researchers have developed an initial list of possible causes for non-validation data. The list covers possible causes that may or may not be something the provider can control. This list of possible causes for non-validation will be the starting point for determining why data did not validate. The list of possible sources of non-validation is provided below:

- Faulty equipment.
- Improper calibration.
- Improper operation/settings.
- Duration between provider and TTI measurements.
- Site influences (traffic, vehicle access, tracking asphalt, roadway curvature, road surface).
- Not taking readings in good weather conditions.
- Taking readings too soon after installation.
- Poor pavement marking installation.

Corrective Actions

Corrective actions will need to take place if the provider data do not validate with the TTI data and a specific reason or possible reason can be determined. Continued non-validating data by a provider will result in the loss of certification and require the provider to go back through the certification process.

If it is found that the equipment is faulty, the provider will have to stop data collection until the equipment can be serviced and repaired. Improper calibration, operation, and settings are the result of operator error. These three areas may require additional training of the operator to ensure they are not repeated in the future. If the errors continue or the magnitude is egregious, operator certification may be revoked.

Site influences and the duration between the provider and TTI readings are out of the control of the provider. TTI will attempt to collect data within a week of the provider to minimize differences caused by the length of time between the two data sets (the goal is to take measurements within three days). Influences like traffic and the weather will have a larger impact as the duration between collecting the two sets of data increases. Increased access will increase traffic crossing over the markings as will higher traffic volumes, both of which can increase the variability of the data collected. Varying road surfaces and tracked asphalt will also increase the variability of the data. These factors are outside the control of the operator and thus will try to be accounted for when conducting the analysis. Researchers may develop mixed effect

models to try and account for these outside influence factors. Roadway curvature increases the variability of the retroreflectivity data and is a more difficult situation for data collection. The curvature of the roadway is outside of the provider's control, but additional care should be taken during data collection to minimize the influence of the roadway curvature, which is part of proper equipment operation. Additional training may be required if roadway curvature is deemed as a cause of non-validation.

This type of retroreflectivity evaluation needs to take place in dry conditions with a dry road surface and no precipitation. Water on the markings or retroreflectometer can greatly decrease retroreflectivity levels. Item 666 requires providers to evaluate the markings between 3 and 10 days after installation. Readings taken too soon after installation may not be valid due to excessive beads still remaining on the marking. Readings taken beyond 10 days, if weather caused delay, should not be a problem as long as the TTI comparison measurements are taken in a similar timeframe. Both situations, taking readings in wet conditions, and taken readings too soon are provider-controlled issues. Training of the operator to better follow standard practices and observe proper data collection protocol may be required if these areas are deemed to have caused non-validation.

Poor pavement marking installation may also be a cause for non-validating retroreflectivity data. Poor installation may result in a highly variable marking or a marking that rapidly loses retroreflectivity. Either of these scenarios could result in the provider and TTI collecting non-validating data within a few days of one another. The goal of the retroreflectivity requirements are to help improve the quality of installed markings. The provider and/or TTI data may show that a poorly installed marking does not meet the required retroreflectivity levels, which would require restriping.

REFEREE TESTING

For contract purposes, the retroreflectivity level of the markings needs to exceed the minimum performance requirements as identified in TxDOT Item 666. TxDOT's Material and Tests Division (MTD) and/or the local TxDOT office will serve as the referee by performing additional testing if needed to determine if a marking meets the required retroreflectivity level. If both the provider and TTI indicate that the marking does not meet the required level, whether the data validate or not, then restriping would be necessary. If both the provider and TTI indicate that the marking meets the required level, whether the data validate or not, then the marking would be acceptable. In both scenarios, corrective actions would need to take place to improve future mobile retroreflectivity data collection by the provider if the data did not validate.

Referee testing may be required in circumstances where the provider and TTI data disagree on whether the data meet the minimum requirements or not. Referee testing will be at TxDOT's discretion. It is possible that the provider and TTI data could validate but may not agree on whether the marking is above the required performance level. In this case, it is very likely that the marking is close to the required performance level. TxDOT may choose to accept the data and not perform the referee testing. If the provider and TTI data do not validate, and do not agree on whether the marking is above the required performance level, referee testing may be needed. If the TTI data indicate the marking passes, TxDOT may choose to accept the TTI data and not perform referee testing. If the provider says it passes but TTI says it fails, TxDOT may need to

perform referee testing to make sure the marking is truly below the required level prior to requiring restriping by the provider.

APPENDIX: REGISTRATION FORM

To register, the provider 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 provider to begin scheduling the certification. An electronic version of the registration form is available from the Program Coordinator.

Provider Information	Company Name	
	Company Representative	
	Address	
	City, State Zip	
	Phone	
	Fax	
	Email	
	Website (if applicable)	
Vehicle Information	Manufacturer, year and model	
	Vehicle identification number	
	License plate number	
Mobile Retroreflectometer Information	Manufacturer	
	Model number	
	Serial number	
Handheld Retroreflectometer Information	Manufacturer	
	Model number	
	Serial number	

Registration form (continued)

Computer and Software Information	Computer manufacturer and model number	
	Computer serial number	
	Data collection software name and version number	
Personnel Information	Operator's (or driver/operator) name	
	Operator's driver license state	
	Operator's mobile/work telephone number(s)	
	Operator's email address	
	Driver's name (if using two-person crew)	
	Driver's driver license state	
Scheduling Information	Person responsible for scheduling	
	Preferred contact information	
	Preferred certification dates	
Additional Comments or Information		